Work Plan

Southeastern VISTAS II Regional Haze Analysis Project

Prepared for:

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TITLE and APPROVAL SHEET

Work Plan for

Southeastern VISTAS II Regional Haze Analysis Project for

SESARM (Final)

This Work Plan is approved by the undersigned and effective on the latest date signed by any party. The organizations implementing the project are Eastern Research Group, Inc. (ERG) and Alpine Geophysics, LLC (Alpine).

April 18, 2018

Regi Oommen – ERG Program Manager and Technical Project Coordinator — Date

April 19, 2018

John Hornback – SESARM Executive Director — Date

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Abbreviations/Acronym List

AIRMoN	Atmospheric Integrated Research Monitoring Network
Alpine	Alpine Geophysics, LLC
AMET	Atmospheric Model Evaluation Tool
AMNet	Atmospheric Mercury Network
AMoN	Ammonia Monitoring Network
APC	Administrative Project Coordinator
AQS	Air Quality System
ARL	Air Resources Laboratory
ASOS	Automated Surface Observing System
AWOS	Automated Weather Observing System
BNDEXTR	Program used to extract boundary conditions
bext	Beta extinction
Ca^{2+}	Calcium
CAMx	Comprehensive Air Quality Model with Extensions
CASTNET	Clean Air Status and Trends Network
CC	Coordinating Committee
CCRS	Coarse PM species (CAMx PM species)
CIRA	Cooperative Institute for Research in the Atmosphere
Cl^-	Chloride
CMAQ	Community Multiscale Air Quality
CO	Carbon monoxide
CONUS	Continental United States
CPRM	Coarse PM
CWRT	Concentration weighted residence time
CWT	Concentration weighted trajectory
d	Distance
DVB	Design value for base year
DVF	Design value for future year
EGU	Electricity Generating Unit
EIS	Emission Inventory System
EPA	United States Environmental Protection Agency
ERG	Eastern Research Group, Inc.
ERTAC	Eastern Regional Technical Advisory Committee
ESRI	Environmental Systems Research Institute
EWRT	Extinction-weighted residency time
f(RH)	Monthly relative humidity function
f_s(RH)	Monthly relative humidity function associated with small size distribution
f_L(RH)	Monthly relative humidity function associated with large size distributions
f_{ss}(RH)	Monthly relative humidity function associated with sea salt
FAA	Federal Aviation Administration
FAT32	File Allocation Table, 32-bit
FCRS	Crustal fraction of PM
FF10	Flat File 2010
FIPS	Federal Information Processing Standard

FLM	Federal Land Manager
FPRM	Fine Other Primary (diameter $\leq$2.5 µm)
FR	Federal Register
g	Gram
GB	Gigabyte
GIS	Geographic Information System
H^+ as pH	Free acidity
ha	Hectare
Hg	Total mercury
HgP	Particulate mercury
HNO_3	Nitric acid
HYSPLIT	Hybrid Single Particle Lagrangian Integrated Trajectory
IC/BC	Initial conditions and boundary conditions
IMPROVE	Interagency Monitoring of Protected Visual Environments
K^+	Potassium
km	Kilometers
L	Liter
m	Meters
m^2	Square meters
m^3	Cubic meters
MAR	Marine, aircraft, and rail
MDL	Method Detection Level
MDN	Mercury Deposition Network
mg	Milligram
Mg^{2+}	Magnesium
MLM	Multi-Layer Model
MPE	Model performance evaluation
Na^+	Sodium
NAAQS	National Ambient Air Quality Standards
NADP	National Atmospheric Deposition Program
NAICS	North American Industry Classification System
NAM-12	North American Mesoscale forecast data at the 12-km level
NCEI	National Centers for Environmental Information
NH_3	Ammonia
NH_4^+	Ammonium
NO_2	Nitrogen dioxide
NO_3^-	Nitrate
NOAA	National Oceanic and Atmospheric Administration
NO_x	Oxides of nitrogen
NTN	National Trends Network
NWS	National Weather Service
ORIS	Plant identifier issued by U.S. Department of Energy
PEC	Primary elemental carbon
PGMs	Photochemical grid models
PM	Particulate matter

PM_{10}-PRI	Primary particulate matter less than or equal to 10 microns in aerodynamic diameter
$PM_{2.5}$	Fine particle; primary particulate matter less than or equal to 2.5 microns in aerodynamic diameter
$PM_{2.5}$-PRI	Primary particulate matter less than or equal to 2.5 microns in aerodynamic diameter
PNH4	Ammonium
PNO3	Particulate nitrate
POA	Primary organic carbon
POC	Parameter occurrence code
ppb	parts per billion
PSAT	Particulate Matter Source Apportionment Technology
PSO4	Sulfate
Q	Emissions
Q/d	Emissions over distance
Q/d^2	Emissions over distance squared
QA	Quality assurance
QA/G-5M	Guidance for Quality Assurance Project Plans for Modeling
QA/QC	Quality assurance/quality control
QA/R-2	EPA Requirements for Quality Management Plans
QAPP	Quality Assurance Project Plan
QMP	Quality Management Plan
r	Pearson correlation coefficient
RFP	Request for Proposal
RH	Relative humidity
RHR	Regional Haze Rule
RRF	Relative response factor
SATA	Serial AT Attachment
SCC	Source Classification Code
SEARCH	SouthEastern Aerosol Research and Characterization
SESARM	Southeastern States Air Resource Managers, Inc.
SIP	State Implementation Plan
SMAT-CE	Software for Model Attainment Test - Community Edition
SMOKE	Sparse Matrix Operator Kernel Emissions
SO_2	Sulfur dioxide
SO_4^{2-}	Sulfate
SOA	Secondary organic aerosol
SOP	Standard Operating Procedure
SOW	Scope of Work
TAWG	Technical Analysis Work Group
TB	Terabytes
TDEP	Total Deposition
TSD	Technical Support Document
VISTAS	Visibility Improvement - State and Tribal Association of the Southeast
VOC	Volatile organic compounds
WBAN	Weather Bureau Army-Navy

1. INTRODUCTION

This work plan was prepared by Eastern Research Group, Inc. (ERG) and Alpine Geophysics, LLC (Alpine) in response to Southeastern States Air Resource Managers, Inc. (SESARM) Contract Number V-2018-03-01 (VISTAS Contract). SESARM initiated a Request for Proposals (RFP) on December 21, 2017, entitled "Southeastern VISTAS II Regional Haze Analysis Project." On February 20, 2018, ERG was selected by SESARM to provide technical support to this project. ERG and SESARM executed the VISTAS Contract on March 1, 2018.

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

EPA finalized revisions to various requirements of the RHR in January 2017 (82 FR 3078) that were designed to strengthen, streamline, and clarify certain aspects of the agency's regional haze program including:

A. Strengthening the Federal Land Manager (FLM) consultation requirements to ensure that issues and concerns are brought forward early in the planning process.

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

B. Updating the SIP submittal deadlines for the second planning period from July 31, 2018 to July 31, 2021 to ensure that they align where applicable with other state obligations under the Clean Air Act. The end date for the second planning period remains 2028; that is, the focus of state planning will be to establish reasonable progress goals for each Class I area against which progress will be measured during the second planning period. This extension will allow states to incorporate planning for other Federal programs while conducting their regional haze planning. These other programs include: the Mercury and Air Toxics Standards, the 2010 1-hour SO_2 National Ambient Air Quality Standards (NAAQS); the 2012 annual fine particle ($PM_{2.5}$) NAAQS; and the 2008 and 2015 ozone NAAQS.

C. Adjusting interim progress report submission deadlines so that second and subsequent progress reports will be due by: January 31, 2025; July 31, 2033; and every ten years thereafter. This means that one progress report will be required midway through each planning period.

D. Removing the requirement for progress reports to take the form of SIP revisions. States will be required to consult with FLMs and obtain public comment on their progress reports before submission to the EPA. EPA will be reviewing but not formally approving or disapproving these progress reports.

The regional haze rule defines “clearest days” as the 20% of monitored days in a calendar year with the lowest deciview index values. “Most impaired days” are defined as the 20% of monitored days in a calendar year with the highest amounts of anthropogenic visibility impairment. The long-term strategy and the reasonable progress goals must provide for an improvement in visibility for the most impaired days since the baseline period and ensure no degradation in visibility for the clearest days since the baseline period.

This work plan describes the ERG Team’s approach for supporting SESARM to help the VISTAS states meet the above deadlines and requirements. The project activities will include the following:

- Review and update of EPA emissions inventories for the 2028 base year;
- Air quality modeling and evaluation of modeling results;
- Ambient air monitoring data analysis; and
- Website activities, including data transfer.

Confidential Business Information. ERG does not anticipate that collecting, handling, and storing confidential business information will be necessary in conducting this work assignment.

Subcontracting. This work plan includes the use of subcontractor support (Alpine).

Travel. ERG and Alpine will attend two VISTAS project meetings/workshops, if scheduled.

Meetings. ERG and Alpine employees will clearly identify themselves as such during any meetings or telephone conversations.

Limitation of Contractor Activities. ERG will submit drafts of all deliverables to the SESARM Administrative Project Coordinator (APC) for review prior to submission of the final product. ERG will incorporate all SESARM APC comments into all final deliverables, unless otherwise agreed upon by the SESARM APC. ERG will adhere to all applicable management control procedures as implemented by the SESARM APC.

2. TECHNICAL APPROACH

The work assignments prescribed in the VISTAS Contract will be performed within the eleven tasks described below.

2.1 Task 1 – Project Management

Under this task, ERG will conduct all management activities, as described below in the following subtasks:

2.1.1 Subtask 1.1 – Contract Management

Under this subtask, the ERG Project Manager and the contractor staff will work closely together and with SESARM to ensure that they are familiar with and conform to all terms and conditions of the VISTAS Contract, and will ensure that no technical work related to Tasks 2 through 11 (Sections 2.2 through 2.11) will be initiated until EPA has approved the Quality Assurance Project Plan (QAPP) and SESARM has authorized in writing that the work on a technical task, or subtask as applicable, may begin. The ERG Project Manager will manage project activities to produce required deliverables that meet all administrative, technical, quality, schedule, and cost requirements. If any problems are identified which affect compliance with the VISTAS Contract, ERG will inform SESARM immediately at the earliest possible date and will work with SESARM to rectify any compliance issues as soon as practicable. Additionally, ERG will develop the Subcontract with Alpine.

2.1.2 Subtask 1.2 – Contract Development

Under this subtask, ERG worked with SESARM to develop and execute a project contract and to comply with all terms and conditions upon execution. Most of the contract development activities between ERG and SESARM took place prior to the execution of the VISTAS Contract on March 1, 2018. No additional work is planned for this subtask.

2.1.3 Subtask 1.3 – Work Plan Development

Under this subtask, ERG produced and delivered to SESARM on March 13, 2018 a draft work plan (this document) consistent with the Scope of Work (SOW) in the RFP, the executed VISTAS Contract, applicable Federal guidance, and any other requirements provided by SESARM. ERG will provide a final work plan to SESARM within 7 days of receipt of comments from SESARM. The work plan will incorporate appropriate methodologies and techniques for thoroughly and efficiently completing the prescribed tasks. The work plan will provide details of methods and approaches that will be used in the project including evaluation of products and software tools. The work plan will contain:

- Task and subtask descriptions and procedures for completion;
- A detailed list of deliverables and milestones associated with each task and subtask;
- Staff assignments and allocated hours for each task and subtask; and
- Other pertinent information for each task.

2.1.4 Subtask 1.4 – QAPP Development

Under this subtask, ERG will develop the project-specific QAPP, which SESARM is obligated to provide to EPA for review and approval prior to initiation of technical work.

