BART DETERMINATION FOR INTERSTATE PAPER

Interstate Resources Incorporated owns and operates paper facility called Interstate Paper located in Riceboro, Georgia. Interstate Paper is located within 100 Km of Wolf Island Class I area and Okefenokee Wilderness Class I area.

To be BART eligible a source must fall within one of the 26 BART eligible source categories included in Clean Air Act, The source must have been in existence on August 7, 1977 and must have began operation after August 7, 1962 and the source must have potential emissions of visibility impairing pollutant of 250 tons per year or more. Three of Interstate Paper's units satisfy these criteria and hence are BART eligible. These three units are Power Boiler (F1), Recovery Boiler (F3), and Lime Kiln (F4).

INTRODUCTION TO BART ANALYSIS

The Best Available Retrofit Technology (BART) analysis follows the "five factor" approach. The basic steps of a "five factor" analysis are as follows:

1. Cost of Controls
2. Energy and non-air quality environmental impacts
3. Existing controls at the source
4. Remaining useful life of the source
5. Visibility improvement reasonably expected from the controls

A detailed description of cost of controls for BART-subject units at Interstate Paper, LLC mill in Riceboro, Georgia is given in the BART engineering analysis section. Most of the control costs were obtained from AirControlNET-4.1. Fuel switching cost was based on the facilities fuel usage and the cost of fuel in 2007 based on number provided by the facility itself. This section also gives an in-depth description and usage of the existing controls at the source.

There are no known energy and non-air quality environmental impacts related to BART determined controls for Interstate paper, LLC. Remaining useful life of the source is known to be at least 10 years. Visibility improvement reasonably expected from application of the controls is described in the modeling analysis section.

Georgia EPD performed the five steps for each visibility-affecting pollutant emitted from the BART-subject units. Relevant pollutants are only: sulfur dioxide (SO_2), nitrogen oxides (NO_x) and particulate matter (PM_{10}). The following sections provide detailed engineering and modeling analysis for each BART-subject unit.

1.0 ENGINEERING ANALYSIS METHODOLOGY

The Best Available Retrofit Technology (BART) engineering analysis in this application follows the "top-down" approach. The "top-down" approach starts with the most stringent control technology alternative that has been applied to similar sources and provides a basis for rejecting this alternative in favor of the next most stringent technology or proposing it as BART. The basic steps of a "top-down" analysis are as follows:

1. Identify all control strategies
2. Eliminate technically infeasible options
3. Rank remaining control strategies by control effectiveness or efficiency
4. Eliminate economically infeasible ones
5. Evaluate most effective controls and document results for BART recommendation

Georgia EPD performed the five steps for each visibility-affecting pollutant. Georgia EPD has determined that the relevant pollutants are only: sulfur dioxide (SO_2), nitrogen oxides (NO_x) and particulate matter (PM_{10}).

The following sections provide a detailed engineering analysis for each BART-eligible unit.

2.0 BART ENGINEERING ANALYSIS FOR RECOVERY BOILER

2.1 SOURCE DESCRIPTION

The Recovery Boiler (F3) is a low odor, indirect contact evaporator design. It fulfills the following essential functions:

1. Evaporates the residual moisture from the black liquor solids.
2. Burns the organic constituents.
3. Produces steam.
4. Produces sodium carbonate and sodium sulfides in molten form

Black liquor with more than 68% solids is fired into the recovery boiler where the organics from the black liquor are burned off in a reducing atmosphere generating steam, molten sodium carbonate and sodium sulfides.

Air pollutants emitted from the recovery boiler include all the three BART relevant pollutants i.e. sulfur dioxide (SO_2), 2.46 tons/yr, nitrogen oxides (NO_x), 349.92 tons/yr, and particulate matter (PM_{10}), 0.5 tons/yr. Emissions of the Recovery Boiler currently pass through a venturi scrubber.

2.2 PARTICULATE MATTER

Step 1.0-Identification of Control Technologies

Emission control equipments that may be considered to control particulate matter emissions from recovery boilers include ESP's, baghouses and high efficiency wet scrubbers. Each of these types of control equipments is capable of significantly reducing particulate matter emissions.

Step 2.0-Technical feasibility Analysis of the identified Control Technologies

While baghouses can achieve high levels of particulate matter control, the exhaust gas streams from recovery boilers have relatively high moisture contents that cause the particulate matter to be hydroscopic in nature. These characteristics of the gas will result in clogging up of the bag filters in the baghouse. This indicates that baghouses are not a good control option for recovery boilers. Therefore, baghouses are not considered further as part of this BART analysis.

ESP's and wet scrubbers are feasible technologies for reducing particulate matter emissions from recovery boilers, with ESP's having 99+% of control efficiency and wet scrubbers having 98+% of control efficiency.

Step 3.0-Control Efficiency and Cost Evaluation

An ESP has a slightly better control efficiency as compared to wet scrubber but the recovery boiler at the facility already uses a venturi scrubber to control PM emissions. Thus it is economically infeasible to install an ESP for a control efficiency enhancement of about 1% and incur an expenditure of about $ 68,239,64 (includes capital investment, installation, maintenance, and cost per ton of reduction achieved). Approximately similar control efficiency can be obtained without any additional cost.

Step 4.0-Control Technology Selected for BART

The unit already utilizes a venturi scrubber to control particulate matter emissions, no additional controls are proposed.

2.3 NITROGEN OXIDES

Step 1.0-Identification of Control Technologies

Emission control equipments that may be considered to control nitrogen oxide emissions from recovery boilers include combustion modification techniques and post-combustion controls.

Combustion Modification Techniques

A number of combustion modification techniques are available for reducing NO_x emissions from boilers in general. These include:

- Staged air combustion
- Low NO_x burner with flue gas recirculation system
- Oxygen trim and water injection

The combustion modification techniques listed above reduce NO_x by minimizing its formation in the combustion chamber of the boiler or by using less oxygen than is stoichiometrically required for complete combustion of the fuel.

Post-Combustion Controls

The technologies for post-combustion control include:

- Selective non-catalytic reduction (SNCR)
- Selective catalytic reduction (SCR)

Step 2.0-Technical feasibility Analysis of the identified Control Technologies

- Staged air combustion is integral to the operation of most recovery boilers, is the most effective strategy for minimizing NO_x formation in a recovery boiler hence, is technically feasible. As such, it is also integral to the operation of most recovery boilers. The recovery boiler at the Riceboro mill currently employs staged air combustion with primary, secondary and tertiary combustion air. A fourth level of staged air combustion cannot be added, as it would require a new recovery boiler and cannot be considered as a retrofit control.
- Use of a low NOx burner is of minimal value for NOx reduction because the primary fuel of the recovery boiler is black liquor.
- Flue Gas Recirculation has not been commercially applied to Babcock & Wilcox furnaces. Furthermore, the reducing atmosphere needed to convert sulfate compounds to sulfide compounds in the lower furnace tends to preclude FGR in the lower furnace. In other words, FGR wouldn't provide any measurable NOx reduction on the recovery boiler, if applied to the lower furnace. Use of FGR may also unreasonably restrict throughput and create safety issues due to anticipated smelt bed control problems, if applied to the lower furnace. There may be some benefit to FGR application above the tertiary air level but such has not been commercially applied.
- Kraft recovery boilers already employ some method of oxygen trim due to the reduction atmosphere demanded by the process itself. Interstate Paper typically targets 3 to 4 % excess oxygen at the economizer, which trims air combustion in response. The use of more advanced oxygen trim methods probably won’t provide any measurable impact on NOx. Thus use of further oxygen trim is not technically feasible.

