District of Columbia Regional Haze State Implementation Plan

Submitted to:

U.S. Environmental Protection Agency, Region 3

Prepared by:

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The District Department of the Environmental acknowledges
the Mid-Atlantic Visibility Union (MANE-VU),
Mid-Atlantic Regional Air Management Association (MARAMA),
Northeast States for Coordinated Air Use Management (NESCAUM),
all of the other MANE-VU states, as well as Federal counterparts at the
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of this State Implementation Plan.

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ACRONYMS AND ABBREVIATIONS

BART	Best Available Retrofit Technology
BEIS	Biogenic Emission Inventory System
BOTW	Beyond On the Way
CAIR	Clean Air Interstate Rule
CALMET	CALPUFF meteorological wind field pre-processor
CALPUFF	California Puff Model
CAMR	Clean Air Mercury Rule
CAP	Cooperative Agency Profilers
CASTNET	Clean Air Status Trends Network
CEED	*Center for Energy and Economic Development v. EPA*
CEM	Continuous Emissions Monitoring
CERR	Consolidated Emissions Reporting Rule
CFR	Code of Federal Regulations
CMAQ	Community Multiscale Air Quality
CMAS	Community Modeling and Analysis System
D.C.	District of Columbia
EGU	Electric Generating Unit
EKPC	East Kentucky Power Cooperative
EPA	Environmental Protection Agency
FGD	Flue Gas Desulfurization
FLM	Federal Land Manager
GCVTC	Grand Canyon Visibility Transport Commission
GEOS	Goddard Earth Observing System
HAP	Hazardous Air Pollutant
ICI	Industrial, Commercial, and Institutional
IMPROVE	Interagency Monitoring of Protected Visual Environments
IPM	Integrated Planning Model
kW	Kilowatts
LSD	Low Sulfur Diesel
MACT	Maximum Achievable Control Technology
MANE-VU	Mid-Atlantic and Northeast Visibility Union
MARAMA	Mid-Atlantic Regional Air Management Association
MDE	Maryland Department of the Environment
MM5	NCAR 5th Generation Mesoscale Model
MRPO	Midwest RPO
NCAR	National Center for Atmospheric Research
NESCAUM	Northeast States for Coordinated Air Use Management
NEI	National Emissions Inventory
NET	National Emissions Trends
NH_3	Ammonia (NH_3)
NIF	NEI Input Format
NJDEP	New Jersey Department of Environmental Protection
NMHC	Non-Methane Hydrocarbons
NP	National Park
NSPS	New Source Performance Standards
NTI	National Toxics Inventory
NWS	National Weather Service
NYSDEC	New York State Department of Conservation
OTB	On the books
OTB/W	On the books/On the way
OTC	Ozone Transport Commission
OTR	Ozone Transport Region
OTW	On the way

PAG	Policy Advisory Group
PES	Pepco Energy Services, Inc.
PJM	PJM Interconnection, LLC
PM_{10}	Particles with an aerodynamic diameter less than or equal to 10 µm
$PM_{2.5}$	Particles with an aerodynamic diameter less than or equal to 2.5 µm
PPR	Potomac Power Resources, LLC
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
RACT	Reasonably Available Control Technology
REMSAD	Regional Model for Aerosols and Deposition
RPG	Reasonable Progress Goals
RPO	Regional Planning Organization
RWC	Residential Wood Combustion
SCC	Source Category Code
SCR	Selective Catalytic Reduction
SIP	State Implementation Plan
SMOKE	Sparse Matrix Operator Kernel Emissions
SO_2	Sulfur Dioxide (SO_2)
SOA	Secondary Organic Aerosols
TPY	Tons Per Year
TSC	Technical Support Committee
UMD	University of Maryland
U.S.	United States
USC	United States Code
VADEQ	Virginia Department of Environmental Quality
VEPCO	Virginia Electric and Power Company
VISTAS	Visibility Improvement State and Tribal Association of the Southeast
VOC	Volatile Organic Compounds (VOC)
VTDEC	Vermont Department of Environmental Conservation
WRAP	Western Regional Air Partnership

1. Background

1.1. General Description of Regional Haze

Good Visibility – viewing the scenery through clean, fresh air – is one of the most important attributes of national parks and wilderness areas. This plan addresses visibility impairment at key national parks and wilderness areas caused by the emission of air pollutants from numerous sources located over a wide geographic area, otherwise known as regional haze.

Regional haze in the Eastern United States is caused primarily by anthropogenic (manmade) pollutants but can also be influenced by a number of natural phenomena, including forest fires, dust, storms, and sea spray. The optical effects of these pollutants and natural substances result from the scattering and absorption of light by particles and gasses. The scattering of light by fine particles (those less than 2.5 microns in diameter) is the predominant contributor at most times and places.

Some haze-causing particles are emitted directly to the atmosphere by primary sources of particle emission such as electric power plants, factories, automobiles, construction activities, and agricultural burning. Others occur when gases emitted into the air (particle precursors) interact to form secondary particles. Some secondary particles including sulfate and nitrate compounds are hygroscopic, and will grow in size and scatter more light as relative humidity increases.

Fine particles formed from multiple primary and secondary sources can mix together over broad geographic areas and can be transported hundreds or thousands of miles. Consequently, regional haze occurs in every part of the nation.

1.2. The Clean Air Act Goal and the Federal Regional Haze Rule

In amending the Clean Air Act in 1977, Congress added Section 169A (42 U.S.C. 7491) setting forth the following national visibility goal:

> *Congress hereby declares as a national goal the prevention of any future, and the remedying of any existing, impairment of visibility in mandatory Class I Federal areas which impairment results from man-made air pollution.*

Class I Federal Areas are:

- International parks;
- National wilderness areas which exceed 5,000 acres in size;
- National memorial parks which exceed 5,000 acres in size; and
- National parks which exceed 6,000 acres in size.

Class I areas near the District of Columbia are shown in Figure 1.1.

Figure 1.1. Class I Areas Within 300 km of the District of Columbia

Source: Draft BART analysis prepared by ENSR/AECOM for PEPCO Energy Systems (October 2008)

Note that Shenandoah National Park in Virginia is the closest Class I area to the District, and that the next closest areas are the Brigantine Wilderness area in New Jersey, the Dolly Sods and Otter Creek Wilderness Areas in West Virginia, and the James River Face Wilderness in Virginia. The Federal Land Management (FLM) agencies responsible for protecting these areas are the National Park Service and the U.S. Fish and Wildlife Service (both of the U.S. Department of Interior), and the U.S. Forest Service (U.S. Department of Agriculture).

When Congress amended the Clean Air Act in 1990, they added Section 169B (42 USC 7492), authorizing further visibility research and periodic assessments of the progress made toward improving visibility in Class I areas. Based on the results of research conducted in the 1990s, and to implement the Clean Air Act visibility goal, EPA adopted the Regional Haze Rule (64 FR 35714) on July 1, 1999, and the rule went into effect on August 30, 1999. This rule seeks to address the combined visibility effects of various pollution sources over a wide geographic region. This wide-reaching rule requires many states – even those without Class I Areas – to participate in haze reduction efforts.

The following points summarize key requirements of the Regional Haze Rule:

- States with Class I areas must establish "reasonable progress goals" for visibility improvement and monitor air quality at Class I areas to determine whether visibility is meeting these goals.
- States with emissions sources impacting visibility in Class I areas must collaborate with the Class I state to formulate a long-term strategy for meeting the reasonable progress goals.
- States must adopt measures to ensure that certain large sources placed into operation between 1962 and 1977 use the Best Available Retrofit Technology (BART).
- States must adopt a State Implementation Plan (SIP) to formalize measures they have taken to meet the requirements of the Regional Haze Rule, and this plan must be provided to Federal Land Managers and the public for review and then submitted to the U.S. Environmental Protection Agency (EPA) for approval.
- States must review their plans every five years to determine whether the goals previously set are still reasonable, whether reasonable measures have been implemented to meet those goals, and what measures will be implemented in the next five to ten years.

On May 24, 2002, the U.S. Court of Appeals, D.C. District Court ruled on the challenge brought by the American Corn Growers Association against EPA's Regional Haze Rule of 1999. The Court remanded to EPA the BART provisions of the rule, and denied industry's challenge to the rule's goals of natural visibility and no degradation requirements.

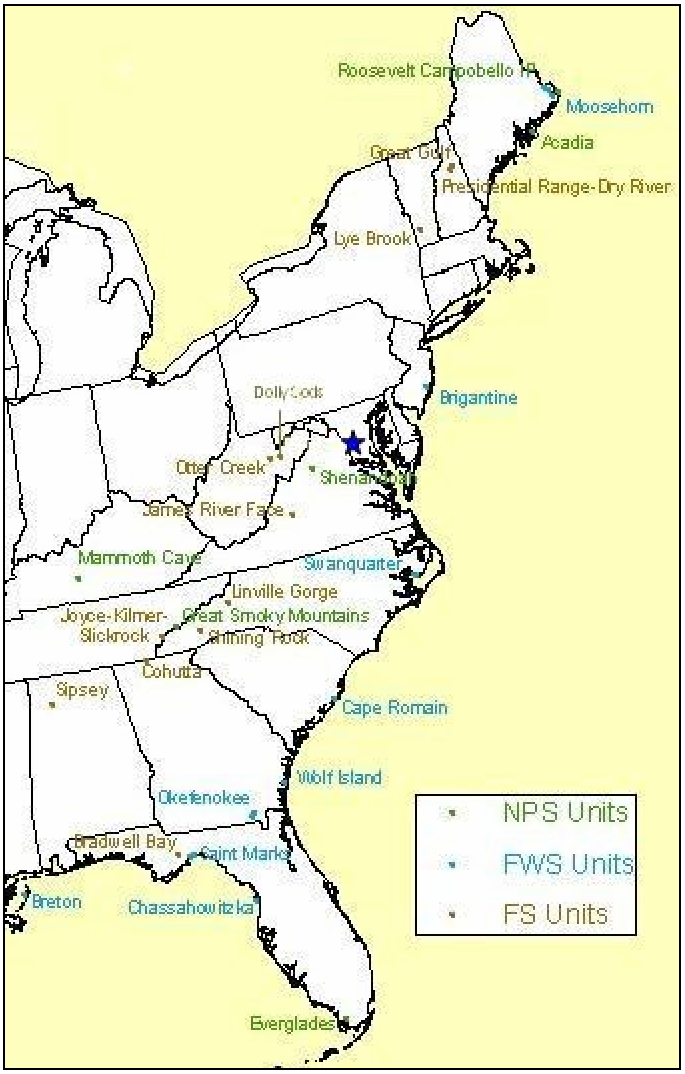
On February 18, 2005, the U.S. Court of Appeals, D.C. District Court issued another ruling vacating the Regional Haze Rule in part and sustaining it in part. For more information, see *Center for Energy and Economic Development v. EPA*, no. 03-1222, (D.C. Cir. Feb. 18, 2005) ("*CEED v. EPA*"). In this case, the court granted a petition challenging provisions that governed the optional emissions trading program for certain Western States and Tribes (the WRAP Annex Rule).

On July 6, 2005, EPA addressed the court's remand and published amendments to the rule and BART guidelines. The final rulemaking provided the following changes to the Regional Haze Rule:

1. Revised the regulatory text in Section 51.308(e)(2)(i) in response to the *CEED* court's remand, to remove the requirement that the determination of a BART "benchmark" be based on cumulative visibility analyses, and to clarify the process for making such determinations, including the application of BART presumptions for EGUs as contained in Appendix Y to 40 CFR 51;
2. Added new regulatory text in Section 51.308(e)(2)(vi), to provide minimum elements for cap and trade programs in lieu of BART; and
3. Revised regulatory text in Section 51.309, to reconcile the optional framework for certain Western States and Tribes to implement the recommendations of the Grand Canyon Visibility Transport Commission (GCVTC) with the *CEED* decision.

The regional strategies implemented to improve visibility in Class I areas will also benefit visibility outside these areas and may help address other air quality problems as well, particularly high concentrations of fine particles.

Figure 1.2. Class I Areas in the MANE-VU and VISTAS Regions, In Relation to the District



Source: Based on National Park Service map of "Mandatory Class I Areas" (updated 3/16/2006, accessed in 2010 at http://www.nature.nps.gov/air/maps/images/ClassIAreas.jpg)

2. State Implementation Plan Requirements

Pursuant to the requirements of 40 CFR 51.308(a) and (b), the District of Columbia prepared this SIP to meet the requirements of EPA's Regional Haze Rule. Elements of this Plan address the Core Requirements pursuant to 40 CFR 51.308(d) and the Best Available Retrofit Technology (BART) components of 40 CFR 51.308(e).

In addition, this SIP addresses requirements for Regional Planning and State/Tribe and Federal Land Manager coordination and consultation.

Title 40 CFR 51.308(f) requires the District to submit periodic revisions to its Regional Haze SIP by July 31, 2018, and every ten years thereafter. The District acknowledges and will comply with this schedule.

Title 40 CFR 51.308(g) requires the District to submit a report to EPA every five years that evaluates progress toward the reasonable progress goals for each mandatory Class I area located outside the State that may be affected by emissions from within the State. The District will use the five-year review to look at where the District is in terms of emissions projections within five years of submittal of this initial plan.

Pursuant to 40 CFR 51.308(d)(4)(v), the District will make periodic updates to its emissions inventory. The District proposes to complete these updates to coincide with the EPA requirements for periodic emission inventories.

Pursuant to 40 CFR 51.308(h), the District will submit a determination of adequacy of its Regional Haze SIP whenever a progress report is submitted. Depending on the findings of its five-year review, the District will take one or more of the following actions at that time, whichever actions are appropriate or necessary:

- If the District determines that the existing SIP requires no further substantive revision in order to achieve established goals for visibility improvement and emissions reductions, the District will provide to the EPA a negative declaration that further revision of the plan is not needed.
- If the District determines that the SIP is or may be inadequate to ensure reasonable progress due to emissions from sources within the District, the District will revise its SIP to address the deficiencies within one year from the determination, allowing the FLMs and the public to review how the District plans to meet emissions projections.

There are several sections of the Regional Haze Rule that establish requirements applicable only to states containing Class I areas. The following is a list of requirements of the Regional Haze Rule that do not pertain to the District, since the District has no Class I areas, as well as a brief discussion of some of those requirements:

- **Monitoring**: The District of Columbia does not contain any Class I Areas; therefore no monitoring strategy for measuring, characterizing, and reporting regional haze visibility impairment within the District into the future is required under 40 CFR Section 51.308(d)(4) of EPA's Regional Haze Rule.

Class I areas outside the District have monitors to track visibility trends. A nation-wide visibility monitoring network was established under the Interagency Monitoring of Protected Visual Environments (IMPROVE) program in 1985 to track current visibility conditions, changes in visibility, and help determine the causes of visibility impairment in Class I Areas. The IMPROVE Steering Committee provides national oversight for the IMPROVE network and establishes protocols for monitoring techniques and data analysis. Section 5 of this SIP explains how the District will use data from the IMPROVE network to help assess progress in visibility improvement.