Because the results of this project will be evaluated by the VISTAS states and EPA for establishing policy initiatives, reproducible and transparent procedures and methodologies will be of highest priority in the QAPP. To ensure the technical quality of work products, ERG will follow the procedures of its Corporate *Quality Management Plan*, following the requirements in EPA QA G-5M.[2] The QAPP will address all applicable project tasks and will describe data collection and evaluation, model performance evaluation (MPE), and modeling procedures and processes. The QAPP will include appropriate policies, procedures, specifications, standards, documentation, communications, and other activities necessary to ensure the accuracy and dependability of all data collected, used, and produced during the project. ERG will incorporate necessary standards and procedures to minimize costs, time required to complete the project, and repetitive work.

ERG submitted the draft QAPP to SESARM on March 15, 2018, within the prescribed VISTAS Contract timeframe. ERG will prepare a final QAPP for SESARM's review within one week of receipt of final comments from SESARM and EPA.

2.1.5 Subtask 1.5 – Communications

Under this subtask, ERG and Alpine's Task Leaders will meet weekly or bi-weekly to monitor the technical activities of the team and ensure adherence to project budget, schedule, and quality specifications for deliverables. To ensure close communication with SESARM, ERG will additionally hold bi-weekly to monthly status meetings with SESARM, which may include members of the Coordinating Committee (CC) and the Technical Analysis Work Group (TAWG) to provide updates on progress, identify areas of technical concern, propose solutions to challenges where applicable, and discuss any preliminary results and/or data. ERG will provide a bulleted agenda to SESARM via email prior to each status meeting that will facilitate the discussion of progress and related issues. After each meeting, ERG will summarize for SESARM the discussion including issue resolutions, action items, and responsible team members.

2.1.6 Subtask 1.6 – Reports

Under this subtask, ERG will prepare and submit a monthly progress report within two weeks of the end of each calendar month. Monthly progress reports will be electronically submitted to the SESARM APC. The monthly progress report will contain information about:

- Administrative items;
- Technical progress achieved by task and subtask;
- Any significant quality assurance (QA) efforts and progress, as described in the QAPP;
- Work and deliverables to be accomplished the next month;
- Meetings and deliverables that took place;
- Problems that need to be addressed and solutions; and
- Financial information about resources spent and remaining.

[2] EPA QA/G-5M, Guidance for Quality Assurance Project Plans for Modeling, December 2002.

For reports, ERG will work closely with the SESARM APC to determine the number and size of the interim draft and interim final reports, which may be as frequent as the completion of each task or subtask. Each interim report will document the methodologies, data, and QA activities, and will act as stand-alone documents for their respective tasks. The interim reports from each task will serve as the basis of the final report. In preparation of the final report, ERG will prepare a detailed outline that will be provided to SESARM for review and comment. The final report will contain, at a minimum:

- An executive summary that provides a brief overview and summary of the modeling effort, emissions and air quality models used, model configuration, MPE overview and results, and rationale for the selected configuration;
- Summaries of QA procedures completed for the project;
- Technical details for all technical work performed as part of this project including:
    - Area of influence analysis,
    - Emission inventory updates,
    - Emissions and air quality models used,
    - Model configuration and rationale, and
    - MPE
- Summaries and conclusions;
- A list of all final work products being delivered; and
- A discussion of data accessibility and availability for review by SESARM, stakeholders, and the public.

ERG will prepare a draft final report for SESARM review, and a final report will be prepared within four weeks of receiving comments from SESARM. ERG will submit two hard copies of the final report to SESARM for its files and for transmittal to EPA. Electronic copies of the report in Microsoft Word (.docx) and Adobe (.pdf) formats will be submitted to SESARM and will be made available on the Technical Web Site, to be developed in Task 10 (Section 2.10).

Finally, ERG will provide project summaries in the form of slide presentations that can be distributed to VISTAS agencies and stakeholders to inform them of progress and findings. Each slide deck will contain the appropriate SESARM/VISTAS logo.

2.1.7 Subtask 1.7 – Invoicing

Under this subtask, ERG will prepare and submit a monthly invoice within two weeks of the end of each calendar month. Invoices will be itemized and contain information about unpaid services that are billable and payable at the end of the previous calendar month, including invoice billing period, current and cumulative expenditures by personnel, other direct costs, indirect costs, and subcontractor charges. Monthly invoices will be electronically submitted to the SESARM APC with the monthly progress reports that are described in Subtask 1.6 (Section 2.1.6).

2.2 Task 2 – Emissions Inventory Development

In Task 2, ERG will prepare emission inventory files and ensure the data are in the proper formats for emissions modeling.

2.2.1 Subtask 2.1 – 2011 Base Year Emissions Inventory

Under this subtask, ERG will retrieve EPA's 2011v6.3el modeling platform emissions and prepare it for emissions modeling. ERG anticipates only minor processing of the data (i.e., reformatting for state review), as the Team is familiar with this inventory.

2.2.2 Subtask 2.2 – Projection Year Emissions Inventory

Under this subtask, ERG will prepare state-specific summary comparisons of EPA's 2028v6.3el modeling platform emissions to the 2023v6.3en modeling platform emissions for stationary electricity generating unit (EGU) and non-EGU stationary point sources to facilitate review by each VISTAS state. The summaries between the two inventories will be grouped by Emission Inventory System (EIS) facility, emissions unit, process, and release point identifiers and source classification code (SCC) for annual emissions of:

- Oxides of nitrogen (NO_x);
- Volatile organic compounds (VOC);
- Primary particulate matter less than or equal to 2.5 microns in aerodynamic diameter ($PM_{2.5}$-PRI);
- Primary particulate matter less than or equal to 10 microns in aerodynamic diameter (PM_{10}-PRI);
- Carbon monoxide (CO);
- Sulfur dioxide (SO_2); and
- Ammonia (NH_3).

ERG will work with SESARM on the final format of the comparison tables, including additional fields that may be useful for review, such as: facility information; SCC descriptions; unit, process, and release point descriptions; ORIS boiler identifiers; control information; and absolute and percentage differences between the two emissions inventories. All data will be provided in a single Excel (.xlsx) file, unless the file size is prohibitive, at which point ERG will work with SESARM on the best way to divide the data across multiple files.

Additionally, for EGU sources only, the ERG/Alpine team will use an already-obtained version of the 2028 emissions forecast and associated files produced by the Eastern Regional Technical Advisory Committee (ERTAC) EGU projection tool from the most recent Continental United States (CONUS) 2.7 run available at the time of subtask authorization. The team will prepare state-specific summary comparisons of EPA's 2028v6.3el modeling platform emissions to the ERTAC 2028 modeling platform emissions for EGU point sources to facilitate the VISTAS state review. The summaries will be produced in Microsoft Excel (.xlsx) format grouped by EIS facility, emissions unit, process, and release point identifiers, ORIS ID, and SCC for annual emissions of NO_x, VOC, $PM_{2.5}$-PRI, PM_{10}-PRI, CO, SO_2, and NH_3 between the two emissions inventories.

ERG will work with SESARM on the final format of the comparison tables, including additional fields that may be useful for review, such as: facility information; SCC descriptions; unit, process, and release point descriptions; ORIS boiler identifiers; control information; and absolute and percentage differences between the two emissions inventories.

SESARM will identify for ERG in the final comparison tables which emissions projection platform (e.g., EPA 2023en, EPA 2028el, ERTAC EGU, or state provided) should be used in the final 2028 modeling file preparation. For any one EGU source, only a single platform should be selected. In other words, emissions from one platform cannot be mixed with emissions from another platform at the same unit.

2.2.3 Subtask 2.3 – Revisions to 2028 Projection Year Emissions Inventory

Under this subtask, with direction from SESARM, ERG will update the 2028 EGU and non-EGU point source projection year mass emissions inventories in Flat File 2010 (FF10) format based on the information collected from Subtask 2.2. All revisions will be documented to account for changes in emissions due to retirements, control enhancements, and/or fuel switches, as well as any additional metadata to describe the data. For certain situations, a state may wish to develop their own revised 2028 point sources emissions inventory using updated growth and/or control factors on the 2011 point sources emissions inventory. In these cases, ERG will work with the state agencies to provide the data into the format needed for integration.

For the other source categories, ERG will use the 2028 emissions projections for:

- Onroad and nonroad mobile sources
- Marine, aircraft, and rail (MAR) sources
- Fires
- Area (non-point) sources
- Biogenic and international sources

When final, ERG will prepare Sparse Matrix Operator Kernel Emissions (SMOKE)-ready files for emissions processing. Each emissions record will have primary keys assigned to ensure no duplication occurs, as well as conform to EPA’s format and content checks. Data files will then be transferred to Alpine for Task 3 SMOKE processing (the Task 3 SMOKE processing is described in Section 2.3.) A technical memorandum/interim report describing the changes, and their source origins, will be prepared for SESARM based on the “Reports” requirement in Subtask 1.6 (Section 2.1.6).

2.2.4 Optional Subtask 2.3.1 – Preparing Emission Summary Comparisons of the 2028v6.3el and 2023v6.3en Emissions Modeling Platforms

If directed by SESARM, ERG will generate state-specific summary comparisons of EPA’s 2028v6.3el modeling platform mass emissions to the 2023v6.3en modeling platform emissions for stationary area sources and MAR sources to facilitate review by the VISTAS states. The summaries will be grouped by county and SCC for annual emissions of NO_x, VOC, $PM_{2.5}$-PRI, PM_{10}-PRI, SO_2, CO, and NH_3 between the two emissions inventories. ERG will work with SESARM on the final format of the comparison tables, including additional fields that may be useful for review, such as: SCC descriptions and percentage differences between the two emissions inventories.

If directed by the state agency, ERG will update the 2028 projection year mass emissions inventory files in FF10 format to reflect changes, and include in the documentation.[3] When final, ERG will prepare SMOKE-ready files for emissions processing. Each emissions record will have primary keys assigned to ensure no duplication occurs, as well as conform to EPA's format and content checks. The Task 3 SMOKE processing is described in Section 2.3. A technical memorandum/interim report describing the changes, and their source origins, will be prepared for SESARM based on the "Reports" requirement in Subtask 1.6 (Section 2.1.6).

2.2.5 Subtask 2.4 – Emission Summaries and Quality Assurance

Upon completion of the updates to the 2028 emissions as agreed upon, ERG will prepare state-specific final 2011 and 2028 emission summaries for EGU, non-EGU point, area, onroad, nonroad, fire, MAR source categories, and all sectors. Summaries and quality assurance will follow procedures laid out in EPA guidance[4] and described in the project QAPP. Per such guidance, ERG will develop county-level emissions density plots and/or tables that show the 2011 emissions, 2028 emissions, absolute difference, and percent difference to facilitate review. Summaries will include aggregations at the state-county, EPA Tier Levels (Tier 1, 2, and 3) and descriptions, and SCC (with description) levels, and for state/sector combinations. Significant differences that are identified will be documented and checked for reasonableness against what future changes that may occur by 2028. The summaries will be produced in Microsoft Excel (.xlsx) format grouped by EIS facility, emissions unit, process, and release point identifiers, ORIS ID, and SCC for annual emissions of NO_x, VOC, $PM_{2.5}$-PRI, PM_{10}-PRI, CO, SO_2, and NH_3 between the two emissions inventories.

ERG will work with SESARM on the final format of the comparison tables, including additional fields that may be useful for review, such as: facility information; SCC descriptions; unit, process, and release point descriptions; ORIS boiler identifiers; control information; and absolute and percentage differences between the two emissions inventories.

Data entered for these two emissions inventories have passed QA/QC procedures employed by EPA and documented in the technical support document (TSD).[5] If revisions are directed for the 2028 emissions inventories by the states, then those changes will be documented, and double-checked to ensure that they were processed correctly. As part of this QA, ERG would prepare a tabular revisions summary for 2028, comparing the original 2028 vs. the revised 2028 that can be shared with SESARM. Comparisons would include absolute differences and percentage differences, along with comments about sizable changes.