- Water injection cannot be considered due to its' inherently dangerous nature for Kraft recovery furnaces. Thus water injection is technically infeasible and will not be further considered for BART analysis
- SNCR as a control option for flue gas treatment is technically not very feasible based on the fact that SNCR systems work by injecting ammonia or urea into the combustion chamber of the boiler, thereby converting NO_x to elemental nitrogen, carbon dioxide, and water vapor. The recovery boiler is a complete, chemical reaction system and any disruption of the delicate chemistry could possible damage the boiler, impact the quality of the product, or otherwise affect the system unacceptably. The injection of ammonia gas or urea solution would have a detrimental effect upon the chemistry inside the boiler. Thus usage of SNCR as a NOx control for recovery boilers is infeasible and will not be further considered for BART analysis.
- The technical feasibility of a SCR system for treatment of flue gases generated from recovery boiler is questionable. The toxic metals present in the flue gas exhaust are of sufficient quantity to build up on the surface of the catalyst bed and poison the catalyst within a relatively short period of time. Thus SCR is also technically infeasible for a recovery boiler and will not be further considered for BART analysis.

Step 3.0-Control Efficiency and Cost Evaluation
No control technology was technically feasible.

Step 4.0-Control Technology Selected for BART
No additional BART controls are proposed.

2.4 SULFUR DIOXIDE

Step 1.0-Identification of Control Technologies
Emission control equipments that may be considered to control sulfur dioxide emissions from recovery boilers include any number of absorption (i.e., scrubbing) processes, flue

gas desulfurization (FGD), combustion control and usage of high black liquor solid content.

Step 2.0-Technical feasibility Analysis of the identified Control Technologies

- Gas absorption systems are designed to maximize contact between the gas and liquid in order to permit interphase diffusion of the SO_2. Absorbers found to adequately disperse the liquid include packed towers, plate or tray towers and tray chambers. SO_2 emission reductions of 90-98% can be expected by usage of gas absorption systems. However if the pollutant concentration entering the absorber is relatively low, then SO_2 removal efficiency will be much lower. Thus gas absorption systems are feasible control equipments for reduction of SO_2 emissions.
- Combustion control and high black liquor solids content are effective means to control SO_2 emissions from recovery boilers. SO_2 emissions are formed by the oxidation of reduced sulfur compounds in recovery boilers. These emissions vary depending upon the sulfur content of the black liquor being burned, the quantity of oxygen available in the combustion chamber and the black liquor solids content. Higher black liquor solids content, yields lower SO_2 emissions. Thus combustion control and black liquor solid contents are feasible control technologies for SO_2 emissions from the recovery boiler.
- Flue gas desulfurization technology is used on coal-fired boilers and works in one of the two ways. The first method works by injecting dry limestone into the combustion chamber of the boiler, where limestone reacts with sulfur dioxide gases to form calcium sulfate. Injection of chemicals into the combustion chamber of the recovery boiler as a means to control SO_2 emissions will interfere with the recovery process that is taking place inside the boiler. For this reason flue gas desulfurization using “dry limestone” method is not considered technically feasible for reduction of SO_2. Additionally, there are no known recovery boilers in the U.S utilizing this particular type of SO_2 control. The second method works by adding a wet slurry of limestone into a scrubber that is controlling the flue gas from the boiler. Limestone reacts to form calcium sulfate in the slurry form. Usage of wet limestone outside the boiler is technically feasible and would lead to

a removal efficiency of 90% or higher depending on the SO_2 content in the flue gas.

Step 3.0-Control Efficiency and Cost Evaluation

- Gas absorption systems are technically feasible control systems involving high capital investment and installation costs of about $166,5000. These systems usually have high-pressure drops in the range of 6-8 inches w.c. This may require additional expenditure for a new fan, which should be designed to handle that pressure drop. These systems also require routine maintenance and hence would also involve high maintenance cost. Thus they cannot be considered as BART controls because of their economic infeasibility.
- Combustion control along with being a technically feasible means of controlling SO_2 emissions is also inherent in the design of a recovery boiler due to the chemical reactions that take place inside of the combustion chamber when black liquor is combusted. Black liquor normally contains a number of sulfur-bearing compounds when it is generated from the Kraft pulping process. When black liquor is oxidized, most of the oxidized sulfur compounds are converted into sulfides. These inorganic compounds, primarily sodium sulfide and sodium sulfate, recovered in molten form at the bottom of the bed, are referred as "smelt". The smelt is drained through the bottom of the recovery boiler into a smelt-dissolving tank. The majority of the sulfur compounds that leave the smelt bed as sodium fume from the reduction process are tied up with boiler bottom ash as sodium sulfate, there by reducing SO_2 emissions discharged from the boiler. The capture of SO_2 is primarily dependent upon the boiler bed temperature. An increase in the dry solids content raises the temperature at the bottom part of the furnace thus reducing SO_2 emissions. Thus a control efficiency of 99+% can be obtained without the usage of any additional control technology. Hence combustion control with high solids content is economically feasible control for SO_2 emissions from the recovery boiler.
- Flue gas desulfurization technique with wet limestone slurry is technically feasible but would involve additional equipment capital, installation and maintenance cost of about $ 290,6000 and lead to SO_2 removal efficiency of

about 90% which is less than what can be achieved by combustion control and high black liquor solids content. Hence it's not considered to economically feasible and will not be further considered for BART analysis of the recovery boiler.

Step 4.0-Control Technology Selected for BART

Presence of black liquor solids content of up to 68% or more along with inherent design of the recovery boiler satisfies the requirement of combustion control technology thus leading to a control efficiency of 99+%. Thus no additional BART control is suggested.

3.0 BART ENGINEERING ANALYSIS FOR LIME KILN

3.1 SOURCE DESCRIPTION

The lime kiln dries and processes lime mud from the causticizing system by burning fuel oil with sulfur content no greater than 2.5%. The lime kiln is permitted to burn natural gas, No. 6 fuel oil, or limited quantities of used oil. It is equipped with a venturi scrubber to control particulate matter emissions. The lime kiln also serves as a back-up combustion device for low-volume, high concentration (LVHC) non-condensable gases (NCGs) generated in the pulp mill.

Air pollutants emitted from the Lime Kiln include all the three BART relevant pollutants i.e. sulfur dioxide (SO_2), 9.50 tons/yr, nitrogen oxides (NO_x), 149.16 tons/yr, and particulate matter (PM_{10}), 127.56 tons/yr. Emissions of the Lime Kiln currently pass through a venturi scrubber.

3.2 PARTICULATE MATTER

Step 1.0-Identification of Control Technologies

Emission control equipments that may be considered for particulate matter control are baghouses, cyclonic separators, venturi scrubbers, other wet scrubbers and a combination of a venturi scrubber and ESP.

Step 2.0-Technical feasibility Analysis of the identified Control Technologies

All the above-listed technologies other than baghouses are technically feasible for removal of particulate matter from the lime kiln exhaust gas.

Step 3.0-Control Efficiency and Cost Evaluation

Table 1.0 ranks all the technically feasible control technologies based on top control efficiency values. The lime kiln at Interstate paper is currently equipped with a venturi scrubber. The venturi scrubber primarily uses fresh water as the scrubbing media. As shown in Table 1.0, the control efficiency that can be achieved with a venturi scrubber is about 98-99%. Cyclones are not considered because their control efficiencies are lesser than that of a Venturi scrubber. A venturi scrubber along with an ESP shows an increase in the control efficiency by about 1%. Installation of an ESP in combination to the venturi scrubber would approximately cost $5,495,014/yr. Hence it's economically infeasible to endure such a high expense for an efficiency increase of about 1% only.

Table 1.0. Ranking of Particulate Matter Control Equipments for Existing lime kilns

Control Technology	Removal Efficiency
Venturi Scrubber and ESP	99.9%+
Venturi Scrubber	98-99%
Dry/Wet ESP	98-99%
Packed Bed Wet Scrubber	85+%
Cyclone Separator	25-95%

Step 4.0-Control Technology Selected for BART

A venturi scrubber is the second most effective technology for removing particulate matter from lime kiln exhaust. Because the unit already utilizes a venturi scrubber to control particulate matter emissions, no additional controls are proposed.

3.3 NITROGEN OXIDES

Step 1.0-Identification of Control Technologies

Emission control equipments that can be considered for control of nitrogen oxide emissions from the lime kiln are low NO_x burners, SNCR-NH_3 based, SNCR-urea based and SCR.

Step 2.0-Technical feasibility Analysis of the identified Control Technologies

All the above-mentioned control equipments are technically feasible for removal of nitrogen oxide from the lime kiln exhaust.

