Particulate Source Apportionment Technology Modeling Results Task 7

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Abbreviations/Acronym List

Alpine	Alpine Geophysics, LLC
AOI	Area of Influence
b_{ext}	Beta (or light) extinction
CAMx	Comprehensive Air Quality Model with Extensions
CCRS	Coarse PM species (CAMx PM species)
CenRAP	Central Regional Air Planning
CPRM	Coarse PM
EGU	Electric Generating Unit
EPA	United States Environmental Protection Agency
ERG	Eastern Research Group, Inc.
ERTAC	Eastern Regional Technical Advisory Committee
EWRT	Extinction Weighted Residence Time
FCRS	Crustal fraction of PM
FPRM	Fine Other Primary (diameter ≤2.5 µm)
HYSPLIT	Hybrid Single-Particle Lagrangian Integrated Trajectory
HgP	Particulate mercury
IMPROVE	Interagency
LADCO	Lake Michigan Air Directors Consortium
MANE-VU	Mid-Atlantic and Northeast Visibility Union
MARAMA	Mid-Atlantic Regional Air Management Association, Inc.
Mm-1	Inverse Megameters
Na^+	Sodium ion
NO_x	Oxides of nitrogen
PCL	Chorine
PEC	Primary elemental carbon
PM	Particulate Matter
$PM_{2.5}$	Fine particle; primary particulate matter less than or equal to 2.5 microns in aerodynamic diameter
PNH4	Ammonium
PNO3	Particulate nitrate
POA	Primary organic carbon
PSAT	Particulate Source Apportionment Technology
PSO4	Sulfate
RHR	Regional Haze Rule
RPO	Regional Planning Organization
SESARM	Southeastern States Air Resource Managers, Inc.
SIP	State Implementation Plan
SMAT	Software for Model Attainment Test
SMOKE	Sparse Matrix Operator Kernel Emissions
SO_2	Sulfur dioxide
SOA	Secondary Organic Aerosol
tpy	Tons per year
VISTAS	Visibility Improvement – State and Tribal Association of the Southeast
WRAP	Western Regional Air Partnership

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1.0 INTRODUCTION

Southeastern States Air Resource Managers, Inc. (SESARM) has been designated by the United States Environmental Protection Agency (EPA) as the entity responsible for coordinating regional haze evaluations for the ten Southeastern states of Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia. The Eastern Band of Cherokee Indians and the Knox County, Tennessee local air pollution control agency are also participating agencies. These parties are collaborating through the Regional Planning Organization known as Visibility Improvement - State and Tribal Association of the Southeast (VISTAS) in the technical analyses and planning activities associated with visibility and related regional air quality issues. VISTAS analyses will support the VISTAS states in their responsibility to develop, adopt, and implement their State Implementation Plans (SIPs) for regional haze.

The state and local air pollution control agencies in the Southeast are mandated to protect human health and the environment from the impacts of air pollutants. They are responsible for air quality planning and management efforts including the evaluation, development, adoption, and implementation of strategies controlling and managing all criteria air pollutants including fine particles and ozone as well as regional haze. This project will focus on regional haze and regional haze precursor emissions. Control of regional haze precursor emissions will have the additional benefit of reducing criteria pollutants as well.

The 1999 Regional Haze Rule (RHR) identified 18 Class I Federal areas (national parks greater than 6,000 acres and wilderness areas greater than 5,000 acres) in the VISTAS region. The 1999 RHR required states to define long-term strategies to improve visibility in Federal Class I national parks and wilderness areas. States were required to establish baseline visibility conditions for the period 2000-2004, natural visibility conditions in the absence of anthropogenic influences, and an expected rate of progress to reduce emissions and incrementally improve visibility to natural conditions by 2064. The original RHR required states to improve visibility on the 20% most impaired days and protect visibility on the 20% least impaired days.[1] The RHR

[1] RHR summary data is available at: http://vista.cira.colostate.edu/Improve/rhr-summary-data/

requires states to evaluate progress toward visibility improvement goals every five years and submit revised SIPs every ten years.

This report documents the steps taken by Alpine Geophysics, LLC (Alpine) in developing Particulate Source Apportionment Technology (PSAT) modeling results, which was completed under Task 7 of VISTAS Contract No. V-2018-03-01, entitled "Southeast VISTAS II Regional Haze Analysis Project". Under this contract, SESARM exercised the option of increasing PSAT tags from the base of 150 tags to up to 250 tags. A "tag" can be identified as a specific source, or group of sources. Sources of interest are for those emitting sulfur dioxide (SO_2) and/or oxides of nitrogen (NO_x).

2.0 PSAT OVERVIEW

In order to gain a better understanding of the source contributions to modeled visibility, Alpine used the CAMx PSAT modeling.[2] PSAT uses multiple tracer families to track the fate of both primary and secondary PM. PSAT is designed to apportion the following classes of CAMx PM species:

- Sulfate (PSO4)
- Particulate nitrate (PNO3)
- Ammonium (PNH4)
- Secondary organic aerosol (SOA)
- Primary PM (PEC, POA, FCRS, FPRM, CCRS, and CPRM)
- Particulate mercury (HgP)

PSAT allows emissions to be tracked (tagged) by various combinations of sectors and geographic areas (e.g., by state). For this application, 2028elv3 emissions were tagged per configuration provided by SESARM.[3]

Although an update of the 2028 emissions was completed in March 2020, the PSAT modeling was not rerun.

[2] More information on CAMx modeling can be found at: http://www.camx.com/home.aspx

[3] The 2028elv3 emissions were completed in August 2018, and is summarized in the Task 2 Report entitled "Southeastern VISTAS II Regional Haze Analysis Project – Task 2A: Emission Inventory Updates Report for Area Of Influence and Point Source Apportionment Tagging. August 2020."

3.0 PSAT TAGS

SESARM worked with its stakeholders and surrounding regional planning organizations (RPOs) within the VISTAS modeling domain to compile a list of tags for PSAT analysis. The starting point for identifying tags were the results of Task 5, Area of Influence (AOI) Analysis.[4] Under Task 5, Class I-specific workbooks within the VISTAS modeling domain were created from combining Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) back trajectories, NO_x and SO_2 emissions inventories (facility-level and county-level),[5] and extinction weighted residence time (EWRT) values of nitrate and sulfate to calculate relative contributions of facility-level sources and source category sectors (e.g., point, onroad, nonroad, nonpoint, and fires).

Each tag identified was chosen to inform SESARM and its stakeholders on sources or groups of sources that are likely affecting visibility in the SESARM states, warranting further understanding of their contributions.

Additionally, the following RPOs were asked to provide comment on potential tags for its member states within the VISTAS modeling domain:

- The Central States Regional Air Partnership (CENRAP);
- The Mid-Atlantic and Northeast Visibility Union (MANE-VU);
- The Lake Michigan Air Directors Consortium (LADCO); and
- The Western Regional Air Partnership (WRAP).

As a result of this consultation, two rounds of PSAT tagging for SO_2 and NO_x emissions were conducted. Round 1 is presented in Table 3-1 for groups of sources (70 tags) and Table 3-2 for individual facilities (55 tags).[6] Each of these emissions sources or source sectors were processed through Sparse Matrix Operating Kernal Emissions (SMOKE) software and tracked in

[4] The steps for developing the AOI analysis are documented in the report entitled "Area of Influence Analysis, Southeastern VISTAS II Regional Haze Analysis Project – Documentation Report for Task 5." December 2019.

[5] Due to additional state review and updates from sources within the VISTAS modeling domain, the AOI analyses included updated emissions and/or facility/unit-closures beyond what is described in Task 2. These updates are captured in the Task 5 report.

[6] Officially SESARM requested 54 PSAT facility tags for Round 1. However, PSAT facility tagged results were conducted for McGhee Tyson Airport (AOI Facility ID = 47009-9159211, PSAT Tag ID = 034) based on the initial list of PSAT tags for Round 1. This source was officially removed from the PSAT tagging list on a June 1, 2019 e-mail from Mr. John Hornback, SESARM to Mr. Regi Oommen, ERG.

PSAT as individual source tags. For this application, only sulfate and nitrate were tracked using PSAT.