- **Determining baseline and natural visibility conditions**: Baseline visibility is the average visibility during the five-year period from 2000 to 2004. Natural conditions represent an estimate of the visibility that would be present in Class I areas in the absence of human-caused pollution. Under 40 CFR 51.308(d)(2), each state containing a Class I area must determine baseline and natural visibility conditions for its Class I area(s). Comparing baseline conditions to natural visibility conditions determines a rate of improvement called the uniform rate of progress, which must be considered as states set reasonable progress goals for each Class I area.

  The District contains no Class I areas and therefore is not required to determine baseline and natural conditions for any Class I areas. However, as described in Section 10.9, the District reviewed information developed by states with Class I areas.

- **Establishing reasonable progress goals:** Since there are no Class I areas within the District of Columbia, the District is not required to establish reasonable progress goals for any Class I areas. Under 40 CFR Section 51.308 (d)(1)(iv), as they establish reasonable progress goals, states with Class I areas must consult with other states reasonably anticipated to cause or contribute to regional haze in those Class I areas. Section 8 of this SIP describes the District's consultation with Class I states potentially affected by emissions from within the District.

- **Notification if SIP is inadequate due to transport:** If a Class I state determines that its SIP is or may be inadequate to ensure reasonable progress as a result of emissions from sources in other states which participated in the regional planning process, the state is required to provide notification to EPA and to those other states.

  If a Class I state determines that its implementation plan is or may be inadequate to ensure reasonable progress as a result of emissions from sources in another country, such as Canada, the state is required to provide notification and available information to EPA.

  The District will collaborate with the other states through the regional planning process for the purpose of developing additional strategies to address any such deficiencies in the District's SIP.

3. Regional Planning and Consultation

3.1. Participation in Regional Planning Organization

Sections 51.308(d)(1) and (3) of EPA's Regional Haze Rule, on development of reasonable progress goals and development of a long-term strategy, require interstate consultation. In the preamble to the Regional Haze Rule, published in the Federal Register on July 1, 1999, EPA strongly encourages states to participate in a regional planning process as they prepare their Regional Haze SIPs.

In 1999, EPA and affected states and tribes agreed to create five Regional Planning Organizations (RPOs) to facilitate interstate coordination on Regional Haze SIPs. The District of Columbia is a member of the Mid-Atlantic and Northeast Visibility Union (MANE-VU) RPO. Members of MANE-VU are listed in Table 3.1. A copy of MANE-VU's *Final Interim Principles for Regional Planning* can be found in Appendix A.

Table 3.1. MANE-VU Members

Connecticut	Pennsylvania
Delaware	Penobscot Nation
District of Columbia	Rhode Island
Maine	St. Regis Mohawk Tribe
Maryland	Vermont
Massachusetts	U.S. Environmental Protection Agency*
New Hampshire	U.S. National Park Service*
New Jersey	U.S. Fish and Wildlife Service*
New York	U.S. Forest Service*

*Non-voting members

This SIP relies on data analysis, modeling results and other technical support documents prepared for MANE-VU members. By coordinating with MANE-VU and other RPOs, the District of Columbia has worked to ensure that its long-term strategy (see Section 10) and BART determinations (see Section 9) provide sufficient reductions to mitigate impacts of sources from the District of Columbia on affected Class I areas.

Information and a description of consultation with other states are available later in this section, and information and a description of consultation with Federal Land Managers is available in Section 3.4 of this SIP.

Since its inception on July 24, 2001, MANE-VU maintained an active committee structure to address both technical and non-technical issues related to regional haze. The Technical Support Committee (TSC) is charged with assessing the nature and magnitude of the regional haze problem within MANE-VU, interpreting the results of technical work, and reporting on such work to the MANE-VU Board. The TSC evolved to function as a valuable sounding board for all the technical projects and processes of MANE-VU. The TSC established a process to ensure that important regional haze-related projects were completed in a timely fashion, and members were kept informed of all MANE-VU tasks and duties. There were three standing working groups of the TSC: the Emissions Inventory, Modeling, and Monitoring/Data Analysis Workgroups.

The Communications Committee oversaw the development of MANE-VU's newsletter and outreach tools both for stakeholders and the public regarding regional issues among MANE-VU's membership. The Communications Committee is charged with developing approaches to inform the public about the regional haze problem in the region and making any recommendations to the MANE-VU Board to facilitate that goal. Ultimately, policy decisions are made by the MANE-VU Board.

MANE-VU also established a Policy Advisory Group (PAG) to provide advice to decision-makers on policy questions. FLMs, EPA, states, and tribes were represented on the PAG. It met on an as needed basis.

MANE-VU's work is managed by the Ozone Transport Commission (OTC) and also carried out by OTC, the Mid-Atlantic Regional Air Management Association (MARAMA), and the Northeast States for Coordinated Air Use Management (NESCAUM). The states, along with Federal agencies and professional staff from OTC, MARAMA, and NESCAUM are members of the various committees and workgroups.

The following points highlight many of the ways the District and other MANE-VU member states and tribes have cooperatively addressed regional haze:

- Issue Coordination: MANE-VU established a conference call and meeting schedule for each of its committees and workgroups. In addition, MANE-VU Directors regularly discuss pertinent issues.
- SIP Policy and Planning: MANE-VU states/tribes collaborated on the development of a SIP Template. MANE-VU members also agreed on an approach to setting reasonable progress goals and considering measures to ensure long-term progress in improving visibility.
- Capacity Building: To educate its staff and members, MANE-VU offered technical presentations on conference calls and organized workshops with nationally recognized experts. Presentations on data analysis, BART work, inventory topics, modeling, control measures, and the like were an effective education and coordination tool.
- Routine Operations: MANE-VU staff at OTC, MARAMA, and NESCAUM established a coordinated approach to budget, grant deliverables and due-dates, workgroup meetings, inter-RPO feedback, etc.

The District of Columbia participated in reviewing work conducted by MANE-VU and developing a long-range strategy for reducing haze at MANE-VU Class I areas. The District has utilized MANE-VU work products in preparing this SIP, and is committed to following the MANE-VU modeling and RPO recommendations included throughout this SIP.

3.2. Consultation Framework

The Regional Haze Rule at 40 CFR Section 51.308(d)(3)(i) requires the District to consult with other States/Tribes to develop coordinated emission management strategies. This requirement applies both where emissions from the State/Tribe are reasonably anticipated to contribute to visibility impairment in Class I areas outside the State/Tribe, and when emissions from other States/Tribes are reasonably anticipated to contribute to visibility impairment in Class I areas within the State/Tribe.

The District consulted with other states/tribes by participation in the MANE-VU and through MANE-VU's consultation with other RPOs.

On May 10, 2006, MANE-VU adopted the *Inter-RPO State/Tribal and FLM Consultation Framework* (Appendix B). That document set forth the following principles:

1. All State, Tribal, RPO, and Federal participants are committed to continuing dialogue and information sharing in order to create understanding of the respective concerns and needs of the parties.
2. Continuous documentation of all communications is necessary to develop a record for inclusion in the SIP submittal to EPA.
3. States alone have the authority to undertake specific measures under their SIP. This inter-RPO framework is designed solely to facilitate needed communication, coordination and cooperation among jurisdictions but does not establish binding obligation on the part of participating agencies.
4. There are two areas which require State-to-State and/or State-to-Tribal consultations ("formal" consultations): (i) development of the reasonable progress goal for a Class I area, and (ii) development of long-term strategies. While it is anticipated that the formal consultation will cover the technical components that make up each of these policy decision areas, there may be a need for the RPOs, in coordination with their State and Tribal members, to have informal consultations on these technical considerations.
5. During both the formal and informal inter-RPO consultations, it is anticipated that the States and Tribes will work collectively to facilitate the consultation process through their respective RPOs, when feasible.
6. Technical analyses will be transparent, when possible, and will reflect the most up-to-date information and best scientific methods for the decision needed within the resources available.
7. The State with the Class I area retains the responsibility to establish reasonable progress goals. The RPOs will make reasonable efforts to facilitate the development of a consensus between the State with a Class I area and other States affecting that area. In instances where the State with the Class I area cannot agree with such other States that the goal provides for reasonable progress, actions taken to resolve the disagreement must be included in the State's regional haze implementation plan (or plan revisions) submitted to the EPA Administrator as required under 40 CFR Section 51.308(d)(1)(iv).
8. All States whose emissions are reasonably anticipated to contribute to visibility impairment in a Class I area, must provide the Federal Land Manager ("FLM") agency for that Class I area with an opportunity for consultation, in person, on their regional haze

implementation plans. The States/Tribes will pursue the development of a memorandum of understanding to expedite the submission and consideration of the FLMs' comments on the reasonable progress goals and related implementation plans. As required under 40 CFR Section 51.308(i)(3), the plan or plan revision must include a description of how the State addressed any FLM comments.

9. States/Tribes will consult with the affected FLMs to protect the air resources of the State/Tribe and Class I areas in accordance with the FLM coordination requirements specified in 40 CFR Section 51.308(i) and other consultation procedures developed by consensus.
10. The consultation process is designed to share information, define and document issues, develop a range of options, solicit feedback on options, develop consensus advice if possible, and facilitate informed decisions by the Class I States.
11. The collaborators, including States, Tribes and affected FLMs, will promptly respond to other RPOs'/States'/Tribes' requests for comments.

The document also describes a process primarily applicable to formal consultation with states in other RPOs concerning Regional Haze SIP elements. Although other RPOs, such as the Visibility Improvement State and Tribal Association of the Southeast (VISTAS), did not formally adopt the same process, in general, the process was followed and provided significant opportunities for consultation concerning the long-term strategy as well as reasonable progress goals.

3.3. Consultation with Other States

Because of long-range transport of fine particulate matter, emissions from within the District have the potential to affect visibility in Class I areas hundreds of kilometers away. However, because the emissions from sources in the District are a small part of regional emissions, the impacts of these emissions are also relatively small. Section 7 of this SIP reviews the District's contribution to visibility impairment in Class I areas.

3.3.1. States Notifying the District of Contribution to Haze

New Jersey requested the District's participation as a member of MANE-VU in the development of a regional long-term strategy to improve visibility at its Class I area, the Brigantine Wilderness (Appendix V). According to Section 7.7 of New Jersey's September 5, 2008, proposed Regional Haze SIP:

> *New Jersey does not expect that states that were identified because they were MANE-VU members, and did not meet the criteria for contribution of greater than 0.1 ug/m^3 or greater than two percent sulfate contribution to the Brigantine Wilderness Area, will need to document in their Regional Haze Plan that they have obtained their share of emission reductions necessary to reach the first progress goal for the Brigantine Wilderness Area, unless any of the top 167 EGU stacks is located in the states. Rather, New Jersey would like to see these MANE-VU members, not identified as contributing to meet the 2018 reasonable progress goal, propose and adopt through their administrative processes the agreed upon Reasonable Measures.*

Based on Table 3.2, the District did not contribute greater than 0.1 ug/m^3 or greater than two percent sulfate contribution to the Brigantine Wilderness Area, nor does it contain any of the top 167 EGU stacks (see Figure 10.1). The District has agreed to pursue agreed upon measures, as addressed in Section 10.6.

In a letter dated April 4, 2007, New Hampshire also asked the District to join in the consultative process to develop a collective solution to regional haze in New Hampshire (Appendix V). New Hampshire has two Class I areas: Great Gulf Wilderness and the Presidential Range-Dry River Wilderness.

No other states have informed the District that its emissions contribute to visibility impairment in their Class I areas. As Figure 1.1 indicates, the District is within 300 km of Shenandoah National Park and James River Face Wilderness, both Class I areas in Virginia, and Dolly Sods Wilderness and Otter Creek Wilderness, both Class I areas in West Virginia. Both Virginia and West Virginia are members of the VISTAS RPO, and the District participated in MANE-VU's consultation with VISTAS states, including Virginia and West Virginia. Shenandoah National Park (Virginia) and Dolly Sods Wilderness Area (West Virginia) were included in MANE-VU's technical analysis of emissions contributing to regional haze, and the District's contributions to both these areas (as well as areas within MANE-VU) are summarized in Section 7.

3.3.2. MANE-VU Consultation Area

For the maximum protection of visibility at Class I areas, MANE-VU concluded that it was appropriate to consult with all of its participating states, as well as with states outside of MANE-VU that contributed at least two percent of the sulfate ion to its Class I areas in 2002. Table 3.2 lists states included in the MANE-VU consultation area.

This selection of states was made for purposes of consultation and does not necessarily indicate a substantial impact on all MANE-VU Class I areas. Note that several of the MANE-VU states, including the District of Columbia, have impacts on these Class I areas that are below the two percent threshold – that is, their impacts on any Class I areas are insignificant according to this measure. These states and the District were included in the consultation area because they are MANE-VU members.