Step 3.0-Control Efficiency and Cost Evaluation

Table 2.0 ranks all the technically feasible control technologies based on top control efficiency values.

Table 2.0. Ranking of Nitrogen Oxide Control Technologies for Existing Lime Kilns

Control Technology	**Removal Efficiency**	**Cost Evaluation**		
		Capital + Operation Cost ($)	**Cost/ton of NO_x reduction ($/ton)**	**Total Annual cost ($)**
SCR	80%	208,793,6	4,450	424,647
Fuel Switch to burning of Natural Gas only	73%	0	4,320	105,027.5
Low NO_x burner	50%	144,242	740	26,461
SNCR-Urea based	50%	174,006	1,017	60,641
SNCR-NH_3 based	30%	263,593	1,123	66,942

The low-NOx burner control option and the two SNCR control options are considered to be economically feasible. However, they are not considered further as retrofit controls because of the relatively small benefit to visibility of NOx controls. Comparison of the visibility benefits of SO2 control versus NOx control is presented in Section 5.0.

Step 4.0-Control Technology Selected for BART

All the above-mentioned technologies are economically infeasible and cannot be considered as retrofit controls. Hence, no additional BART controls are suggested for the NOx emissions of the lime kiln at the Riceboro mill.

3.4 SULFUR DIOXIDE

Step 1.0-Identification of Control Technologies

Emission control equipments that can be considered for control of sulfur dioxide are gas absorption with caustic scrubber; wet scrubber with lime mud; and use of low sulfur fuels.

Step 2.0-Technical feasibility Analysis of the identified Control Technologies

All the above-mentioned control equipments are technically feasible for removal of sulfur dioxide from the lime kiln exhaust.

Step 3.0-Control Efficiency and Cost Evaluation

The control efficiency of a gas absorber with caustic scrubbing is similar to that of a wet scrubber with lime mud. Each of these technologies can reduce sulfur dioxide emissions by up to 95%. Reducing the oil from 2.5% sulfur content to a low-sulfur fuel will show a control efficiency of approximately 50%.

Step 4.0-Control Technology Selected for BART

The lime kiln at Interstate Paper utilizes a venturi scrubber (wet scrubber) for particulate matter control. This scrubber further augments the SO_2 removal process since the scrubbing solution becomes alkaline from the captured lime dust, consequently the lime kiln emits a very low level of SO_2. Hence, no additional SO_2 controls are proposed.

4.0 BART ENGINEERING ANALYSIS FOR POWER BOILER

4.1 SOURCE DESCRIPTION

The Power Boiler at Interstate Paper was installed in 1968 and has a maximum heat input of 400 MMBTU/hr. It fires natural gas and No. 6 fuel oil. The power boiler, along with the lime kiln, is used as a backup control device and it burns non-condensable gases too. Air pollutants emitted from the Power Boiler include all the three BART relevant pollutants i.e. sulfur dioxide (SO_2), 300.49 tons/yr, nitrogen oxides (NO_x), 409.24 tons/yr, and particulate matter (PM_{10}), 19 tons/yr.

4.2 PARTICULATE MATTER

Step 1.0-Identification of Control Technologies

Emission control equipments and technologies that may be considered for particulate matter controls are ESP, fabric filter and fuel switch to natural gas.

Step 2.0-Technical feasibility Analysis of the identified Control Technologies

All the above-mentioned control technologies are technically feasible for removal of particulate matter from the exhaust gases of the power boiler.

Step 3.0-Control Efficiency and Cost Evaluation

Table 3.0 ranks all the technically feasible control technologies and their total annual cost.

Table 3.0. Ranking of Particulate matter Control Technologies for Existing Power Boilers

Control Technology	**Removal Efficiency**	**Cost Evaluation**		
		Capital + Operation Cost ($)	**Cost/ton of PM reduction ($/ton)**	**Total Annual cost ($)**
Fuel Switch to Natural Gas	99%	0	5,705	102,000
ESP	98-99%	4,129,230	19,364	1,705,983
Fabric Filter	98-99%	3,355,180	79,470	1,782,035

ESP and fabric filter are technically feasible controls for PM emission reduction, but there are high capital and maintenance costs which cause them to be economically infeasible for BART and hence will not be further considered for BART analysis.

Step 4.0-Control Technology Selected for BART

The fuel switch to natural gas gives a particulate matter removal efficiency of more than 99%. The cost that the facility will incur for such a fuel switch is also relatively less than the addition of control equipment. Along with reduction in PM emissions, reduction in NO_x and SO_2 will also be achieved therefore fuel switch to natural gas is an economically feasible option. Hence in the power boiler at the Riceboro mill, it is recommended to burn natural gas only, other than during periods of curtailment (i.e. reduction or discontinuance of natural gas supply).

4.3 NITROGEN OXIDES

Step 1.0-Identification of Control Technologies

Emission control equipments and technologies that may be considered for nitrogen oxide controls are low NO_x burner, low NO_x burner with flue gas recirculation, SCR, SNCR and fuel switch to natural gas.

Step 2.0-Technical feasibility Analysis of the identified Control Technologies

All the above-mentioned control technologies are technically feasible for removal of nitrogen oxides from the exhaust gases of the power boiler.

Step 3.0-Control Efficiency and Cost Evaluation

Table 4.0 ranks all the technically feasible control technologies and their total annual cost.

Table 4.0. Ranking of Nitrogen Oxide Control Technologies for Existing Power Boilers

Control Technology	**Removal Efficiency**	**Cost Evaluation**		
		Capital + Operation Cost ($)	**Cost/ton of NO_x reduction ($/ton)**	**Total Annual cost ($)**
SCR	80%	304,095	1,955	30,241
Low NO_x Burner + Flue Gas Recirculation	60%	104,006	1,479	17,163
Low NO_x Burner	50%	30,838	528	5,108
SNCR	50%	313,418	3,407	32,948

Fuel Switch to Natural Gas	13%	0	29,800	102,000

SCR, Low NO_x burner; Low NO_x burner with flue gas recirculation are economically feasible controls for NO_x emission reduction. However, they are not considered further for BART analysis because of the relatively small benefit to visibility of NOx controls. Comparison of the visibility benefits of SO2 control and NOx control is presented in Section 5.0.

Step 4.0-Control Technology Selected for BART

Along with reduction in NO_x emissions, reduction in PM and SO_2 emissions can also be achieved by "fuel switch to natural gas" thus, it is an economically feasible option. Therefore, it is recommended that only natural gas be permitted as fuel in the power boiler at Riceboro mill, other than during periods of curtailment (i.e. during reduction or discontinuance of supply in natural gas).

4.4 SULFUR DIOXIDE

Step 1.0-Identification of Control Technologies

Emission control equipments and technologies that may be considered for sulfur dioxide controls are venturi scrubbers with caustic addition, spray dry scrubbers, dry scrubbers and fuel switch to natural gas.

Step 2.0-Technical feasibility Analysis of the identified Control Technologies

All the above-mentioned control technologies are technically feasible for removal of sulfur dioxide from the exhaust gases of the power boiler.

Step 3.0-Control Efficiency and Cost Evaluation

Table 5.0. Ranking of Sulfur Dioxide Control Technologies for Existing Power Boilers

Control	**Removal**	**Cost Evaluation**

Technology	**Efficiency**	**Capital + Installation + Operation Cost ($)**	**Cost/ton of SO_2 reduction ($/ton)**	**Total Annual cost ($)**
Fuel Switch to Natural Gas	99+%	0	370.00	102,000
Wet Scrubber w/ caustic? (venturi)	90%	2,377,636	1,630	528, 246
Spray Dry Scrubber	80-90%	NA	NA	NA
Dry Scrubber	50 to 80%	NA	NA	NA

Fuel switch and wet scrubber are technically feasible. The cost per ton of SO_2 emission reduction of each alternative is well within the range that EPA considers economically feasible. Hence both the techniques will be further considered for BART analysis.

Step 4.0-Control Technology Selected for BART

Both the above-mentioned technologies are economically feasible. Natural gas has higher control efficiency at lower cost as compared to a wet scrubber. Therefore it is recommended that power boiler at Riceboro mill burn natural gas only, other than during curtailment periods (i.e., during reduction or discontinuance of supply in natural gas).

