AIR MODELING REPORT

Santee Cooper > Cross Generating Station

1-Hour Sulfur Dioxide NAAQS Compliance Demonstration Modeling

Prepared By:

J. Russell Bailey – Principal Consultant
Jon Hill – Managing Consultant
Allison Cole – Consultant
Andrew Kessler – Consultant

TRINITY CONSULTANTS
15 E. Salem Ave.
Suite 201
Roanoke VA 24011
540-342-5945

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1. PROJECT DESCRIPTION

1.1. PURPOSE

The Santee Cooper Cross Generating Station (Cross or CGS) is a coal-fired power station located in Berkeley County, South Carolina. Berkeley County has been designated "unclassified" with respect to its attainment status to the 1-hour sulfur dioxide (SO_2) national ambient air quality standards (NAAQS). The Cross facility has selected modeling under the SO_2 Data Requirements Rule (DRR) for establishing attainment designation of the area surrounding the Cross facility. As demonstrated in this report, the Cross station is in compliance with the 1-hour SO_2 NAAQS, with maximum impacts less than 50% of the standard.

The procedures used in this report are consistent with applicable guidance, including the February 2016 "SO_2 NAAQS Designations Modeling Technical Assistance Document" (TAD) issued in draft form by the United States Environmental Protection Agency (EPA). The procedures are consistent with the final DRR for the 2010 1-hour SO_2 primary NAAQS, which was effective September 21, 2015 (80 FR 51052, August 21, 2015).

The current version of TAD references other EPA modeling guidance documents, including the following clarification memos:

- The August 23, 2010 "Applicability of Appendix W Modeling Guidance for the 1-hour SO_2 National Ambient Air Quality Standard"; and
- The March 1, 2011 "Additional Clarification Regarding Applicability of Appendix W Modeling Guidance for the 1-hour NO_2 National Ambient Air Quality Standard" (hereafter referred to as the "additional clarification memo").

Although the additional clarification memo was written primarily for the 1-hour NO_2 NAAQS, some of the guidance provided applies to the 1-hour SO_2 NAAQS after the differences in the form of the standards are taken into account. In the additional clarification memo, EPA declares that the memo applies equally to the 1-hour SO_2 NAAQS even though it was prepared primarily for the 1-hour NO_2 NAAQS. The approach used also accounts for guidance provided by modeling staff at the South Carolina Department of Health and Environmental Control (DHEC).

Santee Cooper submitted a draft modeling protocol to DHEC on May 11, 2016 and received comments via letter dated May 20, 2016. After addressing those comments, Santee Cooper provided DHEC a final modeling protocol on June 14, 2016. EPA provided comments on the June protocol to DHEC, who in turn provided those comments to Santee Cooper on August 26, 2016. Santee Cooper addressed those comments in a revised modeling protocol sent to DHEC on November 14, 2016 and DHEC provided the updated protocol to EPA. EPA confirmed approval of the revised protocol via email to DHEC on December 8, 2016. This report follows the procedures from the approved protocol.

Note that the final modeling does not use either the LOWWIND3 setting in AERMOD or the adjusted U* setting in AERMET that were each listed as possible options in the final protocol. EPA has signed approval of the adjusted U* setting since approval of the final Cross protocol, as well as published an updated AERMOD version 16216. The revised rule is effective 30 days after publication in the Federal Register (which has not occurred at the time of this report), which means that the new rule will not be effective at the time this report is due (January 13, 2017). This final modeling report for Cross is completed using the currently effective modeling requirements as in the protocol approved by EPA and does not use the newly signed rule.

1.2. FACILITY DESCRIPTION

The Cross facility consists of four (4) dry bottom utility steam boilers (Units 1, 2, 3, and 4) fired on bituminous coal; the boilers can also combust coal blended with petcoke (up to 30% petcoke, by weight). For operational purposes, No. 2 fuel oil firing is required for short periods during startups, shutdowns, and significant boiler load changes. No. 2 fuel oil is not fired for the purpose of steam generation and accounts for less than 0.5% of the total annual heat input.[1] Units 1 and 2 each have a nominal heat input capacity of 5,200 million British thermal units per hour (MMBtu/hr) and Units 3 and 4 each have a nominal long-term heat input capacity of 5,400 MMBtu/hr. Each boiler is equipped with an electrostatic precipitator (ESP) for PM emissions control, a wet scrubber for SO_2 emissions control, and a selective catalytic reduction (SCR) system for oxides of nitrogen (NO_X) control. Commercial operation dates for the four units are 1995 (Unit 1), 1983 (Unit 2), 2007 (Unit 3), and 2008 (Unit 4).

In addition, the Cross facility has a number of stationary diesel and propane engines onsite that are considered intermittent emissions sources. Consistent with guidance provided in the additional clarification memo, intermittent emissions sources are not included in the modeling because they do not operate continuously or frequently enough to significantly contribute to the annual distribution of daily maximum 1-hour SO_2 concentrations. Actual operating hours for 2015 (a representative year) are 26 for the emergency generators assigned to each boiler, 43 for the emergency fire pump engines, and 61 for the guard house generator. The guard house generator is propane-fired, while the remainder are fired on ultra low sulfur diesel oil.

Coal handling, limestone handling, gypsum handling, pet coke handling, cooling towers, boiler feed water treatment, cooling tower water treatment, unpaved and paved haul road traffic, and material stockpiles are also present at the Cross facility. These sources do not emit SO_2 and as such, are not included in this analysis.

1.3. LOCATION

The Cross facility is located between Lake Marion and Lake Moultrie, off South Carolina Highway 45, southwest of Pineville, South Carolina. Figure A-1, in Appendix A, shows the area around the Cross facility, with the approximate center of the facility at 582,700 meters (m) Easting and 3,693,000 m Northing in Universal Transverse Mercator [UTM] Zone 17, Northern Hemisphere, North American Datum 1983 (NAD83).

The Cross facility is located on the diversion canal that connects Lake Marion and Lake Moultrie. The facility is approximately 1 kilometer (km) from Lake Moultrie and 2 km from Lake Marion. The terrain surrounding the facility is a mixture of residential areas and woods. Figure A-2 shows the 2001 National Land Cover Data (NLCD), which is obtained from the United States Geologic Survey (USGS) seamless data server.[2] NLCD data are entered into AERSURFACE to determine appropriate surface characteristics for AERMET.

Source, building, and receptor elevations input to the model are based on interpolation from the United States Geological Survey's 1/3 arc-second National Elevation Dataset (NED). The NED consists of arrays of regularly spaced elevations at 10 m intervals. Elevation values assigned to model objects are interpolated using AERMAP (version 11103).

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[1] Units 1 – 4 may also burn on-specification used oil, as defined in the Title V permit (Condition Nos. 5.E.28 and 6.B.32).

[2] http://viewer.nationalmap.gov/viewer/

1.4. NEARBY FACILITIES

The EPA Facility Registry Service (FRS) database[3] is used to help identify stationary sources of air emissions located near the Cross facility. Searches were conducted for point sources within 5 km of the Cross facility using zip codes 29468 (northeast of the canal) and 29436 (southwest of the canal). A list of the sources, categorized by type can be found in Table 1-1. Although these nearby facilities appear in the FRS database, they are not listed in EPA's ICIS-AIR database[4] and, therefore their SO_2 emissions, if any, are negligible and do not interfere with attainment or maintenance of the 1-hour NAAQS for SO_2.

Table 1-1. Nearby Facilities

Facility Name	Facility Description	Distance To Cross
Burgess Brogon Concrete	Concrete mixing facility	1.8
Cross High School	High School	3.5
South Carolina Public Service Authority	Public Service Authority	3.6
Angels Landing Café, Campground	Recreation Area	2.5
Big Oak Landing	Recreation Area	4.2
Blacks Landing	Recreation Area	2.0
Canal Lakes Resort and Hills Landing	Recreation Area	3.1
Eagles Nest Campground	Recreation Area	4.5
Johnston Landing	Recreation Area	3.9
Canal One Stop	Convenience Store	3.8
Quattlebaums	Grocery Store	4.2
Fishermans Bar and Grill	Restaurant	5.0
Lovers Lane Bar and Grill	Restaurant	4.4
Cross Trailer Parks	Trailer Parks	3.8
M&M MHP	Trailer Parks	2.7
Pine Lake MHP	Trailer Parks	4.0

[3] https://www.epa.gov/enviro/frs-query-page

[4] https://www.epa.gov/enviro/icis-air-search

2. MODEL SELECTION

The dispersion model utilized in the analysis is the currently approved version of AERMOD (version 15181). AERMOD is a refined, steady-state, multiple-source, Gaussian dispersion model. AERMOD is recommended in the EPA "Guideline on Air Quality Models" for a wide range of near-field applications in all types of terrain. AERMOD is used with regulatory defaults and is used to model all sources.

Building parameters needed by AERMOD to model potential building downwash effects are obtained using the latest version (04274) of the EPA Building Profile Input Program for PRIME (BPIPPRIME).

The EPA Guideline on Air Quality Models (Appendix W) prescribes a set of approved models for regulatory applications for a wide range of source types and dispersion environments. The modeling analysis in this report utilizes the current regulatory default options.

3. MODELING DOMAIN

The modeling domain comprises both emission sources and the receptor grid. Emissions sources modeled consist of the primary source (the Cross facility) and any nearby sources that may be expected to contribute to ambient air quality impacts. The receptor grid is designed to identify the areas of maximum ambient concentrations of SO_2 due to the Cross facility. As documented in this section, there are no nearby sources that are relevant to the analysis, and as a result the final modeling includes just the Cross facility.

3.1. SOURCES TO INCLUDE

3.1.1. Primary Sources

The modeling domain for this SO_2 attainment area designation modeling analysis focuses on the primary facility that is the subject of this modeling report, the Cross facility. A primary source is considered by the final DRR as a source having actual emissions greater than 2,000 tons per year (tpy) based on the most recent year of emissions data. The Cross facility's actual SO_2 emissions are in excess of 2,000 tpy and thus the facility requires modeling (or alternatively monitoring, which Cross is not using) to establish the attainment status of the surrounding area with respect to the 1-hour NAAQS for SO_2.

3.1.2. Nearby Sources

Applicable guidance in the TAD states that nearby sources should be included in the modeling if they are expected to cause a significant concentration gradient in the vicinity of the primary source. If the nearby sources do not cause a significant concentration gradient, they may be incorporated into the model through the background concentration.

Although some regulatory agencies have informally established minimum source emission rate thresholds below which nearby sources do not need to be explicitly included in the area designation modeling, neither EPA nor DHEC has yet done so. Therefore, a variety of considerations and technical justifications are considered to complete the process of selecting which nearby sources (if any) should be included as part of the cumulative impact analysis.

Actual emission rates and proximity to the primary source are the two factors considered when determining whether to include or exclude a potential nearby source.

3.1.2.1. Screening Area

A screening area extending 50 km from the Cross facility is used to identify other potential nearby sources for inclusion in the analysis. Sources beyond 50 km are very unlikely to cause or contribute either to a violation of the NAAQS or to a concentration gradient in the vicinity of the primary source.

3.1.2.2. Review of Possible Inventory Sources – Potential Emissions

DHEC's modeling inventory of potential emissions is the first data source for reviewing offsite sources for potential inclusion in the modeling. DHEC provided modeling files for all sources within 51 km of Cross to account for the potential for some sources to have coordinates based on NAD27 while others (including all coordinates for Cross in this assessment) are based on NAD83. The modeling files list potential emissions for each source. For each facility, emissions are summed to arrive at a facility-wide tpy value.

Consideration of both the proximity and the emission rate data are needed to assess whether these potential sources need to be included in the modeled sources along with Cross. The initial step of consideration is the 20D methodology, which is a specific variant of the Q/d screening method used in other modeling analyses, such as Air Quality Related Values (AQRV).

The purpose of the 20D method is to assist in objectively deciding which sources to include in the cumulative impact analysis. The 20D method allows for potential nearby sources to be excluded if their facility-wide emission rates, in tpy, are less than 20D, where D is the distance between the candidate source and the primary source. In this first level screening review, potential emissions from the DHEC modeling inventory are used in the 20D analysis, with the results shown in Table 3-1.

Ten facilities remain after consideration of the 20D methodology based on potential emissions; these sources can be seen in Figure A-3 and undergo further review as seen in Table 3-2.

Table 3-1. Potential SO_2 20D Analysis for Possible Inventory Sources within 50 km of Cross

Facility Name	Permit No.	County	UTM X (m)	UTM Y (m)	Potential Emissions (tpy)	Distance (km)	20-D (km)	Potential SO2 / 20-D (%)	Exclude from Inventory?
Chargeurs Wool USA	0420-0001	Berkeley	622,554	3,684,017	41.0	41.0	820	5%	exclude
Santee Cooper - Jefferies	0420-0003	Berkeley	594,354	3,678,588	10,965.8	18.5	369	2968%	no
SCE&G Williams	0420-0006	Berkeley	600,207	3,653,687	17,743.2	42.9	858	2069%	no
Albany Int'l-Press Fabrics	0420-0009	Berkeley	599,931	3,697,858	191.4	18.2	364	53%	exclude
E.I.Dupont	0420-0011	Berkeley	598,835	3,658,846	66.9	37.6	753	9%	exclude
Joint Base Charleston-Weapons	0420-0014	Berkeley	596,268	3,649,529	19.7	45.4	907	2%	exclude
Alcoa - Mt. Holly [Century Aluminum]	0420-0015	Berkeley	588,314	3,657,269	4,090.1	35.9	719	569%	no
C. R. BARD	0420-0017	Berkeley	594,681	3,678,870	2.9	18.5	369	1%	exclude
BP-Amoco Cooper River	0420-0029	Berkeley	604,466	3,648,893	2,416.2	49.0	981	246%	no
JW ALUMINUM	0420-0033	Berkeley	588,718	3,654,998	111.9	38.2	765	15%	exclude
SC Pipeline Corp.	0420-0048	Berkeley	599,591	3,654,203	0.2	42.2	843	0%	exclude
Berkeley Co. Water & Sanitation Authority	0420-0059	Berkeley	590,361	3,665,052	24.6	28.8	576	4%	exclude
Nucor Steel	0420-0060	Berkeley	604,344	3,652,411	613.1	45.9	917	67%	exclude
Air Liquide Large	0420-0064	Berkeley	605,076	3,652,546	0.2	46.1	922	0%	exclude
AAI Corporatioin	0420-0071	Berkeley	585,250	3,654,400	0.1	38.4	769	0%	exclude
Hanahan Water Treatment	0420-0072	Berkeley	591,939	3,643,463	123.0	50.2	1003	12%	exclude
DAK Americas LLC	0420-0089	Berkeley	598,854	3,658,134	4,241.4	38.3	766	554%	no
McAllister Smith Funeral Home Goose Creek	0420-0107	Berkeley	586,370	3,656,350	0.8	36.6	732	0%	exclude
Santee Cooper Berkeley County LFGTE	0420-0112	Berkeley	590,538	3,665,146	0.1	28.7	575	0%	exclude
Cooper River Partners	0420-0113	Berkeley	599,995	3,650,028	2,097.8	46.2	923	227%	no
BioEnergy Technologies	0420-0120	Berkeley	588,448	3,666,915	0.0	26.5	530	0%	exclude
Trident Medical Center	0560-0138	Charleston	586,593	3,648,706	0.1	44.2	884	0%	exclude
Carolina Starches	0560-0240	Charleston	587,178	3,645,258	2.3	47.7	954	0%	exclude
National Starch, LLC	0560-0298	Charleston	587,377	3,645,259	0.1	47.7	955	0%	exclude
Cummins Turbo Technologies	0560-0384	Charleston	582,213	3,647,898	4.0	44.8	897	0%	exclude
Southwoods Lumber & Millwork	0680-0005	Clarendon	574,369	3,728,097	0.6	36.3	726	0%	exclude
Clarendon Memorial Hospital	0680-0024	Clarendon	573,123	3,727,550	18.9	36.1	721	3%	exclude
Grant Clarendon, Inc	0680-0046	Clarendon	571,067	3,739,759	247.0	48.4	968	26%	exclude
Giant Cement	0900-0002	Dorchester	552,064	3,678,323	2,372.9	33.7	673	353%	no
Argos Cement	0900-0004	Dorchester	550,989	3,676,424	3,355.5	35.5	709	473%	no
Linq Industrial Fabrics, Inc.	0900-0016	Dorchester	572,370	3,657,010	0.0	37.1	742	0%	exclude
Kapstone Summerville Lumber Mill	0900-0017	Dorchester	575,315	3,654,951	8.7	38.5	769	1%	exclude
Robert Bosch Corporation	0900-0020	Dorchester	584,010	3,641,259	20.1	51.5	n/a	n/a	n/a
Showa Denko Carbon	0900-0025	Dorchester	561,439	3,661,480	1,116.7	37.7	753	148%	no
Chambers Oakridge Landfill	0900-0058	Dorchester	559,525	3,665,497	59.3	35.6	712	8%	exclude
Raisio Staest US Inc	0900-0063	Dorchester	573,580	3,657,480	0.3	36.4	727	0%	exclude
Cemplank Inc.	0900-0069	Dorchester	572,861	3,657,278	52.3	36.7	735	7%	exclude
SRE Dorchester	0900-0102	Dorchester	550,802	3,678,037	30.1	34.9	698	4%	exclude
Banks Construction Co.	9900-0461	Dorchester	573,518	3,655,905	101.6	37.9	758	13%	exclude
Holcim, Inc.	1860-0005	Orangeburg	553,134	3,682,367	4,012.3	31.1	622	645%	no
Brewer Properties/Roseburg Forest Products	1860-0038	Orangeburg	552,575	3,682,175	36.7	31.7	634	6%	exclude
Carolina Pole, Inc	1860-0059	Orangeburg	559,510	3,692,946	230.0	23.0	459	50%	exclude
Pennington Crossarm Co.	1860-0096	Orangeburg	552,475	3,688,714	18.7	30.3	605	3%	exclude
Orangeburg County Biomass	1860-0123	Orangeburg	535,055	3,700,750	11.5	48.1	962	1%	exclude
Banks Construction - DSM Drying Operations	1860-0133	Orangeburg	570,337	3,690,844	214.6	12.3	246	87%	exclude
Martek	2320-0001	Williamsburg	610,989	3,732,981	441.9	49.3	986	45%	exclude
Black River Hardwood Company	2320-0005	Williamsburg	603,140	3,731,860	0.9	44.2	885	0%	exclude
Williamsburg Co. Mem. Hospital	2320-0018	Williamsburg	609,540	3,725,100	18.6	42.2	844	2%	exclude
Williamsburg Federal Correctional Inst.	2320-0037	Williamsburg	604,225	3,717,100	53.3	32.7	653	8%	exclude
Arc Technology, LLC	2320-0040	Williamsburg	610,159	3,732,118	0.2	48.1	963	0%	exclude
Salters Renewable Fuel, LLC	2320-0046	Williamsburg	601,928	3,716,700	146.7	30.9	617	24%	exclude
United Phosphorus	2320-0048	Williamsburg	610,027	3,729,502	0.1	45.9	919	0%	exclude
Sanders Brothers	9900-0227	Portable	583,054	3,657,236	30.4	35.5	710	4%	exclude
Banks Construction Co. -- Summerville	9900-0461	Portable	573,518	3,655,905	101.6	37.9	758	13%	exclude

3.1.2.3. Review of Possible Inventory Sources – Actual Emissions

For the facilities that did not screen out of review based on the 20D potentials analysis, actual annual facility SO_2 emission rates were obtained from DHEC emissions inventories for 2012; these data are summarized in Table 3–2. Note that some facility names differ between the names used in the modeling inventory and the names used in DHEC's annual emissions inventories but the permit number is constant.

As requested by EPA, two groupings of facilities are also considered based on the general proximity of sources in those areas – a west/southwest grouping (W/SW) and a south/southeast grouping (S/SE).