Table 3.2. States included in the MANE-VU Consultation Area

State	RPO	Class I Areas receiving Impacts of 2% or More from Listed State
Connecticut	MANE-VU	None
Delaware	MANE-VU	Brigantine
District of Columbia	**MANE-VU**	**None**
Maine	MANE-VU	Acadia, Great Gulf, Moosehorn
Maryland	MANE-VU	Acadia, Brigantine, Dolly Sods, Lye Brook, Shenandoah
Massachusetts	MANE-VU	Acadia, Brigantine, Great Gulf, Lye Brook, Moosehorn
New Hampshire	MANE-VU	Acadia, Great Gulf
New Jersey	MANE-VU	Brigantine
New York	MANE-VU	Acadia, Brigantine, Great Gulf, Lye Brook, Moosehorn, Shenandoah
Pennsylvania	MANE-VU	Acadia, Brigantine, Dolly Sods, Great Gulf, Lye Brook, Moosehorn, Shenandoah
Rhode Island	MANE-VU	None
Vermont	MANE-VU	None
Georgia	VISTAS	Brigantine, Dolly Sods, Shenandoah
Kentucky	VISTAS	Brigantine, Dolly Sods, Lye Brook, Shenandoah
North Carolina	VISTAS	Brigantine, Dolly Sods, Shenandoah
Tennessee	VISTAS	Dolly Sods, Shenandoah
Virginia	VISTAS	Brigantine, Dolly Sods, Shenandoah
West Virginia	VISTAS	Acadia, Brigantine, Dolly Sods, Great Gulf, Lye Brook, Shenandoah
Illinois	MRPO	Dolly Sods, Great Gulf, Lye Brook, Shenandoah
Indiana	MRPO	Acadia, Brigantine, Dolly Sods, Great Gulf, Lye Brook, Moosehorn, Shenandoah
Michigan	MRPO	Acadia, Brigantine, Dolly sods, Great Gulf, Lye Brook, Shenandoah
Ohio	MRPO	Acadia, Brigantine, Dolly Sods, Great Gulf, Lye Brook, Moosehorn, Shenandoah

Source: Table 8-1 from the MANE-VU Contribution Assessment.(Appendix K)

3.3.3. Summary of MANE-VU Consultation

MANE-VU held numerous conference calls and meetings which provided opportunities for the District to consult with other states concerning reasonable progress goals, a coordinated regional emissions management strategy, and other elements of the SIP. MANE-VU consultation meetings and conference calls included those held on the following dates:

- MANE-VU Intra-Regional Consultation, March 1, 2007
  - At this meeting, MANE-VU members reviewed the requirements for regional haze plans, preliminary modeling results (including estimates of the uniform rate of progress and potential reasonable progress goals), the work being done to prepare the MANE-VU report on reasonable progress factors, and control strategy options under review.
- MANE-VU Class I States Consultation, June 7, 2007
  - At this meeting, the MANE-VU Class I states adopted a statement of principles (included in Appendix V), and all MANE-VU members discussed draft statements concerning reasonable controls within and outside of MANE-VU. Federal Land Managers also attended the meeting, which was open to stakeholders.
- MANE-VU Conference Call, June 20, 2007
  - On this call, the MANE-VU states concluded discussions of statements concerning reasonable controls within and outside MANE-VU and agreed on the statements called the MANE-VU "Ask," including a statement concerning controls within MANE-VU, a statement concerning controls outside MANE-VU, and a statement requesting a course of action by the U.S. EPA. Federal Land Managers also participated in the call. Upon approval, all statements as well as the statement of principles adopted on June 7 were posted and publicly available on the MANE-VU web site.
- MANE-VU Class I States' Consultation Open Technical Call, July 19, 2007
  - On this call, the MANE-VU "Ask" was presented to states in other RPOs, RPO staff and Federal Land Managers. An opportunity was provided to request further information. This call was intended to provide information to facilitate informed discussion at follow-up meetings.
- MANE-VU Consultation Meeting with MRPO, August 6, 2007
  - This meeting was held at LADCO offices in Chicago, Illinois, and was attended by representatives of both MANE-VU and Midwest RPO (MRPO) states as well as staff. Modeling results were reviewed as well as draft reasonable progress goals. The meeting provided an opportunity to formally present the MANE-VU "Ask" to MRPO states and to consult with them regarding the reasonableness of the requested controls. Federal Land Manager agencies also attended the meeting.
- MANE-VU Consultation Meeting with VISTAS, August 20, 2007
  - This meeting was held at State of Georgia offices in Atlanta and was attended by representatives of both MANE-VU and VISTAS states as well as staff. Modeling results were reviewed as well as draft reasonable progress goals. The meeting provided an opportunity to formally present the MANE-VU "Ask" to VISTAS states and to consult with them regarding the reasonableness of the requested controls. Federal Land Manager agencies also attended the meeting.

- MANE-VU – Midwest RPO Consultation Conference Call, September 13, 2007
  - This call was a follow-up to the meeting held on August 6 in Chicago and provided an opportunity to further clarify what was being asked of the MRPO states. The flexibility in the "Ask" was explained. Both MRPO and MANE-VU staff agreed to work together to facilitate discussion of further controls on ICI boilers and EGUs.
- MANE-VU Air Directors' Consultation Conference Call, September 26, 2007
  - This call allowed MANE-VU members to clarify their understanding of the "Ask" and to provide direction to modeling staff as to how to interpret the "Ask" for purposes of estimating visibility impacts of the requested controls.
- MANE-VU Air Directors' Conference Call, March 31, 2008
  - On this call, NESCAUM presented the results of the final 2018 modeling and described the methods used to represent the impacts of the measures agreed to by the Class I States. The reasonable progress goals were also discussed. Federal Land Manager agencies also attended this call.

3.4. Federal Land Manager Coordination

Coordination between States/Tribes and the Federal Land Managers (FLMs) is required by 40 CFR Section 51.308(i).

3.4.1. Preliminary Consultation with FLMs

On July 31, 2008, the District wrote to representatives of the U.S. Fish and Wildlife Service, the National Park Service, and the U.S. Forest Service to inform them that the District was preparing a Regional Haze SIP and to identify Ms. Cecily Beall as the primary contact for further information.

3.4.2. Consultation with FLMs Concerning this SIP

In addition to the consultation calls and meetings described in Section 3.3.3, MANE-VU provided opportunities for FLMs to review and comment on each of the technical documents developed by MANE-VU and included in this SIP.

In the development of this Plan, the FLMs were consulted in accordance with the provisions of 40 CFR 51.308(i)(2). The District of Columbia provided the FLMs an opportunity for consultation, in person and at least 60 days prior to holding any public hearing on the SIP. A draft of this SIP, except for the BART chapter, was provided to FLMs on November 19, 2009, for review and comment. A draft of the BART chapter was provided to the FLMs on May 12, 2010.

In accordance with 40 CFR 51.308(i)(3), the District of Columbia received comments regarding the SIP from FLMs. Comments received from the FLMs on the Plan were addressed and are included in Appendix C.

3.4.3. Commitment to Continuing Consultation with FLMs in the Future

In accordance with 40 CFR Section 51.308(i)(4), the District will continue to coordinate and consult with FLMs on the implementation of the visibility protection program, including development of future plan revisions. In particular, the District will consult with the FLMs on the following implementation items:

1. Implementation of emissions strategies identified in the SIP as contributing to achieving improvement in the worst-day visibility;
2. Summary of major new source permits issued, since projected emissions growth under permitting programs such as New Source Review (NSR) and Prevention of Significant Deterioration (PSD) may impact regional haze and reasonable progress goals;
3. Status of District actions to meet commitments for completing any future assessments or rulemakings on sources identified as likely contributors to visibility impairment, but not directly addressed in the most recent SIP revision;
4. Any changes to the monitoring strategy or monitoring stations status that may affect tracking of reasonable progress;
5. Work underway for preparing the 5-year review or 10-year revision;
6. Items for FLMs to consider or provide support for in preparation for any visibility protection SIP revisions (based on a 5-year review or 10-year revision schedule under EPA's Regional Haze Rule);
7. Summary of topics (discussion, meetings, emails, other records) covered in ongoing communications between the District and the FLMs regarding implementation of the visibility program.

The District is committed to the goal of improving visibility, so will consider the link of regional haze to other air programs having the potential to contribute to the impairment of visibility in Class I areas. Consultation will be coordinated with the designated visibility protection program coordinators for the National Park Service, U. S. Fish and Wildlife Service and the U.S. Forest Service.

3.4.4. Reasonably Attributable Visibility Impairment

Section 51.302(c) provides for general plan requirement in cases where the affected FLM has notified the State that Reasonably Attributable Visibility Impairment (RAVI) exists in a Class I Area in the state. There are no RAVI sources in MANE-VU.

4. Emissions Inventory

In order to help assess the causes of regional haze, Section 51.308(d)(4)(v) of EPA's Regional Haze Rule requires states to inventory emissions of pollutants that are reasonably anticipated to cause or contribute to visibility impairment in any Class I area. The inventory must include emissions for a baseline year, future (projected) year, and the most recent year for which data are available. Section 51.308(d)(3)(iii) of EPA's Regional Haze Rule requires states to identify the baseline emissions level on which strategies are established.

Consistent with the MANE-VU and VISTAS states, the District's baseline year is 2002. The District inventoried the following pollutants whose emissions affect fine particle formation, and thus contribute to regional haze: sulfur dioxide (SO_2), oxides of nitrogen (NO_x), volatile organic compounds (VOC), ammonia (NH_3), and particles with an aerodynamic diameter less than or equal to 10 and 2.5 μm (i.e., primary PM_{10} and $PM_{2.5}$).

The following source categories were included in the District's emissions inventory: stationary point sources, stationary area sources, onroad mobile sources, and nonroad mobile sources. An inventory of biogenic emissions was also prepared for the region as part of the modeling process. These emissions categories are discussed further later in Section 4.

Section 4.1 provides an overview of the development of baseline and future year emission inventories for the District and the region and summarizes baseline and future projected emissions from sources in the District.

4.1. Baseline and Future Year Inventories for Modeling

The baseline inventory is intended to be used to assess progress in making emission reductions. In accordance with EPA guidance entitled *2002 Base Year Emission Inventory SIP Planning: 8-Hour Ozone, PM $_{2.5}$, and Regional Haze Programs,* all MANE-VU states used 2002 as the anticipated baseline emission inventory year for regional haze.

To meet the requirements of EPA's Consolidated Emissions Reporting Rule (CERR; 40 CFR Part 51), a consolidated 2002 inventory of point, area, onroad, and nonroad emissions was submitted by MANE-VU state and local agencies to EPA between May and July of 2004. The District of Columbia submitted its final 2002 periodic inventory to EPA on May 25, 2004.

The emissions data submitted to EPA by MANE-VU states and the District were the starting point for development of the MANE-VU base year emissions inventory for regional modeling. As described below, MARAMA and its contractors worked with the state and local agencies in the MANE-VU region to quality assure and improve this initial inventory, so the final 2002 baseline inventory summarized in this document may differ slightly from the District's original 2002 baseline inventory submittal.

Future year emissions inventories for 2009, 2012, and 2018 were projected from the 2002 base year by MARAMA and its contractors. These future year emissions inventories include emissions growth due to projected increases in economic activity as well as emissions reductions expected from the implementation of control measures. Because 2018 is the primary focus of the regional long-term strategy for improving visibility at Class I areas, only the 2002 and 2018 inventories are summarized below.

Both baseline and future year inventories were processed for use in regional modeling. This required MARAMA and its contractors to revise the format of the emissions inventory and provide it to NESCAUM and other modeling centers. The modeling centers then further processed the emissions data using the Sparse Matrix Operator Kernel Emissions (SMOKE) emissions pre-processor to prepare input data for the CMAQ and REMSAD air quality models, as described in Section 5.

Emissions inventories for other parts of the modeling domain (outside MANE-VU) were obtained from other RPOs, such as VISTAS. EPA provided data for Canadian sources within the modeling domain.

4.1.1. Development of MANE-VU's 2002 Baseline Inventory

MANE-VU's baseline inventory of emissions in the region includes annual average emissions for the year 2002. Preparation of the MANE-VU inventory involved three major development steps, known as Versions 1.0, 2.0 and the final Version 3.0.

Work on Version 1.0 of the 2002 MANE-VU inventory began in April 2004. To meet the requirements of the CERR, a consolidated inventory of point, area, onroad, and nonroad sources was submitted by MANE-VU state and local agencies to EPA between May and July of 2004. Electronic quality assurance (QA) programs, including the EPA QA software, were run to identify format and data content issues.[1] Pechan worked with MANE-VU member states and MARAMA staff to resolve quality assurance issues and augment the inventories to fill data gaps in accordance with the MANE-VU Quality Assurance Project Plan.[2] The final Version 1.0 inventory was finalized in January 2005.

Work on Version 2.0 (conducted from April through September 2005) involved incorporating revisions requested by some MANE-VU state and local agencies on the point, area, and onroad inventories.

The Version 3.0 inventory for point, area, and onroad sources was built upon Versions 1.0 and 2.0. Work on Version 3.0 (conducted from December 2005 through April 2007) included additional revisions to the point, area, and onroad inventories as requested by some states. For Version 3.0, the nonroad inventory was rebuilt as a result of changes to the NONROAD2005 model by EPA. During the same time period, the New York Department of Environmental Conservation also developed the biogenics inventory for the entire MANE-VU region.

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[1] EPA. Basic Format & Content Checker 3.0 (Formerly known as the Quality Assurance/Quality Control Software 3.0) – March 2004. Extended Quality Control Tool – Updated May 18, 2004. United States Environmental Protection Agency. 2004.

[2] MANE-VU. Quality Assurance Project Plan (QAPP) for Area and Point Source Emissions Modeling Inventory Project, Final. Prepared for the Mid-Atlantic/Northeast Visibility Union by E.H. Pechan & Associates, Inc. and Carolina Environmental Program, August 3, 2004.

Version 3.0 of the 2002 base year emission inventory was used in the regional modeling. A technical support document explaining the data sources, methods, and results for the MANE-VU 2002 base inventory is presented in Appendix D.

As mentioned in Appendix D, the District provided point source data for CO, NH_3, NO_x, SO_2, VOC, and at least one form of PM. PM emissions were augmented by MANE-VU to calculate emissions for the other forms of PM. The District provided annual emissions for the majority of area source categories, except for categories for which the District elected to use data from MANE-VU-sponsored inventories (i.e., outdoor wood burning, paved roads, composting, and open burning). For the nonroad inventory, there was no District or NEI data available for aircraft. Commercial marine vessels data was taken from a 2002 preliminary NEI, and locomotives data came from the District's CERR submittal. For nonroad and onroad modeling, the District provided some data sets and requested use of model defaults for others. The OTC-LEV program implementation schedule was included in the modeling, starting implementation in the 1999 model year followed by a full implementation of the National LEV program in the 2001 model year. (Appendix D)

4.1.2. Development of Future Year Emission Inventories for MANE-VU

MARAMA and its contractors developed future year emission inventories for the MANE-VU region for the years 2009, 2012 and 2018 based on projections from the 2002 base year, using EPA-approved methods. These future year emission inventories include emissions growth due to projected increases in economic activity as well as the emissions reductions due to the implementation of control measures. Detailed documentation of these inventories is included in Appendices E, F, and G:

APPENDIX E	*Development of Emissions Projections For 2009, 2012, and 2018 for Non-EGU Point, Area, and Nonroad Sources in the MANE-VU Region*
APPENDIX F	*Documentation of 2018 Emissions from Electric Generating Units in the Eastern United States for MANE-VU's Regional Haze Modeling*
APPENDIX G	*Development of MANE-VU Mobile Source Projection Inventories for SMOKE/MOBILE6 Application*

Version 3.0 of the MANE-VU 2002 inventory was the basis for projections of future emissions for stationary sources (point and area) other than electricity generating units (EGUs) and for mobile sources (onroad and nonroad). No change was projected in biogenic emissions. MANE-VU used emissions projections for EGUs developed by a contractor hired by VISTAS on behalf of the eastern RPOs. The contractor used the Integrated Planning Model (IPM®). Projections for onroad mobile sources were developed for 2018 by NESCAUM using the SMOKE model.

Projections for future years were developed in three steps:

- First, a future base case scenario was developed that included emissions growth and control measures that were either already "on the books" (promulgated as of June 15, 2005) or were considered well "on the way" to being implemented because they were proposed but not yet final (OTB/W).
    - Non-EGU point source controls included NO_x SIP Call Phase I (NO_x Budget Trading Program); NO_x SIP Call Phase II; NO_x RACT in 1-Hour Ozone SIPs; NO_x OTC 2001 Model Rule for ICI Boilers; 2-, 4-, 7-, and 10-year MACT Standards; Combustion Turbine and RICE MACT; Industrial Boiler/ Process Heater MACT; Refinery Enforcement Initiative; and Source Shutdowns; and
    - Area source control factors included 2001 OTC VOC Model Rules; Federal On-Board Vapor Recovery; New Jersey Post-2002 Area Source Controls; and Residential Woodstove NSPS.