Table 3-1. Round 1 SESARM Defined Regional-Category Combination Tags

Tag Name	Tagging Description
Alabama – All NOX	Total NO_x emissions from Alabama
Alabama – All SO2	Total SO_2 emissions from Alabama
Florida – All NOX	Total NO_x emissions from Florida
Florida – All SO2	Total SO_2 emissions from Florida
Georgia – All NOX	Total NO_x emissions from Georgia
Georgia – All SO2	Total SO_2 emissions from Georgia
Kentucky – All NOX	Total NO_x emissions from Kentucky
Kentucky – All SO2	Total SO_2 emissions from Kentucky
Mississippi – All NOX	Total NO_x emissions from Mississippi
Mississippi – All SO2	Total SO_2 emissions from Mississippi
North Carolina – All NOX	Total NO_x emissions from North Carolina
North Carolina – All SO2	Total SO_2 emissions from North Carolina
South Carolina – All NOX	Total NO_x emissions from South Carolina
South Carolina – All SO2	Total SO_2 emissions from South Carolina
Tennessee – All NOX	Total NO_x emissions from Tennessee
Tennessee – All SO2	Total SO_2 emissions from Tennessee
Virginia – All NOX	Total NO_x emissions from Virginia
Virginia – All SO2	Total SO_2 emissions from Virginia
West Virginia – All NOX	Total NO_x emissions from West Virginia
West Virginia – All SO2	Total SO_2 emissions from West Virginia
CENRAP – All NOX	Total NO_x emissions from the CENRAP region
CENRAP – All SO2	Total SO_2 emissions from the CENRAP region
MANE-VU – All NOX	Total NO_x emissions from the MANE-VU region
MANE-VU – All SO2	Total SO_2 emissions from the MANE-VU region
LADCO – All NOX	Total NO_x emissions from the LADCO region
LADCO – All SO2	Total SO_2 emissions from the LADCO region
Alabama – Point EGU NOX	Total Point NO_x EGU emissions from Alabama
Alabama – Point EGU SO2	Total Point SO_2 EGU emissions from Alabama
Florida – Point EGU NOX	Total Point NO_x EGU emissions from Florida
Florida – Point EGU SO2	Total Point SO_2 EGU emissions from Florida
Georgia – Point EGU NOX	Total Point NO_x EGU emissions from Georgia
Georgia – Point EGU SO2	Total Point SO_2 EGU emissions from Georgia
Kentucky – Point EGU NOX	Total Point NO_x EGU emissions from Kentucky
Kentucky – Point EGU SO2	Total Point SO_2 EGU emissions from Kentucky
Mississippi – Point EGU NOX	Total Point NO_x EGU emissions from Mississippi

Table 3-1. Round 1 SESARM Defined Regional-Category Combination Tags

Tag Name	Tagging Description
Mississippi – Point EGU SO2	Total Point SO_2 EGU emissions from Mississippi
North Carolina – Point EGU NOX	Total Point NO_x EGU emissions from North Carolina
North Carolina – Point EGU SO2	Total Point SO_2 EGU emissions from North Carolina
South Carolina – Point EGU NOX	Total Point NO_x EGU emissions from South Carolina
South Carolina – Point EGU SO2	Total Point SO_2 EGU emissions from South Carolina
Tennessee – Point EGU NOX	Total Point NO_x EGU emissions from Tennessee
Tennessee – Point EGU SO2	Total Point SO_2 EGU emissions from Tennessee
Virginia – Point EGU NOX	Total Point NO_x EGU emissions from Virginia
Virginia – Point EGU SO2	Total Point SO_2 EGU emissions from Virginia
West Virginia – Point EGU NOX	Total Point NO_x EGU emissions from West Virginia
West Virginia – Point EGU SO2	Total Point SO_2 EGU emissions from West Virginia
CENRAP – Point EGU NOX	Total Point NO_x EGU emissions from the CENRAP region
CENRAP – Point EGU SO2	Total Point SO_2 EGU emissions from the CENRAP region
MANE-VU – Point EGU NOX	Total Point NO_x EGU emissions from the MANE-VU region
MANE-VU – Point EGU SO2	Total Point SO_2 EGU emissions from the MANE-VU region
LADCO – Point EGU NOX	Total Point NO_x EGU emissions from the LADCO region
LADCO – Point EGU SO2	Total Point SO_2 EGU emissions from the LADCO region

Table 3-2. Round 1 SESARM-Defined Individual Facility Tags

Requesting State	Area of Influence Facility ID	Facility Name	PSAT Tag ID[a]	Facility State	SO_2 Emissions (tpy)	NOx Emissions (tpy)
AL/FL	01053-7440211	Escambia Operating Company LLC	001	AL	18,974	349
AL	01053-985111	Escambia Operating Company LLC	002	AL	8,590	150
AL	01073-1018711	Drummond Company, Inc.	003	AL	2,562	1,229
AL	01097-1056111	Ala Power – Barry	004	AL	6,026	2,182
AL	01097-1061611	Union Oil of California – Chunchula Gas Plant	005	AL	2,573	349
AL	01097-949811	Akzo Nobel Chemicals Inc.	006	AL	3,336	21
AL	01103-1000011	Nucor Steel Decatur LLC	007	AL	170	331
AL	01109-985711	Sanders Lead Co	008	AL	7,951	122
FL	12005-535411	Rocktenn CP LLC	009	FL	2,591	1,405
FL	12017-640611	Duke Energy Florida, Inc. (Def)	010	FL	5,306	2,490
FL	12031-640211	JEA	011	FL	2,094	652
FL/GA	12033-752711	Gulf Power – Crist	012	FL	2,616	2,998
FL	12047-769711	White Springs Agricultural Chemicals, Inc.	013	FL	3,198	112
FL/GA	12057-538611	Tampa Electric Company (Tec)	014	FL	6,085	2,665
FL	12057-716411	Mosaic Fertilizer, LLC	015	FL	3,034	160
FL	12089-753711	Rock Tenn CP, LLC	016	FL	2,607	2,317
FL	12089-845811	Rayonier Performance Fibers LLC	017	FL	2,327	562
FL	12105-717711	Mosaic Fertilizer LLC	018	FL	7,901	310
FL	12105-919811	Mosaic Fertilizer, LLC	019	FL	4,426	141
FL	12123-752411	Buckeye Florida, Limited Partnership	020	FL	1,520	1,831
GA/TN	13015-2813011	Ga Power Company – Plant Bowen	021	GA	10,453	6,643
GA	13051-3679811	International Paper – Savannah	022	GA	3,945	1,561
GA	13127-3721011	Brunswick Cellulose Inc.	023	GA	294	1,555
KY	21091-7352411	Century Aluminum of KY LLC	024	KY	5,044	198
AL	21145-6037011	Tennessee Valley Authority (TVA) – Shawnee Fossil Plant	025	KY	19,505	7,007

Table 3-2. Round 1 SESARM-Defined Individual Facility Tags

Requesting State	Area of Influence Facility ID	Facility Name	PSAT Tag ID[a]	Facility State	SO_2 Emissions (tpy)	NOx Emissions (tpy)
KY	21177-5196711	Tennessee Valley Authority – Paradise Fossil Plant	026	KY	2,990	2,927
AL/KY	21183-5561611	Big Rivers Electric Corp – Wilson Station	027	KY	6,934	1,152
NC	37013-8479311	PCS Phosphate Company, Inc. – Aurora	028	NC	4,846	496
NC	37087-7920511	Blue Ridge Paper Products – Canton Mill	029	NC	1,127	2,992
SC	45015-4834911	Alumax of South Carolina	030	SC	3,752	108
SC	45019-4973611	Kapstone Charleston Kraft LLC	031	SC	1,864	2,356
SC	45043-5698611	International Paper Georgetown Mill	032	SC	2,768	2,031
TN	47001-6196011	TVA Bull Run Fossil Plant	033	TN	623	964
TN	47009-9159211[b]	McGhee Tyson Airport	034	TN	79	595
TN	47093-4979911	Cemex – Knoxville Plant	035	TN	121	712
TN	47105-4129211	Tate & Lyle, Loudon	036	TN	473	883
TN	47145-4979111	TVA Kingston Fossil Plant	037	TN	1,886	1,687
AL/TN	47161-4979311	TVA Cumberland Fossil Plant	038	TN	8,427	4,917
TN	47163-3982311	Eastman Chemical Company	039	TN	6,420	6,900
VA	51023-5039811	Roanoke Cement Company	040	VA	2,290	1,973
VA	51027-4034811	Jewell Coke Company LLP	041	VA	5,091	520
VA	51580-5798711	Meadwestvaco Packaging Resource Group	042	VA	2,115	1,986
WV	54023-6257011	Dominion Resources, Inc. – Mount Storm Power Station	043	WV	2,124	1,984
WV	54033-6271711	Allegheny Energy Supply Co, LLC-Harrison	044	WV	10,083	11,831
WV	54041-6900311	Equitrans – Copley Run Cs 70	045	WV	<1	511
WV	54049-4864511	American Bituminous Power-Grant Town Plt.	046	WV	2,210	1,245
WV	54051-6902311	Mitchell Plant	047	WV	5,372	2,720
WV	54061-16320111	Longview Power	048	WV	2,314	1,557
WV	54061-6773611	Monongahela Power Co.- Fort Martin Power	049	WV	4,882	13,743
WV	54061-6773811	Morgantown Energy Associates	050	WV	829	656

Table 3-2. Round 1 SESARM-Defined Individual Facility Tags

Requesting State	Area of Influence Facility ID	Facility Name	PSAT Tag ID[a]	Facility State	SO_2 Emissions (tpy)	NOx Emissions (tpy)
WV	54073-4782811	Monongahela Power Co – Pleasants Power Station	051	WV	16,817	5,497
WV	54079-6789111	Appalachian Power Company – John E Amos Plant	052	WV	10,984	4,878
WV	54083-6790511	Glady 6c4350	053	WV	<1	343
WV	54083-6790711	Files Creek 6c4340	054	WV	<1	643
WV	54093-6327811	Kingsford Manufacturing Company	055	WV	17	141

[a] The PSAT ID tags match the "Facility to Area" spreadsheet tab in Attachment A.