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3 As noted in the RFP, ERG prepared a cost estimate for developing summaries for one state (assume North Carolina). ERG notes that the cost estimate presented for this example location will be marginal for additional states due to economies of scale for preparing, processing, and presenting the data.

4 Emissions Inventory Guidance for Implementation of Ozone and Particulate Matter NAAQS and Regional Haze Regulations" available at https://www.epa.gov/sites/production/files/2017-07/documents/ei_guidance_may_2017_final_rev.pdf

5 U.S. Environmental Protection Agency. 2016. Technical Support Document (TSD), Preparation of Emissions Inventories for the Version 6.3, 2011 Emissions Modeling Platform. https://www.epa.gov/sites/production/files/2016-09/documents/2011v6_3_2017_emismod_tsd_aug2016_final.pdf

2.3 Task 3 – Emissions Processing

In Task 3, ERG will direct Alpine to prepare SMOKE-ready input files from the mass emissions data prepared in Task 2 (Section 2.2). In this task, Alpine will ensure that annual emission changes are carried through to any relevant daily and hourly input files (as necessary) consistent with EPA's 2011 and 2028 v6.3el platform processing. Upon the completed development of these new input files, Alpine will use EPA's modeling platform scripts, with the updated input files from this task, to generate Comprehensive Air Quality Model with Extensions (CAMx) photochemical model version 6.40-ready inputs using the SMOKE Modeling System.

2.3.1 Subtask 3.1 – Create Photochemical Model Ready EGU Emission Files for 2028

In this subtask, Alpine will create photochemical model ready EGU emissions files for 2028 using a set of scripts that have been used for many recent ozone and PM analyses that utilize existing temporal distribution ratios and create updated SMOKE-ready modeling files from annual emissions input data. These scripts contain both conversion and QA procedures allowing for a single step processing of the data. The generated output and QA files are used to ensure that no mass is lost in the conversion from annual to episodic file preparation and that the new files can be used as valid replacements for the older inputs to the model run.

As directed by SESARM, for states located outside of the VISTAS domain, Alpine will use EGU emissions as generated from the ERTAC EGU model version 2.7 simulation as discussed in Task 2 above.

When completed, the output and QA files will be made available to the VISTAS states for review through the file share procedures outlined in Task 10 (Section 2.10).

2.3.2 Optional Subtask 3.1.1 – Full EGU Emissions Replacement

SESARM has not chosen to fund this Subtask, but rather Subtask 3.1.2, Scale Hourly SMOKE Emissions.

2.3.3 Subtask 3.1.2 – Scale Hourly SMOKE Emissions for EGUs

Under this subtask, emissions from the SESARM-modified EGU review and the 2028 ERTAC run (for non-VISTAS states) will further be processed using hourly distribution ratios as generated from the EPA 2028el modeling platform to prepare SMOKE input files consistent with the base year modeling inputs.

This step is necessary to ensure that the new emissions from the future year platform run will match the hourly temporal distribution as modeled by EPA in the 2011el and 2028el regional haze modeling platforms. These ratios and the updated emissions will be used to prepare PTHOUR files necessary for this temporal replication. Alpine will use scripts identified above to apply SESARM approved scaling factors generated from EPA's 2011el modeling platform to create annual, daily, and/or hourly emission input files necessary to model this category in SMOKE. As part of this process, Alpine will generate state-level monthly emission charts to represent the before and after application of these scaled emissions.

2.3.4 Subtask 3.2 – Create Photochemical Model Ready Non-EGU Point Source Emission Files for 2028

Under this subtask, Alpine will utilize a previously developed set of scripts to create updated non-EGU point source SMOKE-ready files from the SESARM-modified annual emissions data. These scripts contain both conversion and QA procedures allowing for a single step processing of the data. The generated output and QA files are used to ensure that no mass is lost in the conversion from annual mass to model input file preparation and that the new files can be used as valid replacements for the older inputs to the model run.

When completed, output and QA files will be made available to the VISTAS states for review through the file share procedures outlined in Task 10 (Section 2.10).

2.3.5 Subtask 3.3 – Merge Data Files

Under this subtask, Alpine will merge the data from Subtask 3.1 and 3.2 (Sections 2.3.1 and 2.3.4) and EPA-supplied data for unmodified segments. EPA performed the emissions processing for the 2011v6.3el and 2028v6.3el platforms using SMOKE to output CMAQ format files. These emissions were merged in CMAQ format and the elevated and low level files were further merged in CAMx format.

The study team has had extensive experience and have developed the windowing, merging, QA tools and source tagging tools to work on CAMx format files. Alpine has previously applied these tools to the 2023v6.3el platform. To apply these tools the study team will convert the individual sectors that are supplied by EPA, and unchanged by SESARM, into CAMx format and window them onto the VISTAS 12km domain. The SMOKE processing for the changed segments will configure SMOKE to directly output CAMx format files.

2.4 Task 4 – Data Acquisition and Preparation

Under this task, ERG will develop a database with the Interagency Monitoring of Protected Visual Environments (IMPROVE), EPA's Air Quality System (AQS), and meteorological data for use on this project. This database will provide a permanent record of the set of data used to support the MPE and the regional haze calculations.

ERG is familiar with the IMPROVE data through our work developing large ambient air quality monitoring databases for various EPA programs. These data are housed in a SQL server database linked to facility, meteorological, and compliance data and are readily available for use for source analysis, as well as inputs and for quality assurance of our air quality modeling projects. This database includes:

- Hourly meteorological measurements obtained from the National Centers for Environmental Information (NCEI) for the Weather Bureau Army-Navy (WBAN) sites, which include:
    - National Weather Service (NWS) Automated Surface Observing Systems (ASOS); and
    - Federal Aviation Administration (FAA) Automated Weather Observing System (AWOS);

- Total and speciated light extinction (in inverse megameters) and meteorological measurements from the IMPROVE monitoring location via the IMPROVE website; and
- Ambient air pollutant and meteorological measurements from EPA's AQS.

The ERG database is complete for 1996 through 2017. All data is kept at the finest temporal resolution possible. The database includes automated routines to quality ensure data uploads, including filling in missing information (i.e., MDL levels, POC) and calculating concentrations to standard units.

ERG will develop a subset of this database with the IMPROVE, AQS, and meteorological data for use on this project. ERG will poll AQS to ensure the VISTAS II database has the latest version, to account for any corrections since ERG's last update. ERG is aware that the Cooperative Institute for Research in the Atmosphere (CIRA) may not have the most recent IMPROVE data uploaded to AQS. As such, ERG will download the latest information from CIRA's IMPROVE website to ensure a complete database. The database will include a data definitions table that states in plain language the contents of each field and unit, where applicable. ERG will also provide files of station metadata including location information (e.g., latitude, longitude, elevation), site duration, and type. All data retrieval will follow data acquisition and handling procedures outlined in the project QAPP.

ERG anticipates providing the project data in both Microsoft Excel files (.xlsx) and an Access database (.accdb) format. This will provide a permanent record of the set of data used to support the MPE and the regional haze calculations. The databases will include forms to facilitate the extraction of data for those stakeholders not familiar with Access.

The database will be uploaded to the files sharing platform, as designed in Task 10 (Section 2.10). SESARM will be notified when the database is available and ready for use.

2.4.1 Subtask 4.1 – Collecting Additional Data (weekly wet deposition and weekly dry deposition)

Under this subtask, ERG will aggregate deposition information from the various National Atmospheric Deposition Program (NADP) networks. Wet deposition values will be obtained from the National Trends Network (NTN) and the Atmospheric Integrated Research Monitoring Network (AIRMon) sites, which collects free acidity (H^+ as pH), conductance, calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^+), potassium (K^+), sulfate (SO_4^{2-}), nitrate (NO_3^-), chloride (Cl^-), and ammonium (NH_4^+) on a weekly basis. The SouthEastern Aerosol Research and Characterization (SEARCH) monitoring sites have largely been incorporated into the NTN network and are available through the NADP's site.

The Mercury Deposition Network (MDN) provides weekly dry and wet deposition measurement of mercury. The Atmospheric Mercury Network (AMNet) provides concentrations of atmospheric mercury species from automated, continuous measuring systems, concentrations of total mercury in precipitation, and meteorological measurements.

The Clean Air Status and Trends Network (CASTNET), provides weekly measurements of SO_2, nitric acid (HNO_3), particulate sulfate (SO_4^{-2}) and nitrate (NO_3^-), ammonium (NH_4^+), base cations (Mg^{+2}, Ca^{+2}, K^+, and Na^+), and chloride ion (Cl^-). NADP deployed Ammonia Monitoring Network (AMoN) sites at most CASNET sites, which record biweekly concentrations of ambient NH_3^-. Table 2-1 summarizes the measurements available from each deposition monitoring network.

Table 2-1. Wet and Dry Deposition Monitoring Network Measurements

	Wet Deposition			Dry Deposition		
Measurement	**NTN**	**MDN**	**AIRMoN**	**AMNet**	**AMoN**	**CASTNET**
Free acidity (H^+ as pH)	✓		✓			
Conductance	✓		✓			
Calcium (Ca^{2+})	✓		✓			✓
Magnesium (Mg^{2+})	✓		✓			✓
Sodium (Na^+)	✓		✓			✓
Potassium (K^+)	✓		✓			✓
Sulfate (SO_4^{2-})	✓		✓			✓
Nitrate (NO_3^-)	✓		✓			✓
Chloride (Cl^-)	✓		✓			✓
Ammonium (NH_4^+)	✓		✓			
Total mercury (Hg) total concentration		✓				✓
Total mercury (Hg) total deposition		✓				
Ammonia (NH_3)					✓	
Particulate Bound Mercury concentration				✓		
Average Gaseous Oxidized Mercury				✓		

These networks combine to provide substantial coverage across the VISTAS 12-km domain, as well as the continental US. The database will include a data definitions table that states in plain language the contents of each field and unit, where applicable. ERG will also provide files of station metadata including location information (e.g., latitude, longitude, elevation), site duration, and type. All data retrieval will follow data acquisition and handling procedures outlined in the project QAPP. ERG anticipates providing the project data in both Microsoft Excel files (.xlsx) and an Access database (.accdb) format. This will provide a permanent record of the set of data used to support the project. The databases will include forms to facilitate the extraction of data for those stakeholders not familiar with Access. The database will be uploaded to the files sharing platform, as designed in Task 10 (Section 2.10). SESARM will be notified when the database is available and ready for use.

In addition to observational data, the NADP's Total Deposition (TDEP) hybrid data can be downloaded for future use by the VISTAS states. The hybrid approach combines measurements from CASTNET; NADP's NTN, AIRMoN, and AMoN networks; and the SEARCH network with model output from CAMx to produce nationwide maps of deposition values. The data is available as map images and as gridded data in ESRI ArcGRID export files.[6] The ERG/Alpine team can also download this data for reference and review by the VISTAS states. These images and gridded data files will be uploaded to the files sharing platform, as

6 ftp://ftp.epa.gov/castnet/tdep/Total_Deposition_Documentation_current.pdf

designed in Task 10 (Section 2.10). SESARM will be notified when the data is available and ready for use.

2.5 Task 5 – Area of Influence

Under this task, ERG will identify the 20% most impaired days for each Class I area in the VISTAS_12 modeling domain over the 2011-2016 period.

The Hybrid Single Particle Lagrangian Integrated Trajectory (HYSPLIT) model[7] developed by the National Oceanic and Atmospheric Administration's (NOAA) Air Resources Laboratory (ARL) will then be run for each of these days using NAM-12 hybrid meteorology and starting trajectory heights of 100 meters (m), 500 m, 1,000 m, and 1,500 m to identify areas most likely influencing visibility. Trajectories will be run 72 hours backwards in time.