- Next, a "beyond on the way" (BOTW) scenario was projected that included potential new control measures whose adoption was anticipated, primarily to meet requirements for reducing ozone pollution.
    - Non-EGU point source controls included NO_x measures (asphalt production plants; cement kilns; glass and fiberglass furnaces; low sulfur heating oil for commercial and institutional units; and ICI boilers using natural gas, #2 or #4 or #6 fuel oil, and coal); one primary PM_{10} and $PM_{2.5}$ measure (commercial heating oil); SO_2 measures (commercial heating oil and ICI boilers using #2 or #4 or #6 fuel oil and coal); and a VOC measure (adhesives and sealants application); and
    - Area source control factors included NO_x measures (ICI boilers using natural gas, #2 and #4 and #6 fuel oil, and coal; and residential and commercial home heating oil); primary PM_{10} and $PM_{2.5}$ measures (residential and commercial home heating oil); SO_2 measures (residential and commercial home heating oil and ICI boilers using distillate oil); and VOC measures (adhesives and sealants; emulsified and cutback asphalt paving; consumer products; and portable fuel containers).

- Finally, an updated scenario, sometimes referred to as "best and final", was developed to account for additional control measures that became the MANE-VU region's reasonable progress goals (Section 10.6.3). The controls are similar to the measures in MANE-VU's "Ask" of other RPOs (Section 7.1):
    - Top 167 EGU stacks strategy; low sulfur fuel strategy; BART implementation strategy; and continued evaluation of additional control measures.

For the OTB/W scenario, non-EGU point source control factors did not generally apply for the District for the modeling inventories, except for the NO_x Budget Trading Program[3]. Area source control factors applied for the District included the 2001 OTC model rules (consumer products, AIM coatings, portable fuel containers, and mobile equipment repair and refinishing; solvent

3 According to page 2-8 of Appendix E, "compliance with the NO_x SIP Call in the Ozone Transport Commission (OTC) states was scheduled for May 1, 2003. The requirements applied to all MANE-VU states except Maine, New Hampshire, and Vermont." It applies to both EGUs and non-EGUs. The table that identifies non-EGU units included in the NO_x SIP Call Phase I budget program does not include any units in the District, although this assumption is incorrect because the District's rule does contain one non-EGU.

cleaning was already accounted for in the 2002 inventory[4]); on-board vapor recovery; and residential wood combustion.

Of the controls accounted for in the District, the following are already enforceable:

- NO_x Budget Trading Program (20 DCMR Chapter 10).
- 2001 OTC model rules (20 DCMR Chapter 7, adopted in April 2004 and amended in December 2004):
  - Consumer products, 20 DCMR §§ 719 to 734;
  - AIM coatings, 20 DCMR §§ 749 to 754;
  - Portable fuel containers, 20 DCMR §§ 735 to 741;
  - Mobile equipment repair and refinishing, 20 DCMR §718; and
  - Solvent cleaning, 20 DCMR §§ 742 to 748.
- On-Board Vapor Recovery (20 DCMR §705)

The Residential Wood Combustion control factor accounts for the replacement of retired fireplaces and woodstoves that emit at pre-new source performance standard (NSPS) levels, using EPA methodology.

In addition, Federally-enforceable controls were incorporated in the EGU and mobile source models. As discussed in 4.2, these include CAIR; the Nonroad Diesel Rule, the 2007 Highway Diesel Standards, Tier 2 Motor Vehicle Standards, and the Large Spark Ignition and Recreational Vehicle Rule.

For the BOTW scenario, non-EGU point source control factors were applied for asphalt production plants and adhesives and sealants application. Area source control factors applied for the District included residential and commercial home heating oil (for 2012 and 2018, but not for 2009), and the VOC measures (adhesives and sealants, emulsified and cutback asphalt paving, consumer products, and portable fuel containers), which are mostly based on 2006 OTC model rules. No point or mobile controls were included.

Prior to development of the best and final scenario, six additional control options were analyzed using a four factor analysis (see Section 10.6 and Appendix P) to determine whether they would be reasonable. The list of measures was further refined to develop the final list of reasonable progress goals. The District has not yet adopted these strategies, but, as discussed throughout Section 10.6 and summarized in Section 10.9, has agreed to pursue them by 2018 as appropriate and necessary.

Section 6 explores more information about the sources and characteristics of emissions in the MANE-VU region. Additional summary of the control measures assumed to be in place for each of the future inventories may be found in Section 10.5.

4 This assumption is incorrect. The District's solvent cleaning regulation was passed in 2004, along with the other 2001 OTC model rules.

4.2. Brief Summary of Calculation Methods

This section provides a general description of the emission source classifications in the MANE-VU emissions inventories and summarizes information about methods used to calculate emissions.

There are five emission source classifications in the emissions inventory as follows:

- Stationary point
- Stationary area
- Onroad mobile
- Nonroad mobile
- Biogenic

Stationary point sources are large sources such as electric generating units (EGUs). Stationary area sources are those sources whose individual emissions are relatively small but due to the large number of these sources, the collective emissions could be significant (e.g., dry cleaners, service stations, agricultural sources, fire emissions, etc). Onroad mobile sources are automobiles, trucks, and motorcycles that use the roadway system. Nonroad mobile sources are equipment that can move but do not use the roadways, such as lawn mowers, construction equipment, railroad locomotives, and aircraft. The emissions from these onroad and nonroad sources are estimated by vehicle type and road type. Biogenic sources are natural sources such as trees, crops, grasses and natural decay of plants.

Stationary point source emissions data is tracked at the facility/unit level. Emissions for all other source types are summed District-wide (or for states, on the county level).

4.2.1. Stationary Point Sources

Point source emissions are emissions from large individual sources. Generally, point sources have permits to operate and their emissions are individually calculated based on source-specific factors on a regular schedule. The largest point sources are inventoried annually. These are considered to be major sources having emissions of 100 tons per year (tpy) of a criteria pollutant, 10 tpy of a single hazardous air pollutant (HAP), or 25 tpy total HAP. Emissions from smaller sources are also calculated individually but less frequently (every three years). Point sources are grouped into EGU sources and other industrial point sources, termed as non-EGU point sources. (Appendix E)

- **Electricity Generating Units (EGU)**

The base year inventory for large EGU sources was based on 2002 continuous emissions monitoring (CEM) data reported to the EPA in compliance with the Acid Rain program or 2002 hourly emission data provided by stakeholders. These data provide hourly emissions profiles that can be used in the modeling of emissions of SO_2 and NO_x from these large sources. Emission profiles are used to estimate emissions of other pollutants (volatile organic compounds, carbon monoxide, ammonia, fine particles, soil) based on measured emissions of SO_2 and NO_x. (Appendix F)

Future year inventories of EGU emissions for 2009 and 2018 were developed using the IPM® model to forecast growth in electric demand and the replacement of older, less efficient and more polluting power plants with newer, more efficient and cleaner units. The IPM® estimates were reviewed and revised if necessary to reflect newer information on planned controls and shut downs. Adjustments were made by MANE-VU modelers to maintain the CAIR cap.

The output of the IPM® model predicts that certain older plants will be replaced by newer units to meet future electric growth and state-by-state NO_x and SO_2 caps. However, the IPM® model results are not the best basis upon which to reliably predict plant closures. Plant closures are addressed in Section 10.7.

- **Point Sources other than EGUs**

The non-EGU point source category used annual emissions as reported by states and the District for the CERR for the base year 2002. These emissions were temporally allocated to month, day, and source category code (SCC) based allocation factors. (Appendix D)

The general approach for estimating future year emissions was to use growth and control data consistent with EPA's CAIR modeling analysis. This data was supplemented with site-specific growth factors as appropriate. (Appendix E)

4.2.2. Stationary Area Sources

Stationary area source base year emissions were estimated by multiplying an emission factor by some known indicator of collective activity such as fuel usage, number of households, or population. (Appendix D)

The general approach for estimating future year emissions was to use growth factors to account for changes in economic activity and control factors for future emission reductions from the OTB/W control regulations. This data was supplemented with state-specific growth factors as appropriate. (Appendix E)

4.2.3. Onroad Mobile Sources

For onroad vehicles, MOBILE6.2 was used to estimate emissions. For future year emissions, the model considers that a certain number of the vehicle fleet in each state will be replaced every year by newer, less polluting vehicles that meet the EPA Tier II motor vehicle standards. These lower emissions have been built into the 2018 inventory as well as the benefits received from lower sulfur gasoline in onroad diesel and gasoline vehicles and the 2007 heavy-duty diesel standards (see Section 10.5.5). All new mobile source measures and standards, as well as any benefits from implementation of individual state Inspection and Maintenance programs, were used in developing the inventory. (Appendix G)

4.2.4. Nonroad Mobile Sources

For the majority of the nonroad mobile sources, the emissions for base year 2002 were estimated using the EPA's NONROAD model.

For the future year inventories, the NONROAD model considered that a certain number of nonroad sources would be replaced every year by newer, less polluting vehicles that meet the new EPA standards for nonroad sources (Appendix D). These lower emissions due to vehicle replacement have been built into the 2018 inventory as well as the benefits received from lower sulfur gasoline in nonroad vehicles (see Section 10.5.4).

Aircraft engine, railroad locomotives and commercial marine are not estimated using the NONROAD model. For these sources, growth and control data consistent with EPA's CAIR analyses were used. This projection method was used with three exceptions. These exceptions were: 1) Maryland sources, 2) DC locomotive growth and controls, and 3) Logan (Boston) airport. Each of these sources used alternative growth and/or controls provided by the states or developed from current Federal rules for these sources (applies to controls only).

The District of Columbia used alternative growth factors for locomotive emissions in order to represent the effect of future Federal emission control programs. The control factors developed for locomotives for Maryland (based on Federal control programs) were used to apply controls to the DC locomotive emissions. The control factors were "additive" and were used on the base year emission without back-calculating uncontrolled emissions, since the control levels were relative to controls in place for 2002. (Appendix E)

4.2.5. Biogenic Emission Sources

Biogenic emissions were estimated using SMOKE-BEIS3 (Biogenic Emission Inventory System 3, Version 0.9) pre-processor. Biogenic emissions were calculated for VOC and NO_x. Biogenic emissions used for modeling remained constant from 2002 to 2018. Emissions from the District were about 0.1 percent of the regional total biogenic emissions. (See Appendices H and I, which describe preliminary and final modeling.)

4.3. Summary of Emissions

This section summarizes emissions from sources in the District and MANE-VU. More detail is provided in Appendices D (baseline), E (future years for non-EGU point, area, and nonroad sources), F (future years for EGUs), and G (future years for onroad mobile sources).

4.3.1. Emissions from Sources in the District of Columbia

The District's baseline and future year emissions inventories are summarized in Tables 4.1 through 4.3 below. All values are reported in tons per year. All MANE-VU members used 2002 as the baseline year. As discussed in Section 4.1.2, the future base case scenario was developed to include growth and control measures that were already either "on the books" or considered well "on the way" to being implemented. An updated scenario, sometimes referred to as "best and final" was developed to account for the MANE-VU regional long-term strategy. (The "beyond on the way" scenario is not included for comparison purposes.)

Table 4.1. DC 2002 Emissions Inventory Summary
(Tons/Year)

Type of Source	VOC	NO_x	$PM_{2.5}$	PM_{10}	NH_3	SO_2
EGU Point	0	300	4	4	0	345
Non-EGU Point	69	480	128	157	4	618
Area	6,432	1,644	1,029	6,293	14	1,337
Onroad Mobile	4,895	8,902	153	222	398	271
Nonroad Mobile	2,073	3,571	299	310	2	375
Biogenics	1,726	30	-	-	-	-
TOTAL	**14,033**	**15,689**	**1,537**	**4,559**	**422**	**3,403**

Source: Appendix D

Table 4.2. DC 2018 OTB/W Emissions Inventory Summary
(Tons/Year)

Type of Source	VOC	NO_x	$PM_{2.5}$	PM_{10}	NH_3	SO_2
EGU Point	5	103	99	104	12	83
Non-EGU Point	85	627	164	198	5	780
Area	5,255	2,259	917	3,825	17	1,632
Onroad Mobile	1,797	1,717	58	65	438	41
Nonroad Mobile	1,369	1,815	124	135	3	5
Biogenics	1,726	30	-	-	-	-
TOTAL	**10,237**	**6,551**	**1,362**	**4,326**	**474**	**2,541**

Source: Appendices E, F and G

Table 4.3. DC 2018 Final Emissions Inventory Summary
(Tons/Year)

Type of Source	VOC	NO_x	$PM_{2.5}$	PM_{10}	NH_3	SO_2
EGU Point	5	103	99	104	12	83
Non-EGU Point	85	627	161	194	5	481
Area	4,991	2,229	667	1,501	17	159
Onroad Mobile	1,797	1,717	58	65	438	41
Nonroad Mobile	1,369	1,815	124	135	3	5
Biogenics	1,726	30	-	-	-	-
TOTAL	**9,972**	**6,521**	**1,109**	**1,998**	**475**	**769**

The reductions in EGU emissions of SO_2 and NO_x between the 2002 inventory and 2018 OTB/W inventories are primarily due to CAIR. The declines in area source PM and VOC estimates are presumably due to residential wood burning controls. Between the same two inventories, the large differences in onroad and nonroad emissions are due to the implementation of Federal rules to reduce emissions from nonroad diesel and heavy duty diesel engines and motor vehicles, including low sulfur diesel rules, Tier 2 vehicle standards, fleet turnover as reflected in modeling, and similar efforts.

The 38 percent drop in non-EGU point source SO_2 emissions and the 90 percent drop in area source SO_2 emissions between the 2018 OTB/W and the best and final inventory can be attributed to the goal to change the sulfur content of heating oil. The differences in area source

PM and VOC emissions are also due to the low sulfur heating oil control program, which the District has agreed to pursue.

4.3.2. Emissions from the District Compared to MANE-VU Emissions

As reported in the previous section, the following three sets of tables show emissions from the MANE-VU region and the percentage of emissions from the District of Columbia for the 2002 base year, the 2018 OTB/W inventory, and the 2018 final modeling inventory. All MANE-VU members used 2002 as the baseline year.

Tables 4.4 and 4.5 show the MANE-VU emissions inventory summary for 2002 and the percentage of emissions from sources in the District. Note that EGU and non-EGU point are combined.