[b] Please note that PSAT tagged results were conducted for McGhee Tysons Airport based on the initial list of PSAT tags for Round 1. This source was officially removed from the PSAT tagging list on a June 1, 2019 e-mail from Mr. John Hornback, SESARM to Mr. Regi Oommen, ERG.

For Round 2 of tagging, Table 3-3 presents tags for Regional Category combinations (34 tags) and Table 3-4 presents additional facilities (79 tags) for both SO_2 and NO_x emissions.

Table 3-3. Round 2 SESARM Defined Regional-Category Combination Tags

Tag Name	Tagging Description
East Boundary Conditions – All NOX	NO_x boundary conditions on the eastern boundary of the VISTAS modeling domain.
East Boundary Conditions – All SO2	SO_2 boundary conditions on the eastern boundary of the VISTAS modeling domain.
East Boundary Conditions – All NOX	NO_x boundary conditions on the eastern boundary of the VISTAS modeling domain.
East Boundary Conditions – All SO2	SO_2 boundary conditions on the eastern boundary of the VISTAS modeling domain.
East Boundary Conditions – All NOX	NO_x boundary conditions on the eastern boundary of the VISTAS modeling domain.
East Boundary Conditions – All SO2	SO_2 boundary conditions on the eastern boundary of the VISTAS modeling domain.
East Boundary Conditions – All NOX	NO_x boundary conditions on the eastern boundary of the VISTAS modeling domain.
East Boundary Conditions – All SO2	SO_2 boundary conditions on the eastern boundary of the VISTAS modeling domain.
Alabama – Point Non-EGU NOX	Total Point NO_x Non-EGU emissions from Alabama
Alabama – Point Non-EGU SO2	Total Point SO_2 Non-EGU emissions from Alabama
Florida – Point Non-EGU NOX	Total Point NO_x Non-EGU emissions from Florida
Florida – Point Non-EGU SO2	Total Point SO_2 Non-EGU emissions from Florida
Georgia – Point Non-EGU NOX	Total Point NO_x Non-EGU emissions from Georgia
Georgia – Point Non-EGU SO2	Total Point SO_2 Non-EGU emissions from Georgia
Kentucky – Point Non-EGU NOX	Total Point NO_x Non-EGU emissions from Kentucky
Kentucky – Point Non-EGU SO2	Total Point SO_2 Non-EGU emissions from Kentucky
Mississippi – Point Non-EGU NOX	Total Point NO_x Non-EGU emissions from Mississippi
Mississippi – Point Non-EGU SO2	Total Point SO_2 Non-EGU emissions from Mississippi
North Carolina – Point Non-EGU NOX	Total Point NO_x Non-EGU emissions from North Carolina
North Carolina – Point Non-EGU SO2	Total Point SO_2 Non-EGU emissions from North Carolina
South Carolina – Point Non-EGU NOX	Total Point NO_x Non-EGU emissions from South Carolina
South Carolina – Point Non-EGU SO2	Total Point SO_2 Non-EGU emissions from South Carolina
Tennessee – Point Non-EGU NOX	Total Point NO_x Non-EGU emissions from Tennessee
Tennessee – Point Non-EGU SO2	Total Point SO_2 Non-EGU emissions from Tennessee
Virginia – Point Non-EGU NOX	Total Point NO_x Non-EGU emissions from Virginia

Table 3-3. Round 2 SESARM Defined Regional-Category Combination Tags

Tag Name	Tagging Description
Virginia – Point Non-EGU SO2	Total Point SO_2 Non-EGU emissions from Virginia
West Virginia – Point Non-EGU NOX	Total Point NO_x Non-EGU emissions from West Virginia
West Virginia – Point Non-EGU SO2	Total Point SO_2 Non-EGU emissions from West Virginia
CENRAP – Point Non-EGU NOX	Total Point NO_x Non-EGU emissions from the CENRAP region
CENRAP – Point Non-EGU SO2	Total Point SO_2 Non-EGU emissions from the CENRAP region
MANE-VU – Point Non-EGU NOX	Total Point NO_x Non-EGU emissions from the MANE-VU region
MANE-VU – Point Non-EGU SO2	Total Point SO_2 Non-EGU emissions from the MANE-VU region
LADCO – Point Non-EGU NOX	Total Point NO_x Non-EGU emissions from the LADCO region
LADCO – Point Non-EGU SO2	Total Point SO_2 Non-EGU emissions from the LADCO region

Table 3-4. Round 2 SESARM-Defined Individual Facility Tags

Requesting State	Area of Influence Facility ID	Facility Name	PSAT Tag ID[a]	Facility State	SO_2 Emissions (tpy)	NOx Emissions (tpy)
AL	01129-1028711	American Midstream Chatom, LLC	073	AL	3,106	426
AL	05063-1083411	Entergy Arkansas Inc-Independence Plant	056	AR	32,050	1,4133
FL	12086-3532711	Homestead City Utilities	077	FL	0	97
FL	12086-899911	Tarmac America LLC	079	FL	9	880
FL	12086-900011	Florida Power & Light (PTF)	076	FL	13	171
FL	12086-900111	Cemex Construction Materials Fl. LLC.	075	FL	30	910
FL	12123-752411	Buckeye Florida, Limited Partnership	074	FL	1,520	1,831
FL	12129-2731711	Tallahassee City Purdom Generating Sta.	078	FL	3	121
GA	13103-536311	Georgia-Pacific Consumer Products LP (Savannah River Mill)	081	GA	1,860	352
GA	13115-539311	Temple Inland	082	GA	1,791	1,773
GA	13127-3721011	Brunswick Cellulose Inc.	080	GA	294	1,555
AL	17127-7808911	Joppa Steam	062	IL	20,509	4,706
AL/KY	18051-7363111	Gibson	064	IN	23,117	12,280
AL/KY	18125-7362411	Indianapolis Power & Light Petersburg	066	IN	18,142	10,665
KY	18129-8166111	Sigeco AB Brown South Indiana Gas & Ele	067	IN	7,645	1,579
KY, AL/KY/TN	18147-8017211	Indiana Michigan Power DBA AEP Rockport	065	IN	30,536	8,807
KY	18173-8183111	Alcoa Warrick Power Plt Agc Div of AL	063	IN	5,071	11,159
VA/WV	24001-7763811	Luke Paper Company	058	MD	9,876	3,607
MS	28059-6251011	Mississippi Power Company, Plant Victor J Daniel	084	MS	224	3,736
MS	28059-8384311	Chevron Products Company, Pascagoula Refinery	083	MS	742	1,534
AL	29143-5363811	New Madrid Power Plant-Marston	057	MO	16,784	4,394
NC	37013-8479311	PCS Phosphate Company, Inc. - Aurora	088	NC	4,846	496
NC	37023-8513011	SGL Carbon LLC	089	NC	262	22

Table 3-4. Round 2 SESARM-Defined Individual Facility Tags

Requesting State	Area of Influence Facility ID	Facility Name	PSAT Tag ID[a]	Facility State	SO_2 Emissions (tpy)	NOx Emissions (tpy)
NC	37035-8370411	Duke Energy Carolinas, LLC - Marshall Steam Station	087	NC	4,139	7,511
NC	37087-7920511	Blue Ridge Paper Products - Canton Mill	085	NC	1,127	2,992
NC	37117-8049311	Domtar Paper Company, LLC	086	NC	687	1,796
VA, TN	39025-8294311	Duke Energy Ohio, Wm. H. Zimmer Station (1413090154)	070	OH	22,134	7,150
VA	39031-8010811	Conesville Power Plant (0616000000)	069	OH	6,356	9,958
WV	39053-7983011	Ohio Valley Electric Corp., Kyger Creek Station (0627000003)	072	OH	3,400	9,144
WV, TN/VA/WV	39053-8148511	General James M. Gavin Power Plant (0627010056)	071	OH	41,596	8,123
WV	39081-8115711	Cardinal Power Plant (Cardinal Operating Company) (0641050002)	068	OH	7,461	2,467
VA	42005-3866111	Genon NE Mgmt Co/Keystone Sta	059	PA	56,939	6,578
VA	42063-3005111	NRG Wholesale Gen/Seward Gen Sta	061	PA	8,880	2,255
WV, VA/WV	42063-3005211	Homer City Gen LP/ Center Twp	060	PA	11,866	5,216
SC	45015-4120411	Santee Cooper Cross Generating Station	090	SC	4,281	3,723
SC	45015-8306711	SCE&G Williams	092	SC	392	993
SC	45043-6652811	Santee Cooper Winyah Generating Station	091	SC	2,247	1,773
VA	51023-5039811	Roanoke Cement Company	095	VA	2,290	1,973
VA	51027-4034811	Jewell Coke Company LLP	093	VA	5,091	520
VA	51580-5798711	Meadwestvaco Packaging Resource Group	094	VA	2,115	1,986

[a] The PSAT ID tags match the "Facility to Area" spreadsheet tab in Attachment A.