5.0 COMPARISON OF IMPACTS OF SO2 AND NOX CONTROLS ON VISIBILITY

Georgia Tech performed a study for EPD that compared the impacts of statewide reductions of point SO2 and point NOx emissions on visibilities at the Wolf Island and Okefenokee Class I areas (see Appendix A). The metric used for visibility improvement was light extinction (specifically reduction of light extinction), expressed in units of inverse megameters (Mm^{-1}). The study found that a statewide reduction of one ton per year of point SO2 emissions would effect estimated light extinction reductions of 1.97×10^{-5} Mm^{-1} at Wolf Island and 2.59×10^{-5} Mm^{-1} at Okefenokee. A one-ton-per-year reduction of point NOx emissions (statewide) would achieve estimated reductions in light extinction of 0.319 x 10^{-5} Mm^{-1} at Wolf Island and 0.159 x 10^{-5} Mm^{-1} at Okefenokee. The ratios of light extinction reduction from SO2 reduction to light extinction reduction from NOx reduction are then 6.2 at Wolf Island and 16.4 at Okefenokee. SO2 reductions are therefore expected to provide substantially more visibility improvement than NOx reductions at both of these Class I areas.

Sections 3.3, 4.3, and 4.4 evaluate potential BART control options for Interstate Paper's Lime Kiln and Power Boiler emissions. Using the results of the Georgia Tech study and EPD's calculations of visibility impacts due to SO2 reductions at specific emissions sources, it is possible to estimate the total visibility improvements for the potential control technologies. The visibility improvements are presented only for Wolf Island since it has been determined (Section 7.1) that the benefits of Interstate Paper emissions controls on visibility at Okefenokee are too small to be considered. The SO2 visibility impact (0.000076 Mm^{-1}/tpy) used in this calculation is based on site-specific modeling performed by EPD of the impact of Interstate Paper's SO2 emissions on light extinction at Wolf Island (Appendix N.1, Table 1). This is believed to be a more accurate estimate of the impact than the SO2 impacts determined from the statewide emissions impact study.

The NOx visibility impact is then determined by applying the ratio (1/6.2) of the NOx impact to the SO2 impact (from the state-wide study) to the site-specific SO2 visibility impact, resulting in 0.000013 Mm^{-1}/tpy. Note that EPD did not directly model the impact of NOx reductions at specific sites on visibility.

These impacts (0.000076 Mm^{-1}/tpy and 0.000013 Mm^{-1}/tpy) are then applied to the specific emissions reductions associated with the potential control options. Tables 5.1 and 5.2 show the light extinction reductions associated with the potential control options presented in Sections 3 and 4 for the lime kiln and the power boiler. The light extinction reductions from the SO2 control options range from 0.0147 to 0.0225 Mm^{-1}. The light extinction reductions from the NOx control options range from 0.0006 to 0.0041 Mm^{-1}.

Due to the lower extinction reductions (visibility improvements) for the NOx controls they were excluded from further consideration as feasible BART control options.

Table 5.1. Interstate Paper Lime Kiln – Estimated Impacts of NOx Controls on Visibility at Wolf Island

Control Technology	**Emissions (tpy)**	**Removal Efficiency (%)**	**Tons Removed (tpy)**	**Mm^{-1} per TPY***	**Extinction reduction (Mm^{-1})**
<u>NOx Controls</u>					
				.	
SCR	149.2	80	119.4	0.000013	0.0015
Fuel switch to NG	149.2	73	108.9	0.000013	0.0014
Low NOx burner	149.2	50	74.6	0.000013	0.0009
SNCR - urea based	149.2	50	74.6	0.000013	0.0009
SNCR - NH3 based	149.2	30	44.8	0.000013	0.0006

Table 5.2. Interstate Paper Power Boiler – Estimated Impacts of SO2 and NOx Controls on Visibility at Wolf Island

Control Technology	**Emissions (tpy)**	**Removal Efficiency (%)**	**Tons Removed (tpy)**	**Mm^{-1} per TPY***	**Extinction reduction (Mm^{-1})**
<u>SO2 Controls</u>					
				.	
Fuel Switch to NG	300.5	99	297.5	0.000076	0.0225
Wet scrubber with caustic	300.5	90	270.5	0.000076	0.0204
Spray dry scrubber	300.5	85	255.4	0.000076	0.0193
Dry scrubber	300.5	65	195.3	0.000076	0.0147
<u>NOx Controls</u>					
				.	
SCR	409.2	80	327.4	0.000013	0.0041
Low NOx burner with FGR	409.2	60	245.5	0.000013	0.0031
Low NOx burner	409.2	50	204.6	0.000013	0.0026
SNCR	409.2	50	204.6	0.000013	0.0026
Fuel switch to NG	409.2	13	53.2	0.000013	0.0007

* The estimated light extinction benefit at Wolf Island associated with the reduction of one ton per year of emissions (SO2 or NOx) from the emissions unit.

6.0 ENGINEERING ANALYSIS SUMMARY

Table 6.0 summarizes the technically and economically feasible options for the BART-eligible emission units.

Table 6.0. Summary of BART Analysis, Interstate Paper

Emission Unit	**Pollutant**	**Existing Controls**	**BART Options**	**$/ton**
Recovery Boiler	PM10	Venturi Scrubber	Venturi Scrubber	0
Recovery Boiler	NO_x	Staged Air Combustion	Staged Air Combustion	0
Recovery Boiler	SO_2	Combustion Control	Combustion Control	0
Lime Kiln	PM10	Wet Scrubber	Wet Scrubber	0
Lime Kiln	NO_x	Not Available	None Applicable	0
Lime Kiln	SO_2	Wet Scrubber	Wet Scrubber	0
Power Boiler	PM10	Not Available	Fuel Switch to natural gas	5,705
Power Boiler	NO_x	Not Available	Fuel Switch to natural gas	29,800
Power Boiler	SO_2	Not Available	Fuel Switch to natural gas	370.00

7.0 BART DETERMINATION VISIBILITY IMPACTS ASSESSMENT

In order to evaluate the potential visibility impacts or improvements at Class I areas which may be caused by the implementation of various emissions scenarios at the Interstate Paper mill, CALPUFF air dispersion modeling was conducted. Such modeling was conducted in accordance with the VISTAS Regional Planning Organization's BART Modeling Protocol, version 3.2, dated August 31, 2006. The impacts of plant emissions were assessed under three emissions scenarios. The first scenario constitutes a baseline of emissions, based on actual plant emissions of visibility-affecting pollutants as determined from the facility's 2002 worst-case (maximum) actual emissions over any 24-hour period. The second scenario was evaluated on the basis that the facility's Power

Boiler would be shut-down, as initially proposed by the facility. The third scenario was assessed on the basis that the facility's Power Boiler would operate on natural gas.

The facility is located in Riceboro, Georgia. Three Class I areas are within 300 km of the site, the Cape Romain Wildlife Management Refuge (WMR), SC (207 km), the Okefenokee WMR, GA (109 km), and the Wolf Island WMR, GA (42 km).

7.1 Baseline Emission Scenario

On August 8, 2006, Interstate Paper, LLC submitted a facility-specific BART exemption modeling protocol to GA EPD. Review of this protocol indicated that the stack coordinates listed in the protocol did not compare favorably to coordinates for those stacks used in a 2001 Prevention of Significant Deterioration (PSD) permit application. The coordinates were modified, and the Building Profile Input Program (BPIPPRM, version 04274) was run to develop downwash dimensions. Downwash dimensions were required to be evaluated since the facility is located less than 50 km from the Wolf Island WMR and since the facility's stacks are each less than Good Engineering Practice Stack Height (GEP). Also due to the facility's location within 50 km of the Wolf Island WMR, 4-km grid-based CALMET output files, prepared by the VISTAS contractor, were used in all the modeling.