Table 3-2. Actual SO_2 Annual Emissions for Possible Inventory Sources within 50 km of Cross

Facility Name	Permit No.	2012 (tpy)	2013 (tpy)	2014 (tpy)
SANTEE COOPER JEFFERIES	0420-0003	4,229.1	0.1	0.1
SCE&G WILLIAMS	0420-0006	1,030.9	908.1	1,933.6
CENTURY ALUMINUM	0420-0015	3,572.0	3,602.9	3,508.4
BP-AMOCO COOPER RIVER	0420-0029	0.98	0.68	0.77
DAK AMERICAS LLC COOPER RIVER PLANT	0420-0089	572.6	580.4	594.3
COOPER RIVER PARTNERS LLC	0420-0113	47.1	47.1	62.0
GIANT CEMENT CO	0900-0002	354.1	417.5	411.1
ARGOS CEMENT	0900-0004	42.4	47.6	52.8
SHOWA DENKO CARBON INC	0900-0025	951.9	863.5	731.6
HOLCIM (US) HOLLY HILL	1860-0005	90.5	116.3	176.7
	Distance (km)	**2012 (tpy)**	**2013 (tpy)**	**2014 (tpy)**
West/Southwest Source Grouping				
GIANT CEMENT CO	33.7	354.1	417.5	411.1
ARGOS CEMENT	35.5	42.4	47.6	52.8
HOLCIM (US) HOLLY HILL	31.1	90.5	116.3	176.7
West/Southwest Total	33.1	486.9	581.5	640.7
South/Southeast Source Grouping				
SCE&G WILLIAMS	42.9	1,030.9	908.1	1,933.6
BP-AMOCO COOPER RIVER	49.0	1.0	0.7	0.8
DAK AMERICAS LLC COOPER RIVER PLANT	38.3	572.6	580.4	594.3
COOPER RIVER PARTNERS LLC	46.2	47.1	47.1	62.0
South/Southeast Total	41.9	1,651.7	1,536.2	2,590.7

Note: Distance for each grouping is an emission-weighted average distance.

Using data from Table 3-2, Table 3-3 provides a summary of the 20D analysis using the maximum yearly actual emissions (2012-2014) for all sources other than Santee Cooper Jefferies, where the coal boilers ceased operation at the end of 2012.

Table 3-3. Actual SO_2 20D Analysis for Possible Inventory Sources within 50 km of Cross

Facility Name	DHEC Permit	Annual SO_2 (tpy)	Year	Distance (km)	20-D (km)	Actual SO_2 / 20-D (%)	Exclude from Inventory?
SANTEE COOPER JEFFERIES	0420-0003	0.1	2013-2014	18.5	369	0%	exclude
SCE&G WILLIAMS	**0420-0006**	**1,933.6**	**2014**	**42.9**	**858**	**225%**	**no**
CENTURY ALUMINUM	**0420-0015**	**3,602.9**	**2013**	**35.9**	**719**	**501%**	**no**
BP-AMOCO COOPER RIVER	*0420-0029*	*1.0*	*2012*	*49.0*	*981*	*0%*	*no - S/SE Group*
DAK AMERICAS LLC COOPER RIVER PLANT	*0420-0089*	*594.3*	*2014*	*38.3*	*766*	*78%*	*no - S/SE Group*
COOPER RIVER PARTNERS LLC	*0420-0113*	*62.0*	*2014*	*46.2*	*923*	*7%*	*no - S/SE Group*
GIANT CEMENT CO	*0900-0002*	*417.5*	*2013*	*33.7*	*673*	*62%*	*no - W/SW Group*
ARGOS CEMENT	*0900-0004*	*52.8*	*2014*	*35.5*	*709*	*7%*	*no - W/SW Group*
SHOWA DENKO CARBON INC	**0900-0025**	**951.9**	**2012**	**37.7**	**753**	**126%**	**no**
HOLCIM (US) HOLLY HILL	*1860-0005*	*176.7*	*2014*	*31.1*	*622*	*28%*	*no - W/SW Group*
West/Southwest Total		*640.7*	*2014*	*33.1*	*662*	*97%*	*no - W/SW Group*
South/Southeast Total		*2,590.7*	*2014*	*41.9*	*838*	*309%*	*no - S/SE Group*

Note: Italicized sources are not excluded due to the 20-D calculation for the S/SE or W/SW Groups, but would screen out individually.

Only three facilities in Table 3-3 qualify for further consideration alone, and these three are shown in bold. Other sources flagged for consideration based on potential emissions could be excluded from the inventory of sources based on actual emissions; these facilities could reasonably be excluded from the cumulative impacts analysis because these source's emissions are so small that they would not interfere with the attainment or maintenance of the 1-hour NAAQS for SO_2 in the area surrounding the Cross facility.

However, when considered as groupings, the S/SE group is included for further consideration due to the presence of SCE&G Williams as part of the group, which results in including three additional sources. The W/SW group is marginally below the 20-D trigger level. Note that the specified distance for the groupings is the emissions-weighted average distance, which is the most accurate statistic to define a point for a group of sources. While the W/SW group does screen out based on the calculated distance and actual emission rates, both the S/SE and W/SW groups are evaluated further as candidates for inclusions as inventory sources.

As such, all sources listed in Table 3-3 (except Santee Cooper Jefferies) are considered further in Section 3.1.2.4.

3.1.2.4. Concentration Gradient Analysis

Table 3-4 shows the sources still under consideration, and all are located well beyond the 10 km radius that TAD suggests should be the focus for identifying which sources to include in the cumulative impacts analysis. The next step in the analysis, per Section 8.2.3.b of Appendix W, is to determine if these sources cause a significant concentration gradient in the vicinity of the Cross facility.

Table 3-4. Facilities Evaluated by Concentration Gradient Analyses

Facility Name	Facility Emissions Max Actual (tpy)	Facility Location UTM X (m)	UTM Y (m)	Distance from Cross (km)
CENTURY ALUMINUM	3,602.9	588,314	3,657,269	35.9
SHOWA DENKO	951.9	561,439	3,661,480	33.7
South/Southeast Source Grouping	2014 Actual			
SCE&G WILLIAMS	1,933.6	600,207	3,653,687	42.9
BP AMOCO	0.8	604,466	3,648,893	49.0
DAK AMERICAS	594.3	598,854	3,658,134	38.3
COOPER RIVER PARTNERS	62.0	599,995	3,650,028	46.2
South/Southeast Total	2,590.7	599,893	3,654,618	41.9
West/Southwest Source Grouping	2014 Actual			
GIANT CEMENT CO	411.1	552,064	3,678,323	33.7
ARGOS CEMENT	52.8	550,989	3,676,424	35.5
HOLCIM (US) HOLLY HILL	176.7	553,134	3,682,367	31.1
West/Southwest Total	640.7	552,270	3,679,282	33.1

Note: UTMX, UTMY and Distance for S/SE and W/SW groupings is an emission-weighted average.

For these facilities, details on the emissions sources at each facility were obtained from DHEC. Actual and potential emissions are in the same range for Century Aluminum and Showa Denko, while the remaining facilities have a large difference in actual and potential, as can be seen in Table 3-5.

Table 3-5. Comparison of Actual and Potential Emissions for Concentration Gradient Facilities

Facility Name	Facility Emissions Max Actual (tpy)	Potential (tpy)	Actual / Potential (%)
CENTURY ALUMINUM	3,602.9	4,090	88%
SHOWA DENKO	951.9	1,117	85%
South/Southeast Source Grouping	(Year 2014)		
SCE&G WILLIAMS	1,933.6	17,743	11%
BP AMOCO	0.8	2,416.2	0.03%
DAK AMERICAS	594.3	4,241.4	14%
COOPER RIVER PARTNERS	62.0	2,097.8	3%
West/Southwest Source Grouping	(Year 2014)		
GIANT CEMENT CO	411.1	2,372.9	17%
ARGOS CEMENT	52.8	3,355.5	2%
HOLCIM (US) HOLLY HILL	176.7	4,012.3	4%

Because of the large disparity between potential emission and actual emissions for facilities other than Century Aluminum and Showa Denko, refinements are made to the emission rate to be used in the concentration gradient analysis for the those facilities as follows.

- SCE&G Williams – actual hourly data as reported to EPA Clean Air Markets Division (CAMD) under Part 75
- BP Amoco & DAK Americas
  - Available data
    - Monthly actual data in tons/month
  - Approach
    - Divided monthly emissions by clock hours per month
    - Used month with highest hourly emission rate for entire period
- Cooper River Partners
  - Available data
    - Annual emissions for 2012, 2013, and 2014
    - Monthly oil and natural gas consumption for July –December 2012, 2013, and 2014
  - Approach
    - Using oil and natural gas consumption for 2013 and 2014 together with annual emissions for 2013 and 2014, solved to determine SO_2 emission factors for oil and natural gas
    - Calculated monthly SO_2 emissions for each month
    - Divided monthly emission by clock hours per month
    - Used month with highest hourly emission rate for entire period
- Giant Cement & Argos Cement & Holcim Holly Hill
  - Available data
    - Annual SO_2 emissions for 2012, 2013, and 2014 by unit
    - Hours of operation for 2012, 2013, and 2014
  - Approach
    - Sum SO_2 emissions across all units
    - Calculate hourly emission rate for each year using actual hours per year and annual emissions
    - Used year with highest hourly emission rate for entire period

In this analysis, the largest SO_2 emitting stack at each candidate source is identified. The total SO_2 emissions from a given candidate facility are assumed to be emitted from the largest SO_2 emitting stack, which retains its physical stack parameters and associated gas flow parameters. At Showa Denko, there are three stacks with similar emission rates, and the stack with the lowest stack temperature is selected (each stack is in the same height range, but two stacks are at very high temperature [> 1500 °F] and one stack is at 100 °F). Each candidate source is evaluated with a dispersion model to examine the concentration gradients from that source. The selected stacks and their parameters can be seen in Table 3-6.

Table 3-6. Stack Parameters for the Concentration Gradient Analysis

Facility Name	Stack Name	Stack ID	Stack Location Easting (m)	Stack Location Northing (m)	H (ft)	T (F)	V (ft/s)	D (ft)	Modeled Emission Rate (lb/hr)
CENTURY	ALU_02-05 Dry Scrubber Line	CENT01	588,255	3,657,328	200	176	77	11	933.8
SHOWA DENKO	MP68 (S-430-03)	SHOW1	561,326	3,661,532	166	100	60	8	254.9
SCE&G WILLIAMS	UB1 - Utility Boiler #1	WIL1	600,177	3,653,478	400	128	58	26	Varies
BP AMOCO	Boiler 3	BPAM01	604,836	3,648,824	100	270	8	6	1.4
DAK AMERICAS	Boiler 1	DAK01	598,857	3,658,125	150	320	35	5	225.8
COOPER RIVER PARTNERS	EXITBOIL	CRP01	599,995	3,650,028	150	350	104	5	30.1
GIANT CEMENT CO	331-ES-21 Main Baghouse/By	GTC01	552,141	3,678,230	295	230	50	14	118.9
ARGOS CEMENT	EP01	ARC01	550,964	3,676,631	100	222	81	10	19.3
HOLCIM (US) HOLLY HILL	(94) Preheater/Precalciner Kiln	HOL01	553,246	3,682,244	359	244	52	20	53.7

Receptors are placed at 100 m intervals on a line connecting the candidate source (Century, Showa Denko) or center of group of sources (W/SW, S/SE) to the Cross facility. Additional receptors at 100 m intervals are placed in identical parallel lines offset laterally by 100 m on either side of the original line. The receptor grids for the candidate sources can be seen in Figure A-4. Though all four receptor grids are shown together in Figure A-4, for the concentration gradient analysis, each of the four is evaluated individually.

Modeling is conducted to predict the multi-year average of the 4th highest 1-hour concentration at each receptor. To calculate the longitudinal gradient, at each receptor along the middle line, the difference in predicted concentrations at the surrounding two receptors along the middle line is divided by the distance between these two receptors (200 m). For the calculation of the lateral gradients at each downwind distance, at each receptor along the middle line, the difference in predicted concentration at the surrounding two receptors on the lines parallel to the middle line was divided by the distance between the two receptors (200 m).

Profiles showing the variation of concentration gradients with distance from the Cross facility are plotted to determine if the gradients in the vicinity of the primary source are still significant or if they are flattened out. For each of the three background sources, plots of predicted longitudinal and lateral concentration gradients are presented in Figures B-1 to B-8. Note that the axis scale varies between graphs, and values cease at the distance to Cross.

In each case, the gradients are highest near the candidate source and decrease with downwind distance. The predicted concentrations at the Cross facility are much smaller than those in the vicinity of the candidate source and the slope of the gradient near the Cross facility is much flatter than in the vicinity of the candidate source; this indicates that the concentration gradients from the candidate background sources do not need to be included explicitly in the cumulative impact modeling analysis.

Table 3-7 shows the impact of candidate sources at the Cross facility.

Table 3-7. Impact of Candidate Sources at Cross Facility

Candidate Source	Impact at Cross Facility ($\mu g/m^3$)
Century Aluminum	11.4
Showa Denko	10.3
S/SE Grouping	8.5
W/SW Grouping	2.0

For all of the candidate background sources, the predicted value of each impact at the Cross facility is substantially lower than the 1-hour SO_2 monitored design value of 37.5 micrograms per cubic meter ($\mu g/m^3$) at the Jenkins Avenue Fire Station (described in Section 6); additionally, the sum of all together is also below the 37.5 $\mu g/m^3$ value. Since the predicted impacts near the Cross facility are well below the monitored design value, and given the short 1-hour averaging period where wind directions must align closely to have overlapping impacts, it is reasonable to assume that the monitored value accounts for the impacts of the candidate background sources.

Compared to EPA's interim SO_2 significant impact level (SIL) of 8 $\mu g/m^3$, the W/SW grouping is well below, while the other three are slightly above but in the same range as interim SIL. In a recent analysis performed for a Prevention of Significant Deterioration (PSD) permit in South Carolina for Showa Denko, the approved analysis for that site relied upon a concentration gradient for that project which also showed modeled impacts in the same range as but above the interim SIL. Review of Figures B-1 through B-8 provide more relevant data than a simple comparison to an interim SIL value, as the plots each show the consistent gradient at the long distances (over 30 km) to these other facilities from Cross.

There are several other factors, both qualitative and quantitative, that support the conclusion that it is appropriate to exclude the candidate background sources from the SO_2 NAAQS analysis.

- The SO_2 NAAQS is a short-term, 1-hour average basis. As such, impacts must closely align both in space and time to actually be additive.
- The Cross facility is relatively isolated, on a small piece of land between two large lakes, with the nearest potentially relevant source over 30 km distant.
- The isolation of Cross means that there are no other sources in the same vector lines as considered in the concentration gradient analyses, and thus there are no other sources that could impact the 1-hour average.
- The modeled emission rates for the facilities are highly conservative estimates of actual emissions, and were actual emissions to be modeled, the impacts would be lower.
- For Century and Showa Denko, potential emissions are modeled rather than actual emissions, which is even more conservative than the approaches used for the W/SW and S/SE groupings.

Considering all of the factors above, it is clear that none of the facilities considered in the concentration gradient analysis need to be included explicitly in the cumulative impact modeling analysis. Thus, only the Cross facility sources are modeled to demonstrate compliance with the 1-hour SO_2 NAAQS.

3.2. RECEPTOR GRID

Ground-level concentrations are calculated for receptors located on multiple Cartesian grids covering a region that extends 10 km from all edges of the facility. As part of this project, Trinity reviewed high resolution aerial photos from Berkeley County to preliminarily identify the ambient air boundary, which is the area from which the general public is precluded from entering.[5] Trinity then reviewed the preliminary boundary with Santee Cooper site and environmental personnel to determine the proper ambient air boundary. The ambient air boundary is comprised of a combination of fencing, locked gates, a staffed main access gate, the dike along the canal, and regular security patrols. Note that the total property owned by Santee Cooper is appreciably larger than that included within the ambient air boundary. Figure A-5 shows the ambient air boundary. Receptor spacing at the ambient air boundary of Cross is set to 50 m.

As discussed in Section 1.3, the Cross facility is located between two lakes and adjacent to a canal that connects the lakes. The TAD states that the receptor grid should only be placed in locations of ambient air, defined as areas where a monitor could be placed and where the public reasonably has access. The TAD states that bodies of water are not considered ambient air. However, for simplicity, the Cross facility has included these three water areas in the analysis presented in this report.

The Cross facility developed a receptor grid with 100 m spacing for up to 1 km beyond the furthest extent of the ambient air boundary, 250 m spacing between 1 and 5 km, and 500 m spacing from 5 km to 10 km. The receptor grid may be see in Figure A-6. All receptors are in the UTM coordinate system in Zone 17 of the Northern Hemisphere, in NAD83.

Were the maximum predicted SO_2 concentrations not to occur within the 100 m grid, additional receptors would have been placed at 100 m spacing to ensure that maximum impacts are resolved to the nearest 100 m. However, as shown later in this report, the maximum predicted SO_2 concentrations are on the 100 m grid.

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[5] https://www.berkeleycountysc.gov/drupal/gismapping

4.1. STACK PARAMETERS

The TAD allows usage actual emission rates as the best and most accurate predictor of ambient impacts. However, alternatively allowable emissions may be used at Santee Cooper's option. The selected emission rate for modeling determines what parameters will be used for the remainder of the unit inputs to the model.

As provided in Section 6.1 of the TAD, either actual parameters or design parameters may be used for stack height (H), stack temperature (T), exhaust velocity (V), and stack diameter (D), or collectively HTVD, depending on the type of emissions being modeled. If modeling allowable emissions, design HTVD are used including consideration of good engineering practice (GEP) stack height. In contrast, if modeling actual emissions, actual values are used for HTVD. Santee Cooper has selected to model actual emissions, and thus actual values are used for HTVD.

4.1.1. Stack Height

There are two concrete chimneys at Cross, each with two individual stacks inside. Unit 1 and Unit 2 are paired in one chimney, and Unit 3 and Unit 4 are paired in the other chimney.

There are three associated structures with each unit that can potentially cause downwash on the stacks.

1. Main boiler building
2. SCR structure
3. ESP structure

Figure A-7 shows the stack and structure locations at Cross, and Table 4-1 shows the stack and structure height values for each unit, as well as the GEP stack height as reported by BPIP.[6]

Table 4-1. Stack and Structure Heights

	Stack or Structure Height			
ID	Unit 1 (ft)	Unit 2 (ft)	Unit 3 (ft)	Unit 4 (ft)
Stack	600	600	488	488
Boiler Building	267	265	280	280
SCR Structure	203	200	203	203
ESP Structure	97	82	97	97
BPIP Output				
H	280	280	280	280
PBW	290	293	433	433
BPIP GEP	699	699	699	699

[6] Locations are set to the base of the stack or structure. Due to the slight angle of the aerial photo and the tall heights of the stacks and structures, the base location and structure top do not align in the photo.

Based on review of the BPIP output file, GEP for each boiler stack is 699 feet (ft), which is taller than the actual stack heights. As such, the actual stack heights are used.

4.1.2. Stack Diameter

The actual stack diameters for the individual stacks at Cross are:

- Unit 1, Unit 2 – 22 feet each
- Unit 3, Unit 4 – 25 feet each

While there are two individual stacks within each chimney, the individual stacks are spaced very close together; the center-to-center distance is 26 ft for Unit 1 and Unit 2 and 32 ft for Unit 3 and Unit 4, leaving only four feet between the Unit 1 and Unit 2 stacks and seven feet between the Unit 3 and Unit 4 stacks.

Given the proximity of the normal operations paired stacks, plume combination is expected near the stack tip when both units are operating in unison. Based on prior GEP guidance from EPA's Model Clearinghouse, when the separation of individual stacks is less than the stack diameter, the gap can be considered closed and the multiple stacks a single source.[7]

The paired Cross stacks (1&2, 3&4) may be modeled as single stacks with an equivalent diameter set to match the total area of the two individual stacks, which can be calculated by multiplying the individual stack by the square root of two. Thus, the paired equivalent stack diameters are:

- 1&2 merged – 31.11 ft
- 3&4 merged – 35.36 ft

The final modeling analysis uses a combination of individual and paired stacks to represent the stack diameter, resulting in a total of six sources in the model input file, representing the four individual stacks (CGS1, CGS2, CGS3, and CGS4) as well as the two paired stacks (CGS12 and CGS34). Paired stacks are only used when both boilers of the pair are operating in a given hour. To identify when both units in a pair are operating, an electrical generation rate of 50 megawatts (MW) for each of the two units is used. For example, consider the following scenarios, each of which is on an hour by hour basis.