4.0 PSAT POST-PROCESSING

The CAMx 2011 and 2028 model output were post-processed using a "species definition file" that cross references raw CAMx output species names with PM species needed for SMAT. The results of the post-processing are 24-hour average PM species with the "combine file" output names. These are matched to the SMAT species as shown in Table 4-1.

Table 4-1. Matching of CAMx Raw Output Species to SMAT Input Variables

SMAT Species	Raw CAMx 6.40 Species
Sulfate (SO4)[1]	PSO4
Nitrate (NO3)[1]	PNO3
Ammonium (NH4)[1]	PNH4
Organic Matter (OM)	POA+SOA1+SOA2 +SOA3+SOA4+SOPA+SOPB
Elemental carbon (EC)	PEC
Crustal (CRUSTAL)	FPRM+FCRS
Coarse PM (CM)	CPRM+CCRS
PM2.5 (PM25)[2]	PSO4+PNO3+PNH4+POA+PEC+FCRS+FPRM+SOA1+SOA2+SOA3+SOA4+SOPA+SOPB+NA+PCL

[1] Modeled ammonium concentrations are not used in the post-processing of the 2028 visibility values because the IMPROVE network does not measure ammonium and there is not an ammonium term in the IMPROVE visibility equation.

[2] Note that total $PM_{2.5}$ concentration data is needed as a SMAT input variable, but it is not used in the visibility calculations for regional haze. Visibility calculations only use the species specific model outputs.

5.0 PROCESS FOR CREATING PSAT CONTRIBUTIONS FOR CLASS I AREAS

The CAMx hourly concentration data was post-processed to create SMAT input files. This involved processing both the 2028 "full model" and the specific source apportionment outputs. The "full model" results are the total PM species concentrations (e.g. sulfate, nitrate) and are identical to the total species concentrations from the non-source apportionment model run for 2028elv3 (e.g., future year base case). The source apportionment outputs contain the sulfate and/or nitrate contributions for each tagged source.

The PSAT source apportionment tracking uses slightly different variable names for the source apportionment variables. Table 5-1 below shows the SMAT species definition matching to be used for the 2028 full model and 2028 source apportionment results in the VISTAS II analysis.

Table 5-1. Matching of "Bulk Raw Species", PSAT Output Species, and SMAT Input Variables

SMAT Species	2028 Full Model Species	2028 PSAT Tag Raw Species
Sulfate	PSO4	PS4
Nitrate	PNO3	PN3
Ammonium	PHN4	PN4

This analysis uses a comparable method that was documented by EPA in the regional haze modeling for 2028. Slight differences do occur as in this study we are looking at the SMAT-CE generated visibility/extinction deltas whereas EPA's approach was designed for a different purpose than just to estimate emissions sector contributions to 2028 particulate matter concentrations and visibility. As a reminder, SESARM is only looking for individual facility or sector contributions to visibility impairment based on defined sulfate and nitrate tags and not looking to establish a full list of species-based contribution metrics.

The following approach was used in preparing the SMAT input files, running the SMAT software, and analysing the results:

1. Regional haze SMAT was run for the 2028 future case using "standard" 2011 and 2028 SMAT input files. In this SMAT run, the advanced option "Create forecast IMPROVE visibility file" was invoked to create an output file with future year (2028) daily species extinction values at each IMPROVE monitor for each of the 20% best and most impaired days (based on 2011 ambient data). These are the extinction values that are added and averaged to get the 2028 base case projected deciview values for each site. SMAT generates a new output file called "scenario_name Forecast IMPROVE Daily Data.csv" that was re-used to calculate the sector tag fractions.

2. Alpine then created future year, tag-specific SMAT input files by subtracting the 2028 hourly tags from the hourly full model concentration files. This simple arithmetic was implemented using standard IOAPI utility programs and generated files similar to EPA's source category-based tagged SMAT input files. Once the hourly files were created, the same processing stream as was used in Step 1 was used to create the tagged SMAT input files from the hourly model concentration files.

3. SMAT was then run again for each sector tag, using the "advanced options" accessing the "Forecast IMPROVE Daily Data" file (created as an output file from step 1 above) as the "advanced option" input file, the 2028 base case SMAT input file is used as the "Baseline file", and each 2028 sector tag SMAT input file is used as the "Forecast file".

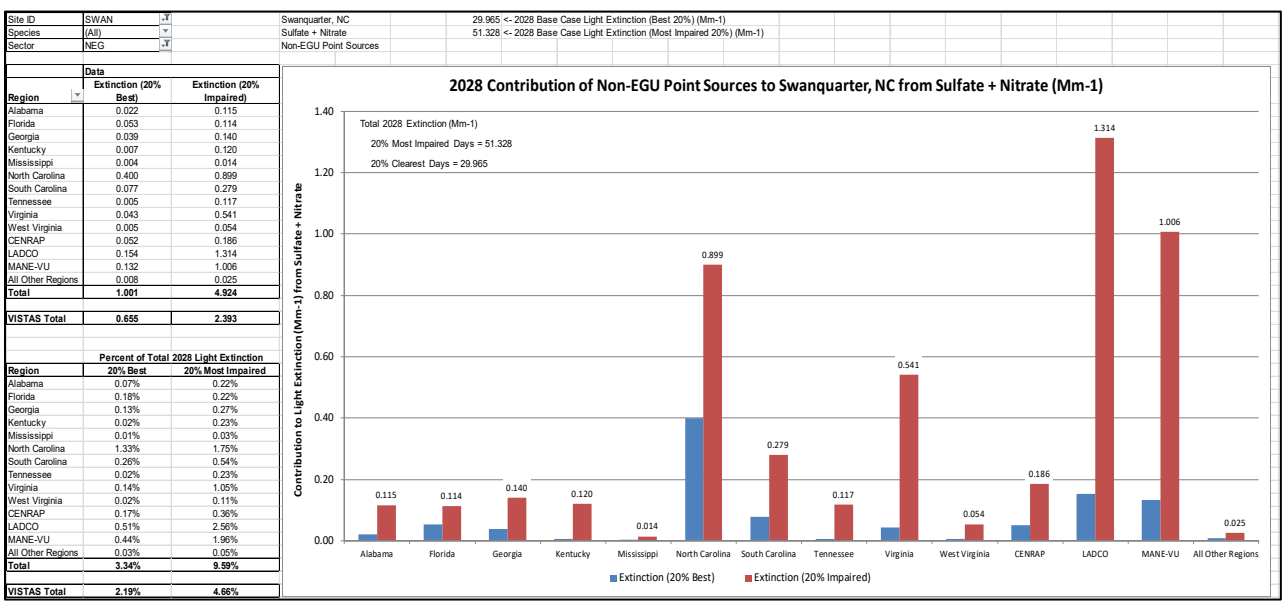
4. The total extinction (on the 20% most impaired days) for each tag was calculated from the SMAT bulk output file and each of the tag output files. The visibility impacts of each tag was computed by subtracting the SMAT output *absent* the tag (created in Step 3) from the full model SMAT output file (created in Step 1).

6.0 SECTOR TAG RESULTS

The sector and facility tag modeling results were consolidated into Attachment A, the Excel workbook "ATTACHMENT_A_PSAT_TAG_RESULTS.xlsm", with the following reports and charts prepared.

6.1 Area By Sector

This tab provides 2028 contribution from source regions-category combinations to light extinction on the 20% best and 20% most anthropogenically impaired days to a single Class I area. Figure 6-1 presents an example of this output.