Table 4.4. Regional Summary of the 2002 MANE-VU Emissions Inventory

(Tons/Year)

Type of Source	VOC	NO_x	$PM_{2.5}$	PM_{10}	NH_3	SO_2
Point	97,300	673,660	55,447	89,150	6,194	1,907,634
Area	1,528,141	262,477	332,729	1,455,311	249,795	316,357
Onroad Mobile	788,560	1,308,233	22,107	31,561	52,984	40,091
Nonroad Mobile	572,751	431,631	30,084	40,114	287	57,257
Biogenics	2,575,232	28,363	-	-	-	-
TOTAL	**5,561,985**	**2,704,397**	**440,367**	**1,616,136**	**309,260**	**2,321,338**

Source: Appendix D

Table 4.5. Percent of 2002 MANE-VU Emissions from Sources in the District

(Percent)

Type of Source	VOC	NO_x	$PM_{2.5}$	PM_{10}	NH_3	SO_2
Point	0.1	0.1	0.2	0.2	0.1	0.1
Area	0.4	0.6	0.3	0.4	0.0	0.4
Onroad Mobile	0.6	0.7	0.7	0.7	0.8	0.7
Nonroad Mobile	0.4	0.8	1.0	0.8	0.7	0.7
Biogenics	0.1	0.1	-	-	-	-
TOTAL	**0.3**	**0.6**	**0.3**	**0.3**	**0.1**	**0.1**

As Tables 4.4 and 4.5 demonstrate, point sources are the leading contributor of SO_2 emissions in the MANE-VU region, and area source emissions make up the second largest category of SO_2 emissions. Emissions from sources in the District of Columbia are a very small part of the emission totals in the MANE-VU region as a whole. Mobile source emissions from the District represent the largest percentage of the regional emissions, along with area source NO_x emissions due to fuel combustion.

Tables 4.6 and 4.8 display the 2018 MANE-VU emissions inventory summaries for the OTB/W and the final MANE-VU modeling inventories. Tables 4.7 and 4.9 indicate the percent of these emissions due to sources located in the District of Columbia.

Table 4.6. Regional Summary of the MANE-VU 2018 OTB/W Emissions Inventory

(Tons/Year)

Type of Source	VOC	NO_x	$PM_{2.5}$	PM_{10}	NH_3	SO_2
EGU Point	4,528	175,219	65,558	52,360	6,148	320,651
Non-EGU Point	110,524	237,802	41,220	63,757	4,986	270,433
Area	1,387,882	284,535	345,419	1,614,476	341,746	305,437
Onroad Mobile	269,981	303,955	9,189	9,852	66,476	8,757
Nonroad Mobile	380,080	271,185	23,938	27,059	369	8,643
Biogenics	2,575,232	28,396	-	-	-	-
TOTAL	**4,728,227**	**1,301,092**	**485,324**	**1,767,504**	**419,725**	**913,921**

Source: Appendices E, F and G

Table 4.7. Percent of MANE-VU 2018 OTB/W Emissions from Sources in the District

(Percent)

Type of Source	VOC	NO_x	$PM_{2.5}$	PM_{10}	NH_3	SO_2
EGU Point	0.1	0.1	0.2	0.2	0.2	0.0
Non-EGU Point	0.1	0.3	0.4	0.3	0.1	0.3
Area	0.4	0.8	0.3	0.2	0.0	0.5
Onroad Mobile	0.7	0.6	0.6	0.7	0.7	0.5
Nonroad Mobile	0.4	0.7	0.5	0.5	0.8	0.1
Biogenics	0.1	0.1	-	-	-	-
TOTAL	**0.2**	**0.5**	**0.3**	**0.2**	**0.1**	**0.3**

The reduction measures represented in Tables 4.6 and 4.7 are expected to be enforceable by 2018. The largest percentage of OTB/W emissions in the District are from mobile sources and from area source NO_x. Table 4.7 indicates that the District would contribute 0.3 percent of the SO_2 emissions in the MANE-VU region under the 2018 OTB/W scenario. This represents a larger percentage than in the 2002 base year, presumably because the District has fewer potential non-EGU controls than other states, although total SO_2 emissions in the region would drop.

Table 4.8. Regional Summary of the MANE-VU 2018 Final Emissions Inventory

(Tons/Year)

Type of Source	VOC	NO_x	$PM_{2.5}$	PM_{10}	NH_3	SO_2
EGU Point	4,528	175,218	52,360	65,558	6,148	386,584
Non-EGU Point	109,762	199,733	40,907	62,925	4,988	211,320
Area	1,334,038	263,031	243,321	720,462	341,747	129,656
Onroad Mobile	269,981	303,955	9,189	9,852	66,476	8,757
Nonroad Mobile	380,076	271,181	23,933	27,055	360	8,643
Biogenics	2,575,232	28,396	-	-	-	-
TOTAL	**4,673,617**	**1,241,514**	**369,710**	**885,852**	**419,719**	**744,960**

Table 4.9. Percent of MANE-VU 2018 Final Emissions from Sources in the District

(Percent)

Type of Source	VOC	NO_x	$PM_{2.5}$	PM_{10}	NH_3	SO_2
EGU Point	0.1	0.1	0.2	0.2	0.2	0.0
Non-EGU Point	0.1	0.3	0.4	0.3	0.1	0.2
Area	0.4	0.8	0.3	0.2	0.0	0.1
Onroad Mobile	0.7	0.6	0.6	0.7	0.7	0.5
Nonroad Mobile	0.4	0.7	0.5	0.5	0.8	0.1
Biogenics	0.1	0.1	-	-	-	-
TOTAL	**0.2**	**0.5**	**0.3**	**0.2**	**0.1**	**0.1**

After implementing reasonable progress goals, which the District has agreed to pursue by 2018, as indicated in Tables 4.8 and 4.9, the District's SO_2 contribution would drop to 0.1 percent as the total SO_2 emissions in the region are also reduced.

The 0.2 percent drop implies that the long-term strategy, mainly the low sulfur heating oil strategy, would impact SO_2 emissions in the District. As mentioned in Section 3.3.2, MANE-VU concluded that it was appropriate to consult with all of its participating states, as well as with states outside of MANE-VU that contributed at least two percent of the sulfate ion to its Class I areas in 2002. Several of the MANE-VU states, including the District of Columbia, have impacts on these Class I areas that are below the two percent threshold – that is, their impacts on any Class I areas are insignificant according to this measure. These states and the District were included in the consultation area because they are MANE-VU members. Tables 4.7 and 4.9 support the conclusion that the District's SO_2 emissions do not contribute significantly to MANE-VU Class I areas, since none of the contributions approach two percent.

5. Air Quality Monitoring and Modeling

5.1. Use of Monitoring Data to Understand Contributions to Class I Areas

The District of Columbia does not contain any Class I Areas; therefore no monitoring strategy for measuring, characterizing, and reporting regional haze visibility impairment within the District into the future is required under 40 CFR Section 51.308(d)(4) of EPA's Regional Haze Rule. However, 40 CFR 51.308(d)(4)(iii) requires that for a State with no mandatory Class I areas, the implementation plan must provide for procedures by which monitoring data and other information are used in determining the contribution of emissions from within the State to regional haze impairment at mandatory Class I Federal areas in other States.

The preamble to the final regional haze rule published in the Federal Register on July 1, 1999, explained that EPA believed it was important for States with no Class I areas to "understand and describe the implications of monitoring data." On page 35744 (FR Vol. 64, No. 126), EPA stated:

> *First, it is important for those states to review monitoring information, including data on the chemical composition of individual species concentrations, to help understand the relative contribution of emissions from their state to Class I areas in other States. Second, it is important for those States to understand and describe how they will use the monitoring data to review progress and trends.*

In general, visibility conditions are evaluated for the days with most-impaired visibility (i.e., the average of the 20 percent most impaired days over a calendar year) and the cleanest or least impaired days (i.e., the average of the 20 percent least impaired days). Baseline conditions are the average visibility for the years 2000 through 2004. Current conditions are determined by the average visibility for the five most recent years for which quality-assured data are available.

Visibility is expressed in deciviews. A deciview is a measure of visibility impairment derived from calculated light extinction. Light extinction is calculated using the mass of various components of airborne particles (nitrates, sulfates, elemental carbon, organic carbon, and crustal material).

Title 40 CFR 51.308(d) and (g) provide for tracking improvements in both visibility and emissions in order to demonstrate reasonable progress toward achieving natural visibility conditions. States with Class I areas have established baseline conditions in their implementation plans and set goals for reasonable progress in improving visibility by 2018. (See Appendix J for more information.) States with Class I areas must establish a monitoring program and report data to EPA that is representative of visibility at the Class I areas. The IMPROVE network meets this requirement.

As a participant in MANE-VU, the District reviewed information about the chemical composition of baseline monitoring data at Class I areas in and near MANE-VU in order to understand the sources of haze causing pollutants. Section 6 of this implementation plan summarizes this analysis.

The District commits to continuing support of ongoing visibility monitoring in Class I areas. The IMPROVE network currently meets this monitoring goal, and the District agrees that IMPROVE is an appropriate monitoring network to track regional haze progress and will work with neighboring states and the FLMs to meet the goals of the IMPROVE program. In the future, as required by 40 CFR 51.308 (f) and (g), the District will use monitoring data to review progress and trends in visibility at Class I areas that may be affected by emissions from the District both for comprehensive periodic revisions of this implementation plan and for periodic reports describing progress towards the reasonable progress goals for those areas.

In September 2003, EPA issued *Guidance for Tracking Progress Under the Regional Haze Rule* (EPA-454/B-03-004). This report describes the procedures for using IMPROVE data and emissions data to track progress. The District will use procedures consistent with this EPA guidance to comply with 40 CFR 51.308(f) and (g).

5.2. Air Quality Modeling Used to Assess Causes of Haze

Air quality modeling to assess regional haze was performed cooperatively by several modeling centers within MANE-VU. These modeling efforts included emissions data processing, meteorological input analyses, and chemical transport modeling to perform regional air quality simulations for calendar year 2002 and several future periods, including the primary target date for this SIP, 2018. Modeling was conducted in order to assess contributions from upwind areas including the District's contribution to Class I areas in downwind states. Further, the modeling evaluated visibility benefits of specific control measures being considered to achieve reasonable progress goals and establish a long-term emissions management strategy for MANE-VU Class I Areas.

Several modeling tools were utilized for these analyses:

- The Fifth-Generation Pennsylvania State University/National Center for Atmospheric Research (NCAR) Mesoscale Model (MM5), version 3.6, was used to derive the required meteorological inputs for the air quality simulations (Penn State, 2005).
- The Sparse Matrix Operator Kernel Emissions (SMOKE) emissions modeling system, version 2.1, was used to process and format the emissions inventories for input into the air quality models (SMOKE, 2007).
- The Community Mesoscale Air Quality model (CMAQ), version 4.5.1, was used for the primary SIP modeling (Byun and Ching, 1999).
- The Regional Model for Aerosols and Deposition (REMSAD), version 8, was used during contribution apportionment (SAI, 2005).
- The California Puff Model (CALPUFF), version 5, and its associated meteorological wind field pre-processor (CALMET) were used to assess the contribution of individual states' emissions to sulfate levels at selected Class I receptor sites (USEPA, 2006).

Each of these tools has been evaluated and found to perform adequately. The SIP-pertinent modeling underwent full performance testing, and the results were found to meet the specifications of EPA modeling guidance. For a demonstration that the models have appropriate skill for the intended application, model performance evaluations were performed and documentation can be found in the following references:

- MM5 – As discussed in Section 5.3, see Appendix H (Sections 1.2 and 2.1) and Appendix L;
- SMOKE – See Appendix H (Section 1.3);
- CMAQ – As discussed in Section 5.5, see Appendix H (Sections 1.4.1 and 2.2) and Appendix M; also, see Appendix C of Appendix K;
- REMSAD – As discussed in Section 5.5, see Appendix H (Sections 1.4.2); also see Appendix C of Appendix K; and
- CALPUFF and CALMET – See Appendix D of Appendix K.

As described in Appendix H, a 2002 base year inventory was developed to assess model performance and to serve as a point of comparison for future year projections in terms of emissions reductions and air quality improvements. Meteorological fields from 2002 were evaluated for use of MM5, and 2002 cooperative modeling efforts were evaluated for use of CMAQ.

The District is aware of concerns about the modeling techniques used by MANE-VU. Because the District's emissions are a very small fraction of total emissions in the MANE-VU region, these models are adequate to demonstrate the District's relative contribution to visibility impairment, as described in Section 6.

Modeling using CALPUFF for the contribution assessment of sulfate impacts at selected Class I receptor sites involved two different platforms for regional scale modeling which each used the exact same source inputs but different meteorological inputs, one using the MM5 meteorology and the other using National Weather Service Data-driven CALMET wind fields. The two platforms were each evaluated separately as described in the NESCAUM report, *Contributions to Regional Haze in the Northeast and Mid-Atlantic United States*, August 2006 (Appendix K).

For more details on the regional haze modeling, refer to the NESCAUM report, *MANE-VU Modeling for Reasonable Progress Goals: Model Performance Evaluation, Pollution Apportionment, and Control Measure Benefits*, February 7, 2008 (Appendix H). The detailed modeling approach for the most recent 2018 projections can be found in NESCAUM's *2018 Visibility Projections*, May 13, 2008 (Appendix I).

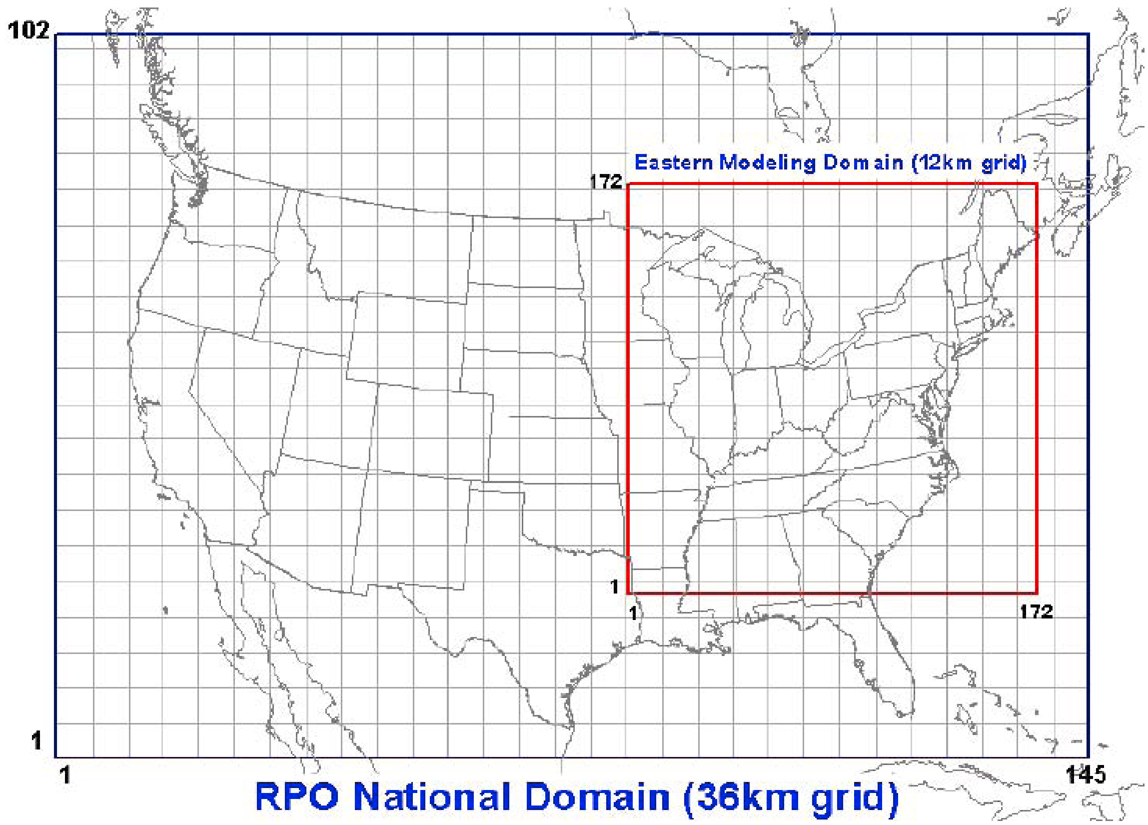
5.3. Meteorology

The meteorological inputs for the air quality simulations were developed by the University of Maryland (UMD) using the MM5 meteorological modeling system. Meteorological inputs were generated for 2002 to correspond with the baseline emissions inventory and analysis year. The MM5 simulations were performed on a nested grid (Figure 5.1). The modeling domain is composed of a 36-km, 145 x 102 continental grid and a nested 12-km, 172 x 172 grid encompassing the eastern United States and parts of Canada. In cooperation with the New York State Department of Conservation (NYSDEC), an assessment was made for the period of May through September 2002 to compare the MM5 predictions with observations from a variety of data sources, including:

- Surface observations from the National Weather Service and the Clean Air Status and Trends Network (CASTNET),

- Wind-profiler measurements from the Cooperative Agency Profilers (CAP) network,
- Satellite cloud image data from the UMD Department of Atmospheric and Oceanic Science, and
- Precipitation data from the Earth Observing Laboratory at NCAR.