Note: The RFP originally requested the NAM-12 (pressure) meteorological data to be used for the trajectories. However, in discussions with SESARM at contract execution, it was decided that ERG would use the NAMS-12 hybrid meteorology, as it provides better vertical and temporal resolution.

Trajectories will be run with start times of 12AM (midnight of the start of the day), 6AM, 12PM, 6PM, and 12AM (midnight at the end of the day) local time. Trajectories will originate from the IMPROVE monitor in each Class I area in the VISTAS_12 domain (Table 2-2 and Figure 2-1). Table 2-3 and Figure 2-2 indicates the representative monitor for each location that will be used in the analysis. For the three VISTAS region Class I areas (i.e., Wolf Island, Joyce Kilmer-Slickrock and Otter Creek) that do not have an IMPROVE monitor, the centroid of each Class I area will be used as the origin of the trajectories.

Table 2-2. IMPROVE Monitors in the VISTAS_12 Domain

IMPROVE Site	IMPROVE Site Code	State	County FIPS Code	Latitude	Longitude	Start Date	End Date
North Birmingham	BIRM1	AL	01073	33.5531	-86.8148	03/01/2004	04/28/2017
Sipsey Wilderness	SIPS1	AL	01079	34.3433	-87.3388	03/04/1992	04/28/2017
Caney Creek	CACR1	AR	05113	34.4544	-94.1429	06/24/2000	04/28/2017
Upper Buffalo Wilderness	UPBU1	AR	05101	35.8258	-93.2030	12/04/1991	04/28/2017
Flat Tops	FLTO1	CO	08103	39.9200	-107.6300	10/27/2011	04/28/2017
Great Sand Dunes NM	GRSA1	CO	08003	37.7249	-105.5185	03/02/1988	04/28/2017
Mount Zirkel Wilderness	MOZI1	CO	08057	40.5383	-106.6766	06/01/1994	04/28/2017
Ripple Creek	RICR1	CO	08103	40.0865	-107.3141	03/02/2009	10/30/2011
Rocky Mountain NP	ROMO1	CO	08069	40.2783	-105.5457	09/01/1990	04/28/2017
White River NF	WHRI1	CO	08097	39.1536	-106.8209	06/02/1993	04/28/2017
Mohawk Mt.	MOMO1	CT	09005	41.8214	-73.2973	09/13/2001	04/28/2017
Washington D.C.	WASH1	DC	11001	38.8762	-77.0344	03/02/1988	06/08/2015

[7] Stein, A.F., Draxler, R.R, Rolph, G.D., Stunder, B.J.B., Cohen, M.D., and Ngan, F., (2015). NOAA's HYSPLIT atmospheric transport and dispersion modeling system, Bull. Amer. Meteor. Soc., 96, 2059-2077, http://dx.doi.org/10.1175/BAMS-D-14-00110.1

Table 2-2. IMPROVE Monitors in the VISTAS_12 Domain

IMPROVE Site	IMPROVE Site Code	State	County FIPS Code	Latitude	Longitude	Start Date	End Date
Chassahowitzka NWR	CHAS1	FL	12017	28.7484	-82.5549	03/03/1993	04/28/2017
Everglades NP	EVER1	FL	12086	25.3910	-80.6806	09/03/1988	04/28/2017
St. Marks	SAMA1	FL	12129	30.0926	-84.1614	08/16/2000	04/28/2017
Cohutta	COHU1	GA	13213	34.7852	-84.6265	06/03/2000	04/28/2017
Okefenokee NWR	OKEF1	GA	13049	30.7405	-82.1283	09/04/1991	04/28/2017
South Dekalb	ATLA1	GA	13089	33.6880	-84.2903	03/01/2004	04/28/2017
Lake Sugema	LASU2	IA	-999	40.6932	-92.0059	12/02/2004	04/28/2017
Viking Lake	VILA1	IA	19137	40.9690	-95.0450	05/08/2002	04/28/2017
Bondville	BOND1	IL	17019	40.0520	-88.3733	03/08/2001	04/28/2017
Cedar Bluff	CEBL1	KS	20195	38.7701	-99.7634	06/01/2002	04/28/2017
Sac and Fox	SAFO1	KS	20013	39.9791	-95.5682	06/01/2002	06/29/2011
Tallgrass	TALL1	KS	20017	38.4341	-96.5602	09/02/2002	04/28/2017
Mammoth Cave NP	MACA1	KY	21061	37.1318	-86.1479	09/04/1991	04/28/2017
Breton Island	BRIS1	LA	22075	30.1086	-89.7617	01/16/2008	04/28/2017
Cape Cod	CACO1	MA	25001	41.9758	-70.0242	04/04/2001	04/28/2017
Martha's Vineyard	MAVI1	MA	25007	41.3309	-70.7846	12/01/2002	04/28/2017
Quabbin Summit	QURE1	MA	25015	42.2985	-72.3346	04/04/2001	12/29/2015
Frostburg Reservoir (Big Piney Run)	FRRE1	MD	24023	39.7058	-79.0122	03/01/2004	04/28/2017
Acadia NP	ACAD1	ME	23009	44.3771	-68.2610	03/02/1988	04/28/2017
Bridgton	BRMA1	ME	23005	44.1074	-70.7292	03/14/2001	12/29/2015
Casco Bay	CABA1	ME	23005	43.8325	-70.0644	03/14/2001	04/28/2017
Moosehorn NWR	MOOS1	ME	23029	45.1259	-67.2661	12/03/1994	04/28/2017
Penobscot	PENO1	ME	23019	44.9480	-68.6479	01/11/2006	04/28/2017
Presque Isle	PRIS1	ME	23003	46.6964	-68.0333	03/08/2001	04/28/2017
Detroit	DETR1	MI	26163	42.2286	-83.2085	09/03/2003	04/28/2017
Isle Royale NP	ISLE1	MI	26083	47.4596	-88.1491	11/17/1999	04/28/2017
Seney	SENE1	MI	26153	46.2889	-85.9503	11/17/1999	04/28/2017
Blue Mounds	BLMO1	MN	27133	43.7158	-96.1913	06/01/2002	12/29/2015
Boundary Waters Canoe Area	BOWA1	MN	27075	47.9466	-91.4955	06/01/1991	04/28/2017
Great River Bluffs	GRRI1	MN	27169	43.9373	-91.4052	06/01/2002	04/28/2017
Voyageurs NP #2	VOYA2	MN	27137	48.4126	-92.8286	03/02/1988	04/28/2017
El Dorado Springs	ELDO1	MO	29039	37.7009	-94.0348	03/03/2002	12/29/2015
Hercules-Glades	HEGL1	MO	29213	36.6138	-92.9221	03/02/2001	04/28/2017
Mingo	MING1	MO	29207	36.9717	-90.1432	06/03/2000	04/28/2017
Fort Peck	FOPE1	MT	30085	48.3080	-105.1022	06/01/2002	04/28/2017

Table 2-2. IMPROVE Monitors in the VISTAS_12 Domain

IMPROVE Site	IMPROVE Site Code	State	County FIPS Code	Latitude	Longitude	Start Date	End Date
Medicine Lake	MELA1	MT	30091	48.4871	-104.4757	12/15/1999	04/28/2017
Northern Cheyenne	NOCH1	MT	30087	45.6495	-106.5574	06/01/2002	04/28/2017
UL Bend	ULBE1	MT	30027	47.5823	-108.7196	01/26/2000	04/28/2017
Linville Gorge	LIGO1	NC	37011	35.9723	-81.9331	04/01/2000	04/28/2017
Shining Rock Wilderness	SHRO1	NC	37087	35.3937	-82.7744	06/01/1994	04/28/2017
Swanquarter	SWAN1	NC	37095	35.4510	-76.2075	06/10/2000	04/28/2017
Lostwood	LOST1	ND	38013	48.6419	-102.4022	12/15/1999	04/28/2017
Theodore Roosevelt	THRO1	ND	38007	46.8948	-103.3777	12/15/1999	04/28/2017
Crescent Lake	CRES1	NE	31069	41.7627	-102.4336	06/01/2002	12/29/2015
Nebraska NF	NEBR1	NE	31171	41.8888	-100.3387	06/01/2002	04/28/2017
Great Gulf Wilderness	GRGU1	NH	33007	44.3082	-71.2177	06/03/1995	04/28/2017
Londonderry	LOND1	NH	33015	42.8624	-71.3801	01/03/2011	04/28/2017
Pack Monadnock Summit	PACK1	NH	33011	42.8619	-71.8786	10/03/2007	04/28/2017
Brigantine NWR	BRIG1	NJ	34001	39.4650	-74.4492	09/04/1991	04/28/2017
Bandelier NM	BAND1	NM	35028	35.7797	-106.2664	03/02/1988	04/28/2017
Bosque del Apache	BOAP1	NM	35053	33.8695	-106.8520	04/15/2000	04/28/2017
Salt Creek	SACR1	NM	35005	33.4598	-104.4042	04/08/2000	04/28/2017
San Pedro Parks	SAPE1	NM	35039	36.0139	-106.8447	08/16/2000	04/28/2017
Wheeler Peak	WHPE1	NM	35055	36.5854	-105.4520	08/16/2000	04/28/2017
White Mountain	WHIT1	NM	35027	33.4687	-105.5349	12/03/2001	04/28/2017
Quaker City	QUCI1	OH	39121	39.9428	-81.3378	04/04/2001	04/28/2017
Ellis	ELLI1	OK	40045	36.0853	-99.9354	03/03/2002	10/18/2015
Stilwell	STIL1	OK	40071	35.7508	-94.6696	04/23/2010	04/28/2017
Wichita Mountains	WIMO1	OK	40031	34.7323	-98.7130	03/02/2001	04/28/2017
Egbert	EGBE1	ON	Canada	44.2312	-79.7832	09/01/2005	04/28/2017
Lawrenceville	PITT1	PA	42003	40.4654	-79.9607	03/01/2004	04/28/2017
Cape Romain NWR	ROMA1	SC	45019	32.9410	-79.6572	09/03/1994	04/28/2017
Badlands NP	BADL1	SD	46071	43.7435	-101.9412	03/02/1988	04/28/2017
Wind Cave	WICA1	SD	46033	43.5576	-103.4838	12/15/1999	04/28/2017
Great Smoky Mountains NP	GRSM1	TN	47009	35.6334	-83.9416	03/02/1988	04/28/2017
Big Bend NP	BIBE1	TX	48043	29.3027	-103.1780	03/02/1988	04/28/2017
Guadalupe Mountains NP	GUMO1	TX	48109	31.8330	-104.8094	03/02/1988	04/28/2017
James River Face Wilderness	JARI1	VA	51163	37.6266	-79.5125	06/03/2000	04/28/2017
Shenandoah NP	SHEN1	VA	51113	38.5229	-78.4348	03/02/1988	04/28/2017
Lye Brook Wilderness	LYBR1	VT	50003	43.1482	-73.1268	09/04/1991	09/30/2012
Lye Brook Wilderness	LYEB1	VT	50025	42.9561	-72.9098	01/01/2012	04/28/2017

Table 2-2. IMPROVE Monitors in the VISTAS_12 Domain

IMPROVE Site	IMPROVE Site Code	State	County FIPS Code	Latitude	Longitude	Start Date	End Date
Proctor Maple R. F.	PMRF1	VT	50007	44.5284	-72.8688	12/01/1993	04/28/2017
Forest County Potawatomi Community	FCPC1	WI	55041	45.5650	-88.8084	11/17/2016	04/28/2017
Dolly Sods Wilderness	DOSO1	WV	54093	39.1053	-79.4261	09/04/1991	04/28/2017
Cloud Peak	CLPE1	WY	56019	44.3335	-106.9565	06/01/2002	07/29/2015
Thunder Basin	THBA1	WY	56005	44.6634	-105.2874	06/01/2002	04/28/2017