Site ID	SWAN	Swanquarter, NC	29.965 <- 2028 Base Case Light Extinction (Best 20%) (Mm-1)
Species	(All)	Sulfate + Nitrate	51.328 <- 2028 Base Case Light Extinction (Most Impaired 20%) (Mm-1)
Sector	NEG	Non-EGU Point Sources	

	Data	
Region	Extinction (20% Best)	Extinction (20% Impaired)
Alabama	0.022	0.115
Florida	0.053	0.114
Georgia	0.039	0.140
Kentucky	0.007	0.120
Mississippi	0.004	0.014
North Carolina	0.400	0.899
South Carolina	0.077	0.279
Tennessee	0.005	0.117
Virginia	0.043	0.541
West Virginia	0.005	0.054
CENRAP	0.052	0.186
LADCO	0.154	1.314
MANE-VU	0.132	1.006
All Other Regions	0.008	0.025
Total	**1.001**	**4.924**
VISTAS Total	**0.655**	**2.393**

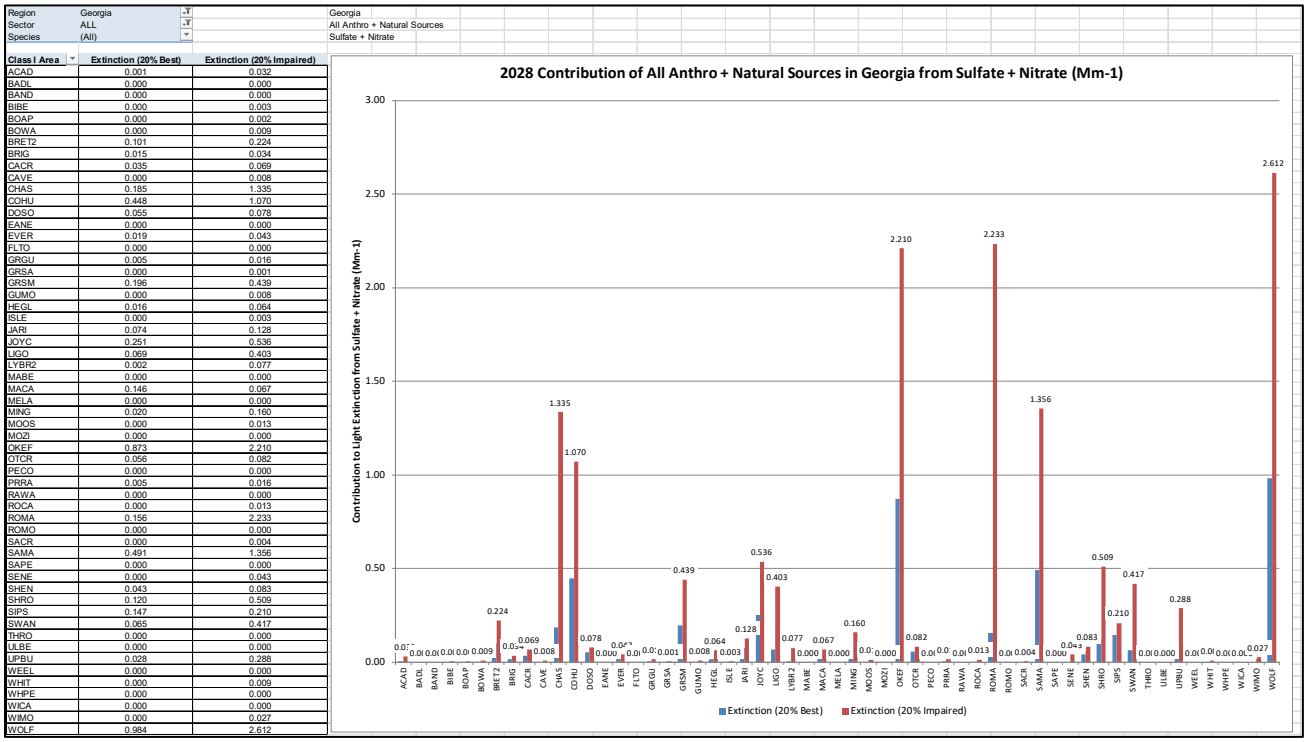
	Percent of Total 2028 Light Extinction	
Region	20% Best	20% Most Impaired
Alabama	0.07%	0.22%
Florida	0.18%	0.22%
Georgia	0.13%	0.27%
Kentucky	0.02%	0.23%
Mississippi	0.01%	0.03%
North Carolina	1.33%	1.75%
South Carolina	0.26%	0.54%
Tennessee	0.02%	0.23%
Virginia	0.14%	1.05%
West Virginia	0.02%	0.11%
CENRAP	0.17%	0.36%
LADCO	0.51%	2.56%
MANE-VU	0.44%	1.96%
All Other Regions	0.03%	0.05%
Total	**3.34%**	**9.59%**
VISTAS Total	**2.19%**	**4.66%**

Figure 6-1. Area by Sector PivotChart and Table Example

- Cell B1 provides options for Class I areas to which combinations contribute.
- Cell B2 provides option for [S]ulfate, [N]itrate, or (All) both.
- Cell B3 provides option for category. [ALL] being all anthro and natural emissions from region; [NEG] representing all non-EGU point source contribution, and [EGU] representing all EGU point source contribution.

6.2 Sector to Area

This tab provides 2028 contribution from source regions-category combinations to light extinction on the 20% best and 20% most anthropogenically impaired days to all Class I areas. Figure 6-2 presents an example of this output.



Region	Georgia
Sector	ALL
Species	(All)

Georgia
All Anthro + Natural Sources
Sulfate + Nitrate

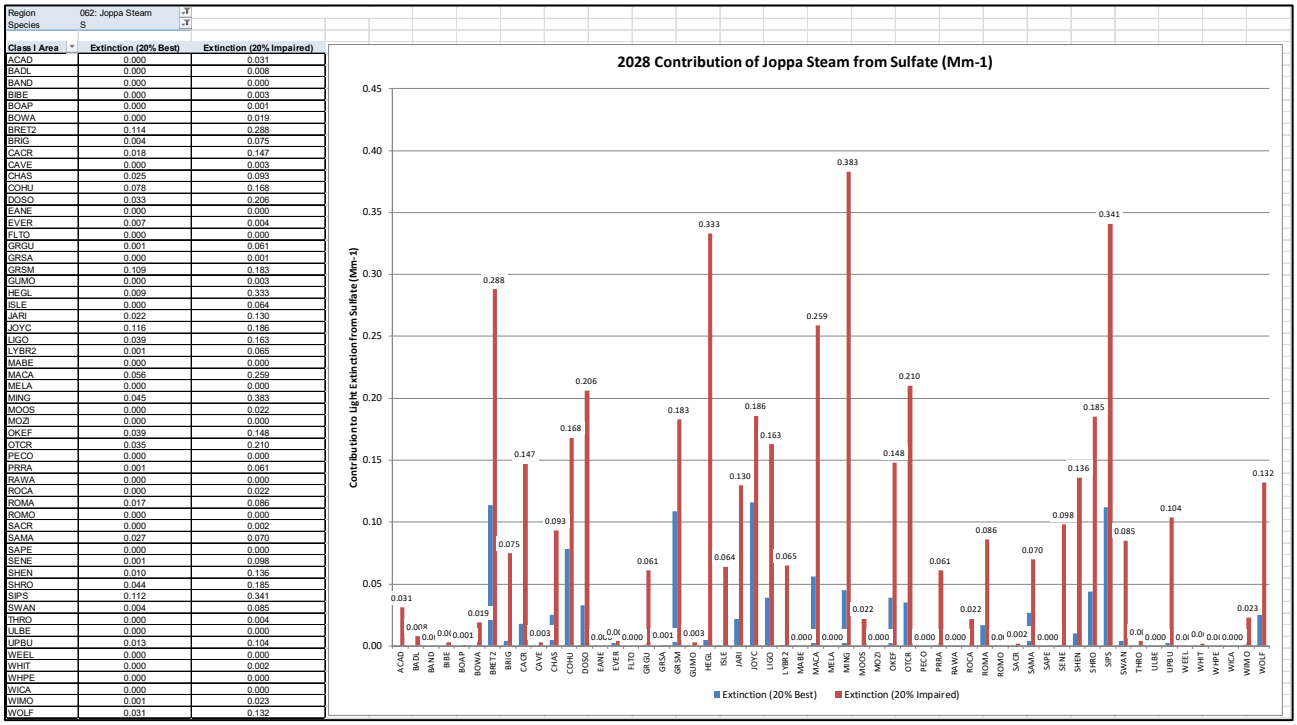
Class I Area	Extinction (20% Best)	Extinction (20% Impaired)
ACAD	0.001	0.032
BADL	0.000	0.000
BAND	0.000	0.000
BIBE	0.000	0.003
BOAP	0.000	0.002
BOWA	0.000	0.009
BRET2	0.101	0.224
BRIG	0.015	0.034
CACR	0.035	0.069
CAVE	0.000	0.008
CHAS	0.185	1.335
COHU	0.448	1.070
DOSO	0.055	0.078
EANE	0.000	0.000
EVER	0.019	0.043
FLTO	0.000	0.000
GRGU	0.005	0.016
GRSA	0.000	0.001
GRSM	0.196	0.439
GUMO	0.000	0.008
HEGL	0.016	0.064
ISLE	0.000	0.003
JARI	0.074	0.128
JOYC	0.251	0.536
LIGO	0.069	0.403
LYBR2	0.002	0.077
MABE	0.000	0.000
MACA	0.146	0.067
MELA	0.000	0.000
MING	0.020	0.160
MOOS	0.000	0.013
MOZI	0.000	0.000
OKEF	0.873	2.210
OTCR	0.056	0.082
PECO	0.000	0.000
PRRA	0.005	0.016
RAWA	0.000	0.000
ROCA	0.000	0.013
ROMA	0.156	2.233
ROMO	0.000	0.000
SACR	0.000	0.004
SAMA	0.491	1.356
SAPE	0.000	0.000
SENE	0.000	0.043
SHEN	0.043	0.083
SHRO	0.120	0.509
SIPS	0.147	0.210
SWAN	0.065	0.417
THRO	0.000	0.000
ULBE	0.000	0.000
UPBU	0.028	0.288
WEEL	0.000	0.000
WHIT	0.000	0.009
WHPE	0.000	0.000
WICA	0.000	0.000
WIMO	0.000	0.027
WOLF	0.984	2.612