- Scenario 1
  - CGS1 > 50 MW, CGS2 > 50 MW
  - Model input
    - Paired
    - Emissions from merged stack CGS12
    - Zero emissions from CGS1 or CGS2
- Scenario 2
  - CGS1 > 50 MW, CGS2 < 50 MW
  - Model input
    - Not paired
    - Emissions from CGS1 and/or CGS2
    - Zero emissions from merged stack CGS12

[7] https://cfpub.epa.gov/oarweb/MCHISRS/index.cfm?fuseaction=main.resultdetails&recnum=91-II%20%20-01

4.1.3. Stack Temperature

Since actual emissions are modeled, actual stack temperatures are obtained for each hour of operation from continuous emissions monitoring system (CEMS) data for each of the individual stacks. When individual stacks are modeled (i.e., non-merged), the reported actual stack temperature is used directly.

When a merged stack is modeled, the temperatures from the individual stacks are used together with flow rates from the individual stacks to calculate a merged stack temperature. The merged stack temperature is calculated based on the energy of the merged gas stream equaling the sum of the energies of the individual gas streams. The calculation is as follows.

T_{merged} : [(T1*FLOW1)+(T2*FLOW2)] / [FLOW1 + FLOW2]

T values are absolute temperature basis (°R or K)
Flow values used were already corrected to standard temperature (68 °F or 527.67 °R)

4.1.4. Stack Velocity

Since actual emissions are modeled, actual stack velocities are calculated for each hour of operation from continuous emissions monitoring system (CEMS) data. The CEMS provides exhaust flow in standard cubic feet per minute (scfm) as well as gas temperature, which can be used to calculate actual cubic feet per minute (acfm). Then, stack diameter and acfm can be used to calculate stack velocity. When individual stacks are modeled (i.e., non-merged), the reported actual stack temperature and exhaust flow are used directly.

When a merged stack is used, the merged stack temperature is used to adjust the sum of the individual stack flow rates to acfm, and then the merged stack diameter is used to calculate the merged stack velocity.

4.2. EMISSION RATES

The TAD allows usage actual emission rates as the best and most accurate predictor of ambient impacts. Santee Cooper has elected to use actual emission rates in this report.

Actual emission data are obtained from two sources.

- Facility-provided CEMS data (Part 60)
  - SO_2 (pounds per hour [lb/hr])
  - Stack flow (scfm)
  - Stack temperature (°F)
  - Gross power (MW)
  - Heat input (MMBtu/hr)
- EPA CAMD data downloaded by Trinity (Part 75)
  - SO_2 (lb/hr)
  - Heat input (MMBtu/hr)
  - Gross power (MW)

While the data have the same source, there are different data handling procedures for Part 75 versus Part 60, Part 75 includes bias factors that result in higher lb/hr readings than Part 60, plus Part 75 data includes data substitution so that if the unit is operating and Part 60 data are missing, under Part 75 the data are filled in a conservative manner so that there are no missing lb/hr data under Part 75.

Trinity compared the Part 60 and Part 75 mass emissions data. Over the 2012-2014 period considered, total mass is slightly higher for Part 75 as would be expected, but generally similar to Part 60: 3% for Unit 1, Unit 3, and Unit 4, and 9% for Unit 2. Given the generally good agreement between Part 60 and Part 75, the Part 75 lb/hr emissions data are used for the modeling.

When a merged stack is used, the modeled emission rate is the sum of the individual unit emission rates. Otherwise, the individual unit Part 75 emission rate is used directly.

4.3. URBAN VS. RURAL

AERSURFACE (version 13016) is utilized to determine if a 3 km area surrounding the Cross facility should be classified as urban or rural for the purposes of this modeling analysis. The 1992 National Land Cover Database (NLCD) data is used as input to AERSURFACE for the analysis.

The land use data within 3 km of the Cross facility can be seen in Table 4-4. 1992 NLCD data are not available in color, so 2001 NCLD data are used for Figure A-2 to better illustrate the variation in land use around Cross; Figure A-2 also identifies the area within 3 km of the Cross facility. There has been little development within the 3 km radius of the Cross facility, such that the 1992 NLCD data accurately represent present day conditions.

The AERSURFACE output data show that half of the area surrounding the facility is either open water or woody wetlands. The remainder of the land use is forest and cropland. Therefore, the area surrounding the Cross facility may be classified as predominantly rural.

Table 4-2. 1992 NLCD Land Use within 3 km of the Cross Facility

Land Use Class	Percentage of Total
Missing, Out-of-Bounds, or Undefined	0%
Open Water	25%
Perennial Ice/Snow	0%
Low Intensity Residential	0%
High Intensity Residential	0%
Commercial/Industrial/Transp	0%
Bare Rock/Sand/Clay	1%
Quarries/Strip Mines/Gravel	0%
Transitional	2%
Deciduous Forest	12%
Evergreen Forest	11%
Mixed Forest	9%
Shrubland	0%
Orchards/Vineyard/Other	0%
Grasslands/Herbaceous	0%
Pasture/Hay	1%
Row Crops	3%
Small Grains	0%
Fallow	0%
Urban/Recreational Grasses	7%
Woody Wetlands	28%
Emergent Herbaceous Wetlands	1%

5.1. METEOROLOGICAL DATA SITE EVALUATION AND SELECTION

Site-specific dispersion models require a sequential hourly record of dispersion meteorology representative of the region within which the source is located. In the absence of site-specific measurements, EPA guidelines recommend the use of readily available data from the closest and most representative National Weather Service (NWS) station. Regulatory air quality modeling using AERMOD requires quality−assured meteorological data that include hourly records of the following parameters:

- Wind speed;
- Wind direction;
- Air temperature;
- Micrometeorological Parameters (e.g., friction velocity, Monin-Obukhov length);
- Mechanical mixing height; and
- Convective mixing height.

The first three of these parameters are directly measured by monitoring equipment located at typical surface observation stations. The friction velocity, Monin-Obukhov length, and mixing heights are derived from characteristic micrometeorological parameters and from observed and correlated values of cloud cover, solar insolation, time of day and year, and latitude of the surface observation station. Surface observation stations form a relatively dense network, are almost always found at airports, and are typically operated by the NWS. Upper air stations are fewer in number than surface observing points since the upper atmosphere is less vulnerable to local effects caused by terrain or other land influences and is therefore less variable. The NWS operates virtually all available upper air measurement stations in the United States.

The U.S. EPA's federal *Guideline on Air Quality Models*, codified at 40 CFR Part 51, Appendix W, states in Section 9.3.1.2, "Meteorological Input Data – Recommendations" that:

> *… representative meteorological data should be used when estimating concentrations with an air quality model… The meteorological data may be collected either onsite or at the nearest National Weather Service (NWS) station.*

The meteorological data that are "representative" for a particular facility are typically determined subjectively, and the *Guideline* offers the following guidance in Section 9.3(a).

> *The meteorological data … should be selected on the basis of spatial and climatological (temporal) representativeness as well as the ability of the individual parameters selected to characterize the transport and dispersion conditions in the area of concern. The representativeness of the data is dependent on: (1) the proximity of the meteorological monitoring site to the area under consideration; (2) the complexity of the terrain; (3) the exposure of the meteorological monitoring site; and (4) the period of time during which data are collected. The spatial representativeness of the data can be adversely affected by large distances between the source and receptors of interest and the complex topographic characteristics of the area.*

The Cross facility is located in the northwestern portion of Berkeley County, South Carolina. By default, DHEC recommends that facilities in Berkeley County utilize surface data observations from the Charleston Airport

NWS site (CHS) in AERMOD modeling analyses.[8] However, since the facility is located near the border with Orangeburg County, the Orangeburg airport site (OGB), which is DHEC's default recommendation for that county, is also considered a candidate meteorological data station for this analysis.

The selection of the most representative meteorological site for AERMOD modeling analyses is based on several factors as discussed in more detail below. As discussed in the TAD, the 2012-2014 meteorological data period is evaluated to determine the final site selection.

5.1.1. Proximity

As shown in Figure 5-1, the Cross facility is located roughly 50 km from the CHS airport site and 70 km from the OGB airport site. Based on distance alone, CHS would be the more appropriate meteorological data site, however there are other important evaluation criteria as well. Both the Cross facility and CHS are in the eastern portion of South Carolina, an area characterized by relatively flat terrain with a combination of forest, agricultural land and wetlands. OGB is further inland yet still in the coastal plain region of South Carolina. As such, both sites are in similar topographic settings and would be expected to have similar weather patterns.

Figure 5-1. Locations of Candidate Meteorological Stations

[8] http://www.scdhec.gov/Environment/AirQuality/ComplianceandReporting/AirDispersionModeling/ModelingData/

5.1.2. Overall Wind Pattern

One of the most important considerations in meteorological data site selection is the wind pattern. Physical features such as terrain and large water bodies impact the overall distribution of wind direction. Since the CHS airport station is in much closer proximity to the ocean than either OGB or Cross, the wind patterns are carefully reviewed to ensure that the land/sea breeze pattern does not impact the overall wind distribution such that CHS would no longer be representative of the Cross facility. Windroses are developed for the CHS and OGB sites, along with the Moncks Corner Airport (MKS), which is located roughly 20 km away from the Cross facility, in a very similar topographic setting. The meteorological data capture and instrumentation at the MKS site is not complete enough for direct use in dispersion modeling; however, MKS is still helpful in comparing overall wind patterns.

Figures 5-2 through 5-4 present the windroses for each site.[9] Each of the patterns shows winds prevailing generally from the northeast and southwest, which is very consistent with locations in the southeastern coastal states. As shown, the CHS airport site compares more favorably to the MKS windrose in 12 of the 16 cardinal wind direction sectors and is roughly equivalent to OGB in the other 4 sectors.

[9] Windroses obtained from the State Climate Office of North Carolina (http://climate.ncsu.edu/windrose.php?state=SC&station=KCHS)

Figure 5-2. 2012-2014 Windrose from MKS

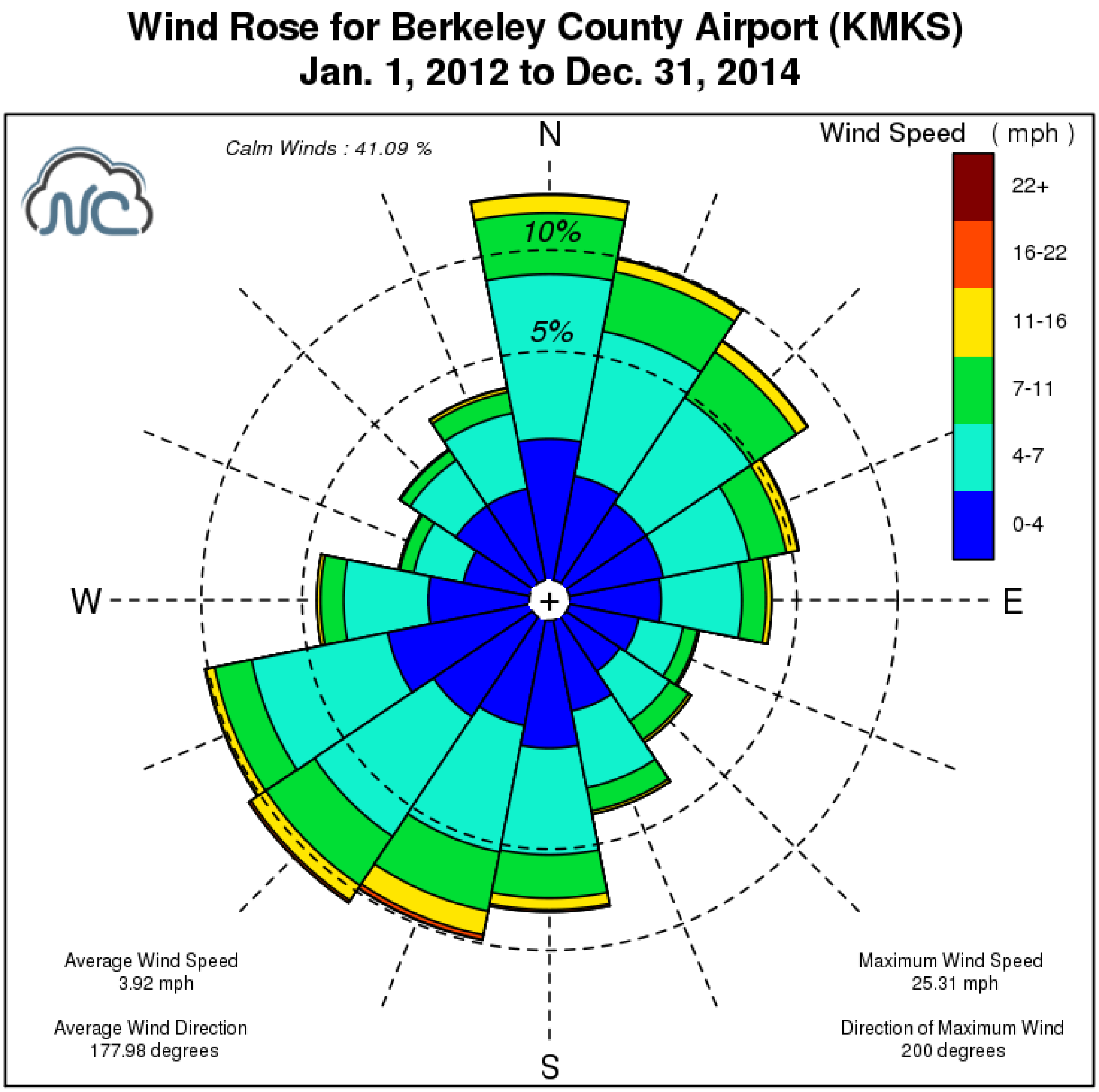


Figure 5-3. 2012-2014 Windrose from CHS

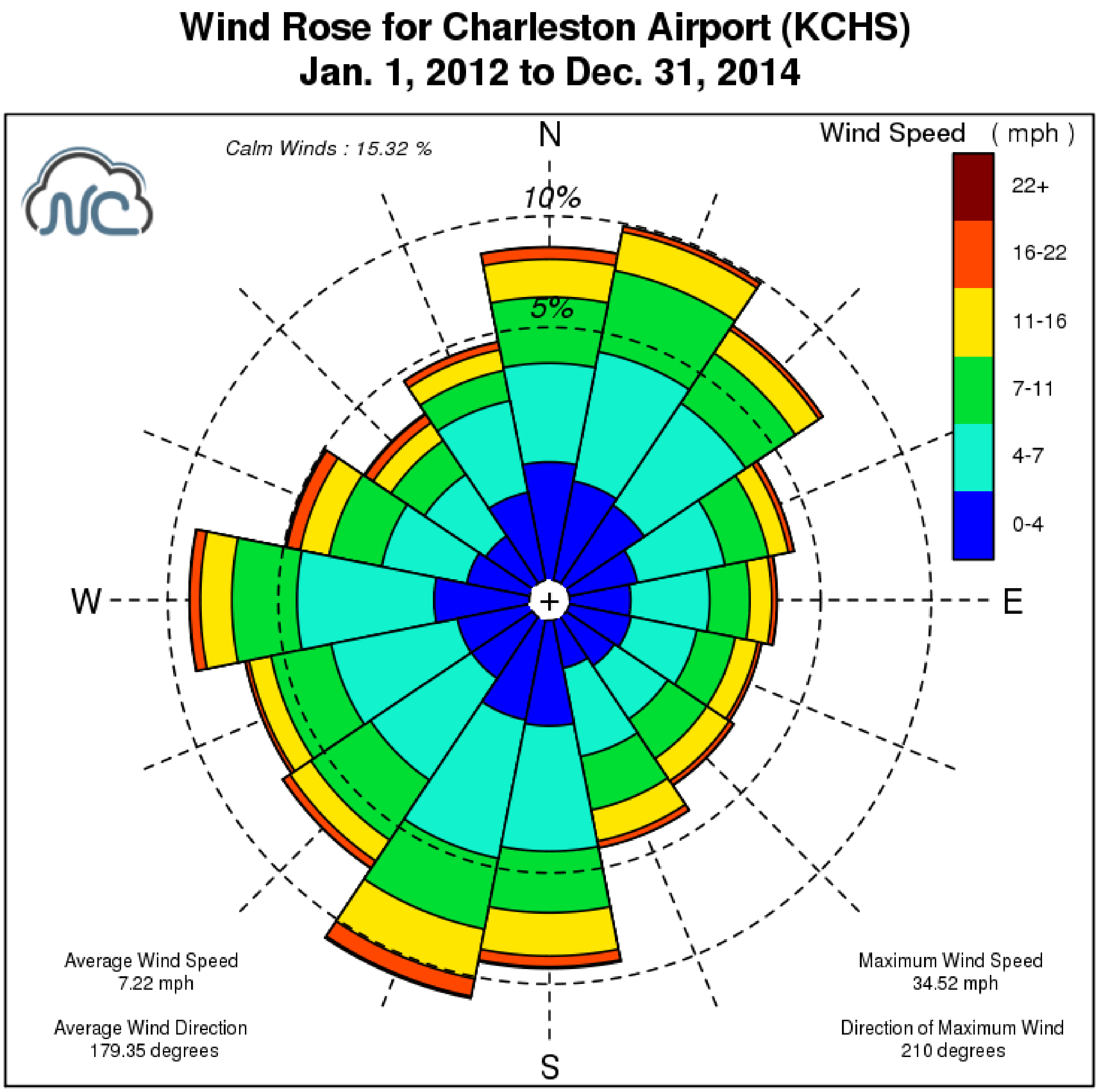
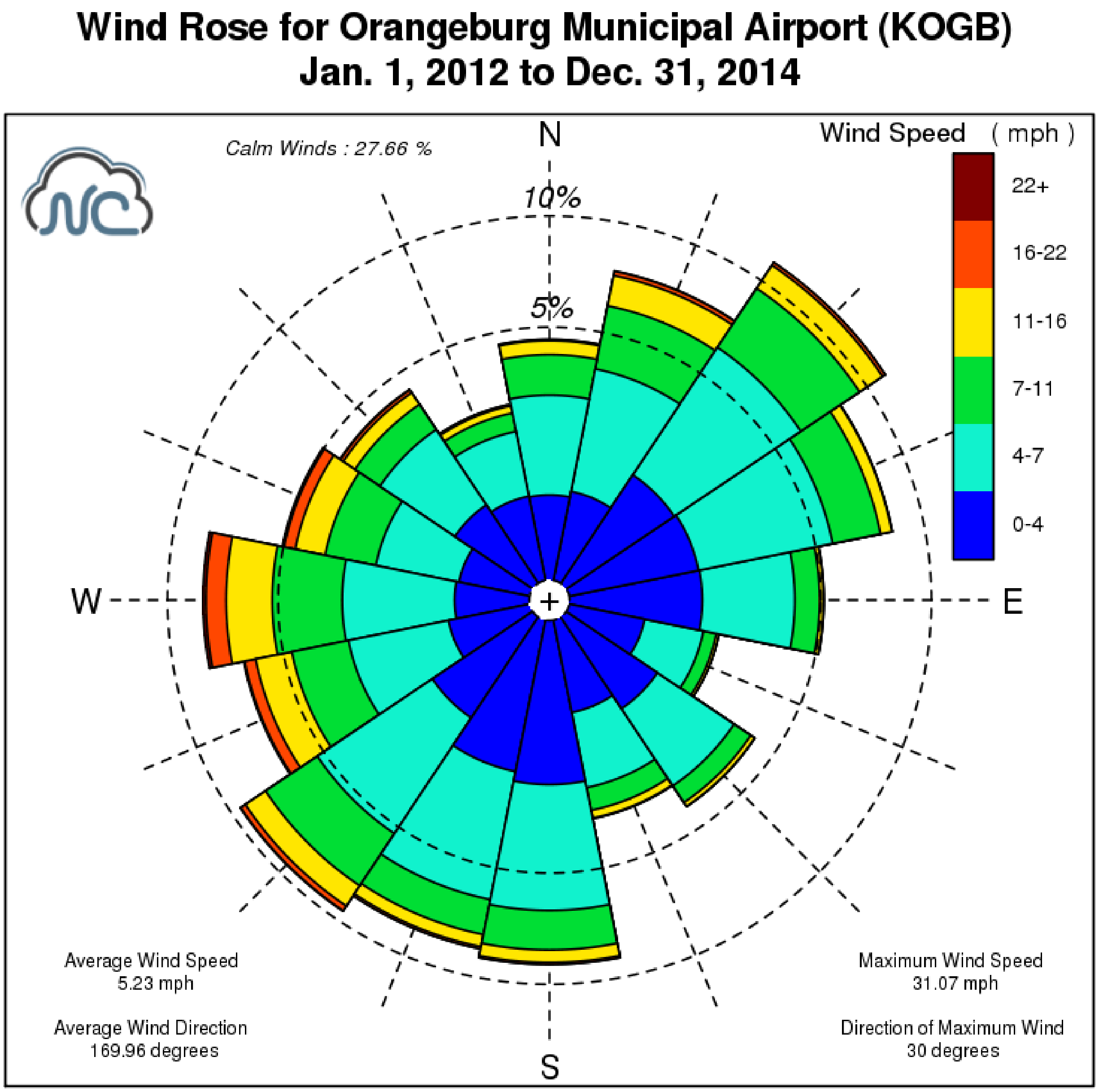