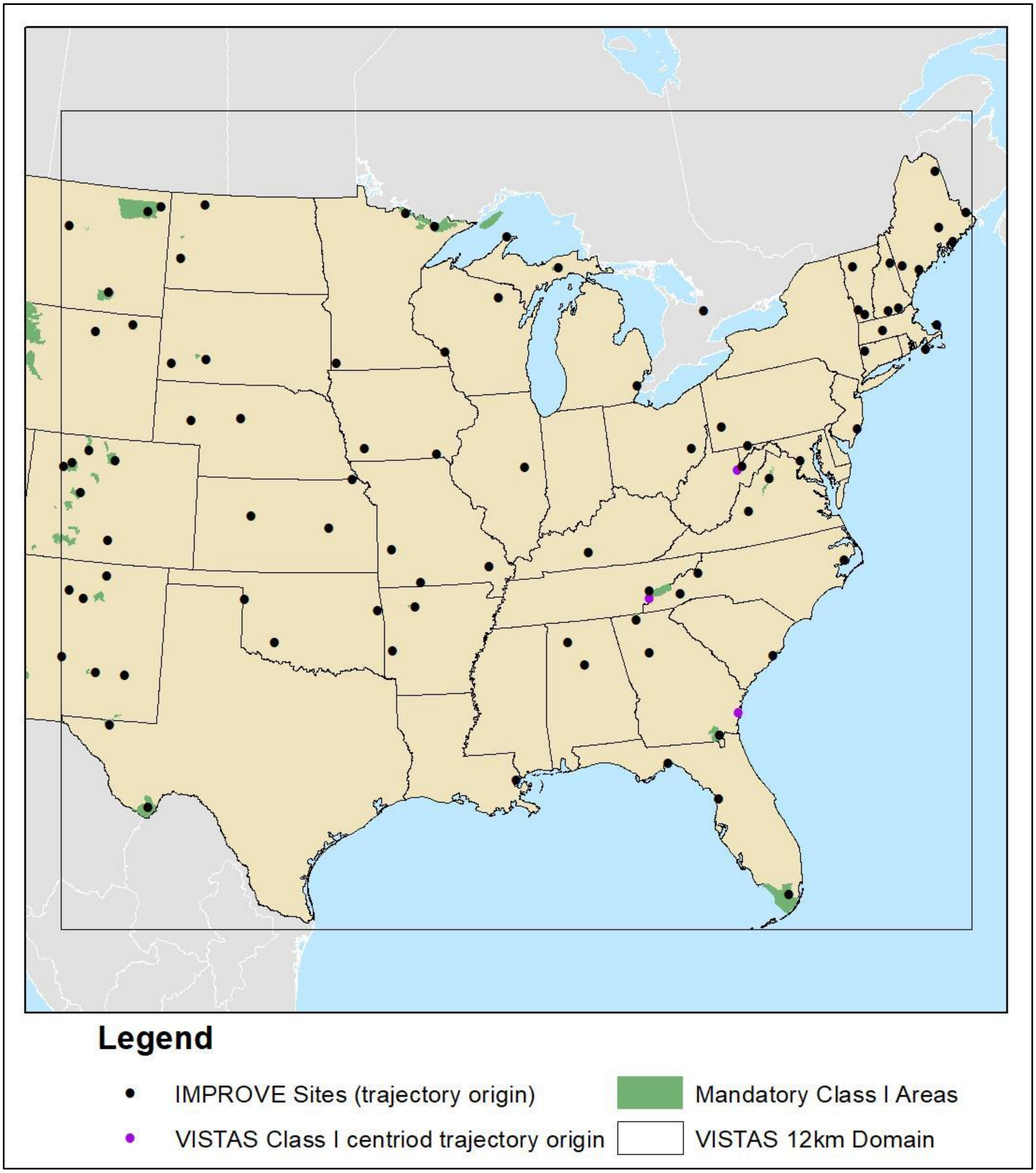

Figure 2-1. IMPROVE Monitor Locations and Starting Points for HYSPLIT Trajectories in the VISTAS 12km Domain

Table 2-3. Representative IMPROVE Monitor for Each VISTAS Class I Area

Class I Area	Representative IMPROVE Site	IMPROVE Site Code	State	FIPS County Code	Latitude	Longitude
AL - Sipsey Wilderness Area	Sipsey Wilderness	SIPS1	AL	01079	34.3433	-87.3388
FL - Chassahowitzka Wilderness Area	Chassahowitzka NWR	CHAS1	FL	12017	28.7484	-82.5549
FL - Everglades National Park	Everglades NP	EVER1	FL	12086	25.391	-80.6806
FL - St. Marks Wilderness Area	St. Marks	SAMA1	FL	12129	30.0926	-84.1614
GA - Cohutta Wilderness Area	Cohutta	COHU1	GA	13213	34.7852	-84.6265
GA - Okefenokee Wilderness Area	Okefenokee NWR	OKEF1	GA	13049	30.7405	-82.1283
GA - Wolf Island Wilderness Area	Okefenokee NWR	OKEF1	GA	13049	30.7405	-82.1283
KY - Mammoth Cave National Park	Mammoth Cave NP	MACA1	KY	21061	37.1318	-86.1479
NC/TN - Great Smoky Mountains National Park	Great Smoky Mountains NP	GRSM1	TN	47009	35.6334	-83.9416
NC/TN - Joyce Kilmer-Slickrock Wilderness	Great Smoky Mountains NP	GRSM1	TN	47009	35.6334	-83.9416
NC - Linville Gorge Wilderness Area	Linville Gorge	LIGO1	NC	37011	35.9723	-81.9331
NC - Shining Rock Wilderness Area	Shining Rock Wilderness	SHRO1	NC	37087	35.3937	-82.7744
NC - Swanquarter Wilderness Area	Swanquarter	SWAN1	NC	37095	35.451	-76.2075
SC - Cape Romain Wilderness Area	Cape Romain NWR	ROMA1	SC	45019	32.941	-79.6572
VA - James River Face Wilderness Area	James River Face Wilderness	JARI1	VA	51163	37.6266	-79.5125
VA - Shenandoah National Park	Shenandoah NP	SHEN1	VA	51113	38.5229	-78.4348
WV - Dolly Sods Wilderness Area	Dolly Sods Wilderness	DOSO1	WV	54093	39.1053	-79.4261
WV - Otter Creek Wilderness Area	Dolly Sods Wilderness	DOSO1	WV	54093	39.1053	-79.4261

Figure 2-2. IMPROVE Monitor Locations and Starting Points for HYSPLIT Trajectories in the VISTAS States

Trajectories will be run utilizing the SplitR package (https://github.com/rich-iannone/SplitR), which allows the control of HYSPLIT through the *R* statistical software. This allows for automation of the HYSPLIT runs for each location, while still generating the GIS shapefiles and separate files of the endpoint for further use in *R*.

The back trajectories for the 20% most impaired days will then be used to develop residency time plots via the openair[8] package for *R*. The residency time plots define the geographic areas with the highest probability of influencing the monitor on the 20% most impaired visibility days. The residency time is calculated as the frequency the trajectory is seen in a grid cell, as a percentage of the total. The grid used would align with the photochemical modeling 12km grid. For further analysis, *R* allows the residence time plots to be split by time increments (i.e., year, season), if that level of analysis is of interest. Images of the residency time plots will be generated for QA and review purposes. Images will at least cover the VISTAS 12-km domain and include outlines of states and counties.

The trajectory data will also be weighted by ammonium sulfate and ammonium nitrate and used to produce separate sulfate and nitrate extinction weighted residency time (EWRT) plots. This allows separate analysis for sulfate and nitrate that is weighted toward the days influenced most by those constituents and not days most influenced by other constituents, like organic carbon. This can be accomplished in *R* using a Concentration Weighted Trajectory (CWT)[9] approach to the trajectory analysis, but substituting the extinction for the concentration. The extinction attributable to each pollutant is paired with the trajectory for that day. *R* then calculates the mean weighted extinction of the pollutant species for each grid cell. The mean weighted extinction is calculated by:

$$\bar{E}_{ij} = \frac{1}{\sum_{k=1}^{N} \tau_{ijk}} \sum_{k=1}^{N} (bext_k)\, \tau_{ijk}$$

where i and j are the indices of grid, k the index of trajectory, N the total number of trajectories used in analysis, $bext_k$ is the extinction attributed to the pollutant measured upon arrival of trajectory k, and τ_{ijk} the residence time of trajectory k in grid cell (i, j).[10] The higher the value of $\bar{E}_{ij}$, the more likely that the air parcels passing over cell (i, j) would cause higher extinction at the receptor site for that light extinction species. The results be normalized by the domain total to present the results as a percentage in images. Images of the extinction weighted residency time plots will be generated for QA and review purposes. Images will at least cover the VISTAS 12-km domain and include outlines of states and counties.

The next step is to combine the EWRT values with the distance weighted gridded emission data to determine the sources most likely contributing to the elevated extinction levels. Distances (d) for the weighting are calculated using ArcGIS and will be calculated from the

8 Carslaw DC and Ropkins K (2012). “openair — An R package for air quality data analysis.” Environmental Modelling & Software, 27–28(0), pp. 52–61. ISSN 1364-8152, doi: 10.1016/j.envsoft.2011.09.008.

9 HSU, Y.-K., T. M. HOLSEN and P. K. HOPKE (2003). “Comparison of hybrid receptor models to locate PCB sources in Chicago”. In: Atmospheric Environment 37.4, pp. 545–562. DOI: 10.1016/S1352-2310(02)00886-5

10 Carslaw, D.C. (2015). The openair manual — open-source tools for analyzing air pollution data. Manual for version 1.1-4, King’s College London. http://www.openair-project.org/PDF/OpenAir_Manual.pdf

location of the point source to the trajectory origin in kilometers. The weighted emission file is comprised of the EGU and non-EGU point source emissions value for each grid cell (Q) divided by the distance (d) to the trajectory origin; that is the final value is (Q/d). Each of these grid cell values is multiplied by its respective sulfate or nitrate extinction weighted residency time plot values (i.e., EWRT *(Q/d)). Similar to the EWRT plots, these values can be normalized by the domain total to present them as a percentage in plots. Images of the results will be mapped over the VISTAS 12-km modeling domain, with state and county boundaries for review and QA purposes.

These gridded results will then be linked with the 2011 and 2028 point source inventories to calculate the emission contribution from each source. ArcGIS will be used to spatially join the gridded information with shapefiles the point source information. This will create a dataset that combines the point source metadata facility identifying information (i.e., Facility ID, Facility Name, State, County, Federal Information Processing Standard (FIPS), North American Industry Classification System (NAICS), and industry description), and the gridded information (i.e., SO_2 and NO_2 emissions, d, Q/d, EWRT, EWRT *(Q/d)). Additional information can be added as deemed necessary in making control strategy decisions. The information from these spatial files can then be exported to separate Excel spreadsheets (.xlsx) for each Class I area in the VISTAS_12 domain for further review by the states.

The Q/d values will be calculated by dividing emissions (tons per year) by distance (km).

All images (.png), shapefiles, and spreadsheets (.xlsx) will be uploaded to the files sharing platform, as designed in Task 10 (Section 2.10), in separate folders for each Class I area or IMPROVE monitor in the VISTAS_12 domain. Each analysis element (e.g., RT plots, summary spreadsheets) will be contained in separate subfolders for ease of navigation. SESARM will be notified when the files are available and ready for use. A technical memorandum/interim report describing the area of influence calculations, and the results, will be prepared for SESARM based on the “Reports” requirement in Subtask 1.6 (Section 2.1.6).