The mill's emissions data was compiled by the mill's consultant, Environmental Planning Specialists, Inc (EPS) from stack test, AP-42, and/or NCASI information. The specific data sources were submitted with the Interstate Paper, LLC BART Exemption Modeling Protocol prepared for the facility by EPS. The emission calculations were reviewed by GA EPD permit engineers (see attached Table 1., prepared by the VISTAS contractor).

Each of the three International Paper BART-eligible emission sources were modeled separately in CALPUFF by the VISTAS contractor, for each model year. Other than point sources, no other emissions were modeled. Wet and dry deposition losses from the plumes were accounted for. Building downwash dimensions from BPIPPRM were provided, but conservatively, only the BPIP dimensions were assessed for downwash effects on plume concentrations. Table 2, prepared by the VISTAS contractor, notes that all PM10 and H_2SO_4 emissions were conservatively partitioned into organic condensable species, split equally by particle size class. This specific measure was implemented in POSTUTIL by the use of scaling factors. Pasquill-Gifford dispersion coefficients were used in the modeling, rather than basing the dispersion on coefficients developed from turbulence data. The meteorological grid was set equal in extent to the computational grid, and the cell size of each was 4 km sq. All source and receptor locations were assessed using the Lambert Conformal Conic coordinate system.

CALPUFF modeling was conducted to provide concentrations at Class I area receptors located in the Cape Romain, SC; St. Marks, FL; Okefenokee, GA; and Wolf Island, GA Wildlife Management Refuges. Chemical transformation rates of SO_2 and NOx into SO_4^{-2}, HNO_3, and NO_3^{-1} were assessed using the MESOPUFF II scheme with hourly ozone concentrations derived from contemporaneous monitoring in the domain, and a constant (uniform) monthly average ammonia concentration of 0.5 ppb throughout the domain.

POSTUTIL conversion of the CALPUFF concentration files was implemented to develop the PM10 (and H_2SO_4) emissions into two equal size fractions of PM2.5 condensable organic matter. The Ammonia-Limiting Method of limiting ammonium nitrate formation due to the scavenging of atmospheric ammonia to form ammonium sulfate, was not implemented in the POSTUTIL processing. The speciated emissions of each of the three modeled sources were summed, by species, at the Class I area receptors modeled.

The CALPOST processor was implemented to assess, by Method 6, the 24-hour average change from annual average, natural background visibility caused by the facility's sources, in delta-deciviews (ΔdV). The FLAG, 2000 proposed relative humidity function, with a maximum value of 95 %, was used to simulate hygoscopic species growth. Extinction coefficients of sulfate and nitrate (hygroscopic) species were computed using monthly relative humidity adjustment factors. The visibility calculations were made using the (original) IMPROVE equation.

The results of the baseline visibility assessment of the Interstate Paper, LLC BART-eligible sources is presented in Tables 3 and 4, prepared by the VISTAS contractor. Table 3 indicates these sources to have no impact at either the St. Marks, FL, or the Cape Romain, SC WMRs.

The expanded results shown in Table 4 indicate that, based on the highest 98th percentile change in visibility (one of the design criteria when modeling using a 4-km computational grid), the impacts of the Interstate Paper BART-eligible sources at the Okefenokee WMR are well below the BART exemption level of 0.5 ΔdV. The alternate design criteria when modeling with a 4-km computational grid is the highest 22nd high over the three years modeled. Table 4 indicates that the BART exemption level of 0.5 ΔdV is met with the 11th highest impact over the three year period modeled at the Okefenokee WMR. This indicates that the Interstate Paper BART-eligible sources do not need to consider their impacts at the Okefenokee WMR further.

However, the expanded results indicated on Table 4 for the Wolf Island WMR fail to meet the BART exemption criteria on both the annual and the 3-year period basis, by exceeding the exemption level with the 98th percentile impact in each of the three modeled years, as well as exceeding the 3-year period design criterion of 0.5 ΔdV with the 22nd highest impact.

7.2 Proposed alternative exemption scenario #1. Interstate Paper proposed to shutdown its Power Boiler, which had by far the greatest impact on the visibility at Wolf Island. The Power Boiler was modeled as it operates, with no air pollution control equipment. The Power Boiler is permitted to burn #6 fuel oil containing as much as 3 wt. percent sulfur. The VISTAS contractor re-evaluated the remaining two Interstate BART-eligible sources, using the same modeling techniques as implemented in the baseline modeling. The results are indicated on Tables 5 and 6, prepared by the VISTAS contractor. These results show only two 24-hour periods were predicted to have visibility impacts in excess of the BART exemption level over the 3-year period modeled, and those impacts were limited to the Wolf Island WMR. Clearly this is a scenario which, if implemented by the facility, would exempt Interstate Paper from further BART requirements. However, Interstate Paper declined to pursue this alternative.

7.3 Proposed alternative exemption scenario #2. The Georgia Environmental Protection Division (GA EPD) completed a BART Determination assessment of several alternative scenarios. Based on the detailed BART analysis of control options feasible for each of the BART-eligible sources, GA EPD determined that the most beneficial control option would be to limit the Power Boiler to burning natural gas.

In developing appropriate emissions estimates for this scenario, it was noticed that the Power Boiler is permitted as a back-up device for controlling non-condensable gases (NCGs). The current Title V application list the SO_2 emission rate due solely to combusting NCGs as 53.8 pounds of SO_2 per hour, and includes a limit of such operation to 1480 hours per year. AP-42 was used to calculate the SO_2 and NOx emission rates appropriate for firing the Power Boiler at 100% capacity. The AP-42 emission rate was increased by the maximum SO_2 emissions due to combustion of NCGs in the Power Boiler. These emissions, indicated in Table 7 and 8, were modeled for this alternative scenario. The modeling was conducted in the same manner as the other two modeled scenarios.

The results of modeling the natural gas combustion scenario are presented in Tables 9 and 10. Only Wolf Island receptors were evaluated, since the other Class I areas had already been demonstrated to be unaffected by Interstate Paper emissions, or Interstate Paper was able to be exempted from further BART requirements in these other Class I areas.

In contrast to the baseline scenario, the natural gas firing scenario showed a total of 14 occurrences of impacts over 0.5 ΔdV at Wolf Island versus 30 occurrences in the baseline scenario. Thus the 3-yr period impacts decreased below the exemption level on this basis. In 2001, the number of 24-hr average exceedances of 0.5 ΔdV decreased from 8 to 6 per year; in 2002, the number decreased from 12 to 6 per year; and in 2003, the number decreased from 10 to 2 per year. Since none of the modeled years in the natural gas firing scenario showed a 98th percentile high impact in excess of 0.5 ΔdV, the facility meets both exemption criteria by implementing this scenario.

7.4 BART modeling results summary. The facility has been shown to conform to BART exemption criteria for visibility impacts under the Regional Haze Regulation in the scenario where the Power Boiler must burn natural gas (and in selected operational scenarios, NCGs). However, since the facility went through the BART Determination mechanism to achieve this status, the facility should not be allowed to burn #6 fuel oil in trade for periods in which NCGs are not combusted in the Power Boiler. The combustion of NCGs should be restricted to periods of emergency only, when the Lime Kiln (primary NCG control device) and the Multi-fuel Boiler (secondary NCG control device) are out-of-service. Both the latter two sources have existing SO_2 control devices on their exhaust streams, while the Power Boiler does not.