Figure 5-4. 2012-2014 Windrose from OGB



5.1.3. Land Use Representativeness Analysis

AERMOD utilizes planetary boundary layer (PBL) turbulence calculations to characterize the stability of the atmosphere, which is affected by the prevailing meteorological conditions and the land use and cover of the surrounding area. Because site-specific parameters are utilized in the meteorological data files, EPA made the following recommendation in the March 19, 2009 AERMOD Implementation Guide:[10]

> *When applying the AERMET meteorological processor (EPA, 2004a) to prepare the meteorological data for the AERMOD model (EPA, 2004b), the user must determine appropriate values for three surface characteristics: surface roughness length {zo}, albedo {r}, and Bowen ratio {Bo}*
> *...*
> *When using National Weather Service (NWS) data for AERMOD, data representativeness can be thought of in terms of constructing realistic planetary boundary layer (PBL) similarity profiles and adequately characterizing the dispersive capacity of the atmosphere. As such, the determination of representativeness should include a comparison of the surface characteristics (i.e., zo, Bo and r) between the NWS measurement site and the source location, coupled with a determination of the importance of those differences relative to predicted concentrations.*
> *...*
> *If the proposed meteorological measurement site's surface characteristics are determined to NOT be representative of the application site, it may be possible that another nearby meteorological measurement site may be representative of both meteorological parameters and surface characteristics. Failing that, it is likely that site-specific meteorological data will be required.*

The surface characteristics of interest for AERMET – surface roughness, albedo, and Bowen ratio – are based on the land use cover (e.g., urban, agriculture, wetlands, forest, water) in the area upwind of the Cross facility (1 km for surface roughness, 10 km for albedo and Bowen ratio). If two locations have similar land use and cover, then the locations are expected to have similar surface characteristics. Thus, a land use analysis must be performed for the area immediately surrounding the source and for the area immediately surrounding the NWS site. In its March 19, 2009 AERMOD Implementation Guide, the U.S. EPA states:[11]

> *Based on model formulations and model sensitivities, the relationship between the surface roughness upwind of the measurement site and the measured wind speeds is generally the most important consideration.*
>
> *The dependence of meteorological measurements and plume dispersion on Bowen ratio and albedo is very different than the dependence on surface roughness. Effective values for Bowen ratio and albedo are used to estimate the strength of convective turbulence during unstable conditions by determining how much of the incoming radiation is converted to sensible heat flux. These estimates of convective turbulence are not linked as directly with tower measurements as the linkage between the measured wind speed and the estimation of mechanical turbulence intensities driven by surface roughness elements.*

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[10] http://www.epa.gov/ttn/scram/7thconf/aermod/aermod_implmtn_guide_19March2009.pdf, Sections 3.1 and 3.1.1, pages 3-4.

[11] http://www.epa.gov/scram001/7thconf/aermod/aermod_implmtn_guide_19March2009.pdf, Section 3.1.2, pages 4-5.

An analysis of the surface characteristics for the Cross facility and both the CHS and OGB airport sites is performed to determine which site has more comparable surface characteristics to the Cross facility. An AERSURFACE evaluation is performed for each of the sites. Table 5-1 presents the average surface characteristics from each of the site, as generated by AERSURFACE.

Table 5-1. Average Surface Characteristics

Site	Albedo	Bowen Ratio	Surface Roughness (m)
CGS	0.130	0.236	0.062
CHS	0.160	0.700	0.035
OGB	0.158	0.552	0.208

As shown, there is some variability in the albedo and Bowen ratio values between the Cross facility and both meteorological sites, largely due to the presence of the large lake adjacent to the plant and other wetlands in the area. The surface roughness values at the Cross facility and CHS are very comparable, while there is greater variability between the Cross facility and OGB. The AERMOD model is much more sensitive to variations in surface roughness, and as such, that parameter is given more weight in the comparison.

5.1.4. Meteorological Data Site Selection

In reviewing the proximity, wind pattern and surface characteristic data, both the CHS and OGB meteorological sites are reasonably representative of the Cross facility and either would qualify as representative for dispersion modeling. Since the CHS airport site is in closer proximity to the Cross facility and compares more favorably in wind pattern and surface characteristics, CHS is the most representative location for Cross and 2012-2014 data for CHS are used in the analysis for the Cross facility. DHEC processed the meteorological data files in AERMET and provided the model-ready files for use in the AERMOD analysis.[12]

DHEC provided meteorological data for Cross both with and without the adjusted U* as proposed by EPA at the time of the protocol. Although EPA has now signed a rulemaking that will allow usage of the adjusted U* in AERMET in the future, the modeling completed for this report does not use the adjusted U* data, and instead uses the current regulatory approach.

[12] Email from John Glass (DHEC) to Jon Hill (Trinity) on March 16, 2016.

6.1. OVERVIEW

Ambient air quality data are used to represent the contribution of sources that are not explicitly included in the modeling analysis. The effects of these small, distant, or natural sources are accounted for by adding a background concentration to the predicted concentrations from Cross to obtain a total design concentration. This total design concentration is then compared to the 1-hr SO_2 NAAQS to determine compliance.

For this analysis, three ambient SO_2 monitors are considered based on general proximity to Cross:

- Jenkins Avenue Fire Station (Site ID: 45-019-003);
- Cape Romain (Site ID: 45-019-0046); and
- Congaree Bluff (Site ID: 45-079-0021).

Figure A-8 shows the locations of the three monitors relative to Cross

- Jenkins Avenue monitor 55 km south
- Cape Romain monitor 60 km southeast
- Congaree Bluff monitor 75 km northwest

Design concentrations for each of the monitors are provided in Table 6-1. The design concentrations are based on the 99th percentile of the peak daily 1-hour SO_2 concentrations averaged over three years. Table 6-1 shows two design concentrations – one for 2012-2014 and one for 2013-2015. The decrease in monitored concentration in the later three-year period is likely the result of the substantial decrease in area SO_2 emissions due to the cessation of coal burning at the Jefferies facility at the end of 2012 and should be expected to continue; as such, the 2012-2014 values likely overestimate realistic background values for the area . However, for consistency with the meteorological dataset, the 2012-2014 design concentration is used in the cumulative impacts analysis.

Table 6-1. 1-hour SO_2 Design Concentrations for Potential Monitors

Monitor	Year	Annual Data Capture		99th Percentile Concentration	Design Concentration (2012-2014 average)		Design Concentration (2013-2015 average)	
		hours	*%*	*ppb*	*ppb*	*µg/m³*	*ppb*	*µg/m³*
Jenkins Avenue Fire Station	2012	8630	99%	17	14.3	37.6	11.1	29.0
	2013	8451	96%	15				
	2014	8691	99%	11				
	2015	8692	99%	7.2				
Cape Romain	2012	8225	94%	9	6.0	15.7	4.3	11.2
	2013	8627	98%	5				
	2014	7274	83%	4				
	2015	8646	99%	3.8				
Congaree Bluff	2012	8548	98%	11	19.3	50.7	17.6	46.1
	2013	8650	99%	22				
	2014	1280	15%	25				
	2015	8571	98%	5.8				

To determine which of the three monitors is most appropriate to use for ambient background concentration in the analysis, several factors will be considered, including proximity, data quality, and influence from nearby sources.

6.2. PROXIMITY

As shown in Figure A-8, all three monitors are located greater than 50 km from the Cross facility. Based solely on considerations of proximity, the Jenkins Avenue Fire Station monitor is expected to be more representative of the background in the vicinity of the Cross facility.

6.3. DATA QUALITY

As shown in Table 6-1, both the Jenkins Avenue Fire Station and the Cape Romain monitors have greater than 90% capture, meaning that data capture rate is sufficiently high to represent the full year. In contrast, the Congaree Bluff monitor is missing a high number of data points in 2014, resulting in a poor a data capture rate of 15%. Based on data quality considerations alone, data from the Jenkins Avenue Fire Station or the Cape Romain monitor are preferred.

6.4. NEARBY SOURCE INFLUENCE

Based on the concentration gradient analysis discussed in Section 3.1.2, the impacts from the largest sources in the same region of the Cross facility are greatly reduced after 20 km. Tables 6-2 and 6-3 list sources that had

SO_2 emissions greater than 1 tpy during 2011[13] that are within 20 km of Jenkins Avenue and Congaree Bluff. The Cape Romain monitor does not have any sources with emissions greater than 1 tpy during 2011 that are within 20 km.

Table 6-2. Sources within 20 km of Jenkins Avenue Fire Station Monitor

Facility Name	2011 SO_2 Emissions Tons	Distance from Jenkins km
MEADWESTVACO SC LLC SPECIALTY CHEMICALS	3.2	2
COGEN SOUTH	801.2	2
KAPSTONE CHARLESTON KRAFT LLC	1,080.5	2
BENNETT	1.7	3
SOLVAY USA INC	5.2	5
Charleston AFB/Intl Airport	22.9	7
COOPER RIVER PARTNERS LLC	47.1	12
SCE&G WILLIAMS	606.9	16
NUCOR STEEL BERKELEY	148.3	16
DAK AMERICAS LLC COOPER RIVER PLANT	576.5	20
CENTURY ALUMINUM	3,751.7	20

Table 6-3. Sources within 20 km of Congaree Bluff Monitor

Facility Name	2011 SO_2 Emissions Tons	Distance from Congaree km
DEVRO INC	6.7	13
SCE&G WATEREE	3,883.5	15
INTERNATIONAL PAPER EASTOVER	4,068.6	15

Of the three monitors, the Jenkins Avenue monitor is located in the most populated area, and also has the most SO_2 sources nearby, though cumulative emissions are less than for Congaree Bluff in the same time period. The Cape Romain monitor is located in a more remote area, and has no significant SO_2 sources nearby. The Jenkins Avenue monitor is influenced more heavily than the Cape Romain monitor by sources that were analyzed individually in the cumulative modeling analysis (Century Aluminum and SCE&G Williams) as well as collectively as part of the South/Southeast source grouping (comprised of SCE&G Williams, DAK Americas Cooper River Plant, Cooper River Partners LLC, and small (< 1 tpy) emissions from BP-Amoco Cooper River).

[13] Via EPA's "Where You Live" database.

The Congaree Bluff monitor is not in a highly populated area, but it does have a paper manufacturer (International Paper – Eastover) and a power plant (SCE&G Wateree) nearby (~15 km). It is unclear what, if any, influence these industrial facilities have on the SO_2 concentration measured at this monitor, but there appears to be substantial local source contribution when comparing Congaree Bluff to the other two monitors at least in 2013 and 2014.

6.5. SELECTED BACKGROUND VALUES

The Congaree Bluff monitor is removed from consideration because of its poor data quality for 2014 and likely nearby source impacts. Given its more remote location, the Cape Romain monitor may be an underestimate of background SO_2 concentrations in the modeling analysis, though it is also possible that Cape Romain is the best fit for background concentrations at Cross. For conservatism, the Cross facility is using the Jenkins Avenue Fire Station monitor as the background concentration for the cumulative impacts analysis.

6.5.1. Annual Value

The design value concentration of 37.6 $\mu g/m^3$ based on 2012-2014 data from the Jenkins Avenue Fire Station monitor can be added to the design concentration to estimate the total impact as an initial and conservative estimate of background values.[14] However, this modeling report uses the more refined background values developed in Section 6.5.2.

6.5.2. Temporal Values

As a refinement to usage of the annual background value, temporal background values are used consistent with EPA guidance. The temporal values are developed as follows.

- Raw hourly data are first downloaded from EPA online monitor archives (http://aqsdr1.epa.gov/aqsweb/aqstmp/airdata/download_files.html).
- The date and time are then reformatted to match the date and time format used in AERMOD (0-23 hours changed to 1-24 format).
- When determining the design value for a given monitor, incomplete days (having < 75% of the hours reported) are generally excluded from the design value calculation as there was likely something at fault with the monitor. These hours are also excluded from any other background calculations.
- When determining the 1 hour SO_2 design value for a monitor, the H4H of the daily maximums at the monitor is taken for a given year.
- Seasonal and Quarterly cut offs are used to determine the season in which each monitor data point falls, to allow for the generation of a seasonally varying background concentration or (for quarterly cutoffs) are used simply for data completeness checking and QA purposes.
- The highest Xth high for use in the design value calculation is then determined. Depending on the number of complete days, a highest high is selected as being representative of the 99th percentile (based on Appendix T to Part 50). For example, the number of complete days in 2012 was 360 (which is > 300) at the Jenkins monitor, hence a 4th high is representative of the 99th percentile.
- The same highest high logic is applied for each background determination. An hour count is used to determine the highest high for each hour. In each case, the hour count exceeded 300, hence a H4H is used to evaluate the 99th percentile for that hour. Additionally, sometimes a monitor will be calibrated during a

[14] Note that the 2012 ambient data are not representative and are biased high compared to current values due to the cessation of operations at the Jefferies facility; compare 2012-2014 and 2013-2015 as shown in Table 6-1.

specific hour every day, which might only become apparent after counting the number of each of the hours in the dataset. The Jenkins monitor had exceptional data completeness, and therefore it wasn't necessary to continue counting data points for the remaining background determinations.

- To determine the highest high for each background averaging time.
  - Hourly – 365 data points per hour -> 4th High
  - Monthly – Use daily maximums instead of individual hours as data points here (same as the design value). Number of data points = 365/12 = 30.5 days per month-> 1st High
  - Seasonal - ~90 days per season, however according to a 1-hour NO_2 modeling guidance document, a 1st high would not mimic the form of the standard appropriately. Typically, 3 values can be ignored in the design value (taking H4H), while a 1st high by season would ignore 0 monitored values. To be commensurate with the SO_2 standard, the 2nd high should be taken, which results in excluding the first 4 monitored values (one for each season) which is more representative of the standard, than taking a 1st high approach.
  - Seasonal Hourly – Same as seasonal
  - Monthly Hourly – Same as monthly
- Once background determinations are made for each year, they are averaged over the 3 year data set, commensurate with the form of the 1 hour SO_2 standard.

Figures 6-1 and 6-2 plot the results of the temporal analysis of background SO_2 values.

Figure 6-1. Background SO_2 by Month or Season

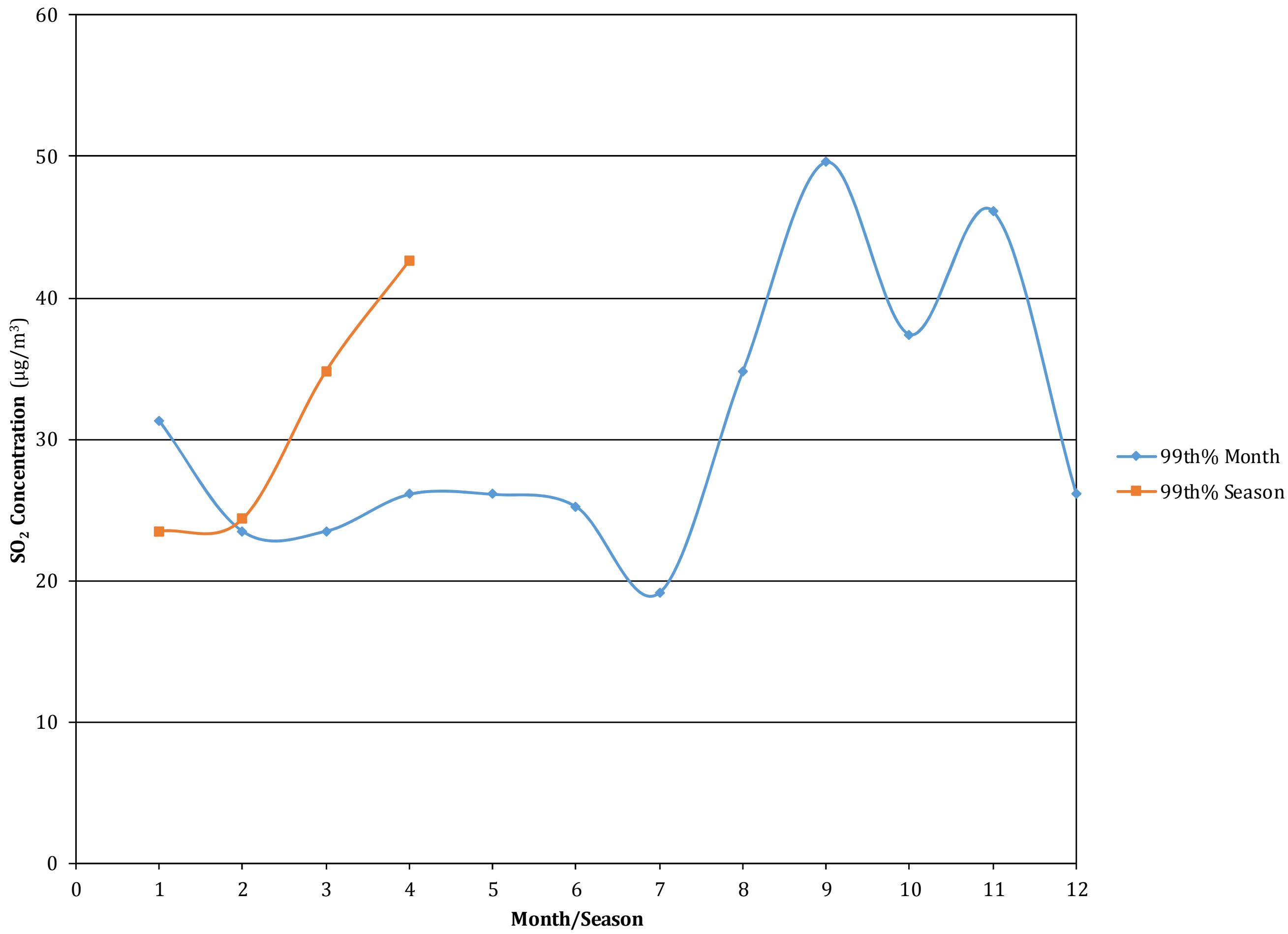
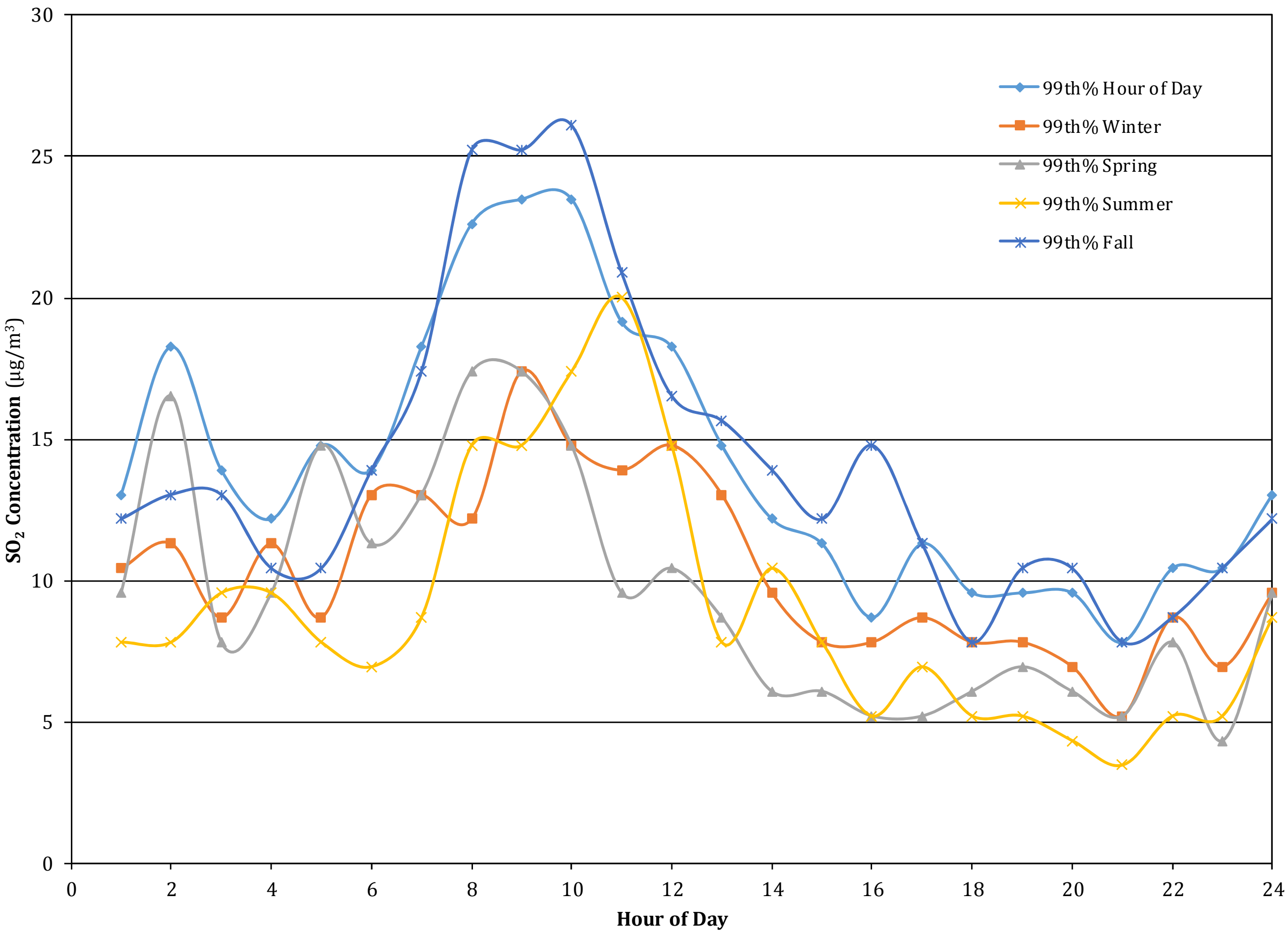