2.5.1 Optional Subtask 5.1 – SO_2 and NO_x Emissions Contribution Rankings

If directed by SESARM for this optional subtask, ERG will provide additional Excel spreadsheets ranking SO_2 and NO_2 emissions contributions for the point, onroad, nonroad, fires, and area source sectors from each county. The process will be similar to the process for point sources previously described in Section 2.5, except calculations of RT and EWRT will be done to counties as opposed to grids. ERG will determine if the trajectories can be weighted further for the time spent in the cell. The length of the trajectory within the cell would be used as a proxy for time, so that trajectories that only cross a small corner of the cell are not weight as much as trajectories passing through the more of the cell. This will be done in GIS using the same calculation as in *R*. The calculation of d would then be from the centroid of the county to the trajectory origin, in kilometers. The final spatial join would be to the county level EWRT and a shapefile of the source information at the county level, for each sector. All county and emissions source identifying information will be provided along with inventory emissions, distance, Q/d and Q/d^2 values, EWRT, EWRT*(Q/d), fraction and sum contributions, and any other information deemed necessary in making control strategy decisions for each source.

This information can also be provided in an aggregated form to provide ranking of NO_x and SO_2 contribution for all source sectors on a county basis. The ERG/Alpine team would consult with the VISTAS states on the levels to which they would like to see the sources divided, and if desired, subdivided to allow the contributions to be viewed at several levels of aggregation and disaggregation. A database will be developed that facilitates the aggregation to multiple levels, so VISTAS states can see a source category, and then drill down into several subcategories to examine the highest contributors. For example, it may be of benefit to see the contribution of light duty versus heavy duty vehicles in addition to total onroad sources contribution at the county level. At a minimum, VISTAS will be able to aggregate at any of the four levels of the SCCs provided in the inventory.

All spreadsheets will be uploaded to the files sharing platform, as designed in Task 10 (Section 2.10), in separate folders for each Class I area in the VISTAS_12 domain. SESARM will be notified when the database is available and ready for use.

2.6 Task 6 – Air Quality Modeling

Under this task, ERG will direct Alpine to use Version 6.40 of CAMx, with Particulate Matter Source Apportionment Technology (PSAT) to generate the files and concentration data necessary to support this and additional tasks. The choice of running the model as quarterly simulations was made in consultation with SESARM to optimize the modeling to fit the computing capabilities of the VISTAS states. ERG will use the CONUS_12 and VISTAS_12 modeling domains for 2011 and 2028 modeling and the VISTAS_12 domain for PSAT work.

2.6.1 Subtask 6.1 – Modeling Protocol

Under this subtask, ERG will direct Alpine to prepare the modeling protocol, which is the “roadmap” for the entire study, laying out how the modeling will be conducted, and providing an opportunity for comment by SESARM and other stakeholders. The protocol will include all elements identified in the SOW to ensure a comprehensive and transparent path forward for the modeling project. The protocol will be developed following EPA’s emissions and air quality modeling guidance and define air quality and meteorological model performance tests to ensure replicable and reliable modeling results.

To be consistent with EPA’s recent regional haze modeling,[11] Alpine will utilize consistent configurations, chemistry, meteorology, and other ancillary data to perform this analysis. As specified in the RFP, the model version will be updated to the most recent available, currently CAMx version 6.40.

Once a final draft of the protocol has been completed, SESARM will submit the document for EPA to review. Upon receipt of comments and revision requests by EPA and approved by SESARM, the ERG/Alpine team will make appropriate revisions to the document with plans to incorporate any revised direction into the air quality modeling itself.

2.6.2 Subtask 6.2 – 2011 Base Year Air Quality Modeling

Under this subtask, ERG will direct Alpine to begin 2011 Base Year Air Quality modeling activities. The EPA 2011v6.3el modeling platform will form the foundation for the VISTAS II modeling. The study team already has EPA’s 2011v6.3el modeling platform installed

[11] https://www3.epa.gov/ttn/scram/reports/2028_Regional_Haze_Modeling-Transmittal_Memo.pdf

on our computer cluster. EPA will be consulted, and any updated platform files will be acquired, developed, or utilized should it be available and requested by SESARM.

The numerics in photochemical grid models (PGMs) are very complex and it is typical to get slightly different model concentrations based on the version of the computer and compilers. When comparing simulations, it is critical to isolate the changes in concentrations to the changes in the model inputs, and not on the computing details (i.e., compiler version, computer architecture, parallelization options). This is especially problematic when looking at particulate matter, since the particulate treatments have multiple pathways, and small concentration differences can lead to different pathways through the code and different concentrations. Should a difference of 2% be seen in the replication of significantly contributing species of the 2011 base year photochemical modeling a call will be convened between ERG, Alpine, SESARM, and the appropriate EPA staff to identify any inconsistencies and come to consensus on appropriate corrective actions.

Development of the VISTAS_12 domain will require the EPA CONUS_12 simulation to be run using the most recent version of the CAMx modeling saving 3-dimensional concentration fields for extraction using the CAMx BNDEXTR program. The outputs of this simulation will be very large, approximately 10.5 Terabytes (TB). The study team has extensive experience with such large datasets and does not anticipate any issues.

Alpine has already processed EPA’s 2011v6.3el platform on its internal modeling systems, using version 6.32 of CAMx that EPA used in its preliminary 2028 regional haze modeling. A comparison of the ozone results between the model run on Alpine’s and EPA’s computer clusters showed very small differences. The maximum ozone differences demonstrated were typically less than 0.01 ppb. Our experience has shown that changing CAMx versions often leads to larger differences than computer differences.

The VISTAS_12 domain will be a subset of the CONUS_12 domain, with the dimension specified in Table 2-4. After the VISTAS_12 simulation is complete, the results will be compared against the simulation over the CONUS_12 domain results and any differences noted. It is expected that the differences will be minor.

Table 2-4. Modeling Domain Specifications

Domain	Columns	Rows	Vertical Layers
CONUS_12	396	246	25
VISTAS_12	269	242	25

2.6.3 Subtask 6.3 – 2028 Projection Year Air Quality Modeling

Under this subtask, ERG will direct Alpine to begin 2028 modeling activities using the CAMx v6.40 model. The input emissions file will be the 2028 emissions inventory file developed in Task 2 (Section 2.2). The specific work elements in Subtask 6.3 (Section 2.6.3) follow those described in Subtask 6.2 (Section 2.6.2).

2.7 Task 7 – Source Apportionment Tagging

Under this task, ERG will direct Alpine to begin Source Apportionment Tagging activities. At this time, SESARM has planned for 250 source tags, but may increase or decrease the number of source tags during the course of the project. To gain a better understanding of the source contributions to modeled visibility, CAMx PSAT modeling will be utilized with the revised 2028 modeling platform. PSAT uses multiple tracer families to track the fate of both primary and secondary PM.[12] 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 or facility). For this application, 2028 emissions will be tagged using SESARM-identified combinations of region, facilities, and/or source category. Each combination accounts for a single "tag" with SESARM planning to identify up to 250 individual tagged combinations. Each of these emissions combinations will be processed through SMOKE and tracked in PSAT as individual source tags. Receptors, identified as all the Class I areas in the VISTAS_12 domain, will be used to analyze the results and impacts of each tagged combination.

For this application, only sulfate and nitrate will be tracked using PSAT. During analysis for the initial regional haze SIPs, analysis found that in the southeast ammonium sulfate ($(NH_4)_2SO_4$), predominantly SO_2 emissions from EGUs and industrial sources, contributes 60 – 70% of the light extinction on the 20% haziest days.[13] Current analysis of IMPROVE measurements continues to confirm the importance of sulfate to visibility impairment on the 20% worst days through the Southeast.[14] In addition to sulfate, the VISTAS states may be interested in the contribution of nitrate from their states to visibility impairment at sites in the north central and eastern United States, as nitrate is generally of concern with respect to transport from VISTAS states to Class I areas outside the VISTAS region. The initial VISTAS analysis showed that the impacts from elemental carbon are minimal on the 20% worst days, with higher impacts from organic carbon. However, the impacts from organic carbon are dominated by biogenic emissions, not anthropogenic emissions, which can be controlled. Tracking of these and other PM species (i.e., elemental carbon, organic carbon, etc.) that contribute to visibility impairment may be of some use, but has not been requested in this analysis.

[12] http://camx.com/publ/pdfs/yarwood_itm_paper.pdf

[13] Patricia Brewer & Tom Moore (2009) Source Contributions to Visibility Impairment in the Southeastern and Western United States, Journal of the Air & Waste Management Association, 59:9, 1070-1081, DOI: 10.3155/1047-3289.59.9.1070

[14] U.S. Environmental Protection Agency. 2016. Technical Support Document (TSD) Revised Recommendations for Visibility Progress Tracking Metrics for the Regional Haze Program U.S. Environmental Protection Agency Office of Air Quality Planning and Standards Air Quality Assessment Division Research Triangle Park, NC 27711. July 2016

2.8 Task 8 – Model Performance Evaluation

Under this task, ERG will direct Alpine to begin MPE activities. Alpine will review EPA's current operational MPE[15] for particulate matter ($PM_{2.5}$ species components and coarse PM) and regional haze to compare the ability of the CAMx v6.40 modeling system to simulate 2011 measured concentrations. Using a combination of the Atmospheric Model Evaluation Tool (AMET) and internal scripts used by Alpine, comprehensive MPE statistics and graphics from the 2011 CAMx simulation using data from the IMPROVE network will be prepared in formats that will be accessible for stakeholder review and use (e.g., .csv, Excel). Alpine will use the current IMPROVE equation[16] (below) inclusive of the monthly relative humidity function [f(RH)] values for both observed and modeled data to develop performance statistics at each IMPROVE monitor in the VISTAS_12 domain.

$$
\begin{aligned}
b_{ext} \approx\ & 2.2 \times f_s(RH) \times [Small\ Sulfate] + 4.8 \times f_L(RH) \times [Large\ Sulfate] \\
& + 2.4 \times f_s(RH) \times [Small\ Nitrate] + 5.1 \times f_L(RH) \times [Large\ Nitrate] \\
& + 2.8 \times [Small\ Organic\ Mass] + 6.1 \times [Large\ Organic\ Mass] \\
& + 10 \times [\text{Elemental Carbon}] + 1 \times [\text{Fine Soil}] \\
& + 1.7 \times f_{SS}(RH) \times [Sea\ Salt] + 0.6 \times [\text{Coarse Mass}] \\
& + \text{Rayleigh Scattering (Site Specific)} + 0.33 \times [\text{NO}_2\ \text{(ppb)}]
\end{aligned}
$$

Tables and plots will be prepared for VISTAS and non-VISTAS IMPROVE monitors as directed to demonstrate light extinction model performance in a graphical manner. Scatter (with linear regression and r^2 value), bugle, and soccer plots for all light extinction and speciated components will be developed for the 20% most impaired and 20% clearest days for each IMPROVE monitor in the VISTAS_12 modeling domain. Alpine will develop (and further include 2028 modeled data in Task 9 (Section 2.9)) the individual day-by-day and site-by-site stacked bar plots of total *beta* extinction (bext) and speciated components of bext for these most impaired and clearest days.[17] To confirm, metrics and plots generated for the most impaired days will be consistent with the latest definition of this classification as "anthropogenically impaired" days as defined by EPA.

Tables of the above-noted MPE statistics will be provided in Excel (.xlsx) or .csv file format and will include the same suite of metrics included in EPA's modeling TSD and this project's QAPP. Additional details will be provided in the modeling protocol. A technical document describing the performance evaluation and results will be prepared for SESARM under the "Reports" requirement in Subtask 1.6 (Section 2.1.6).

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[15] https://www3.epa.gov/ttn/scram/reports/2028_Regional_Haze_Modeling-TSD.pdf

[16] Pitchford, M.; Malm, W.; Schichtel, B.; Kumar, N.; Lowenthal, D.; Hand, J. Revised algorithm for estimating light extinction from IMPROVE particle speciation data; J. Air & Waste Manage. Assoc. 2007, 57, 1326-1336; doi: 3155/1047-3289.57.11.1326.

[17] MPE statistics can be calculated for all IMPROVE days (annual and by season of the year), but was not identified in the original SOW. Additional funds will be needed to accomplish this request.