INTERSTATE PAPER, LLC
Georgia
Visibility Results for 2001-2003 CALPUFF Screening Runs
CALPOST, Method 6
Using annual average Haze Index (HI) values in processing

Table 1. Stack parameters and emissions

Stack ID #	Lambert Conformal Coordinates		Stack Height	Base Elevation	Diameter	Gas Exit Velocity	Stack Gas Exit Temp.	SO_2 Emissions	SO_4 Emissions	NO_x Emissions	PM_{10} Emissions	$PM_{2.5}$ Emissions	NH_3 Emissions
	LCC East	**LCC North**											
	km	**km**	**m**	**m**	**m**	**m/s**	**K**	**g/s**	**g/s**	**g/s**	**g/s**	**g/s**	**g/s**
PB	1470.712	-789.031	46.04	4.30	1.98	15.45	470.92	60.5000	0.0000	8.7000	3.4000	2.0000	
LK	1470.714	-788.897	15.24	3.60	1.52	4.96	342.09	0.1600	0.0000	2.2000	0.7400	0.7200	
RB	1470.714	-789.026	46.04	4.20	2.74	13.73	353.37	0.1200	0.0000	8.8000	5.5000	5.4000	

Table 2. Particle Speciation

Stack ID #	particle speciation		Condensable					Filterable									
	filterable PM_{10}	**condensable PM_{10}**	**organic condensable (OC)**		**inorganic condensable**			**COARSE**		**Soil**				**Elemental Carbon (EC)**			
	%	**%**	**0.625-1.0 µm (g/s)**	**0.5-0.625 µm (g/s)**	**0.625-1.0 µm (g/s)**	**0.5-0.625 µm (g/s)**		**6-10 µm (g/s)**	**2.5-6 µm (g/s)**	**1.25-2.5 µm (g/s)**	**1.0-1.25 µm (g/s)**	**0.625-1.0 µm (g/s)**	**0.5-0.625 µm (g/s)**	**1.25-2.5 µm (g/s)**	**1.0-1.25 µm (g/s)**	**0.625-1.0 µm (g/s)**	**0.5-0.625 µm (g/s)**
PB			1.7000	1.7000													
LK			0.3700	0.3700													
RB			2.7500	2.7500													

Note: Stack parameters and emission data obtained from “EPD BART Emissions.xls” file. The PM speciation was not provided by the state. All PM_{10} - H_2SO_4 emissions were equally divided between the two size categories of OC. This is a conservative approach since, Organic condensable have extinction efficiency of 4 m^2/g.

Table 3. Summary of Visibility Results

Class I Area	2001	2002	2003	Annual average background b_{ext}
	Maximum delta-deciview, (# days>0.5 dv, # days >1 dv)			(Mm^{-1})
Cape Romain	0.330 (0 0)	0.408 (0 0)	0.242 (0 0)	21.22
Okefenokee	**0.670 (4 0)**	**0.561 (3 0)**	**1.153 (4 1)**	21.41
St Marks	0.192 (0 0)	0.196 (0 0)	0.247 (0 0)	21.54
Wolf Island	**1.653 (8 1)**	**0.963 (12 0)**	**0.938 (10 0)**	21.33

Table 4. Visibility Results – 8 highest values

	2001		2002		2003		
	Change in Deciview (dv)	**Day**	**Change in Deciview (dv)**	**Day**	**Change in Deciview (dv)**	**Day**	**Rank**
Okefenokee	0.670	Feb 13	0.561	Dec 8	1.153	Jan 31	1
	0.579	Nov 19	0.516	Oct 22	0.630	Dec 27	2
	0.520	Oct 22	0.500	Jan 27	0.523	Nov 8	3
	0.514	Dec 4	0.462	Oct 25	0.500	Sep 10	4
	0.431	Jun 20	0.461	Dec 18	0.391	Nov 21	5
	0.431	Feb 12	0.456	Jan 26	0.341	Oct 31	6
	0.431	Jan 14	0.401	Oct 14	0.336	Jan 28	7
	0.318	Oct 23	0.338	Feb 3	0.328	Nov 11	8
Wolf Island	1.653	Jan 15	0.963	Jan 28	0.938	Dec 8	1
	0.851	Sep 17	0.962	Dec 27	0.763	Sep 7	2
	0.759	Jan 10	0.943	Nov 26	0.760	Sep 8	3
	0.755	Feb 6	0.823	Sep 17	0.707	Jul 15	4
	0.675	Jan 21	0.751	Nov 1	0.630	Nov 22	5
	0.665	Sep 9	0.731	Dec 30	0.609	Oct 15	6
	0.584	Sep 18	0.691	Jan 16	0.574	Oct 4	7
	0.573	Dec 21	0.650	Oct 26	0.565	Nov 7	8

Table 5. Summary of Visibility Results

Class I Area	2001	2002	2003	Annual average background b_{ext}
	Maximum delta-deciview, (# days>0.5 dv, # days >1 dv)			(Mm^{-1})
Cape Romain	0.069 (0 0)	0.106 (0 0)	0.048 (0 0)	21.22
Okefenokee	0.236 (0 0)	0.187 (0 0)	0.337 (0 0)	21.41
St Marks	0.034 (0 0)	0.041 (0 0)	0.045 (0 0)	21.54
Wolf Island	**0.718 (1 0)**	**0.502 (1 0)**	0.416 (0 0)	21.33

Table 6. Visibility Results – 8 highest values

	2001		2002		2003		
	Change in Deciview (dv)	Day	Change in Deciview (dv)	Day	Change in Deciview (dv)	Day	Rank
Wolf Island	0.718	Jan 15	0.502	Dec 27	0.416	Dec 8	1
	0.371	Sep 17	0.420	Nov 26	0.335	Oct 15	2
	0.345	Jan 10	0.357	Nov 1	0.268	Sep 7	3
	0.312	Feb 6	0.337	Jan 16	0.265	Nov 30	4
	0.310	Dec 21	0.311	Nov 19	0.257	Sep 8	5
	0.282	Jan 21	0.286	Dec 26	0.255	Jan 7	6
	0.231	Dec 30	0.273	Oct 26	0.250	Jan 5	7
	0.216	Jan 2	0.241	Jan 28	0.189	Feb 9	8

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Visibility Results for 2001-2003 CALPUFF Screening Runs
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Table 7. Stack parameters and emissions

Stack ID #	Lambert Conformal Coordinates		Stack Height	Base Elevation	Diameter	Gas Exit Velocity	Stack Gas Exit Temp.	SO_2 Emissions	SO_4 Emissions	NO_x Emissions	PM_{10} Emissions	$PM_{2.5}$ Emissions	NH_3 Emissions
	LCC East	LCC North											
	km	km	m	m	m	m/s	K	g/s	g/s	g/s	g/s	g/s	g/s
PB	1470.712	-789.031	46.04	4.30	1.98	15.45	470.92	60.5000	0.0000	8.7000	3.4000	2.0000	
LK	1470.714	-788.897	15.24	3.60	1.52	4.96	342.09	0.1600	0.0000	2.2000	0.7400	0.7200	
RB	1470.714	-789.026	46.04	4.20	2.74	13.73	353.37	0.1200	0.0000	8.8000	5.5000	5.4000	
PB*	1470.712	-789.031	46.04	4.30	1.98	15.45	470.92	6.81	0.0000	13.83	3.4000	2.0000	

Table 8. Particle Speciation

Stack ID #	particle speciation		Condensable				Filterable									
	filterable PM_{10}	condensable PM_{10}	organic condensable (OC)		inorganic condensable		COARSE		Soil				Elemental Carbon (EC)			
	%	%	0.625-1.0 µm (g/s)	0.5-0.625 µm (g/s)	0.625-1.0 µm (g/s)	0.5-0.625 µm (g/s)	6-10 µm (g/s)	2.5-6 µm (g/s)	1.25-2.5 µm (g/s)	1.0-1.25 µm (g/s)	0.625-1.0 µm (g/s)	0.5-0.625 µm (g/s)	1.25-2.5 µm (g/s)	1.0-1.25 µm (g/s)	0.625-1.0 µm (g/s)	0.5-0.625 µm (g/s)
PB			1.7000	1.7000												
LK			0.3700	0.3700												
RB			2.7500	2.7500												
PB*			1.7000	1.7000												

Note: Stack parameters and emission data obtained from "EPD BART Emissions.xls" file. The PM speciation was not provided by the state. All PM_{10} - H_2SO_4 emissions were equally divided between the two size categories of OC. This is a conservative approach since, Organic condensable have extinction efficiency of 4 m^2/g.

* Power Boiler as modified by GA EPD for Determination modeling to ONLY Wolf Island. Natural gas PTE includes ability to combust non-condensable gases at 53.8 #/hr SO2.