Figure 6-2. Background SO_2 by Hour of Day



For this modeling report, Santee Cooper has elected to use the seasonal hourly background values as shown in Figure 6-2 for Winter, Spring, Summer and Fall. To appropriately pair the seasonal hourly background values with the modeled concentrations for Cross, the 96 seasonal hourly background values (24 hours per day times 4 seasons) are added to the SO section of the model input file using SO BACKGRND SEASHR.

7. 1-HR SO_2 NAAQS MODELING RESULTS

Table 7-1 shows the results of the modeling analysis. Maximum air quality impacts are well below the NAAQS.

Table 7-1. Modeled Results for Comparison to NAAQS

Highest	Receptor Location UTM X (m)	UTM Y (m)	Cross + Background ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)	% of NAAQS (%)
1ST	583,000	3,694,400	87.663	196	44.7%
2ND	583,000	3,694,500	87.331		44.6%
3RD	582,900	3,694,400	87.058		44.4%
4TH	583,100	3,694,500	86.816		44.3%
5TH	583,000	3,694,300	86.713		44.2%
6TH	583,000	3,694,600	86.698		44.2%
7TH	583,000	3,694,800	86.592		44.2%
8TH	583,100	3,694,400	86.372		44.1%
9TH	582,900	3,694,300	86.307		44.0%
10TH	583,000	3,694,700	85.870		43.8%

Inspection of the figures in Appendix C shows that the maximum impacts are all captured by the 100 m grid and are generally to the north and north-northeast of the site. The highest 10 impacts are 100 m east and west of the maximum impact; in north and south direction from the maximum impact, the highest 10 impacts are from 100 m south (i.e., closer to Cross) to 400 m north (i.e., further from Cross).

8. LIST OF ELECTRONIC FILES

Included in electronic form are all of the input and output data used to generate the results from the air quality analyses presented in the concentration gradient analysis (Section 3.1.2.4) and the results analysis (Section 7) of this report.

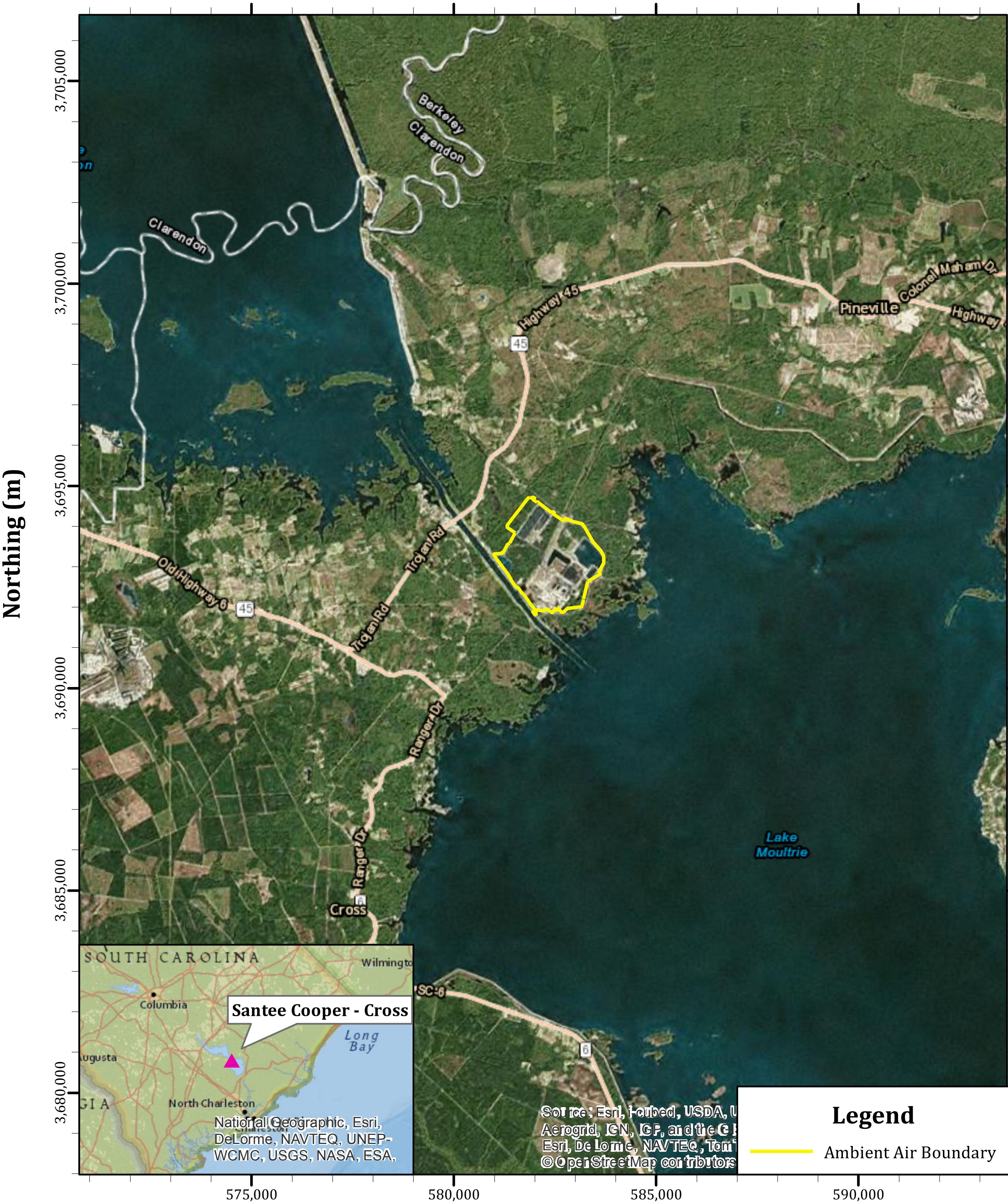
The following provide a summary of the contents of each folder submitted to DEQ.

- BPIP data
  - BPIP input and output files
- Concentration gradient analysis data
  - AERMAP
    - AERMAP input and output files for each of the three candidate inventory emission sources that do not screen out at 20-D
    - One third arc-second NED (.tif) files that are used in the AERMOD runs
  - AERMET
    - Surface (.sfc) and profile (.pfl) meteorological data files that are used in the analysis
  - AERMOD
    - AERMOD input (.ami) and output (.aml) files from the concentration gradient analysis
    - Hourly emissions file for SCE&G Williams
- Results data
  - AERMAP
    - AERMAP input and output
    - One third arc-second NED (.tif) files that are used in the AERMOD runs
  - AERMET
    - Surface (.sfc) and profile (.pfl) meteorological data files that are used in the analysis
  - AERMOD
    - AERMOD input (.ami) and output (.aml and .plt) files from the analysis
    - Hourly emissions file for Santee Cooper-Cross
- NAAQS AERMOD data

APPENDIX A: ARCMAP PROTOCOL FIGURES

Figure A-1: Cross Facility Location

Berkeley County, South Carolina



All coordinates shown in UTM projection, Zone 17, NAD83

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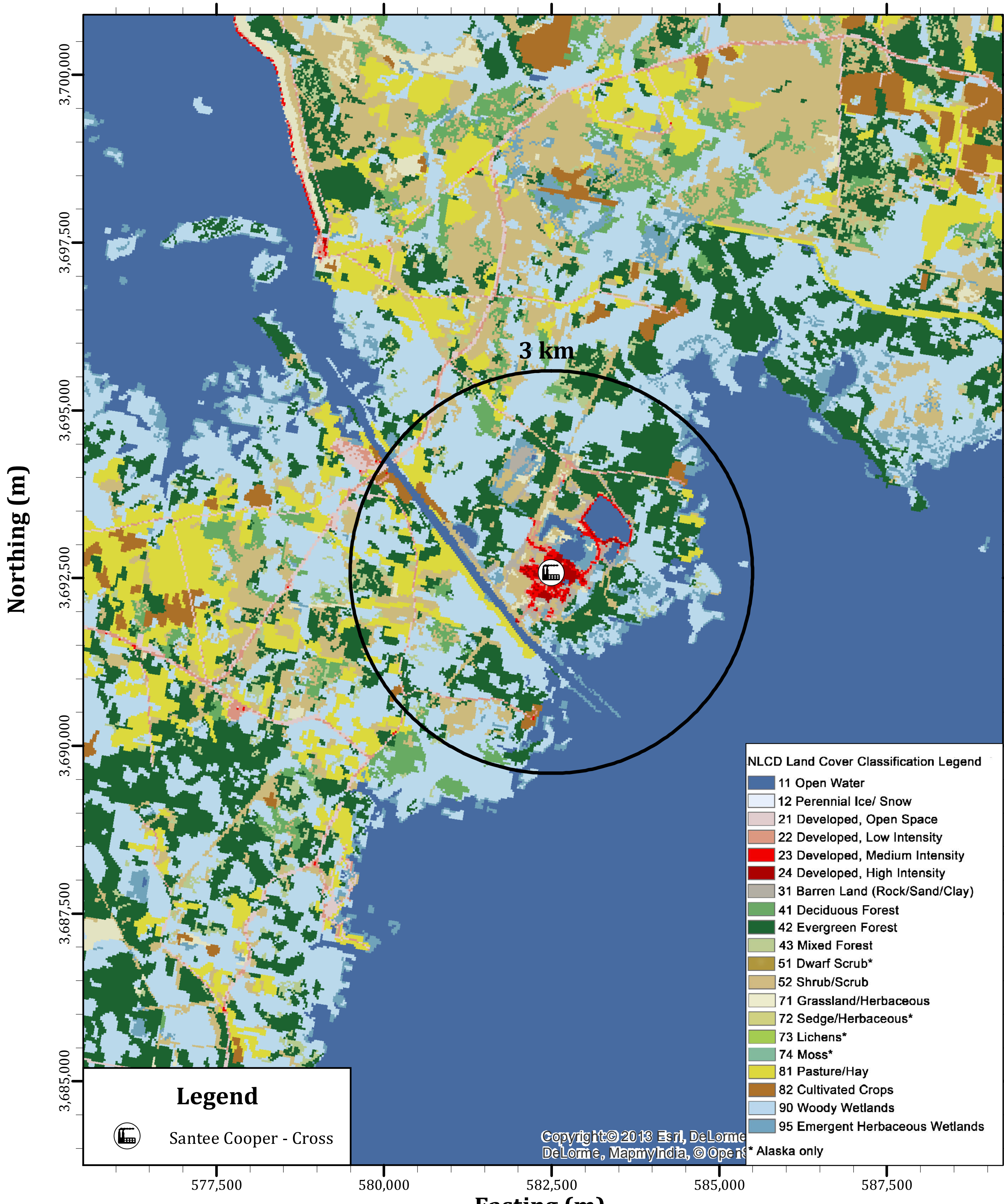
Figure A-2: 2001 NLCD

Berkeley County, South Carolina



All coordinates shown in UTM projection, Zone 17, NAD83

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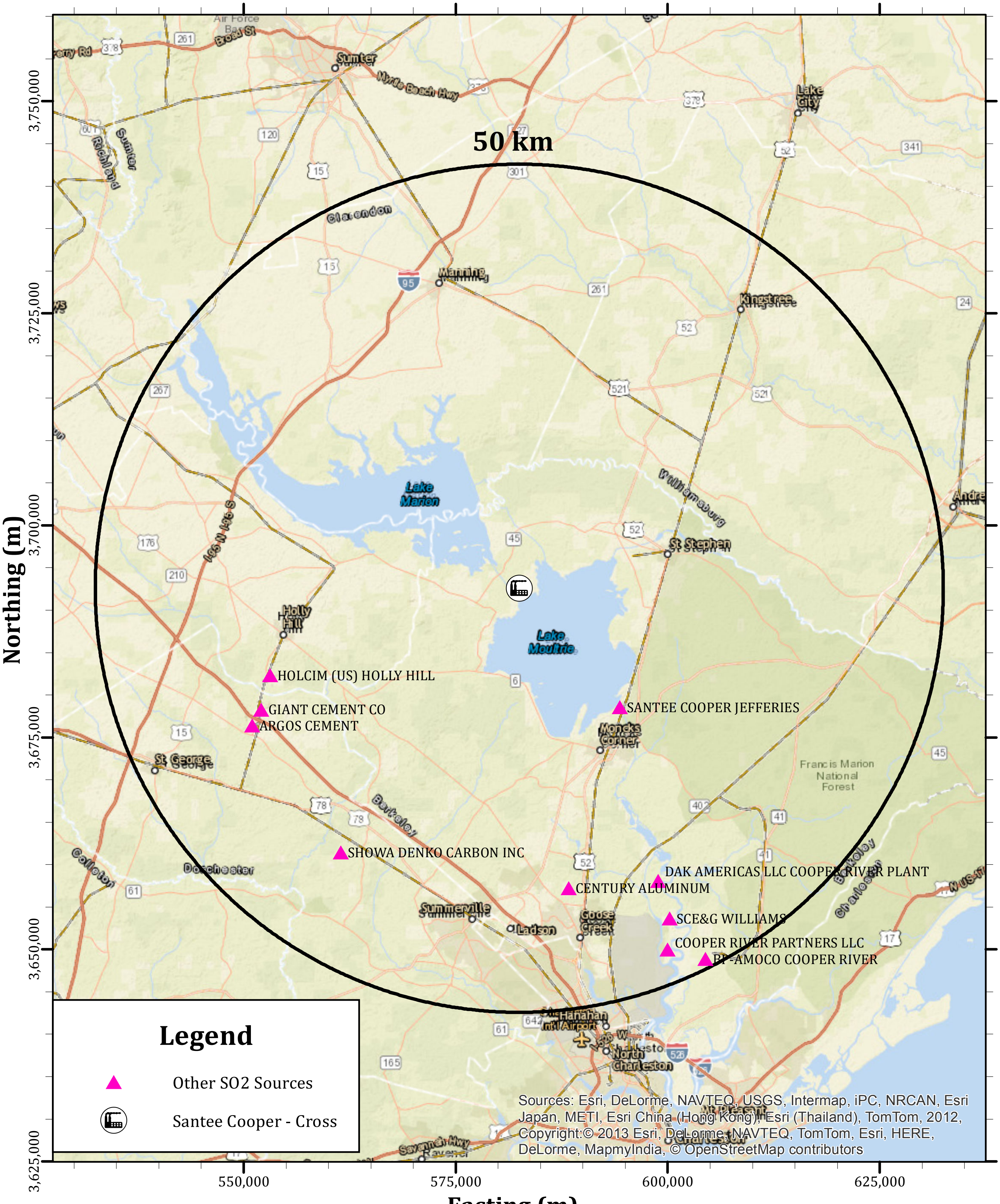
Figure A-3: Nearby SO_2 Source Locations