Figure 6-2. Sector to Area PivotChart and Table Example

- Cell B1 provides options for tagged regions (States, RPOs).
- Cell B2 provides option for category. [ALL] being all anthro and natural emissions from region; [NEG] representing all non-EGU point source contribution, and [EGU] representing all EGU point source contribution.
- Cell B3 provides option for [S]ulfate, [N]itrate, or (All) both.

6.3 Facility to Area

This tab provides 2028 contribution from individual facilities to light extinction on the 20% best and 20% most anthropogenically impaired days to all Class I areas. Figure 6-3 presents an example of this output.



Region 062: Joppa Steam
Species S

Class I Area	Extinction (20% Best)	Extinction (20% Impaired)
ACAD	0.000	0.031
BADL	0.000	0.008
BAND	0.000	0.000
BIBE	0.000	0.003
BOAP	0.000	0.001
BOWA	0.000	0.019
BRET2	0.114	0.288
BRIG	0.004	0.075
CACR	0.018	0.147
CAVE	0.000	0.003
CHAS	0.025	0.093
COHU	0.078	0.168
DOSO	0.033	0.206
EANE	0.000	0.000
EVER	0.007	0.004
FLTO	0.000	0.000
GRGU	0.001	0.061
GRSA	0.000	0.001
GRSM	0.109	0.183
GUMO	0.000	0.003
HEGL	0.009	0.333
ISLE	0.000	0.064
JARI	0.022	0.130
JOYC	0.116	0.186
LIGO	0.039	0.163
LYBR2	0.001	0.065
MABE	0.000	0.000
MACA	0.056	0.259
MELA	0.000	0.000
MING	0.045	0.383
MOOS	0.000	0.022
MOZI	0.000	0.000
OKEF	0.039	0.148
OTCR	0.035	0.210
PECO	0.000	0.000
PRRA	0.001	0.061
RAWA	0.000	0.000
ROCA	0.000	0.022
ROMA	0.017	0.086
ROMO	0.000	0.000
SACR	0.000	0.002
SAMA	0.027	0.070
SAPE	0.000	0.000
SENE	0.001	0.098
SHEN	0.010	0.136
SHRO	0.044	0.185
SIPS	0.112	0.341
SWAN	0.004	0.085
THRO	0.000	0.004
ULBE	0.000	0.000
UPBU	0.013	0.104
WEEL	0.000	0.000
WHIT	0.000	0.002
WHPE	0.000	0.000
WICA	0.000	0.000
WIMO	0.001	0.023
WOLF	0.031	0.132

Figure 6-3. Facility to Area PivotChart and Table Example

- Cell B1 provides options for tagged facilities.
- Cell B2 provides option for [S]ulfate, [N]itrate, or (All) both.

6.4 Stacked Bar S and N by Area

This tab provides 2028 contribution from source regions-category combinations (including boundary conditions) to light extinction on the 20% most anthropogenically impaired days to a single Class I area in multiple compared combinations. Figure 6-4 presents an example of this output.

Site ID	SWAN		Swanquarter
Extinction (Mm-1)	Species		
Row Labels	Nitrate	Sulfate	Total
Alabama	0.044	0.297	0.341
ALL	0.029	0.165	0.194
EGU	0.006	0.026	0.032
NEG	0.009	0.106	0.115
Florida	0.1	0.412	0.512
ALL	0.075	0.219	0.294
EGU	0.009	0.095	0.104
NEG	0.016	0.098	0.114
Georgia	0.155	0.561	0.72
ALL	0.119	0.298	0.417
EGU	0.012	0.151	0.163
NEG	0.028	0.112	0.14
Kentucky	0.092	0.314	0.406
ALL	0.073	0.426	0.499
EGU	0.006	0.279	0.287
NEG	0.011	0.109	0.12
Mississippi	0.009	0.038	0.047
ALL	0.006	0.021	0.027
EGU	0.001	0.005	0.006
NEG	0.002	0.012	0.014
North Carolina	0.573	2.91	3.483
ALL	0.019	1.591	2.21
EGU	0.118	0.556	0.674
NEG	0.136	0.763	0.899
South Carolina	0.182	0.828	1.01
ALL	0.129	0.442	0.571
EGU	0.023	0.137	0.16
NEG	0.03	0.249	0.279
Tennessee	0.073	0.377	0.45
ALL	0.054	0.198	0.252
EGU	0.005	0.076	0.081
NEG	0.014	0.103	0.117
Virginia	0.062	1.302	2.164
ALL	0.045	0.749	1.394
EGU	0.08	0.149	0.229
NEG	0.137	0.404	0.541
West Virginia	0.134	0.361	1.095
ALL	0.092	0.408	0.58
EGU	0.028	0.373	0.401
NEG	0.014	0.04	0.054
CENRAP	0.185	1.851	2.036
ALL	0.134	0.968	1.102
EGU	0.031	0.717	0.748
NEG	0.02	0.166	0.186
LADCO	0.891	10.295	11.186
ALL	0.009	5.315	5.324
EGU	0.954	3.794	3.948
NEG	0.128	1.186	1.314
MANE-VU	1.235	8.483	9.718
ALL	0.9	4.436	5.336
EGU	0.201	3.175	3.376
NEG	0.134	0.872	1.006
All Other Regions	0.035	1.642	2.677
ALL	0.023	1.734	2.557
EGU	0.007	0.088	0.095
NEG	0.005	0.02	0.025
Boundary	0.762	8.721	9.483
BC	0.381	4.363	4.744
EBC	0.063	0.399	0.462
NBC	0.225	3.287	3.512
SBC	0.018	0.173	0.191
IBC	0	0	0
WBC	0.075	0.499	0.574
Initial	0	0	0
IC	0	0	0
Total	6.436	39.612	46.048

2028 Contribution to Light Extinction on 20% Most Impaired Days - Swanquarter

Source Region	Total Sulfate	EGU Sulfate	Non-EGU Sulfate	Total Nitrate	EGU Nitrate	Non-EGU Nitrate	PL Sulfate	PL Nitrate
Alabama	0.165	0.026	0.106	0.029	0.006	0.009	80.00%	51.72%
Florida	0.219	0.095	0.098	0.075	0.009	0.016	88.13%	33.33%
Georgia	0.298	0.151	0.112	0.119	0.012	0.028	88.26%	33.61%
Kentucky	0.426	0.279	0.109	0.073	0.006	0.011	91.08%	26.03%
Mississippi	0.021	0.005	0.012	0.006	0.001	0.002	80.95%	50.00%
North Carolina	1.591	0.556	0.763	0.019	0.118	0.136	82.90%	41.05%
South Carolina	0.442	0.137	0.249	0.129	0.023	0.030	87.33%	41.05%
Tennessee	0.198	0.076	0.103	0.054	0.005	0.014	98.40%	35.19%
Virginia	0.749	0.149	0.404	0.045	0.080	0.137	73.83%	33.64%
West Virginia	0.408	0.373	0.040	0.092	0.028	0.014	88.25%	45.65%
CENRAP	0.968	0.717	0.166	0.134	0.031	0.020	91.22%	38.06%
LADCO	5.315	3.794	1.186	0.009	0.154	0.128	93.70%	46.31%
MANE-VU	4.436	3.175	0.872	0.900	0.201	0.134	91.23%	37.22%
All Other Regions	1.734	0.088	0.020	0.823	0.007	0.005	6.23%	1.40%
Northern Boundary	3.287			0.225				
Eastern Boundary	0.399			0.063				
Southern Boundary	0.173			0.018				
Western Boundary	0.499			0.075				
Lateral Boundary	0.000			0.000				
TOTAL	21.388	9.621	4.240	4.688	0.693	0.694	84.81%	29.10%