Table 9. Summary of Visibility Results

Class I Area	**2001**	**2002**	**2003**	**Annual average background b_{ext}**
	Maximum delta-deciview, (# days>0.5 dv, # days >1 dv)			(Mm^{-1})
Cape Romain	0.330 (0 0)	0.408 (0 0)	0.242 (0 0)	21.22
Okefenokee	**0.670 (4 0)**	**0.561 (3 0)**	**1.153 (4 1)**	21.41
St Marks	0.192 (0 0)	0.196 (0 0)	0.247 (0 0)	21.54
Wolf Island	**1.653 (8 1)**	**0.963 (12 0)**	**0.938 (10 0)**	21.33
Wolf Island*	**1.380 (6 1)**	**0.873 (6 0)**	**0.773 (2 0)**	21.33

Table 10. Visibility Results – 8 highest values (asterisked values (*) indicate GA EPD Determination modeling results)

Bold format concentrations are >0.5Dv, Bold format dates are different or in different sequence from dates exemption modeled.

	2001				2002				2003				
	Chg. in Deciview (dv)	**Day**			**Chg. in Deciview (dv)**	**Day**			**Chg. in Deciview (dv)**	**Day**			**Rank**
Okefenokee	**0.670**	Feb 13			**0.561**	Dec 8			**1.153**	Jan 31			1
	0.579	Nov 19			**0.516**	Oct 22			**0.630**	Dec 27			2
	0.520	Oct 22			**0.500**	Jan 27			**0.523**	Nov 8			3
	0.514	Dec 4			0.462	Oct 25			**0.500**	Sep 10			4
	0.431	Jun 20			0.461	Dec 18			0.391	Nov 21			5
	0.431	Feb 12			0.456	Jan 26			0.341	Oct 31			6
	0.431	Jan 14			0.401	Oct 14			0.336	Jan 28			7
	0.318	Oct 23			0.338	Feb 3			0.328	Nov 11			8
Wolf Island	**1.653**	Jan 15	**1.380***	Jan 15	**0.963**	Jan 28	**0.873***	Jan 28	**0.938**	Dec 8	**0.773***	Dec 8	1
	0.851	Sep 17	**0.614***	Sep 17	**0.962**	Dec 27	**0.786***	Dec 27	**0.763**	Sep 7	**0.529***	**Oct 15**	2
	0.759	Jan 10	**0.604***	Jan 10	**0.943**	Nov 26	**0.604***	Nov 26	**0.760**	Sep 8	0.463*	**Nov 30**	3
	0.755	Feb 6	**0.559***	Feb 6	**0.823**	Sep 17	**0.583***	Sep 17	**0.707**	Jul 15	0.454*	**Sep 7**	4
	0.675	Jan 21	**0.547***	Jan 21	**0.751**	Nov 1	**0.548***	Nov 1	**0.630**	Nov 22	0.440*	**Jan 5**	5
	0.665	Sep 9	**0.525***	**Dec 21**	**0.731**	Dec 30	**0.501***	Dec 30	**0.609**	Oct 15	0.438*	**Sep 8**	6
	0.584	Sep 18	0.396*	**Dec 30**	**0.691**	Jan 16	0.482*	Jan 16	**0.574**	Oct 4	0.420*	**Jan7**	7
	0.573	Dec 21	0.336*	**Jan 2**	**0.650**	Oct 26	0.457*	Oct 26	**0.565**	Nov 7	0.339*	**Feb 9**	8

APPENDIX A

Impacts of SO_2, NO_x, and Primary Carbon (PC) on Okefenokee and Wolf Island Class I Areas

Emission sensitivities were performed by Georgia Tech to examine the impact of SO_2, NO_x, and primary carbon (PC) on Okefenokee and Wolf Island Class I areas. The impacts (Mm^{-1}) were normalized by the emissions (tons/year) to show the relative importance of SO_2, NO_x and PC emission reductions by source category and by state (Figures A-1 and A-2). Figures A-3 and A-4 contain the normalized visibility responses on 20% worst days at Okefenokee and Wolf Island to reductions from the 2009 BaseD inventory for non-EGU point SO_2 emissions and point NO_x emissions in Georgia.

At Okefenokee, the light extinction impact due to one ton of non-EGU SO_2 is 2.59E-05 Mm^{-1}/TPY and the light extinction impact due to one ton of point NO_x is 0.159E-05 Mm^{-1}/TPY. Therefore, the reduction of one ton of SO_2 emissions is 16.4 times more efficient than the reduction of one ton of NO_x emissions at Okefenokee.

At Wolf Island, the light extinction impact due to one ton of non-EGU SO_2 is 1.97E-05 Mm^{-1}/TPY and the light extinction impact due to one ton of point NO_x is 0.319E-05 Mm^{-1}/TPY. Therefore, the reduction of one ton of SO_2 emissions is 6.2 times more efficient than the reduction of one ton of NO_x emissions at Wolf Island.

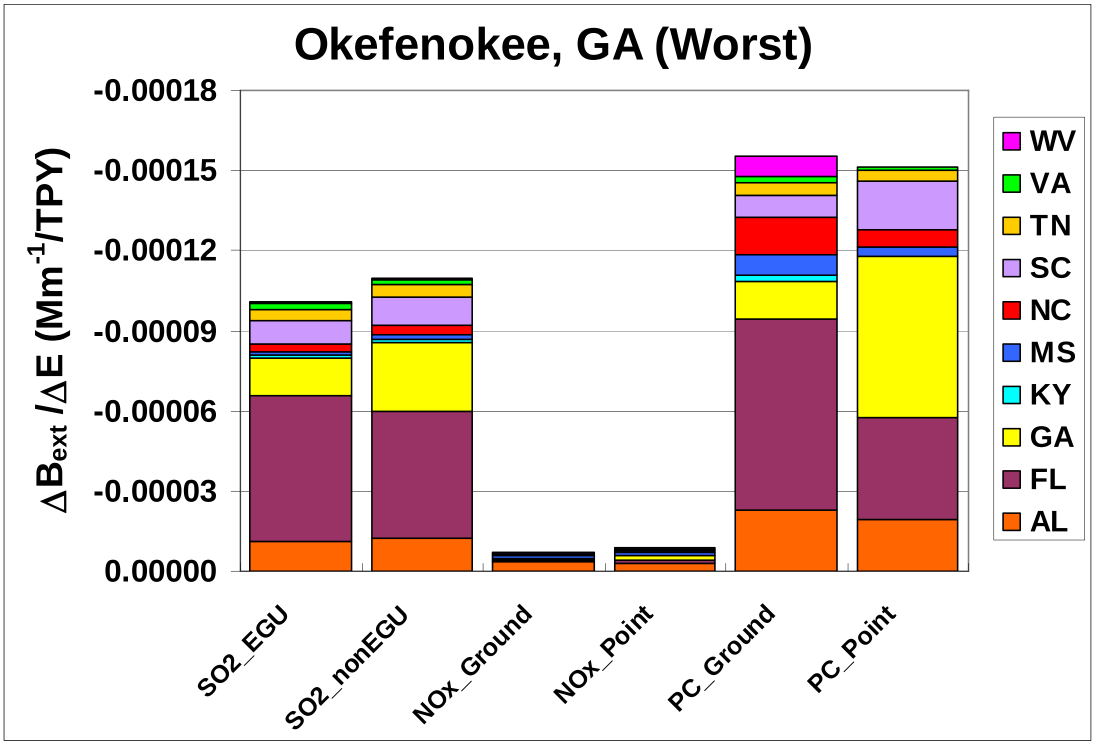

Figure A-1: CMAQ projections of normalized visibility responses on 20% worst days at Okefenokee, GA to reductions from the 2009 BaseD inventory for visibility-reducing pollutants in different source categories and geographic areas.