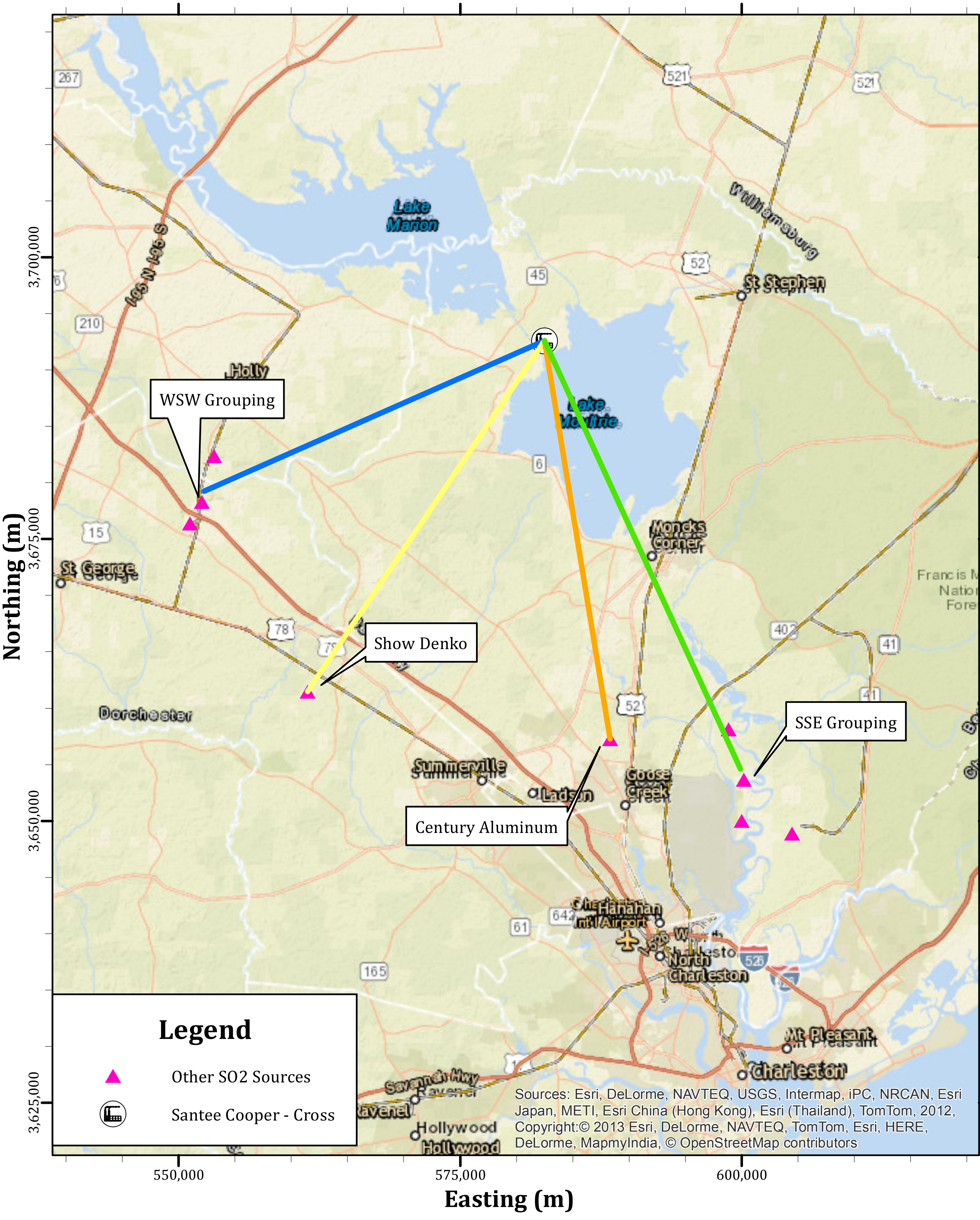
Santee Cooper Cross Generating Station



All coordinates shown in UTM projection,
Zone 17, NAD83

Figure A-4: Concentration Gradient Receptor Map

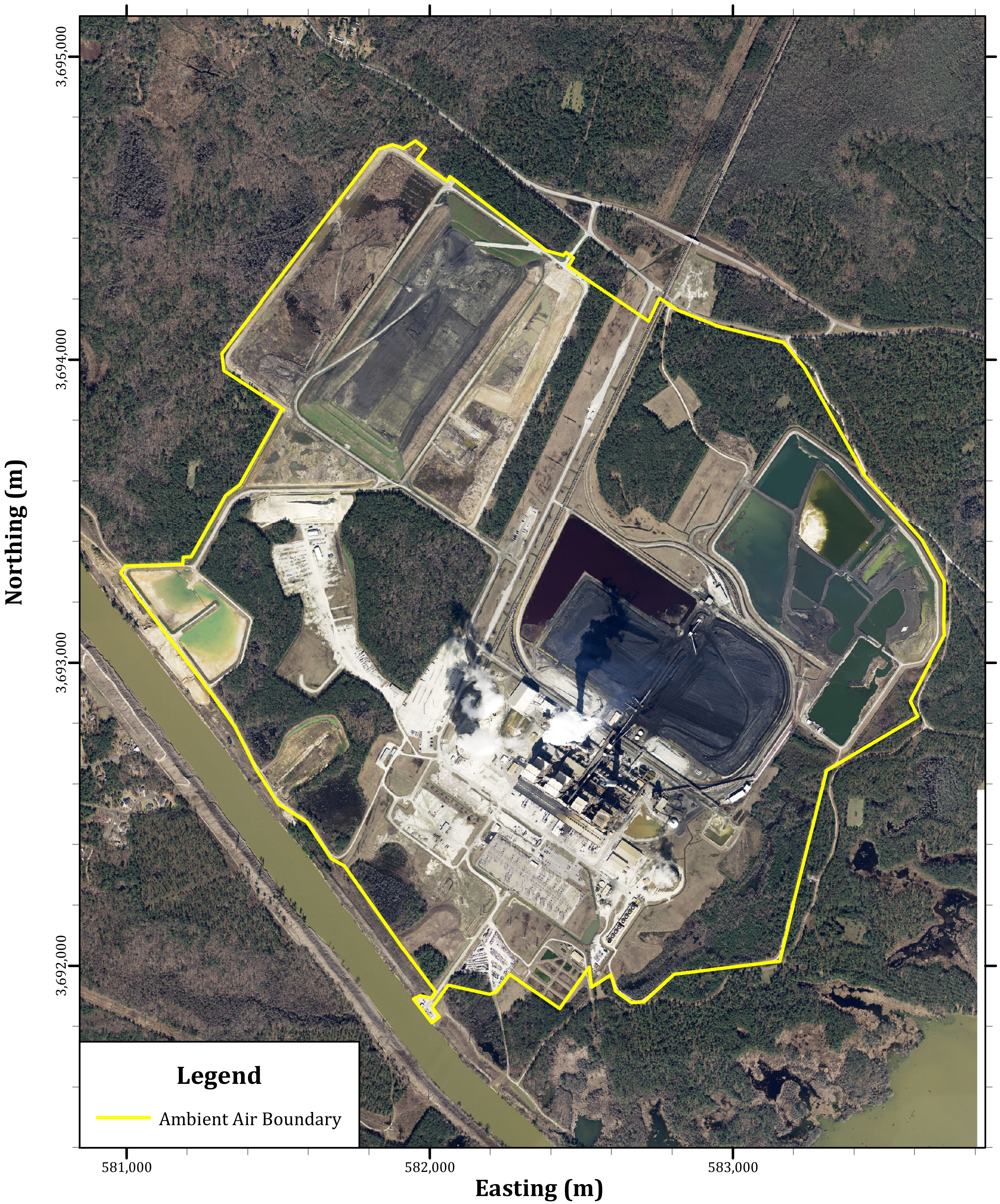
Santee Cooper Cross Generating Station



All coordinates shown in UTM projection,
Zone 17, NAD83

Figure A-5: Ambient Air Boundary

Santee Cooper Cross Generating Station



All coordinates shown in UTM projection,
Zone 17, NAD83

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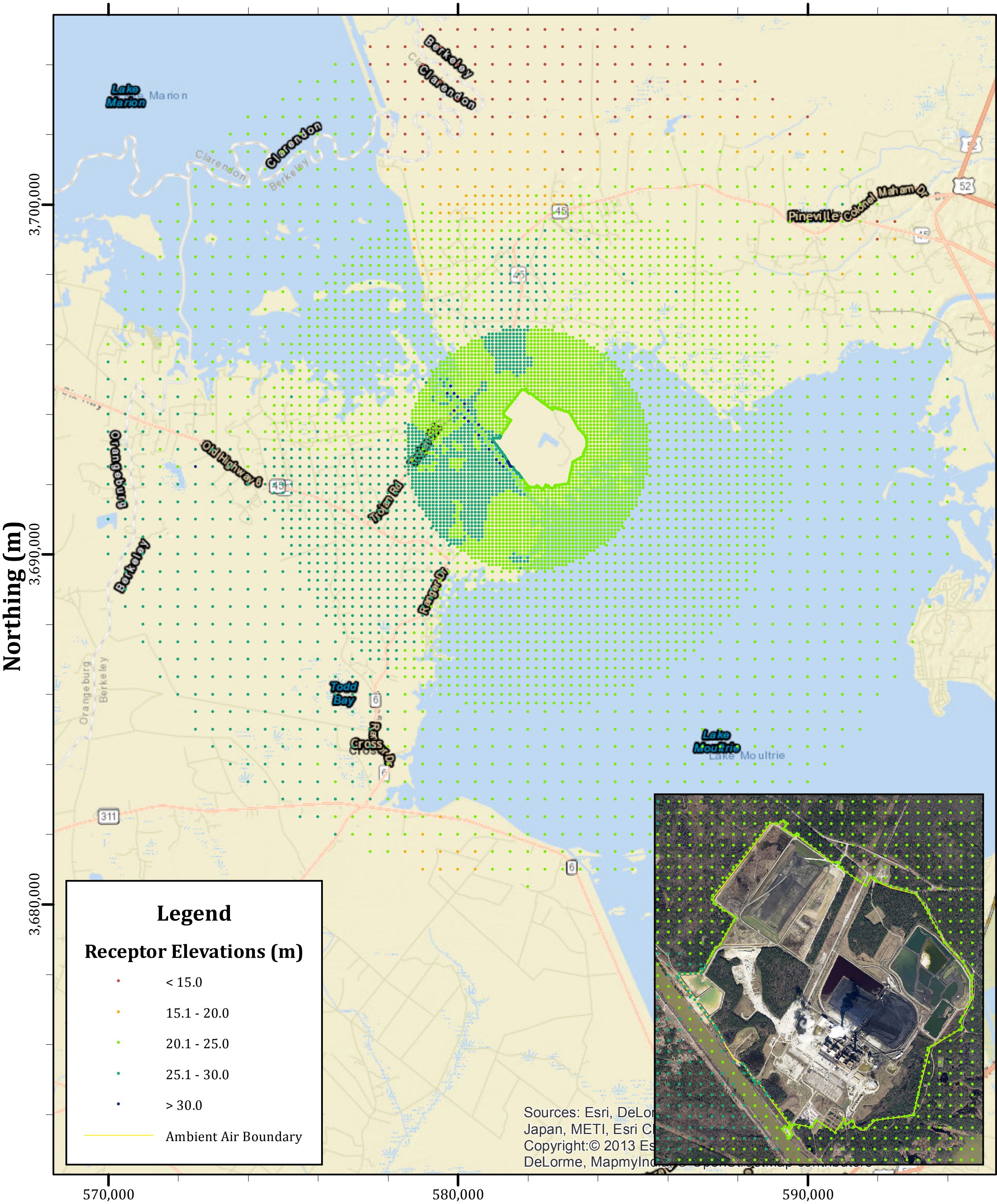
Figure A-6: Receptor Elevations

Santee Cooper Cross Generating Station



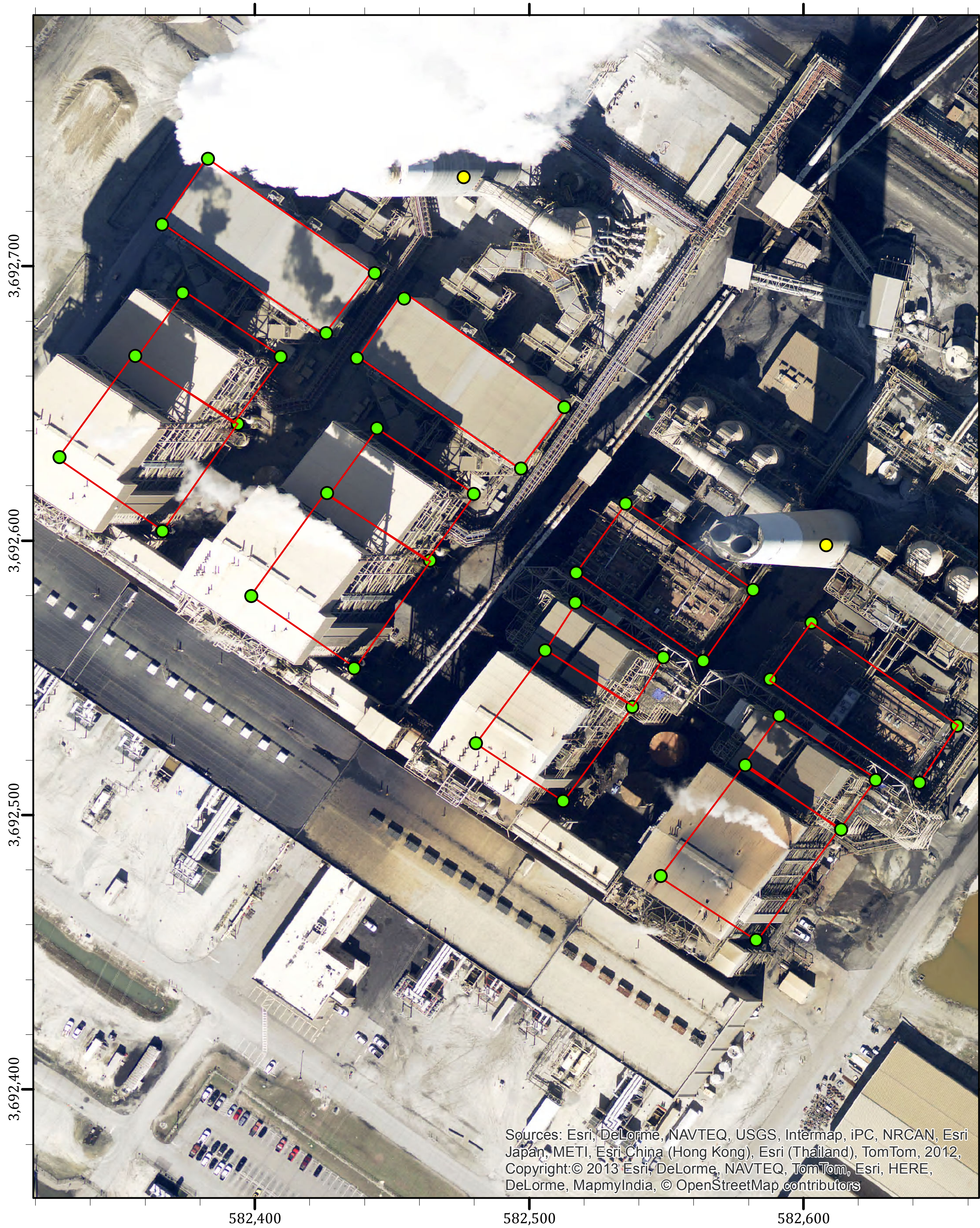
Northing (m)

Easting (m)

All coordinates shown in UTM projection, Zone 17, NAD83

Figure A-7: Buildings and Stacks

Santee Cooper Cross Generating Station



All coordinates shown in UTM projection,
Zone 17, NAD83

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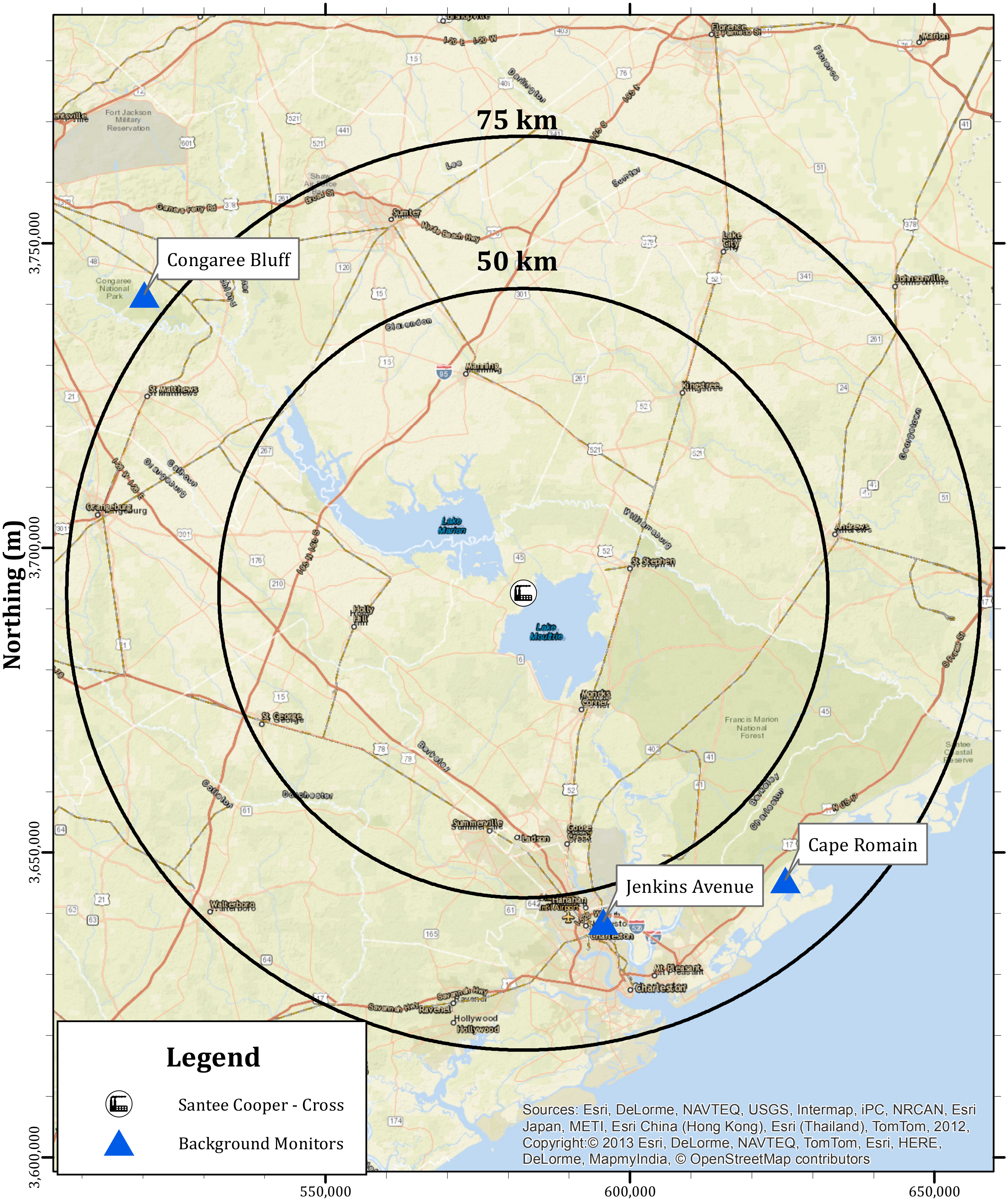
Figure A-8: Background Monitor Locations

Santee Cooper Cross Generating Station



All coordinates shown in UTM projection, Zone 17, NAD83

APPENDIX B: CONCENTRATION GRADIENT PLOTS

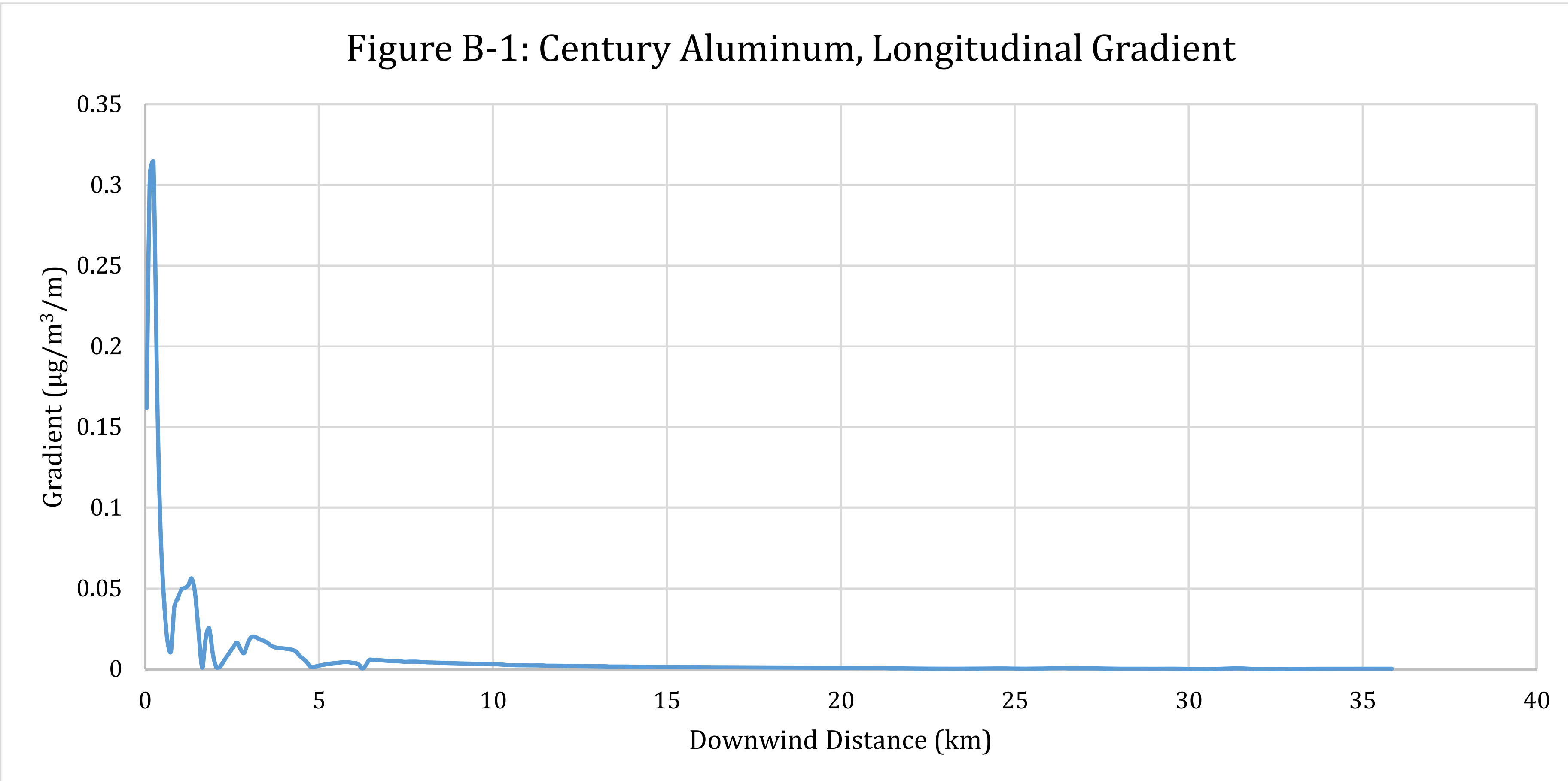


Figure B-1: Century Aluminum, Longitudinal Gradient
Gradient (µg/m3/m)
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
5
10
15
20
25
30
35
40
Downwind Distance (km)