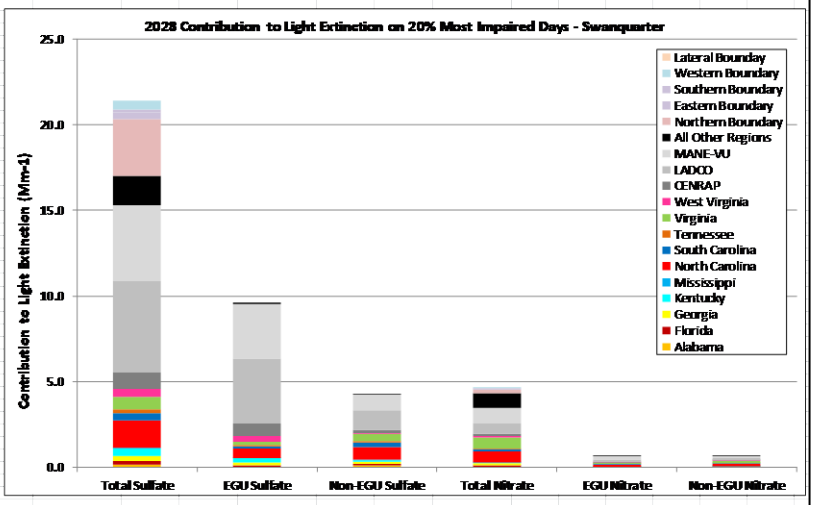


Figure 6-4. Stacked Bar S and N by Area PivotChart and Table Example

- Cell B1 provides options for Class I areas to which combinations contribute.

6.5 Region Sector to Area

This tab provides 2028 contribution from source regions to light extinction on the 20% most anthropogenically impaired days to all Class I areas. Figure 6-5 presents an example of this output.

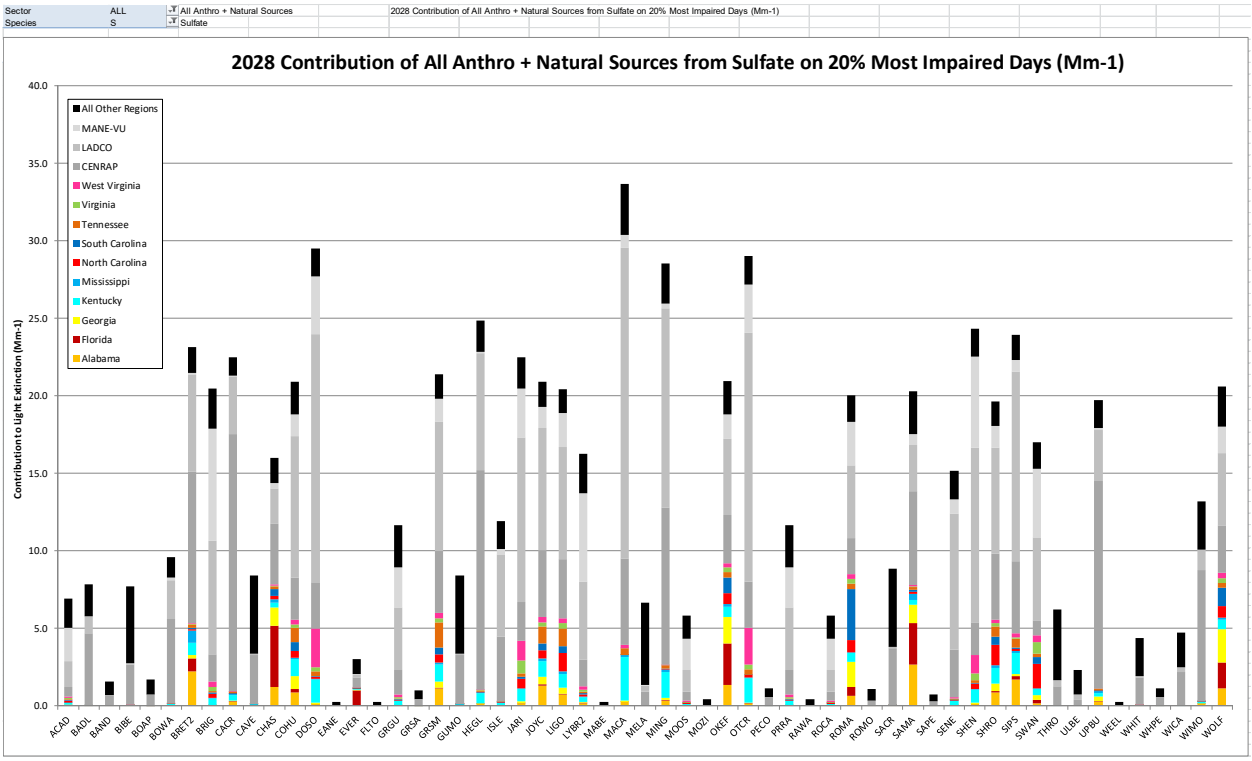


Figure 6-5. Region Sector to Area PivotChart Example

- Cell B1 provides option for category. [ALL] being all anthro and natural emissions from region; [NEG] representing all non-EGU point source contribution, and [EGU] representing all EGU point source contribution.
- Cell B2 provides option for [S]ulfate, [N]itrate, or (All) both.

6.6 Boundary to Area

This tab provides 2028 contribution from boundary condition direction to light extinction on the 20% most anthropogenically impaired days to all Class I areas. Figure 6-6 presents an example of this output.

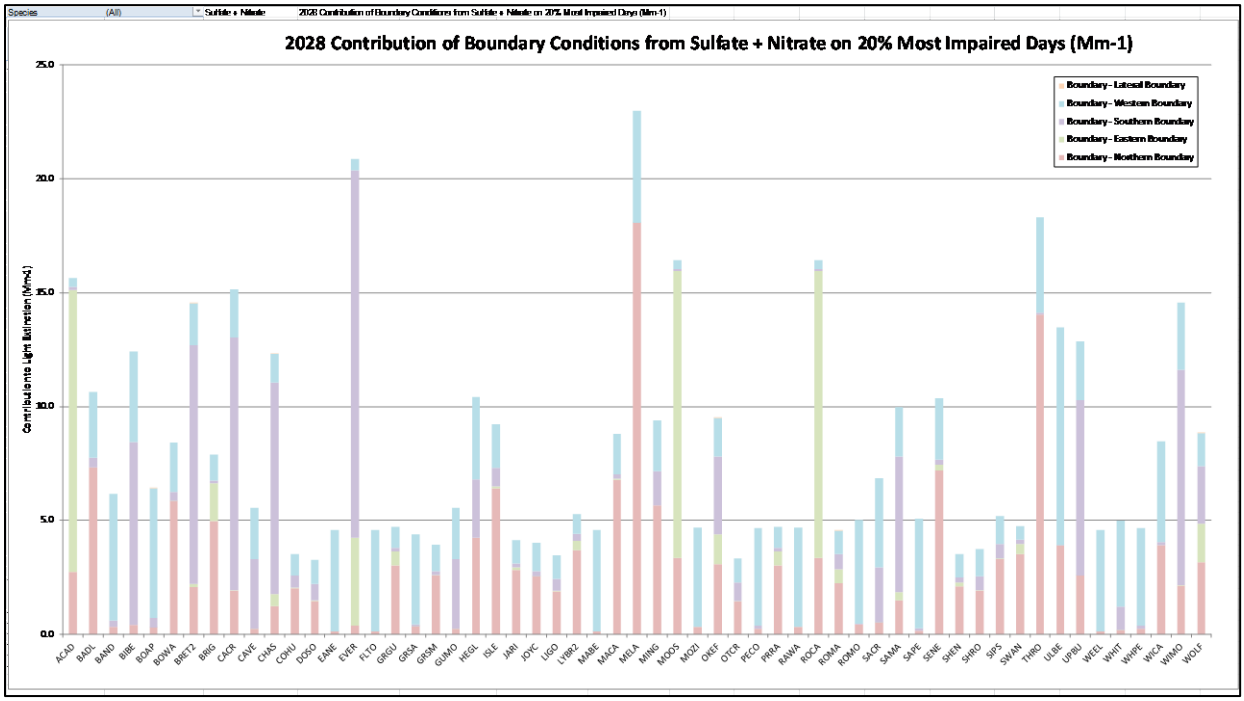


Figure 6-6. Boundary to Area PivotChart Example

- Cell B1 provides option for [S]ulfate, [N]itrate, or (All) both.

7.0 PSAT DAY-TO-DAY ANALYSIS

To further inform the Stakeholders, day-by-day modeled PSAT source apportionment results were prepared for each of the SESARM tagged scenarios relative to Class I areas presented in Tables 3-1 through 3-4. The full results are in Attachment B, as a Excel Workbook titled "ATTACHMENT_B_DAY_BY_DAY_GROUP_10_90.xlsx".