Figure 5.1. National and Northeast Regional RPO Modeling Grid Domains



Source: Appendix H
Note: Outer domain is 36-km grid. Inner domain is 12-km grid. Gridlines are shown at 180-km intervals (5×5 36-km cells and 15×5 12-km cells).

Further details regarding the MM5 meteorological processing and the modeling domain can be found in NYSDEC's technical support document TSD-1a, *Meteorological Modeling Using Penn State/NCAR 5th Generation Mesoscale Model (MM5)*, February 1, 2006 (Appendix L), and in the NESCAUM report, *MANE-VU Modeling for Reasonable Progress Goals, Model Performance Evaluation, Pollution Apportionment, and Control Measure Benefits*, November 27, 2007 (Appendix H).

5.4. Data Preparation

The base year emissions inventory files were converted to the NEI Input Format (NIF) Version 3.0 by Pechan. The future year emissions inventory files were converted to NIF by MACTEC Federal Programs. NESCAUM and the State of New York then processed the NIF files using the Sparse Matrix Operator Kernel Emissions/Inventory Data Analyzer (SMOKE Version 2.1) in preparation for CMAQ and REMSAD modeling, The SMOKE Processing System is principally an emissions processing system, as opposed to a true emissions inventory preparation system, in which emissions estimates are simulated from "first principles." With the exception of mobile and biogenic sources, it simply provides a tool for converting emissions inventory data that have been calculated elsewhere into the formatted emissions files required for a photochemical air quality model.

The SMOKE emissions modeling system supports point, area, mobile (both onroad and nonroad), and biogenic emissions. The SMOKE emissions modeling system uses flexible processing to apply chemical speciation as well as temporal and spatial allocation to the emissions inventories. SMOKE incorporates the Biogenic Emission Inventory System (BEIS) and EPA's MOBILE6 motor vehicle emission factor model to process biogenic and onroad mobile emissions, respectively. Vector-matrix multiplication is used during the final processing step to merge the various emissions components into a single model-ready emissions file. Examples of processed emissions outputs are shown in Figure 5.2.

A description of all SMOKE input files such as area, mobile, fire, point and biogenic emissions files and the SMOKE model configuration are provided in Appendix H.

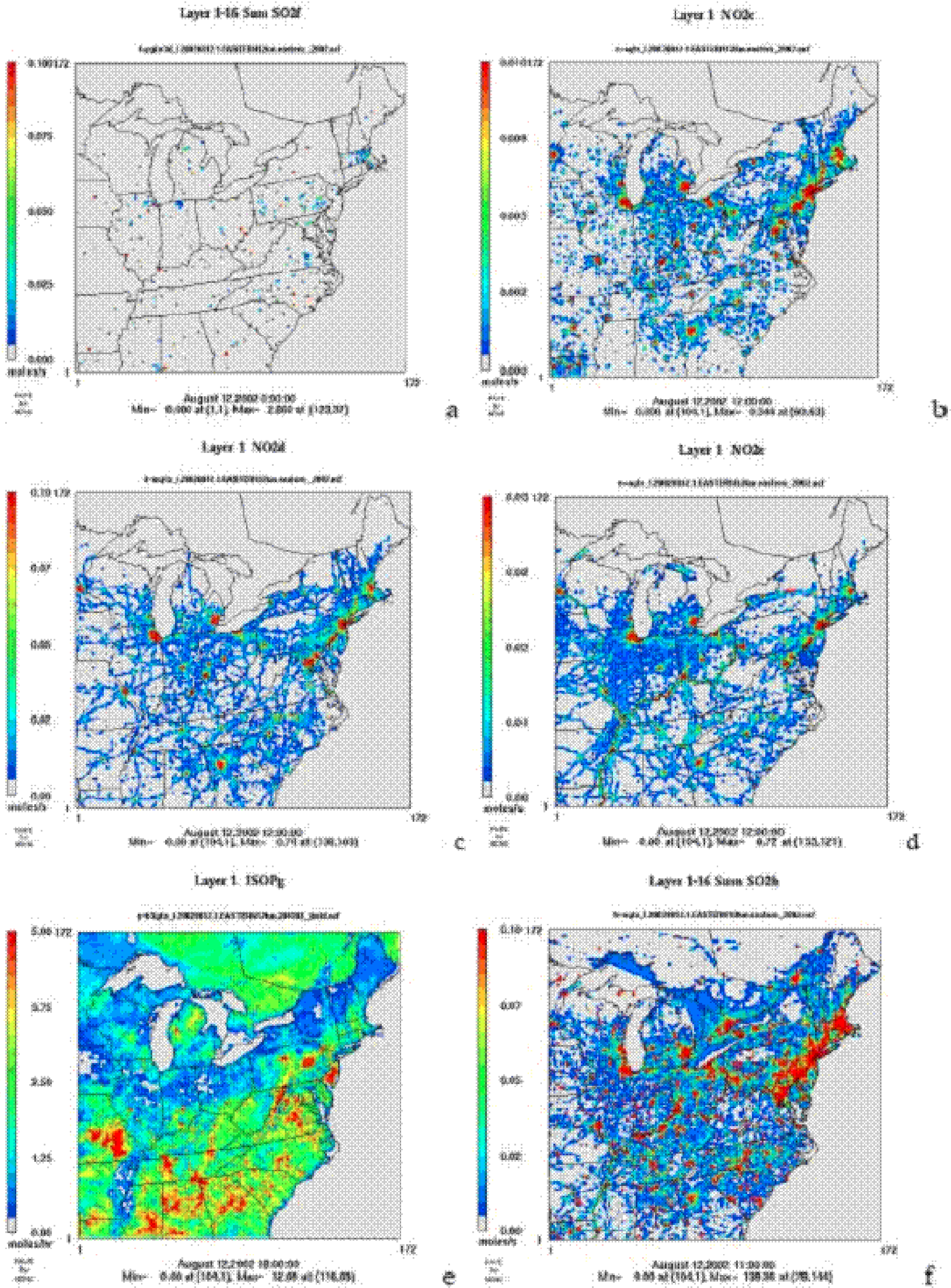
5.5. Model Platforms

Two regional-scale air quality models, CMAQ and REMSAD, were used for the air quality simulations that directly supported the Regional Haze SIP effort. CMAQ was developed by EPA and was used to perform the primary SIP-related modeling. The CMAQ modeling simulations were also an important tool for the 8-hour ozone SIP process. REMSAD was developed by ICF Consulting/Systems Applications International with support from EPA.

REMSAD was used by NESCAUM to perform a source apportionment (contribution assessment) analysis. All of the air quality simulations that were used in the SIP efforts were performed on the 12-km eastern modeling domain shown in Figure 5.1.

NYSDEC performed an extensive model performance analysis to evaluate CMAQ model predictions against observations of ozone, $PM_{2.5}$, and other pollutant species. This model performance evaluation is described in detail in NYSDEC's technical support document TSD-1e, *CMAQ Model Performance and Assessment, 8-Hr OTC Ozone Modeling*, February 23, 2006 (Appendix M). A model performance evaluation for $PM_{2.5}$ species, aerosol extinction coefficient, and the haze index is provided in NESCAUM's report, *MANE-VU Modeling for Reasonable Progress Goals, Model Performance Evaluation, Pollution Apportionment, and Control Measure Benefits*, February 7, 2008 (Appendix H).

Figure 5.2. Examples of Processed Model-Ready Emissions: (a) SO_2 from Point, (b) NO_2 from Area, (c) NO_2 from Onroad, (d) NO_2 from Nonroad, (e) ISOP from Biogenic, and (f) SO_2 from all Source Categories



Source: Appendix H

5.5.1. CMAQ

The CMAQ air quality simulations were performed cooperatively among five modeling centers: NYSDEC, the New Jersey Department of Environmental Protection (NJDEP) in association with Rutgers University, the Virginia Department of Environmental Quality (VADEQ), the University of Maryland at College Park, and NESCAUM. NYSDEC also performed an annual 2002 CMAQ simulation on the 36-km domain shown in Figure 5.1. This simulation was used to derive the boundary conditions for the inner 12-km eastern modeling domain. Boundary conditions for the 36-km simulations were obtained from a run of the GEOS-Chem (Goddard Earth Observing System) global chemistry transport model that was performed by researchers at Harvard University. The technical options that were used in performing the CMAQ simulations are described in detail in NYSDEC's technical support document TSD-1d, *8hr Ozone Modeling Using the SMOKE/CMAQ System*, February 1, 2006 (Appendix N). Further technical details regarding the CMAQ model and its execution are also provided in NESCAUM's report, *MANE-VU Modeling for Reasonable Progress Goals, Model Performance Evaluation, Pollution Apportionment, and Control Measure Benefits*, February 7, 2008 (Appendix H).

5.5.2. REMSAD

The REMSAD modeling simulations were used to produce the contribution assessment required by the Regional Haze Rule. REMSAD's species tagging capability makes it an important tool for this purpose. The REMSAD model simulations were performed on the same 12-km eastern modeling domain as shown in Figure 5.1. NESCAUM's report, *MANE-VU Modeling for Reasonable Progress Goals, Model Performance Evaluation, Pollution Apportionment, and Control Measure Benefits,* February 7, 2008 (Appendix H), further describes the REMSAD model and its application to the Regional Haze SIP efforts.

5.5.3. CALPUFF

CALPUFF is a non-steady-state Lagrangian puff model that simulates the dispersion, transport, and chemical transformation of atmospheric pollutants. Two parallel CALPUFF modeling platforms were developed by the Vermont Department of Environmental Conservation (VTDEC) and the Maryland Department of the Environment (MDE). The VTDEC CALPUFF modeling platform utilized meteorological observation data from the National Weather Service (NWS) to drive the CALMET meteorological model. The MDE platform utilized the same MM5 meteorological inputs that were used in the modeling done in support of the ozone and regional haze SIPs. These two platforms were run in parallel to evaluate individual sources' contributions to sulfate levels at Northeast and Mid-Atlantic Class I areas. The VTDEC CALPUFF modeling effort was tailored to accurately simulate long-term average flow patterns over the Northeastern U.S., in areas removed from the Atlantic coastline. The modeling effort was carefully evaluated for bias and error, both in the base meteorological fields and the final air pollution dispersion calculations. This modeling was performed in 2003 for calendar year 2002 meteorology and emissions and utilized a 'beta' model version, which, in 2003, was not yet formally approved by the EPA for Air Pollution applications. Since then, the fundamental changes to the CALPUFF modeling system that were first made available in the 2003 beta model version have been largely incorporated into the EPA- approved version. The CALPUFF modeling system is designed to allow great variety in its application. One example is the scale of spatial transport modeled, which may range from less than a kilometer, to long range transport applications on the order of 200 kilometers or more. A fundamental manner in which the model performance may be 'tailored' for a given application, involves the interpolation methods for various observational, and/or prognostic model outputs that the CALMET models interpolates to produce final wind, temperature and other fields. In the VTDEC CALPUFF modeling for the contribution assessment, a non-regulatory setting, was the 'radius of influence parameter' for interpolation of surface stations. The default (recommended) setting was not used for 'radius of influence parameter' because evaluation of the wind fields produced when this parameter was set at the default mode (i.e., off), revealed problems with the wind fields in regions where the surface wind observations were sparse. The CALPUFF modeling effort is described in detail in NESCAUM's report, *Contributions to Regional Haze in the Northeast and Mid-Atlantic United States*, August 2006 (Appendix K).

5.6. References for Section 5

(Byun and Ching, 1999) Community Modeling and Analysis System (CMAS) Center, University of North Carolina at Chapel Hill. Community Multiscale Air Quality (CMAQ) Modeling System. http://www.cmaq-model.org.

(Penn State, 2005) Pennsylvania State University/National Center for Atmospheric Research. Mesoscale Model (MM5). http://www.mmm.ucar.edu/mm5/mm5-home.html.

(SAI, 2005) ICF International/Systems Applications International. Regional Modeling System for Aerosols and Deposition (REMSAD). http://remsad.saintl.com.

(SMOKE, 2007) Center for Environmental Modeling for Policy Development, University of North Carolina at Chapel Hill. Sparse Matrix Operator Kernel Emissions (SMOKE) Model. http://www.smoke-model.org/index.cfm.

(USEPA, 2006) Scire, J.S., Strimaitis, D.G., and Yamartino, R.J. A User's Guide for the CALPUFF Dispersion Model (Version 5). January 2000.

6. Understanding the Sources of Haze-Causing Pollutants

This section explores the origins, quantities, and roles of visibility-impairing pollutants emitted in the eastern United States and Canada that contribute significantly to regional haze at mandatory Class I areas potentially affected by emissions from within the District.

The District collaborated with other MANE-VU members to assess the contribution to visibility impairment from emissions within MANE-VU. This work is documented in the report entitled *Contributions to Regional Haze in the Northeast and Mid-Atlantic States*, called the *Contribution Assessment* (Appendix K).

As explained in the *Contribution Assessment* and in Section 5, several procedures were used to analyze visibility at MANE-VU Class I areas. The most detailed analysis of IMPROVE data was receptor modeling. Other analytical techniques included the use of Eulerian (grid-based) source models, Lagrangian (air parcel-based) source dispersion models, as well as a variety of data analysis techniques that include source apportionment models, back trajectory calculations, and the analysis of inventory data. A range of methodological approaches characterize these tools, listed in Table 6.1.