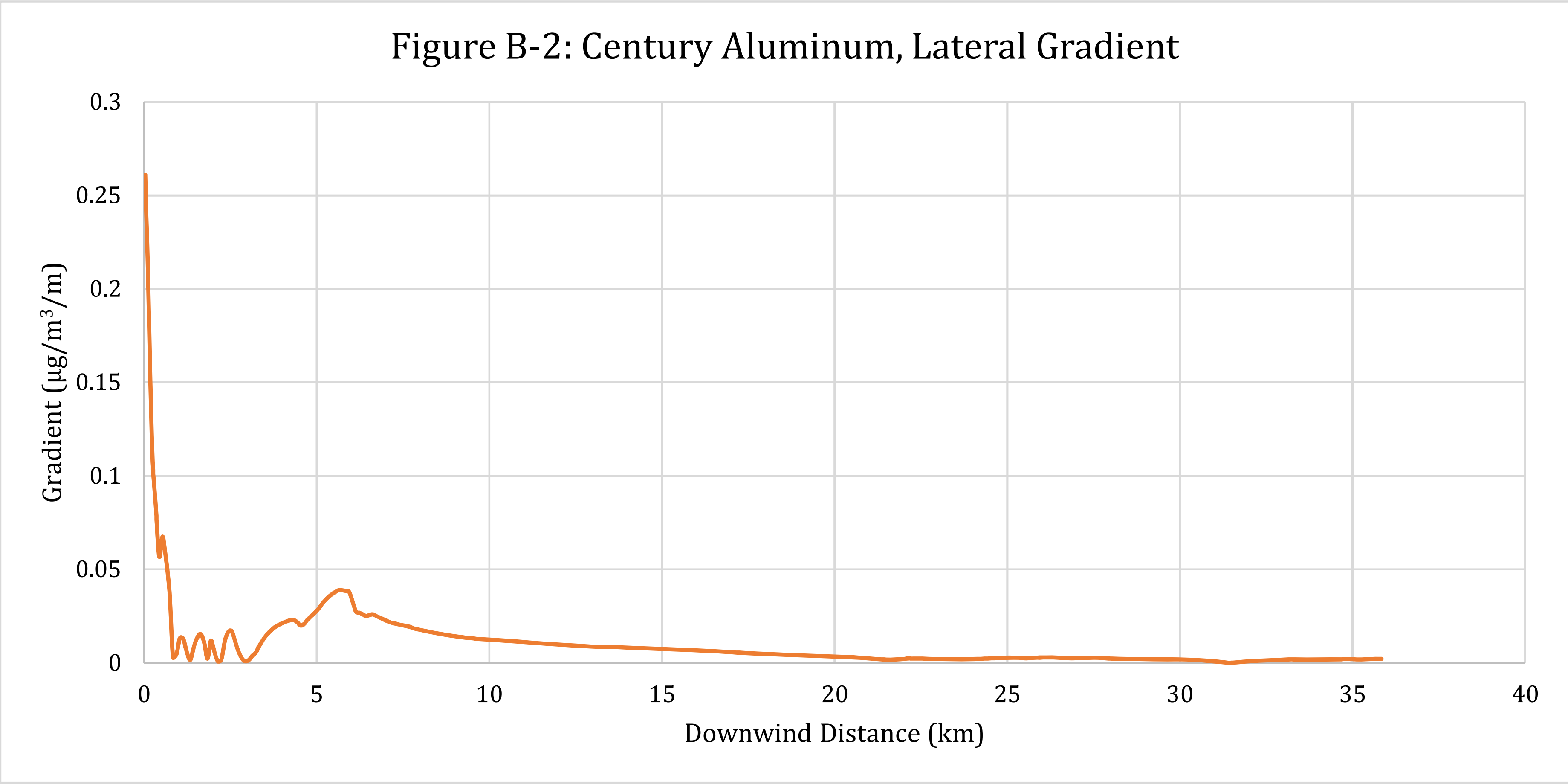
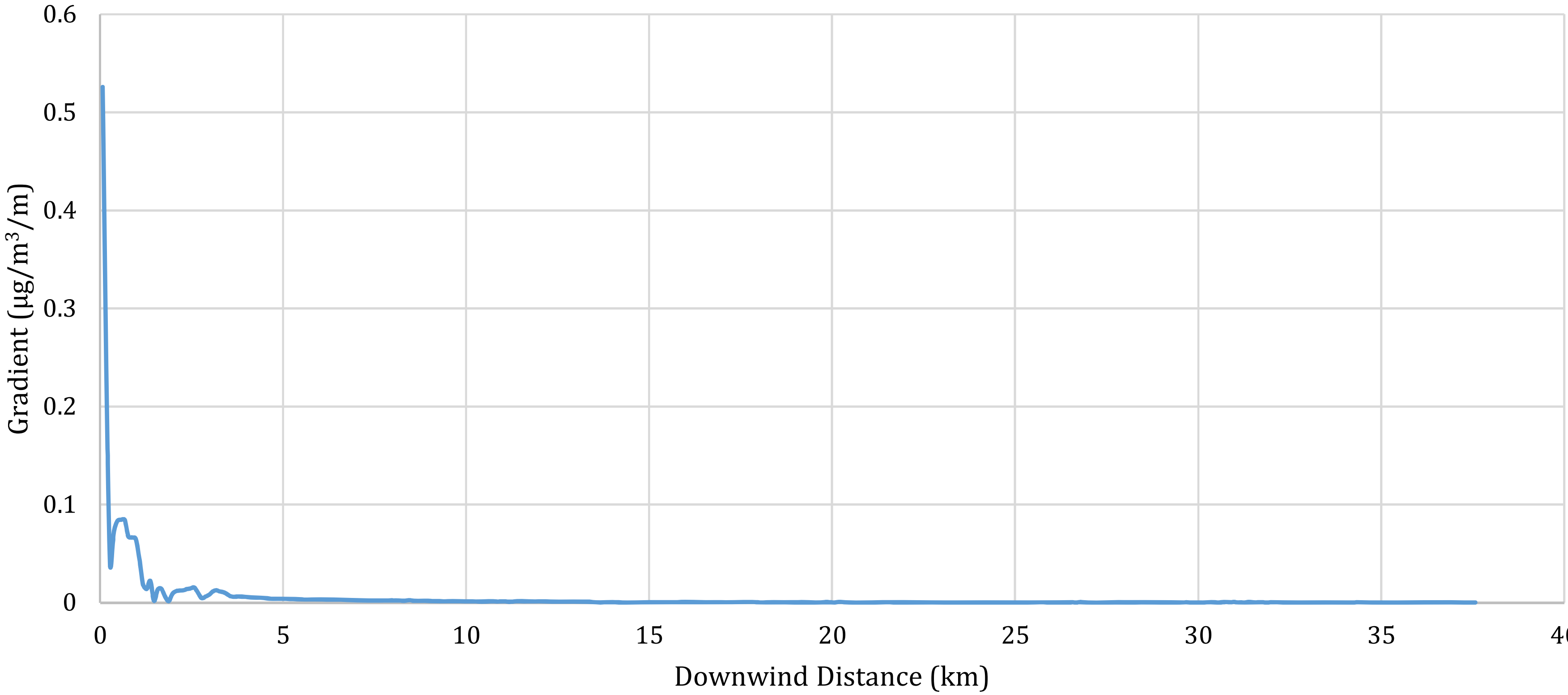


Figure B-2: Century Aluminum, Lateral Gradient
Gradient (µg/m3/m)
0.3
0.25
0.2
0.15
0.1
0.05
0
0
5
10
15
20
25
30
35
40
Downwind Distance (km)

Figure B-3: Showa Denko, Longitudinal Gradient



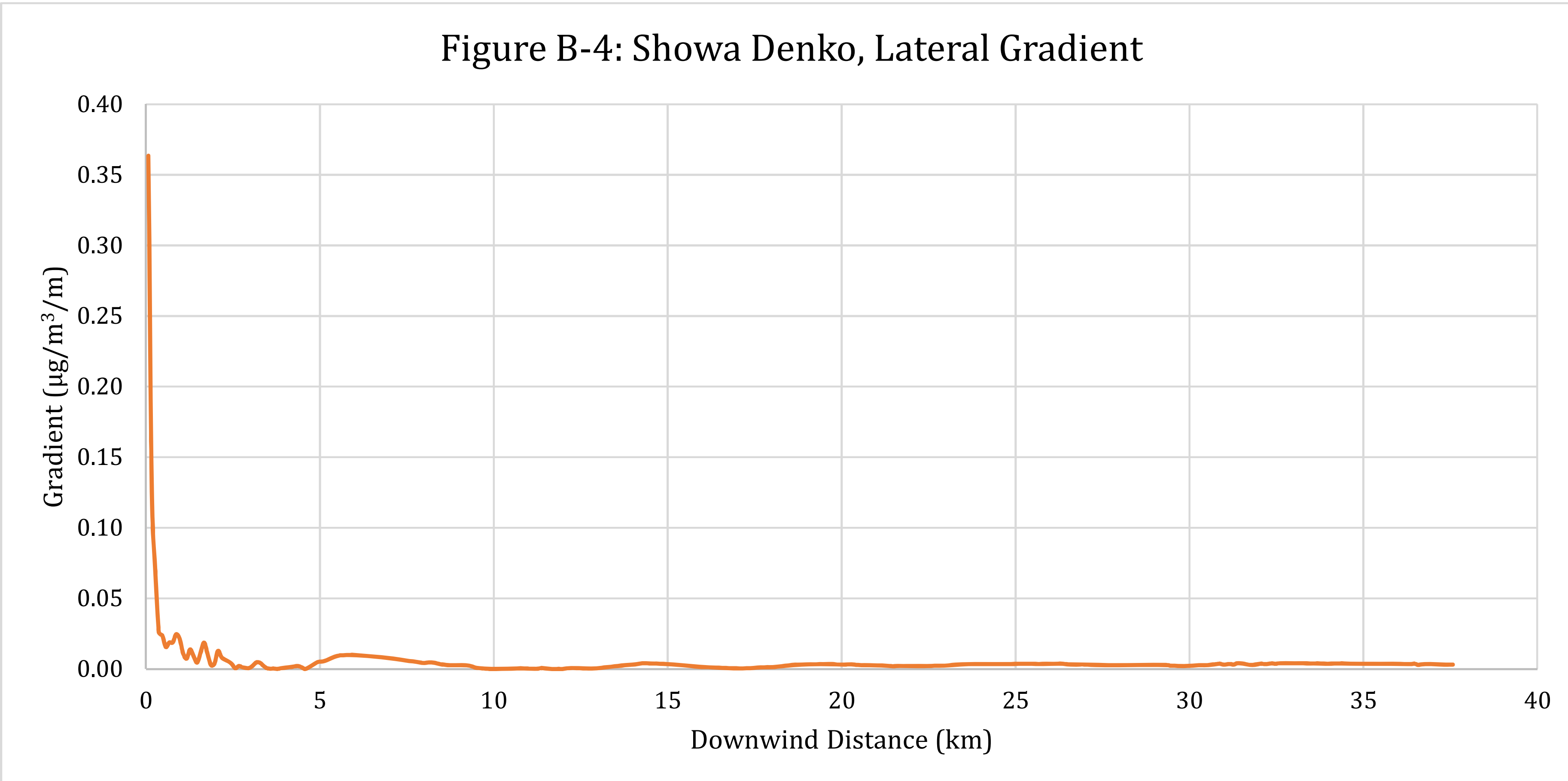


Figure B-4: Showa Denko, Lateral Gradient
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Gradient (µg/m³/m)
0
5
10
15
20
25
30
35
40
Downwind Distance (km)

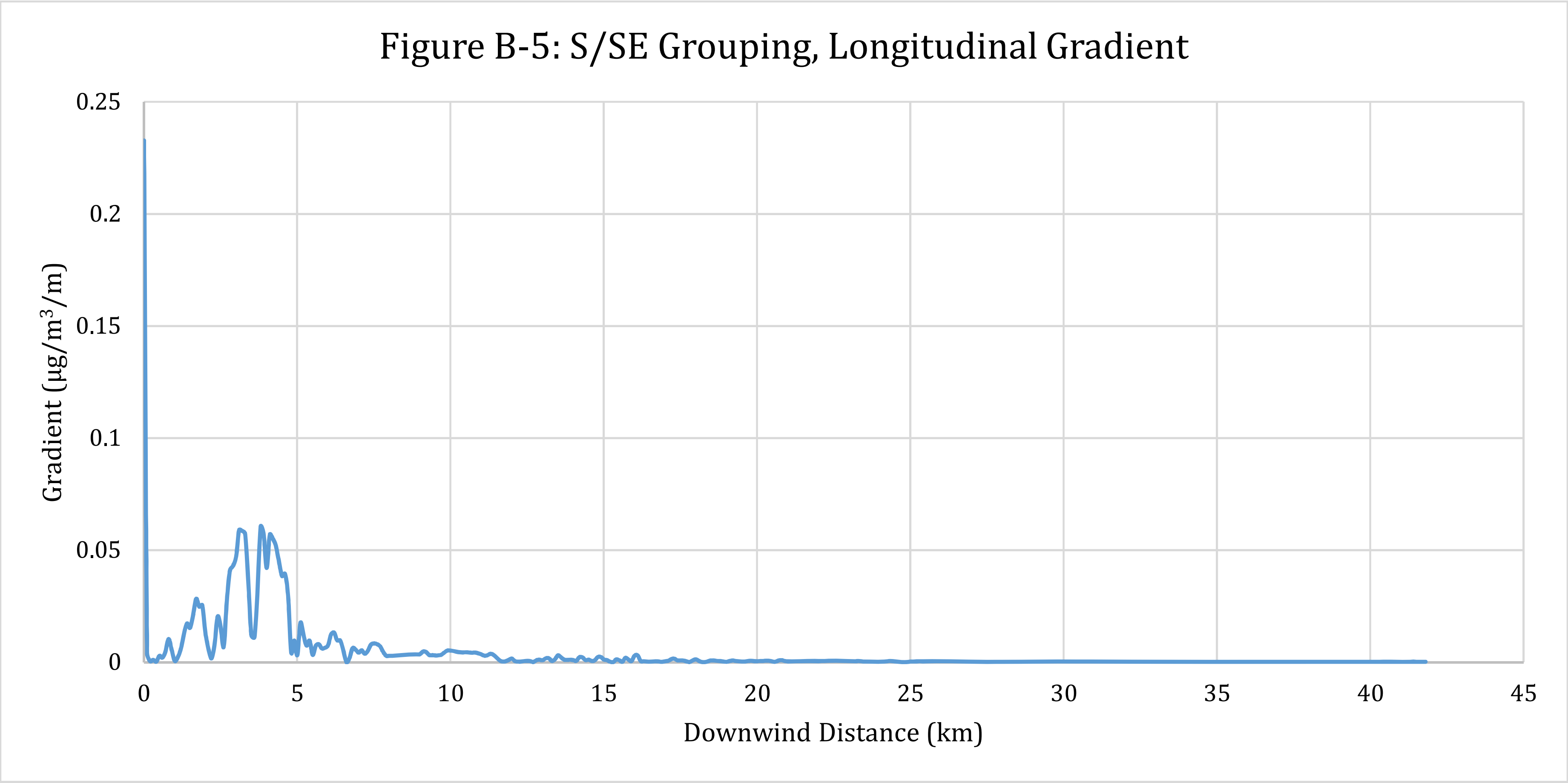


Figure B-5: S/SE Grouping, Longitudinal Gradient
0.25
0.2
0.15
0.1
0.05
0
Gradient (µg/m3/m)
0
5
10
15
20
25
30
35
40
45
Downwind Distance (km)

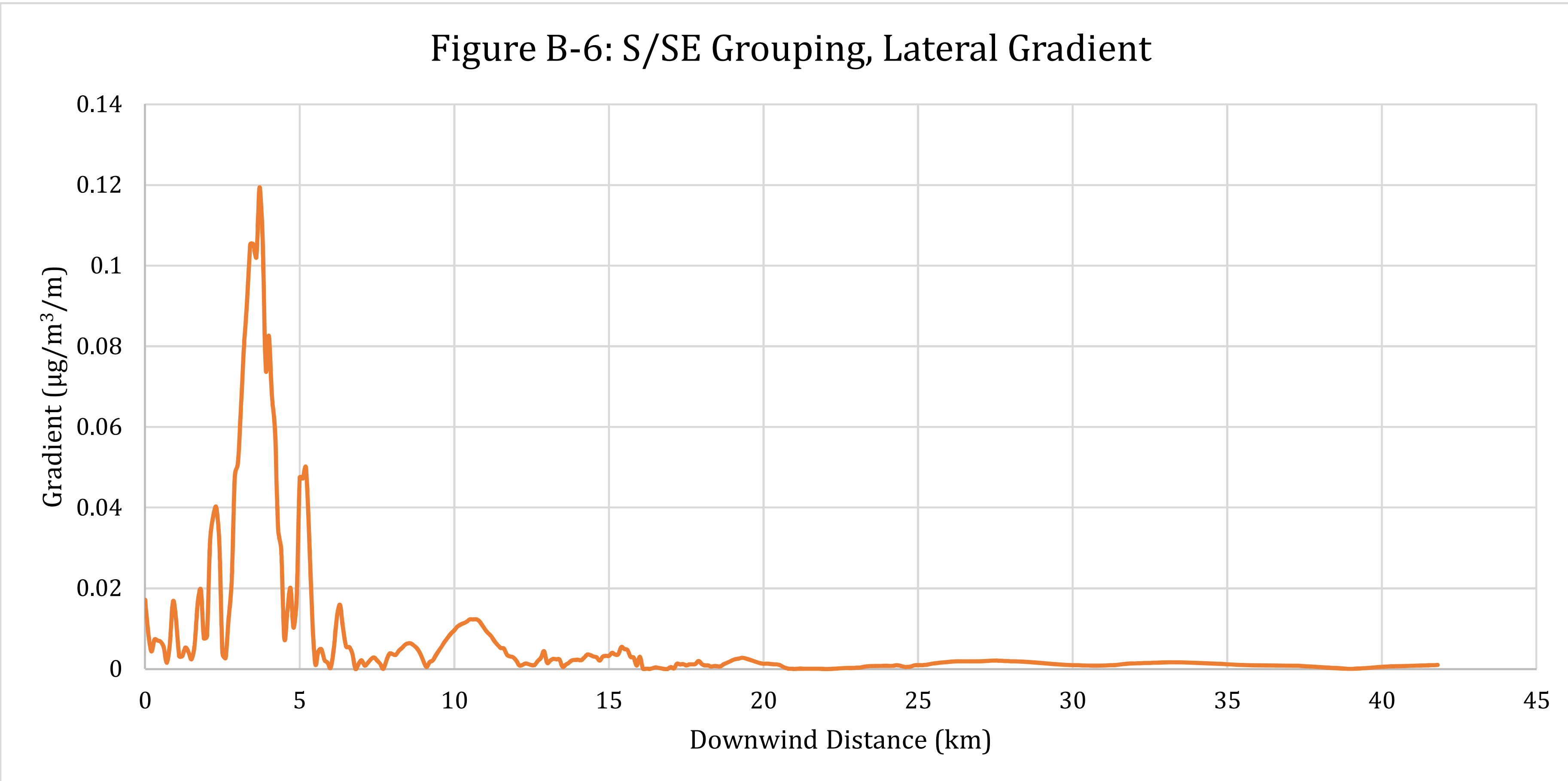


Figure B-6: S/SE Grouping, Lateral Gradient
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Gradient (μg/m3/m)
0
5
10
15
20
25
30
35
40
45
Downwind Distance (km)