Results presented are in light extinction (b_{ext}) with units of inverse megameters (Mm^{-1}) for the 20% clearest days (Group 10) and the 20% most anthropogenically impaired days (Group 90). It should be noted that as the modeled extinction presented is the difference between the PSAT tag run and the base case run and does not utilize RRF calculations for visibility, these results cannot be directly correlated to the base case visibility at any Class I areas. These data are to be used to demonstrate relative contribution across days, not necessarily relative contribution to the overall visibility impairment metrics.

Figure 7-1 presents the Group 10 (20% clearest days) results for Wolf Island in Georgia.

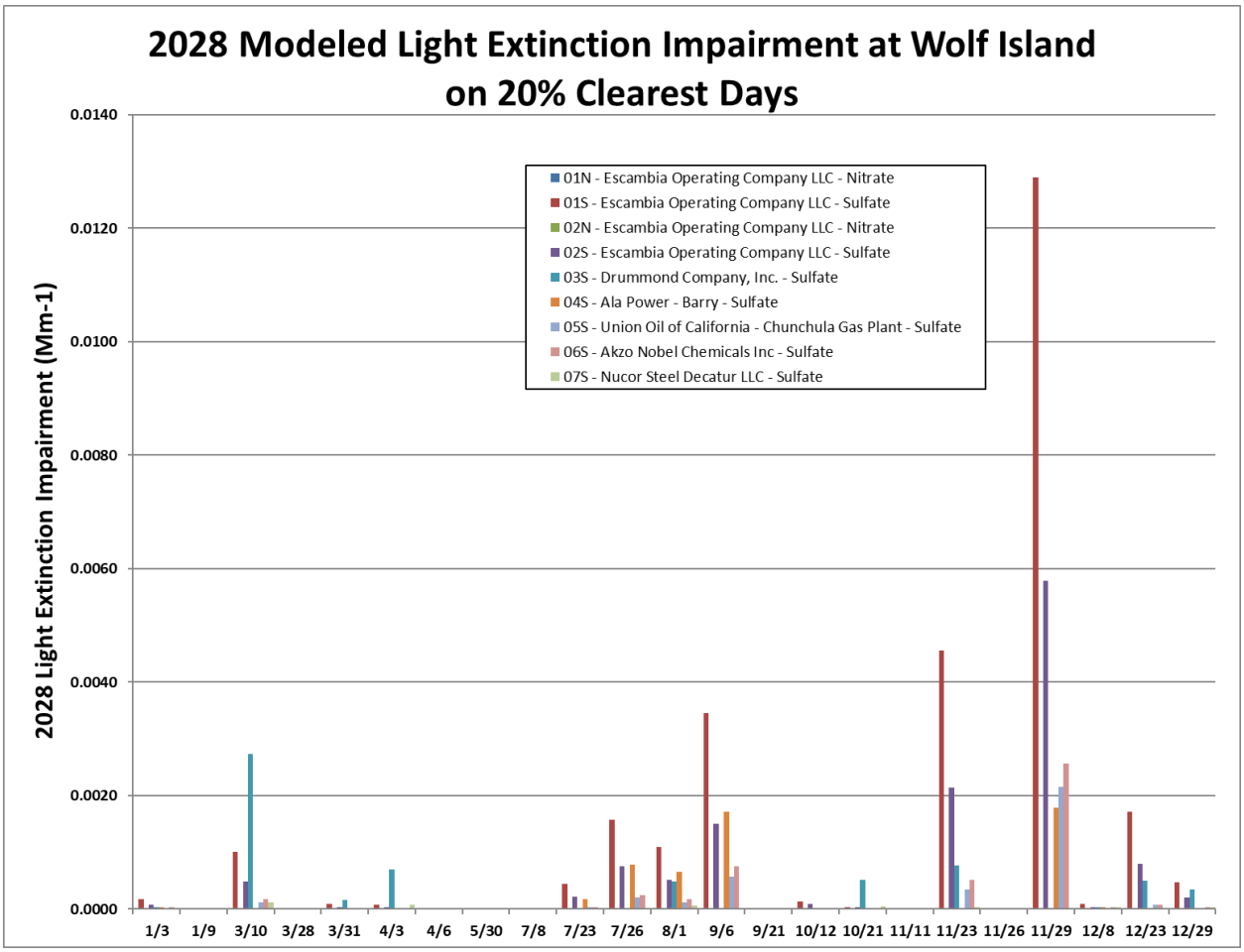


Figure 7-1. 2028 Modeled Light Extinction Impairment at Wolf Island on 20% Clearest Days

In this example, the stacked bar charts represent the relative contributions of tagged sources of interest, and their respective contributions to the light extinction values for each of the 20% clearest days.

Figure 7-2 presents the Group 90 (20% most anthropogenically impaired) results for Wolf Island in Georgia.

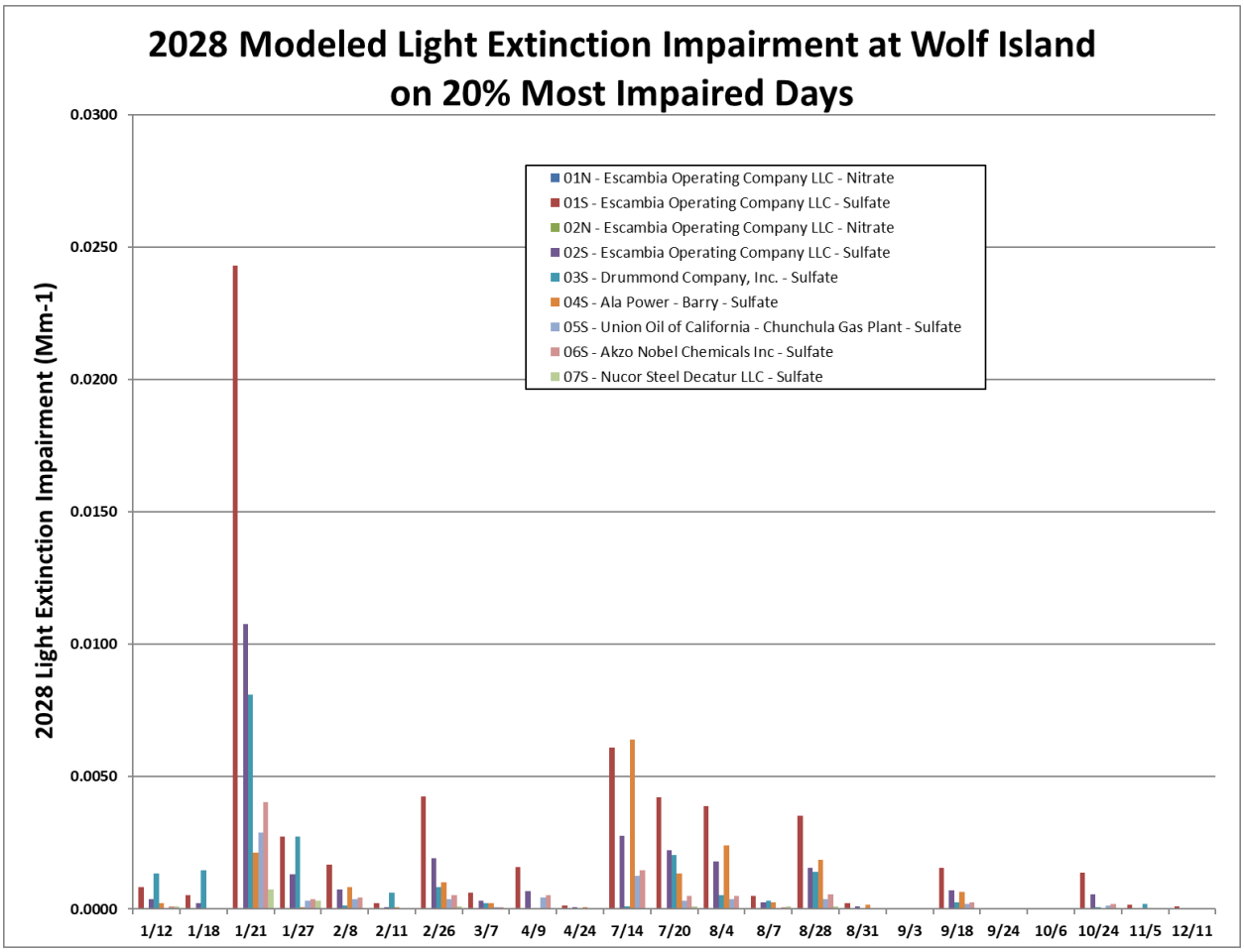


Figure 7-2. 2028 Modeled Light Extinction Impairment at Wolf Island on 20% Most Impaired Days

Similar to Figure 7-1, the stacked bar charts represent the relative contributions of tagged sources of interest, and their respective contributions to the light extinction values for each of the 20% most impaired days.

Attachment A – PSAT Tagging Results

(ATTACHMENT_A_PSAT_TAG_RESULTS.xlsm)

Attachment B – Day-By-Day Results

(ATTACHMENT_B_DAY_BY_DAY_GROUP_10_90.xls)