Table 6.1. Summary of Technical Approaches for Attributing State Contributions to Observed Sulfate in MANE-VU Class I Areas

Analytical Technique	Approach
Emissions/distance	Empirical
Incremental probability	Lagrangian trajectory technique
Cluster-weighted probability	Lagrangian trajectory technique
Emissions × upwind probability	Empirical/trajectory hybrid
Source apportionment approaches	Receptor model/trajectory hybrid
REMSAD tagged species	Eulerian source model
CALPUFF with MM5-based meteorology	Lagrangian source dispersion model
CALPUFF with observation-based meteorology	Lagrangian source dispersion model

There was substantial consistency across these analytical methods using techniques based on disparate chemical, meteorological and physical principles. Taken together, these findings create a strong weight-of-evidence case for the preliminary identification of the most significant contributors to visibility impairment in the MANE-VU Class I areas.

The *Contribution Assessment* concludes that the overall coherence and consistency of results that emerges from application of these tools and techniques suggest that what is known about the causes of sulfate pollution in the MANE-VU region is sufficient to provide a useful and appropriate basis for design of future control programs and for consultations between different regional organizations charged with planning for compliance with the Regional Haze Rule.

It is important to emphasize that these methods have been reviewed, updated, and refined to ensure that high quality results are available for the SIP development process.

6.1. Visibility Impairing Pollutants

The pollutants primarily responsible for fine particle formation, and thus contributing to regional haze, include SO_2, NO_x, VOCs, NH_3, PM_{10}, and $PM_{2.5}$. Emissions of these pollutants combine in the atmosphere to form sulfates, nitrates, elemental and organic carbon, and other particles. Particles contribute to light extinction and thus impair visibility.

Sulfate is the dominant contributor to fine particle pollution throughout the eastern U.S. In 2002, on the haziest 20 percent of days, sulfate accounted for one-half to two-thirds of total fine particle mass and was responsible for about three-quarters of total light extinction at Class I sites in the Northeast and Mid-Atlantic. Even on the clearest 20 percent of days, sulfate typically constitutes 40 percent or more of total fine particle mass in the region. Moreover, sulfate accounts for 60 to 80 percent of the difference in fine particle mass concentrations on haze versus clear days.

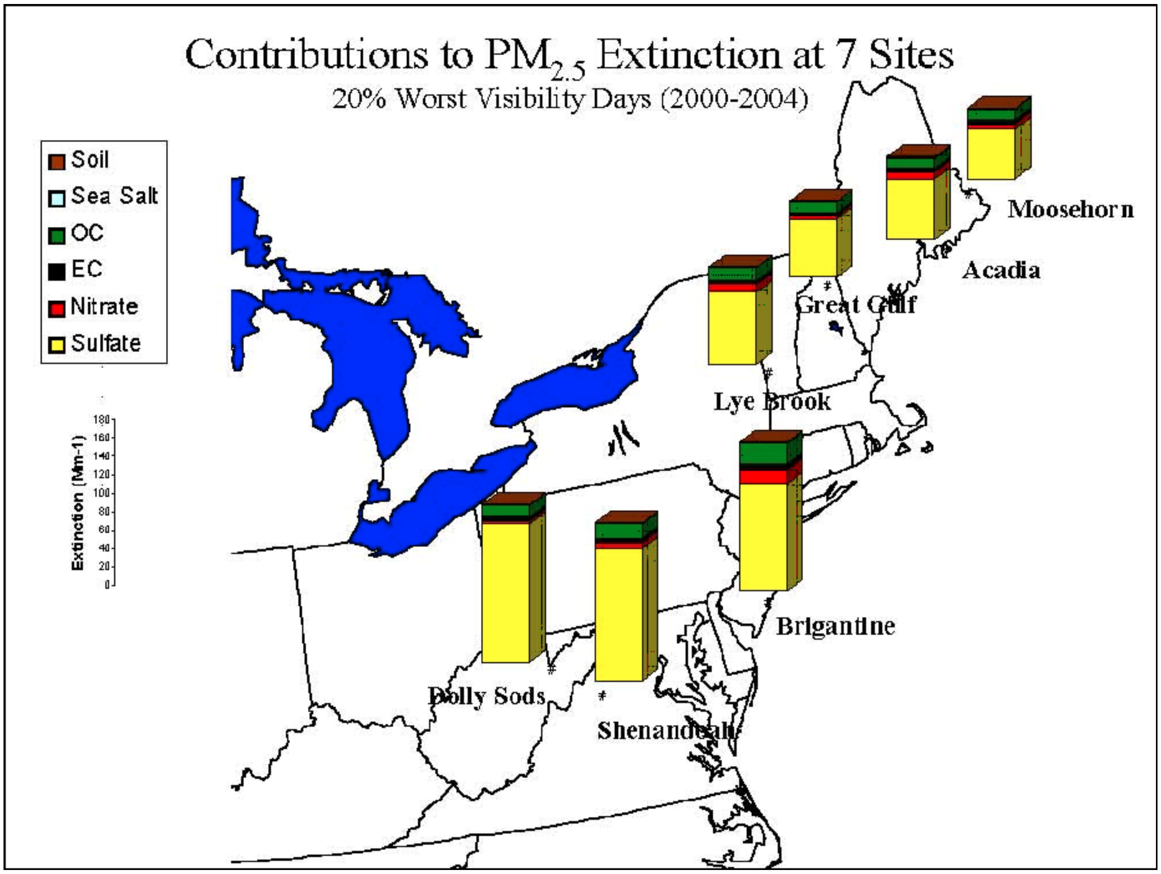
As documented in the *Contribution Assessment* (Appendix K), IMPROVE monitoring and analysis has indicated that while substantial visibility impairment is common across the MANE-VU region, it is most severe in the southern and western portions of MANE-VU that are closest to large power plant sources of sulfur dioxide (SO_2) emissions located in the Ohio River and Tennessee Valleys. Summertime visibility is driven almost exclusively by the presence or absence of regional sulfate, whereas wintertime visibility depends on a combination of regional and local influences coupled with local meteorological conditions (inversions) that can lead to the concentrated build-up of emissions from local sources. These findings suggest that an effective emissions management approach would rely heavily on broad-based regional SO_2 control efforts in the eastern United States aimed at reducing summertime fine particulate matter ($PM_{2.5}$) concentrations.

Available monitoring data provide strong evidence that regional SO_2 reductions have yielded, and will continue to yield, reductions in ambient secondary sulfate levels with subsequent reductions in regional haze and associated light extinction. They indicate that reductions in anthropogenic (i.e., manmade) primary particle emissions will also result in visibility improvements, but that these will not have a zone of influence as large as those of the secondary aerosols.

Given the dominant role of sulfate in the formation of regional haze in the Northeast and Mid-Atlantic region, MANE-VU concluded that it is likely that SO_2 reductions need to play a central role in achieving near-term visibility improvements.

Figure 6.1 shows the dominance of sulfate in visibility extinction calculated from 2000 to 2004 baseline data for seven Northeast Class I Areas.

Figure 6.1. Baseline Contributions to $PM_{2.5}$ Extinction at Seven Class 1 Areas on the 20 Percent Worst Visibility Days



6.2. Contributing States and Regions

The MANE-VU *Contribution Assessment* used various modeling techniques, air quality data analysis, and emissions inventory analysis to identify source categories and states that contribute to visibility impairment in MANE-VU Class I areas. With respect to sulfate, based on estimates from four different techniques, the *Contribution Assessment* estimated emissions from within MANE-VU in 2002 were responsible for about 25 to 30 percent of the sulfate at MANE-VU and nearby Class I areas. (See Section 8 of the *Contribution Assessment*.) Emissions from other regions, Canada, and outside the modeling domain were also important.

Table 6.2 shows the results of one of the four methods of assessing state-by-state contributions to sulfate impacts (the REMSAD model). This table highlights the importance of emissions from outside the MANE-VU region.

Table 6.2. Percent Contributions (Mass Basis) of Individual States and Regions to total Annual Sulfate Impacts at Northeast Class I Areas (REMSAD)

Contributing States or Areas	Acadia, Maine (%)	Brigantine, New Jersey (%)	Dolly Sods, West Virginia (%)	Great Gulf and Presidential Range Dry River, New Hampshire (%)	Lye Brook, Vermont (%)	Moosehorn and Roosevelt Campobello, Maine (%)	Shenandoah, Virginia (%)
Connecticut	0.76	0.53	0.04	0.48	0.55	0.56	0.08
Delaware	0.96	3.20	0.30	0.63	0.93	0.71	0.61
District of Columbia	0.01	0.04	0.01	0.01	0.02	0.01	0.04
Maine	6.54	0.16	0.01	2.33	0.31	8.01	0.02
Maryland	2.20	4.98	2.39	1.92	2.66	1.60	4.84
Massachusetts	10.11	2.73	0.18	3.11	2.45	6.78	0.35
New Hampshire	2.25	0.60	0.04	3.95	1.68	1.74	0.08
New Jersey	1.40	4.04	0.27	0.89	1.44	1.03	0.48
New York	4.74	5.57	1.32	5.68	9.00	3.83	2.03
Pennsylvania	6.81	12.84	10.23	8.30	11.72	5.53	12.05
Rhode Island	0.28	0.10	0.01	0.11	0.06	0.19	0.01
Vermont	0.13	0.06	0.00	0.41	0.95	0.09	0.01
MANE-VU	36.17	34.83	14.81	27.83	31.78	30.08	20.59
Midwest RPO	11.98	18.16	30.26	20.10	21.48	10.40	26.84
VISTAS	8.49	21.99	36.75	12.04	13.65	6.69	33.86
Canada & Other	43.36	25.02	18.18	40.03	33.09	52.83	18.71
TOTAL (ug/m3)	**2.026**	**3.444**	**3.867**	**1.780**	**2.137**	**1.767**	**3.919**

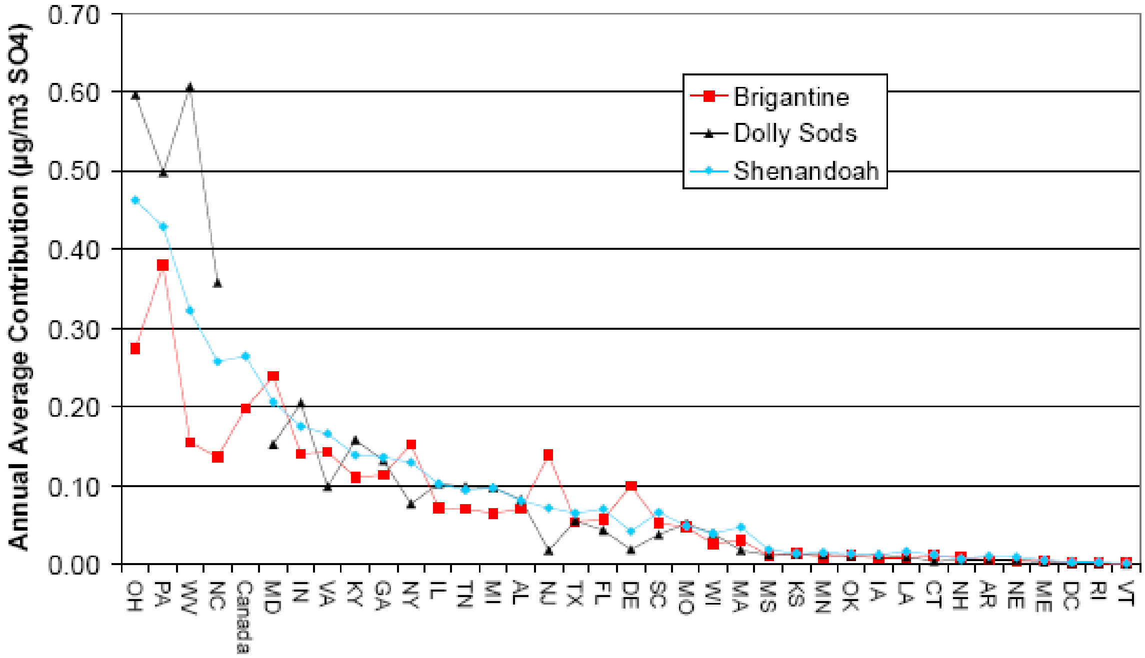
Source: Table 8-1 from the Contribution Assessment (Appendix K)

Note that Table 6.2 indicates that the District's contribution to regional haze in the listed Class I areas is no more than 0.04 percent, with the highest impacts at Brigantine and Shenandoah.

The following figure from the *Contribution Assessment* shows the results of another method used to identify and rank states' contributions to sulfate at MANE-VU and nearby Class I areas using 2002 data. A simple technique for deducing the relative impact of emissions from specific point sources on a specific receptor site involves calculating the ratio of annual emissions (Q) to source-receptor distance (d). This ratio is then multiplied by a factor designed to account for the effects of prevailing winds and to convert units. The use of this technique is explained in the *Contribution Assessment* (pages 4-13 and following).

Based on the results of the Q/d technique, Figure 6.2 shows the resulting rankings across a set of southern Class I areas in or near MANE-VU. Details may be found in Table 4-1 (p. 4-15) in the *Contribution Assessment,* which summarizes impacts using the CALPUFF-scaled Emissions over Distance technique. Emissions of SO_2 from the District were 1.715 tons per year, with estimated impacts on Acadia, Lye Brook, Brigantine, and Shenandoah each less than 0.01 ug/m^3.