Figure B-7: W/SW Grouping, Longitudinal Gradient

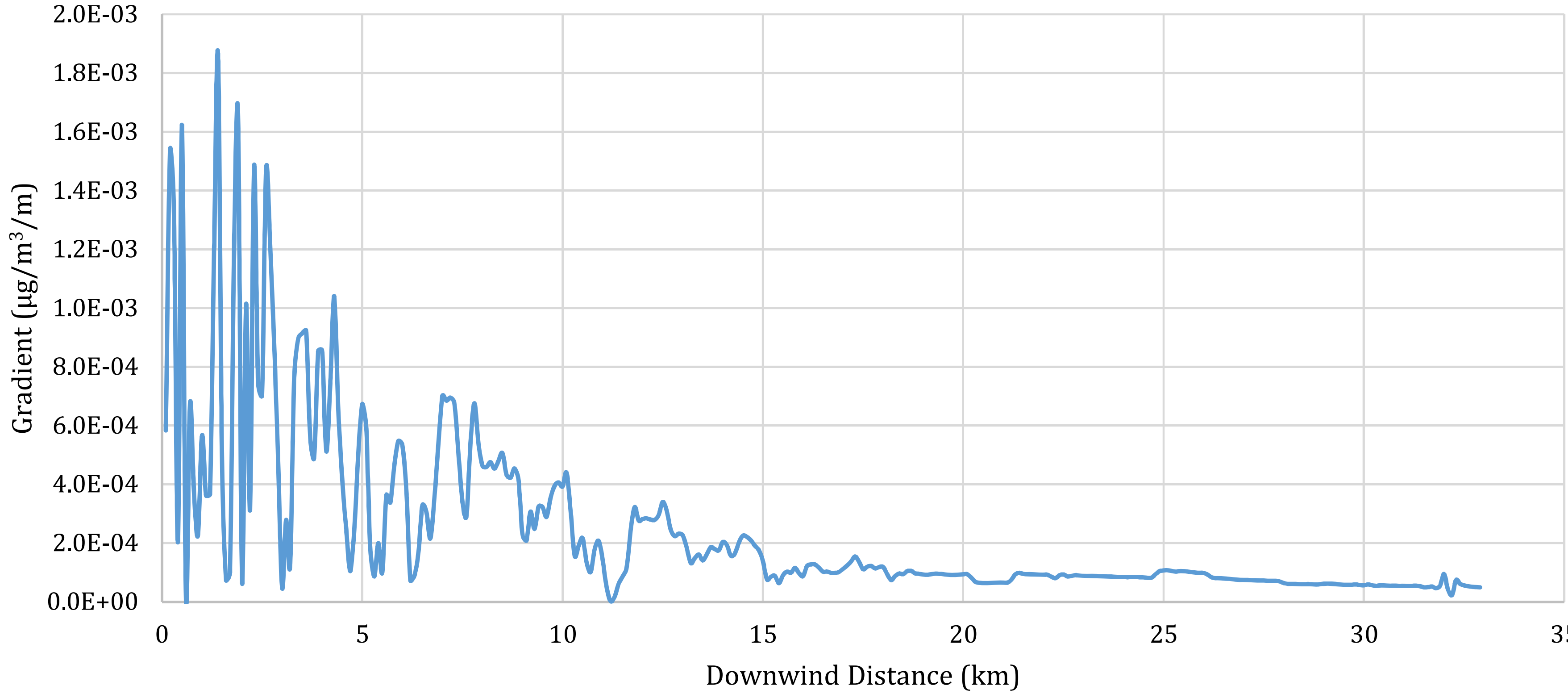
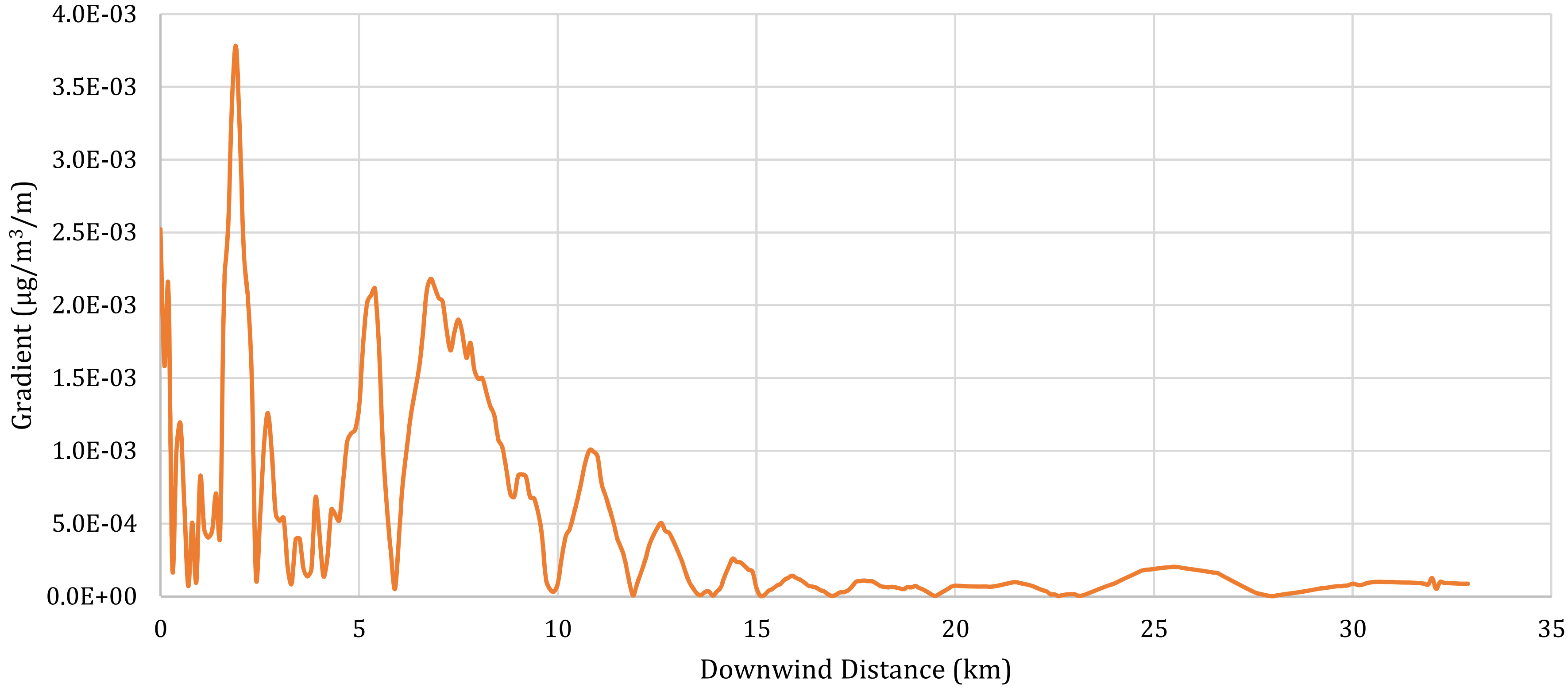


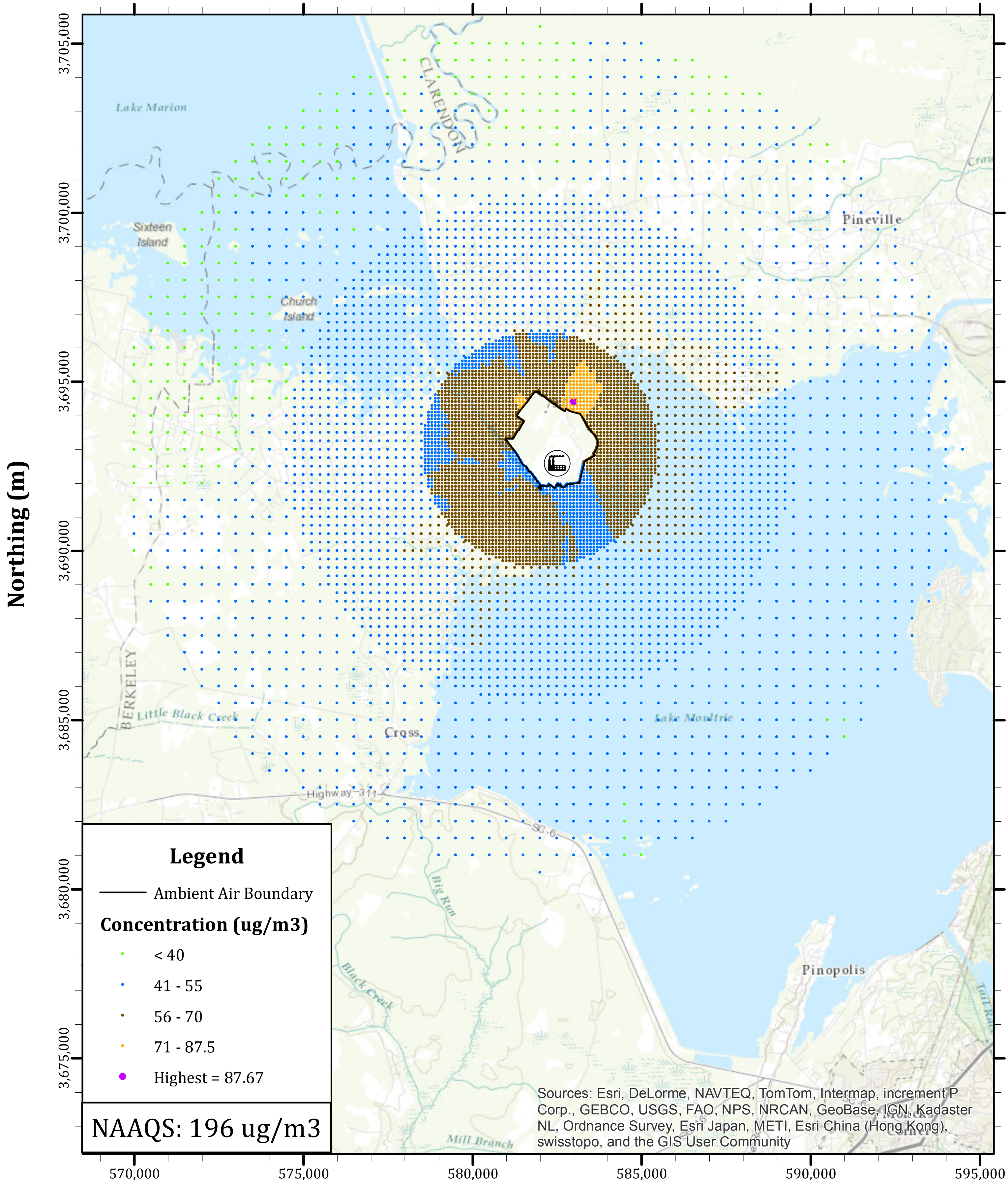
Figure B-8: W/SW Grouping, Lateral Gradient



APPENDIX C: MODELING RESULTS

Figure C-1: Modeled NAAQS Impacts, Cross and Background

Santee Cooper Cross Generating Station



All coordinates shown in UTM projection,
Zone 17, NAD83

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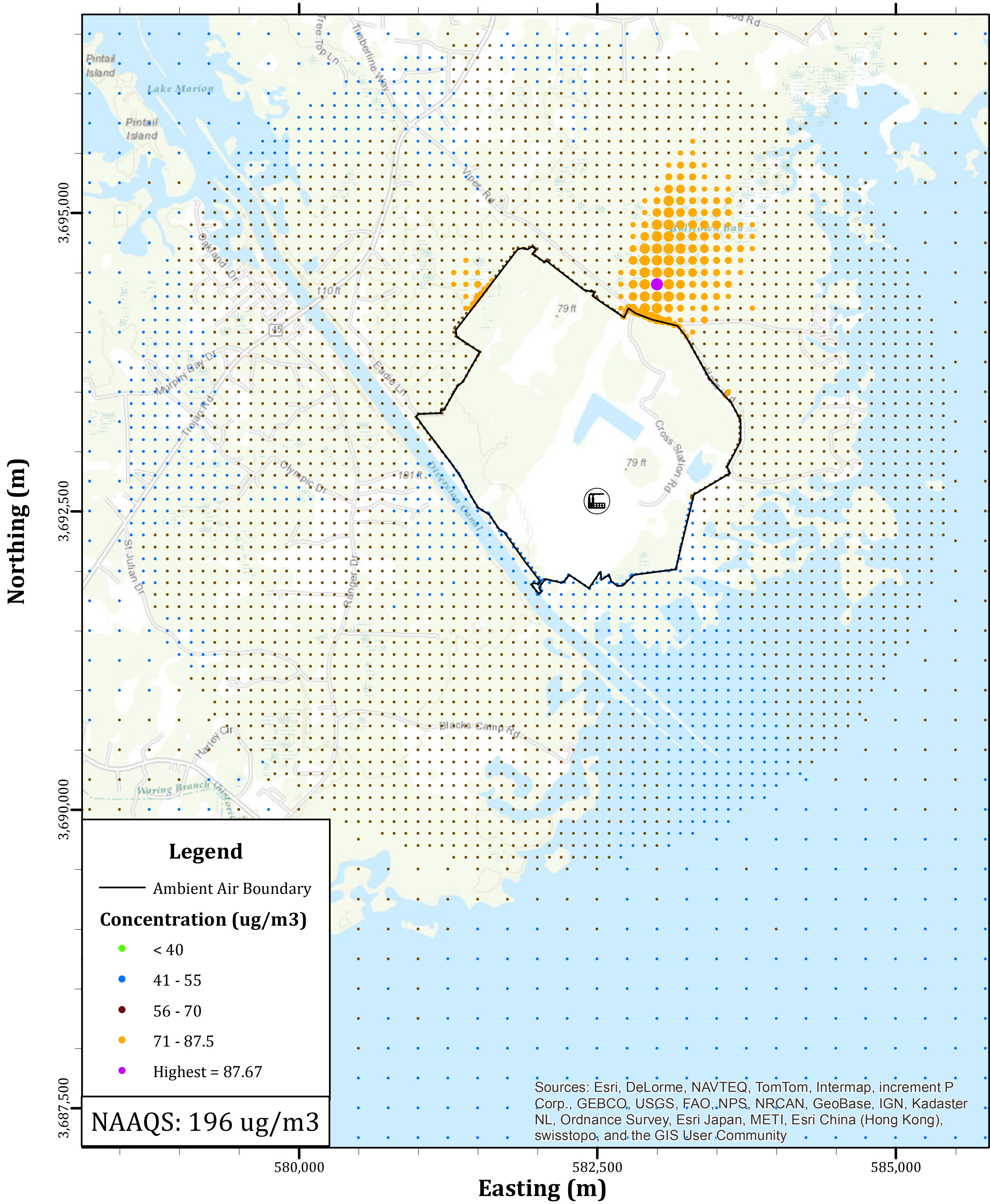
Figure C-2: Modeled NAAQS Impacts, Cross and Background

Santee Cooper Cross Generating Station



All coordinates shown in UTM projection, Zone 17, NAD83

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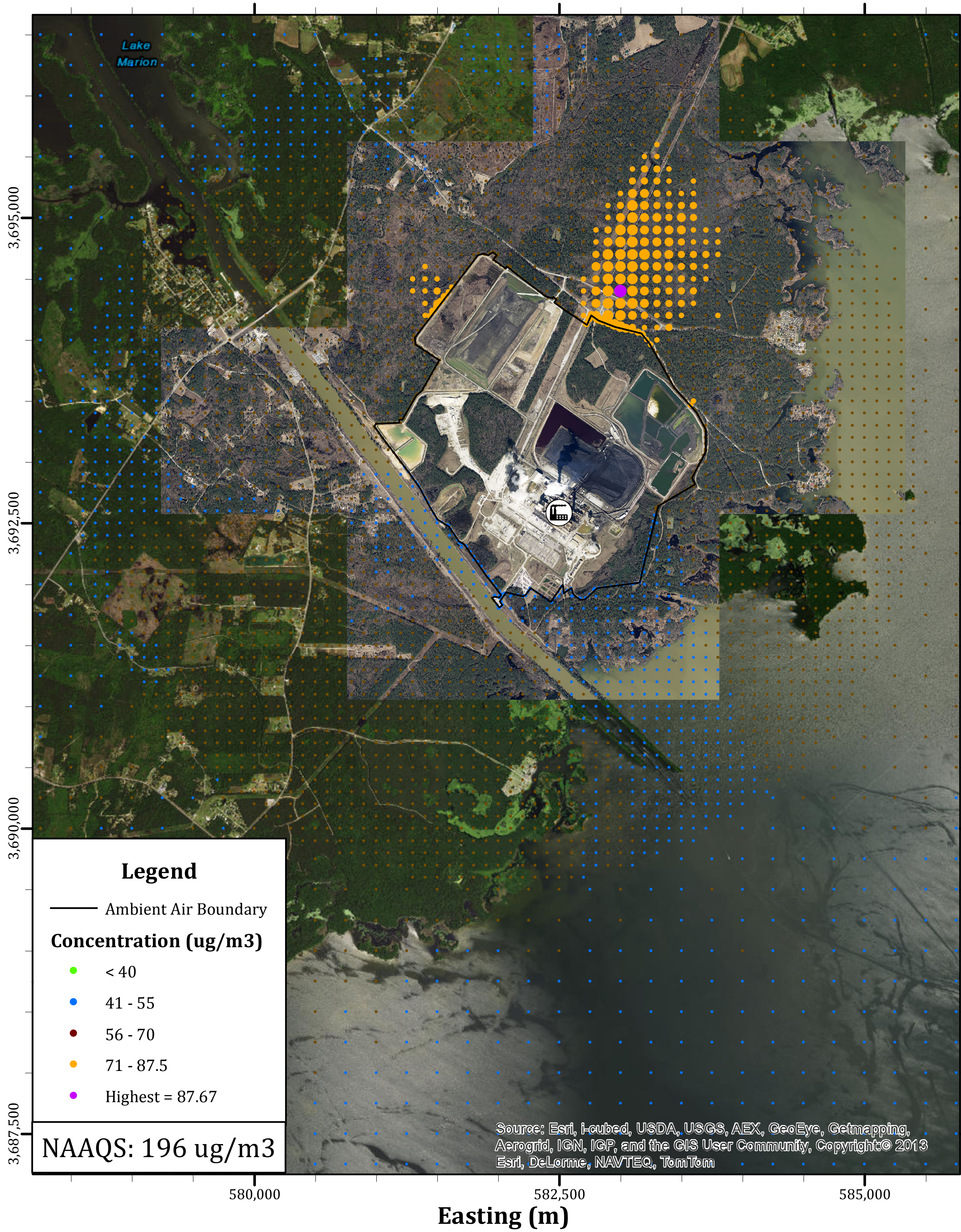
Figure C-3: Modeled NAAQS Impacts, Cross and Background

Santee Cooper Cross Generating Station



All coordinates shown in UTM projection,
Zone 17, NAD83

Trinity Consultants