2.8.1 Subtask 8.1 – Model Performance Evaluation for Weekly Wet and Weekly Dry Deposition Species

Under this subtask, ERG will direct Alpine to perform MPE for weekly wet deposition and weekly dry deposition species collected in Subtask 4.1 (Section 2.4.1). For the MPE, VISTAS CAMx deposition values will be aggregated to appropriate time periods to match the various NADP monitoring network's concentration collection times. To prevent confounding the MPE, the networks with different collection time (i.e., biweekly versus weekly) will be examined separately.

For wet deposition, NADP networks typically present measurements as concentration in mg/L, which is equivalent to g/m^3. These concentrations are then multiplied by the precipitation in meters to yield wet deposition rates in units of g/m^2. The CAMx wet deposition outputs are provided in grams per hectare (g/ha), which will be converted to grams per meter squared (g/m^2), using the conversion of 1 ha = 10,000 m^2, to have consistent units with the NADP monitoring networks. CAMx estimates of wet deposition can also be adjusted to account for the error present in the model estimated precipitation through a ratio of the observed to estimated precipitation.[18] Dry deposition values from CASTNET can be developed from the observed concentration multiplied by a deposition velocity generated by the Multi-Layer Model (MLM)[19] for the site. The MLM generated deposition velocities are available for download with the CASTNET observations.[20]

Annual mean MPE statistics, like the statistics for the base year MPE, will be developed for the wet deposition and dry deposition species available. Analysis will also include scatter plots of NADP network observations versus CAMx predictions, and their correlation (r), both annually and by season. Statistical and scatter plots will also be examined by VISTAS states to provide more refined MPE information to facilitate further use by the states.

Additionally, annual deposition totals will be produced from the VISTAS II base year modeling and compared to the annual Total Deposition Maps developed by the NADP and EPA. These total deposition maps are produced via a hybrid approach that combines the monitored data with modeled data to produce a gridded map of total sulfate and nitrate depositions. While not entirely observed truth, these hybrid estimates could provide the ability to evaluate generally the MPE for the entire domain in areas where data availability is limited due to incomplete records from the monitoring sites.

2.9 <u>Task 9 – Future Year Model Projections</u>

Under this task, ERG will direct Alpine to calculate relative response factors (RRFs) for each IMPROVE monitor in the VISTAS_12 modeling domain. RRFs are a ratio of the air quality

[18] Appel, K. W., et al. 2011. "A multi-resolution assessment of the Community Multiscale Air Quality (CMAQ) model v4. 7 wet deposition estimates for 2002–2006." Geoscientific Model Development 4.2 (2011): 357-371.

[19] Meyers, T. P., Finkelstein, P., Clarke, J., Ellestad, T.G., and Sims, P.F. 1998. A Multilayer Model for Inferring Dry Deposition Using Standard Meteorological Measurements. J. Geophys. Res., 103(D17): 22,645-22,661, DOI: 10.1029/98jd01564.

[20] https://java.epa.gov/castnet/clearsession.do

concentration in the future year to the air quality concentration in the base year.[21] In its simplest form, RRF is defined as:

$$RRF = \frac{Modeled\ Concentration_{FutureYear}}{Modeled\ Concentration_{BaseYear}}$$

This yields an average percent change in pollutant or species concentrations due to emission changes between the base and future years. For regional haze modeling the RRF is based on the measured 20% most impaired and 20% clearest days from the base year. Ultimately, the RRF is multiplied by a base design values (DVB), which is based on monitored data, to produce a design value for the future year (DVF). For regional haze modeling, RRFs for each component of light extinction are calculated and multiplied by their corresponding speciated DVBs to get speciated DVFs for each component of light extinction. Then, the speciated DVFs for each component are summed to give the total future year light extinction (Mm^{-1}) which will be converted to haze index (dV). The haze index DVF is the future year projection that will ultimately be used to determine the 2028 reasonable progress goals (RPGs) at each Class I area. Using the DVB keeps the future projection rooted in observed data, and not just modeling. The advantage to using RRFs is that the modeling is used in a relative sense, which can account for any factor causing bias in the modeling results. That is, any bias seen in the base year will likely be present in the future year and by taking the ratio of the two years that bias is effectively canceled out.

Alpine will use EPA's Software for Model Attainment Test – Community Edition (SMAT-CE) tool to calculate 2028 deciview values and visibility on the 20% most impaired and 20% clearest days at each Class I area in the VISTAS_12 domain. This tool implements the procedures from EPA's modeling guidance to project visibility to a modeled projection year using RRFs. With the results of each SMAT-CE run, executed for each simulation identified in Task 6 (Section 2.6), the ERG/Alpine team will prepare glide slope graphics, demonstrating the progress in visibility improvement for the 20% most impaired and 20% clearest days relative to baseline visibility conditions at each Class I area in the VISTAS_12 domain.

Additionally, using IMPROVE site observations and model concentration projections, Alpine will create day-by-day stacked bar charts of total, sulfate, and speciated component bext for the 20% most impaired and 20% clearest days per site for each IMPROVE monitor in the VISTAS_12 modeling domain. This step requires special processing of the SMAT-CE runs using available advanced options in the tool to generate the contribution calculations for each tagged species from Task 7 (Section 2.7) and for each simulation to be compared back to the baseline run. Details of these methods proposed to be used can be found in EPA's most recent Regional Haze Modeling TSD.[22]

Alpine will also modify the 2011 site-by-site average stacked bar charts of total, sulfate, and speciated component bext for the 20% most impaired and 20% clearest days per site for all IMPROVE monitors in the VISTAS_12 modeling domain from Task 8 (Section 2.8) to include

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[21] Draft Modeling Guidance for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and Regional Haze (PDF)(214 pp, 3.25 M) - December 2014. Available at: https://www3.epa.gov/ttn/scram/guidance/guide/Draft_O3-PM-RH_Modeling_Guidance-2014.pdf

[22] https://www3.epa.gov/ttn/scram/reports/2028_Regional_Haze_Modeling-TSD.pdf

2028 modeled data. At the direction of SESARM, these may be documented separately by VISTAS and non-VISTAS locations.

A technical memorandum/interim report describing the projections, methods, and results will be prepared for SESARM using the “Reports” requirement in Subtask 1.6 (Section 2.1.6).

Upon completion of this task, Alpine will work with ERG to develop procedures necessary to upload all future year regional haze visibility projections and supporting data on the website or dedicated FTP site to be developed in Task 10 (Section 2.10).

2.9.1 Subtask 9.1 – Calculating Relative Response Factors and Future Year Projections of Weekly Wet and Weekly Dry Deposition Species

Under this subtask, ERG will direct Alpine to calculate the RRFs and future year projections of weekly wet deposition and weekly dry deposition species. RRFs have become an integral part of the SIP process, as they are a useful tool in estimating the future year impacts of emission changes, while considering model performance. RRFs for each deposition site will be calculated consistent with EPA guidance for calculating RRFs for ozone and $PM_{2.5}$ species. Future year projections will be developed for each site by multiplying the RRF by monitored values. ERG and Alpine will consult with SESARM on the averaging time used for the development of the RRFs. At a minimum, Alpine will produce annual and maximum weekly RRFs and future projections to provide an estimate of annual and short-term loading changes.

2.10 Task 10 – Data Handling and Sharing

For Task 10, the ERG/Alpine team will develop and implement a solution for the distribution and archival of project assets (emissions and air quality modeling output, summaries, and other project documentation). ERG and Alpine will work with the SESARM to develop an effective data handling and sharing scheme. Alpine acted as the data librarian in the first VISTAS study, and ERG will do so for this study. At that time the most practical data sharing was conducted by mailing 300 gigabyte (GB) external hard drives to groups requesting large datasets. While the computer communications are much faster than they were in 2004, the size of the datasets has expanded.

While some groups have attempted to have fully internet-based transfer schemes, the study team’s experience is that for sharing the full CAMx model inputs and outputs it is still best to continue to ship external USB3 hard drives formatted with FAT32 or exFAT. A typical transfer of an annual CAMx platform takes approximately 18 terabytes (TB) of data. This can be facilitated by sending two 10 TB drives. If SESARM was to purchase 2 sets of drives for distribution, a set could be sent to the requesting group. After the group reads the drives, they are sent back to the librarian. Alternatively, the requesting group can send drives to the librarian, the librarian can copy the data onto the drive and send it back. The study team has had good success with low-cost dedicated Serial AT Attachment (SATA) duplication “docks” that can copy 10 TB drives in approximately 12 hours. External USB3 hard drives will be distributed by the data librarian per the procedure outlined in the QAPP.

The ERG/Alpine team will also consult with SESARM on using SharePoint to manage project asset distribution files among project stakeholders and the Metro 4/SESARM Drupal web site to publish project assets for public use. ERG has extensive experience using SharePoint for project collaboration across agencies and stakeholders. ERG has had a lot of success using

SharePoint, as it allows for collaborative editing, parallel review, and file exchange for multiple users. SharePoint will allow for the following project functions:

- A central web site to provide quick access to project assets and news for stakeholders.
- File exchange and storage. The Team will use folders within SharePoint to organize project assets.
- Access control. Using SharePoint user groups, ERG will customize permissions so only the right people have access to specific files and folders.
- Project asset distribution. SharePoint can be configured to send out notifications related to file publishing.
- Project asset archives. SharePoint uses version control and a recycle bin for file retention. Version control allows keeping previous versions of files as needed and the recycle bin provides a mechanism for restoring files when an entire site collection is deleted.

SharePoint can also provide additional features not specified in the RFP, such as:

- Collaboration in Word and Excel. SharePoint allows simultaneous editing of Word documents and Excel spreadsheets (including data summary files), and enables tracking of response to comments.
- A central tracking location. ERG can adapt the project schedules into a dashboard editable by SESARM and ERG, as appropriate.
- Responsively designed interface to allow access and collaboration regardless of device and operating system and a downloadable app for stakeholder review.

ERG can update the existing Metro 4/SESARM Drupal site (http://www.metro4-sesarm.org/) to distribute project asset files intended for public use. ERG will publish the public data to the emissions, modeling, and reports web pages leveraging the site's Drupal template to create a simple and intuitive mechanism for accessing project assets. ERG will work with SESARM to determine if an interim "shadow" website is to be developed first and then transferred to the existing SESARM website, or if ERG is to work with the existing website and SESARM webmaster.

ERG and Alpine will develop a Standard Operating Procedure (SOP) for uploading files to the SharePoint and Metro 4/SESARM Drupal sites. The SOP will address:

- File formats for all project asset types (e.g., model outputs).
- The review/approval process for publishing files and updates to the two sites.
- Routines for publishing the model outputs after each run is complete, allowing SESARM to review the results in a timely manner.
- Instructions for downloading the SharePoint content locally for offline access.

2.11 Task 11 – Other Potential Tasks (Currently Funded)

In Task 11, ERG will provide support to SESARM for additional work not included in the original RFP. Such support may include assisting the VISTAS states in developing regional haze SIPs. ERG and Alpine have supported a number of states in supporting SIP and similar-type efforts. Prior to the execution of the VISTAS Contract, SESARM requested two additional subtasks under Task 11.

2.11.1 Subtask 11.1 – Extract IC/BC for up to 5 States

Under this subtask, ERG will direct Alpine to extract initial conditions and boundary conditions (IC/BC) from the 2011 and 2028 VISTAS_12 CAMx simulations. Initially, up to 5 roughly state-sized CAMx domains will be extracted. SESARM may request extractions for up to an additional 5 states.

2.11.2 Subtask 11.2 – Extract of Meteorological Data for up to 5 States

Under this subtask, ERG will direct Alpine to extract meteorological data from the CAMx simulations. Initially, up to 5 roughly state-sized CAMx domains will be extracted. SESARM may request extractions for up to an additional 5 states. To assure that the meteorological data are accurately converted (windowed) from the EPA CONUS domain to the VISTAS 12km domains, the meteorological fields all the domains will be compared both graphically and by examining specific grid values.