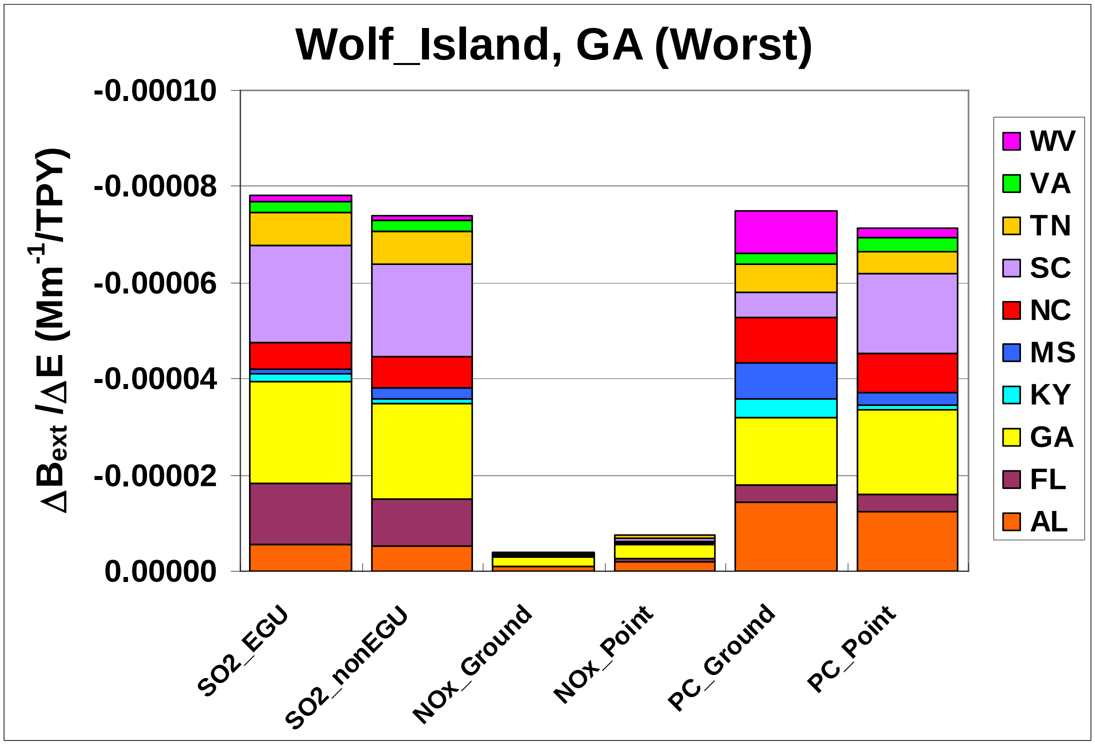

Figure A-2: CMAQ projections of normalized visibility responses on 20% worst days at Wolf Island, GA to reductions from the 2009 BaseD inventory for visibility-reducing pollutants in different source categories and geographic areas.

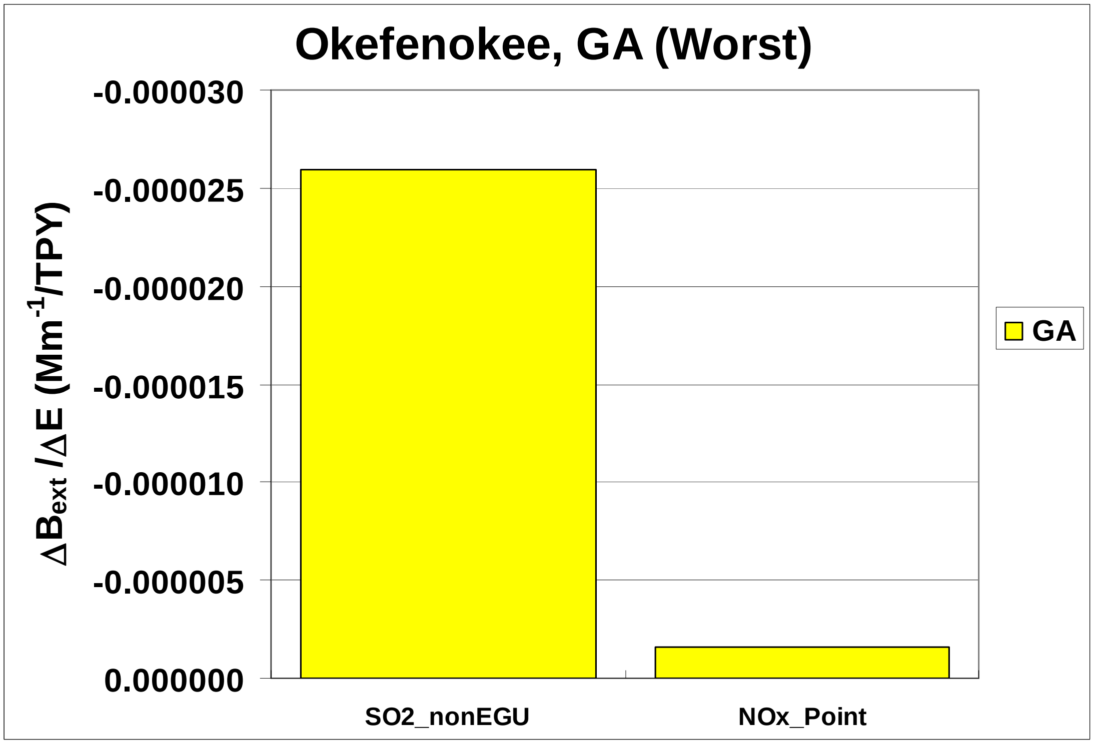

Figure A-3: CMAQ projections of normalized visibility responses on 20% worst days at Okefenokee, GA to reductions from the 2009 BaseD inventory for non-EGU point SO2 emissions and point NOx emissions in Georgia.

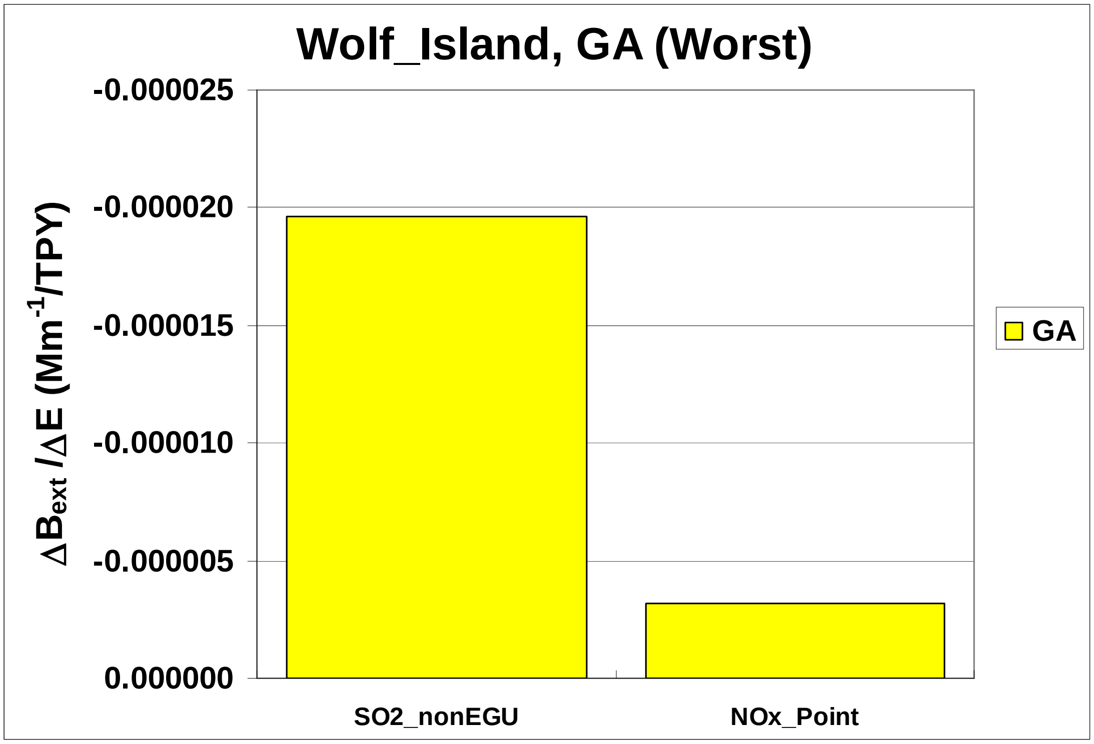

Figure A-4: CMAQ projections of normalized visibility responses on 20% worst days at Wolf Island, GA to reductions from the 2009 BaseD inventory for non-EGU point SO2 emissions and point NOx emissions in Georgia.