3. Schedule of Deliverables

Table 3-1 presents the schedule of deliverables under the VISTAS Contract. The project end-date is July 1, 2019. The contract between ERG and SESARM allows for amendments when determined to be necessary and with agreement between the parties. The due dates specified in Table 3-1 are subject to this amendment process if needed.

Table 3-1. Project Deliverable Schedule

Task	Subtask	Deliverable	Due Date
1	1.3	Contract Management	Ongoing
	1.2	Contract Development	3/1/2018
	1.3	Draft Work Plan to SESARM	3/13/2018
	1.4	Draft QAPP to SESARM	3/15/2018
	1.5	Communications	Ongoing
	1.6a	Reporting – Progress Reports	Monthly, within 2 weeks after the end of the month
	1.6b	Reporting – Draft Interim Reports	Completion of subtasks or group of subtasks
	1.6c	Reporting – Final Interim Reports	Within 2 weeks of receiving comments
	1.6d	Reporting – Draft Final Report	5/8/2019
	1.6e	Reporting – Final Report	7/1/2019
	1.6f	Reporting – Presentation slides	Ongoing, as needed
	1.7	Invoicing	Monthly, within 2 weeks after the end of the month

Table 3-1. Project Deliverable Schedule

Task	Subtask	Deliverable	Due Date
2	2.1	2011 Base year emissions inventories	6/1/2018
	2.2a	Projection Year Emissions Inventory Comparisons, draft	5/18/2018
	2.2b	Projection Year Emissions Inventories, final	Within one week of receiving comments
	2.3a1	2028 EGU Point Source Emissions, draft	5/18/2018
	2.3a2	2028 EGU Point Source Emissions, final	Within one week of receiving comments
	2.3b1	2028 Non-EGU Point Source Emissions, draft	5/18/2018
	2.3b2	2028 Non-EGU Point Source Emissions, final	Within one week of receiving comments
	2.3c1	2028 Emissions for Other Categories, draft	5/18/2018
	2.3c2	2028 Emissions for Other Categories, final	Within one week of receiving comments
	2.3d1	Emission Comparisons from 2028v6.3el and 2023v6.3en, draft	5/18/2018
	2.3d2	Emission Comparisons from 2028v6.3el and 2023v6.3en, final	Within one week of receiving comments
	2.3e1	2028 Documentation, draft	5/18/2018
	2.3e2	2028 Documentation, final	Within one week of receiving comments
	2.4	Emissions summaries and Quality Assurance	6/1/2018
3	3.1	Create Photochemical Model-Ready EGU emissions files for 2028	7/1/2018
	3.1.1*	Full EGU emissions replacement (will not be done)	Not Applicable
	3.1.2	Scale Hourly EGU SMOKE emissions to match annual 2028 (selected)	7/1/2018
	3.2	Create Photochemical Model-Ready Non-EGU emissions files for 2028	7/1/2018
	3.3a	Merge EGU/non-EGU data from Subtasks 3.1 and 3.2 for CAMx Model	7/1/2018
	3.3b*	Merge area/MAR data from Subtasks 3.1 and 3.2 for CAMx Model	7/1/2018
4	4	Data acquisition and preparation	6/1/2018
	4.1	Acid deposition in watersheds	6/1/2018
5	5	Area of Influence Analysis	9/1/2018
	5.1*	SO_2 and NO_x emissions contribution rankings	No later than 9/1/2018
6	6.1a	Modeling protocol, draft	5/2/2018
	6.1b	Modeling protocol, final	Within 2 weeks of receiving comments
	6.2	2011 base year air quality modeling	9/1/2018
	6.3	2028 projection year air quality modeling	12/1/2018
7	7	Source apportionment tagging - 250 tags (final number to be determined)	4/1/2019
8	8	Model performance evaluation	10/1/2018
	8.1	Model performance evaluation (related to Subtask 4.1)	10/1/2018

Table 3-1. Project Deliverable Schedule

Task	Subtask	Deliverable	Due Date
9	9a	Future-year model projections – 250 tags (final number to be determined)	4/19/2019 [23]
	9.1	Calculate Relative Response Factors (related to Subtask 4.1)	5/3/2019
10	10	Website/FTP Site Development; Data Transfer and Archival	Ongoing
	11.1a	Extraction of state-specific modeling initial conditions/boundary conditions (5 states)	Within 1 week after completion of Task 6.1 and 6.2 activities
11	11.1b*	Additional extraction of state-specific modeling initial conditions/boundary conditions (5 states)	Within 1 week after completion of Task 6.1 and 6.2 activities
	11.2a	Extraction of state-specific meteorological files (5 states)	Within 1 week after regions are defined by the time the meteorological data is windowed for the VISTAS_12 domain
	11.2b*	Additional extraction of state-specific meteorological files (5 states)	Within 1 week after regions are defined by the time the meteorological data is windowed for the VISTAS_12 domain

* Optional Task, No decision yet whether to perform it.

4. TASK ORGANIZATION OF KEY PERSONNEL

Table 4-1 presents the distribution of personnel by task.

Mr. Regi Oommen will serve as the ERG Program Manager and Technical Project Coordinator for this work ensuring that ERG's contractual obligations are met. He will be responsible for all management and administrative aspects of the work, including ensuring that the quality of the work, schedule, and budget meet the requirements of the VISTAS Contract. Regi will be supported by **Ms. Darcy Wilson**, who will serve as the Deputy Program Manager and QA Coordinator. Regi will also lead the work conducted under Tasks 1 (Section 2.1), 2 (Section 2.2), and 11 (Section 2.11) and will work in coordination with **Ms. Bebhinn Do** to support Tasks 4 (Section 2.4) and 5 (Section 2.5), and with **Mr. Adam Langmaid** to support Task 10 (Section 2.10). The ERG task managers will be supported by Jeanette Alvis, Richard Billings, Lindsay Dayton, Allison DenBleyker, Stacie Enoch, Karla Faught, Jaime Hauser, Noel Hilliard, Steve Mendenhall, Courtney Myers, Heather Perez, Jennifer Sellers, Paula Fields-Simms, Jody Tisano, and Marty Wolf.

[23] Please note that this date conflicts with Table 3 of the VISTAS Contract as executed but is consistent with ERG's proposal. SESARM and ERG affirm that 4/19/2019 is the correct date and commit to correct the error formally via an amendment or other means consistent with the VISTAS Contract at a later date but before 4/1/2019.

Mr. Gregory Stella will serve as the Alpine Project Manager for this work ensuring that Alpine's contractual obligations are met. He will be responsible for all management and administrative aspects of the subcontracted work, including ensuring that the quality of the work, schedule, and budget meets the requirements of the subcontract. Greg will also lead Tasks 3 (Section 2.3), 8 (Section 2.8), and 9 (Section 2.9), and will work in coordination with **Mr. Dennis McNally** to support Tasks 6 (Section 2.6) and 7 (Section 2.7). Greg and Dennis will be supported by Cynthia Loomis.

Table 4-1. Distribution of Personnel by Task for SESARM Contract V-2018-03-01

Personnel	Role	P-Level	Task											
			1	2	3	4	5	6	7	8	9	10	11	Total Hours
ERG Hours														
Regi Oommen	Program Manager/Task Lead	4	109	37	8	8	10	6	2	7	6	15	0	208
Darcy Wilson	Deputy Program Manager/QA	4	34	8	0	0	0	0	0	0	0	0	0	42
Jeanette Alvis	QAPP Support	4	16	0	0	0	0	0	0	0	0	0	0	16
Richard Billings	Emission Inventory Support	4	0	8	6	0	0	0	0	0	0	0	0	14
Lindsay Dayton	GIS Support	1	0	0	0	6	19	0	0	10	10	0	0	45
Allison DenBleyker	Emission Inventory Support	2	0	0	2	0	0	0	0	0	0	0	0	2
Bebhinn Do	Task Lead	3	84	52	12	19	36	6	2	14	12	15	0	252
Stacie Enoch	Emission Inventory Support	3	6	39	0	0	0	0	0	0	0	0	0	45
Karla Faught	Ambient Monitoring Support	2	0	0	0	24	56	0	0	0	0	0	0	80
Paula Fields-Simms	Emission Inventory Support	4	0	8	10	1	0	0	0	0	0	0	0	19
Jaime Hauser	Ambient Monitoring Support	3	0	0	0	7	0	0	0	0	0	0	0	7
Noel Hilliard	GIS Support	1	0	0	0	6	18	0	0	10	10	0	0	44
Adam Langmaid	Task 10 Lead	3	0	0	0	0	0	0	0	0	0	55	0	55
Steve Mendenhall	Database Support	4	0	20	0	4	6	0	0	0	0	0	0	30
Courtney Myers	Website Support	3	0	0	0	0	0	0	0	0	0	45	0	45
Heather Perez	GIS Support	4	25	2	2	0	8	0	0	0	0	0	0	37
Jennifer Sellers	Emission Inventory Support	2	0	0	2	0	0	0	0	0	0	0	0	2
Jody Tisano	Clerical Support	1	44	8	0	0	4	0	0	0	0	0	0	56
Marty Wolf	Emission Inventory Support	4	0	14	8	0	0	0	0	0	0	0	0	22
Alpine Hours														
Gregory Stella	Subcontract Manager/Task Lead	4	50	18	66	2	10	20	82	70	84	6	2	410
Cynthia Loomis	Modeling Support	4	4	0	68	0	0	0	0	2	0	0	2	76
Dennis McNally	Task Lead	4	12	0	8	2	4	120	220	10	24	6	20	426
Total Hours			**384**	**214**	**192**	**79**	**171**	**152**	**306**	**123**	**146**	**142**	**24**	**1,933**

Task 1 – Project Management
Task 2 – Emission Inventory Development
Task 3 – Emissions Processing
Task 4 – Data Acquisition and Preparation
Task 5 – Area of Influence Analysis
Task 6 – Air Quality Modeling
Task 7 – Source Apportionment Tagging
Task 8 – Model Performance Evaluation
Task 9 – Future Year Model Projections
Task 10 – Data Handling and Sharing
Task 11 – Other Potential Tasks

5. QUALITY CONTROL

ERG's corporate quality management system is detailed in the *Quality Management Plan*, dated December 2015. This QMP was prepared in accordance with *EPA Requirements for Quality Management Plans (QA/R-2)* [dated 03/20/01]. It details the responsibilities of the QA coordinators and Project Management Team and describes procedures used to plan, implement, and assess project quality. These procedures, tailored to the needs of the tasked activities, will be used on this project. An overview of the procedures ERG will use to ensure the quality of work on this project is set out in this section.

ERG has an established internal quality control review procedure for project deliverables (technical memoranda, calculations, etc.). The levels of review required for various types of deliverables anticipated on this project. All tasks conducted and products generated receive (1) a conceptual review, (2) a developmental review, and (3) a final product review.

A *conceptual review* is performed during the initial stages of work development and ensures that the final product and associated documentation address the needs set forth by the SESARM APC and the Tasks. Conceptual review will be provided by the ERG Program Manager and Technical Project Coordinator as well as senior engineers knowledgeable in the technical aspects of the work, but not directly involved in the task work under the Contract. The quality of intermediate deliverables and final products is also evaluated as these work products evolve. This *developmental review* includes (1) a check on calculations and data and (2) a review of draft documents to ensure that the direction of work is consistent with the conceptual review outline. *Final product review* is conducted on all deliverables prior to delivery to SESARM.

The draft QAPP was submitted to SESARM on March 15, 2018. Work on Tasks 2 (Section 2.2) through 11 (Section 2.11) will commence upon approval of the QAPP, subject to written authorization on a task-by-task basis from SESARM to ERG.