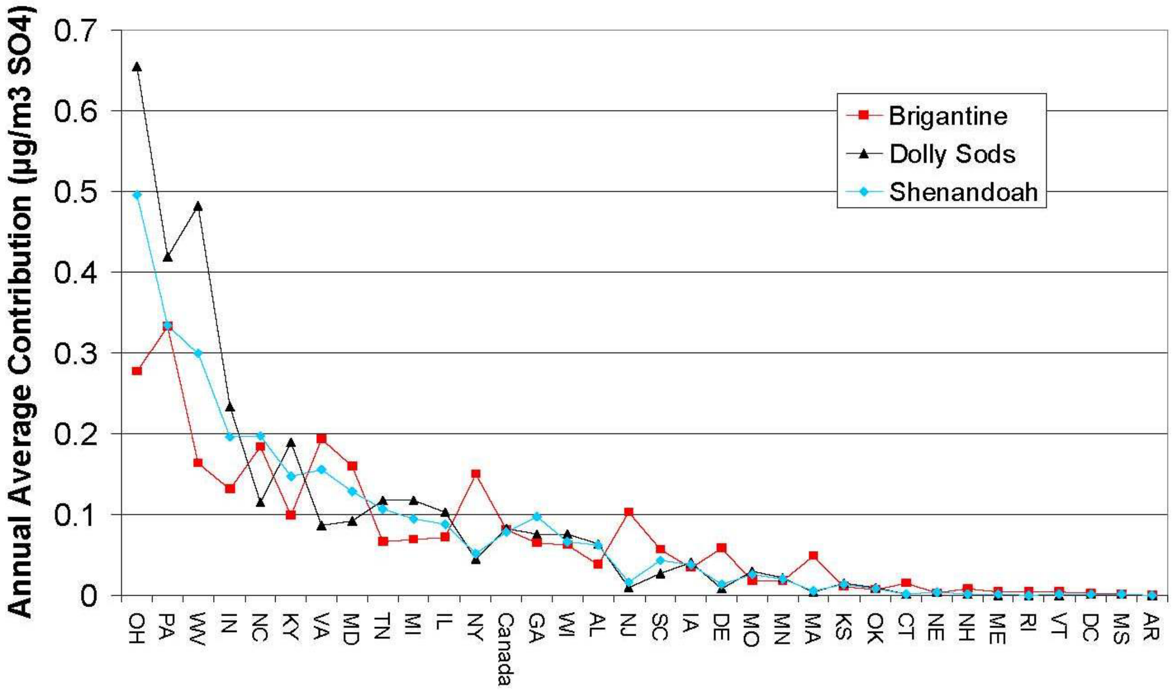
Figure 6.2. Ranked state percent sulfate contributions to Mid-Atlantic Class I receptors based on emissions divided by distance (Q/d) results



Source: Figure 4-13 from the Contribution Assessment (Appendix K)

Modeling results using CALPUFF provided similar results, as shown in Figure 6.3, below. CALPUFF modeling was conducted by two modeling centers for MANE-VU. One center used meteorology inputs calculated using the MM5 model, while the other center used National Weather Service rawinsonde-based meteorology. The models predicted annual average SO_4 ion concentration at Acadia, Lye Brook, Brigantine, and Shenandoah, which are reported in Tables 7-2a, b, c, and d on pages 7-5 through 7-8 of the *Contribution Assessment*. The MM5-based CALPUFF modeling predicted impacts from emissions in the District would be 0.0005 ug/m^3 at Acadia, 0.0030 ug/m^3 at Brigantine, 0.0006 ug/m^3 at Lye Brook, and 0.0013 ug/m^3 at Shenandoah. The NWS-based CALPUFF modeling predicted impacts from emissions in the District would be 0.0004 ug/m^3 at Acadia, 0.0021 ug/m^3 at Brigantine, 0.0005 ug/m^3 at Lye Brook, and 0.0016 ug/m^3 at Shenandoah. Table 8-3 in the *Contribution Assessment* reports the contributions using the NWS-based model as percentages, and the percent contribution to any of these areas from sources in the District ranges from 0.02 percent at Acadia, Dolly Sods, Lye Brook, and Moosehorn to a maximum of 0.07 percent at Brigantine. The percentage contribution at Shenandoah, the Class I area closest to the District, was 0.05 percent. Table 8-4 reports percentage contributions calculated using the MM5 model, with the maximum also being 0.07 percent at Brigantine.

Figure 6.3. Ranked state percent sulfate contributions to Mid-Atlantic Class I receptors based on observation-based (VT) CALPUFF results

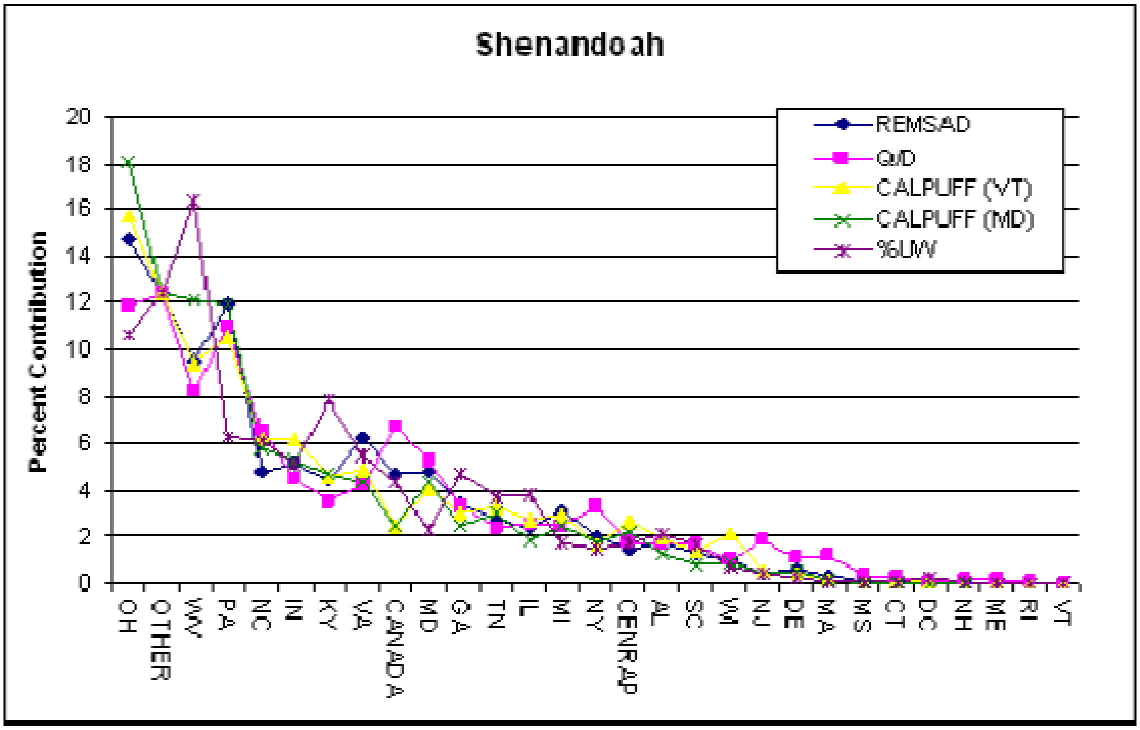


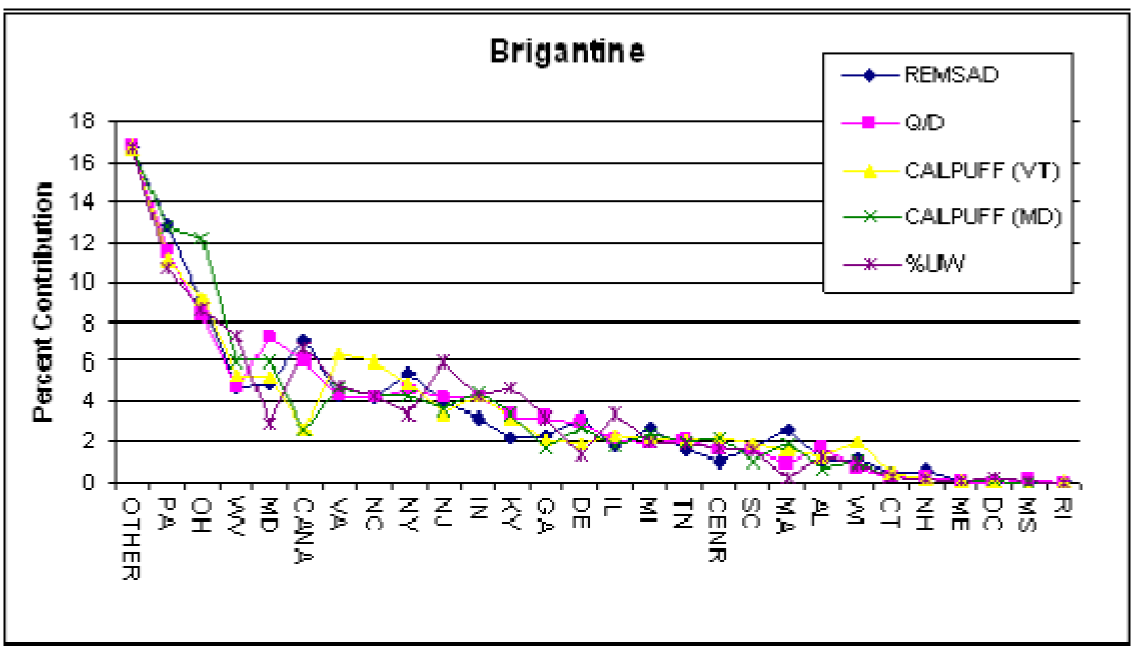
Source: Figure 7-3b from the Contribution Assessment (Appendix K)

Table 4.2 (p. 4-18) in the *Contribution Assessment* documents impacts using the upwind probability method of assessing contribution. This method involves calculating residence time probabilities using back-trajectory techniques. The back-trajectory calculated residence time probability for a grid cell is multiplied by the total emissions over the same time period from that grid cell. The product is an emissions-weighted probability field that can be integrated within state boundaries to calculate relative probabilities of each state contributing to pollution transport. Based on this technique, 2002 SO_2 emissions from within the District contributed less than 0.01 percent to the transport of sulfur to Acadia, Lye Brook, Brigantine, or Shenandoah.

Finally, the *Contribution Assessment* compared results from multiple techniques, showing the similarity of the predicted contributions to haze. See Figure 6.4, which shows the comparison for Shenandoah National Park and Brigantine Wilderness, the two Class I areas receiving the largest impacts from sources in the District.

Figure 6.4 (a and b). Comparison of normalized (percent contribution) results using different techniques for ranking state contributions to sulfate levels at the Shenandoah and Brigantine Class I Areas





Source: Figure 8-1 from the Contribution Assessment (Appendix K)

6.3. Emissions Sources and Trends

In conjunction with other efforts to assess the contribution of various source categories and source regions to regional haze in Class I areas, MANE-VU reviewed trends in emissions inventories. This section describes source categories and characteristics of pollutant emissions contributing to regional haze. It presents information about trends in emissions of the major pollutants responsible for regional haze (SO_2, VOC, NO_x, PM and NH_3) throughout the MANE-VU region. The emissions data and graphics presented in this section rely on several data sources. These include EPA's 1996 National Emissions Trends database (NET), EPA's 1999 National Emissions Inventory (NEI), and Version 3.0 of the 2002 MANE-VU inventory.[5] Because the NET was the predecessor of the NEI, references to the 1996 NET in the discussion below use the shorthand reference 1996 NEI.

6.3.1. Sulfur Dioxide (SO_2)

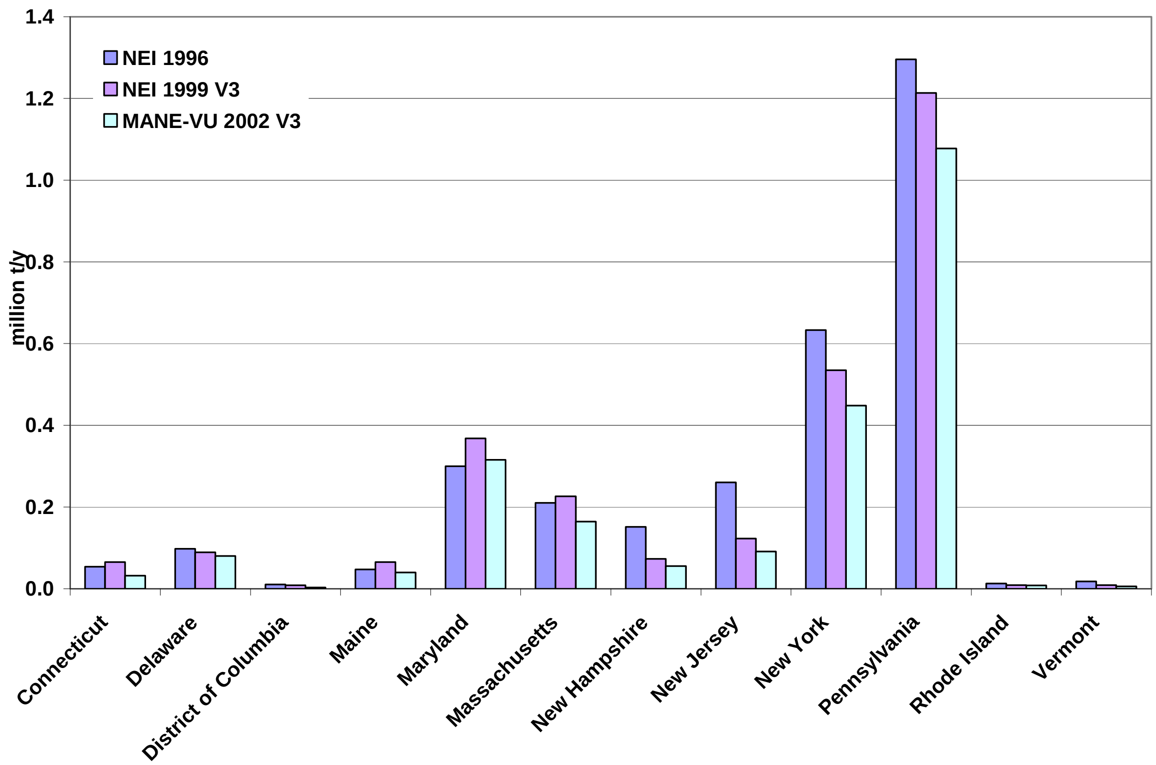
SO_2 is the primary precursor pollutant for sulfate particles which commonly account for more than 50 percent of particle-related light extinction at northeastern Class I areas on the clearest days, and for as much as or more than 80 percent on the haziest days. Hence, SO_2 emissions are an obvious target of opportunity for reducing regional haze in the eastern United States. Combustion of coal and, to a lesser extent, use of certain petroleum products accounts for most anthropogenic SO_2 emissions. In fact, in 1998, a single source category, coal-burning power plants, was responsible for two-thirds of total SO_2 emissions nationwide (NESCAUM, 2001a).

Figure 6.5 shows SO_2 emissions trends in the MANE-VU states extracted from the NEI for the years 1996 and 1999, and the 2002 MANE-VU inventory (EPA 2005 and Pechan, 2006). Except Maryland, the states show declines in 2002 annual SO_2 emissions when compared with 1996 emissions. Some states show an increase in 1999 followed by a decline in 2002, and others show consistent declines throughout the entire period. The upward trend in emissions in 1999 probably reflects electricity demand growth during the late 1990s combined with the availability of banked emissions allowances from initial over-compliance with control requirements in Phase 1 of the EPA Acid Rain Program. This led to relatively low market prices for allowances later in the decade, which encouraged utilities to purchase allowances rather than implement new controls as electricity output expanded. The observed decline in the 2002 SO_2 emissions

[5] EPA's Emission Factor and Inventory Group (EFIG) EPA/OAR (Office of Air and Radiation)/OAQPS (Office of Air Quality Planning and Standards)/EMAD (Emissions, Monitoring and Analysis Division) prepares a national database of air emissions information with input from air agencies, tribes, and industry. This database contains information on stationary and mobile sources that emit criteria air pollutants and their precursors, as well as hazardous air pollutants (HAPs). The database includes estimates of annual air pollutant emissions, by source and area of the country. The NEI includes emission estimates for all 50 states, the District of Columbia, Puerto Rico, and the Virgin Islands. Emission estimates are available for individual point or major sources (facilities), as well as county level estimates for area, mobile and other sources. Prior to 1999, the National Emission Trends (NET) database maintained criteria pollutant emission estimates and the National Toxics Inventory (NTI) database maintained HAP emission estimates. Beginning with 1999, the NEI integrated criteria and HAP emissions into a single database that replaces the NET and the NTI.

inventory reflects implementation of the second phase of the EPA Acid Rain Program, which in 2000 further reduced allowable emissions and extended emissions limits to more power plants.

Figure 6.5. State Level Sulfur Dioxide Emissions

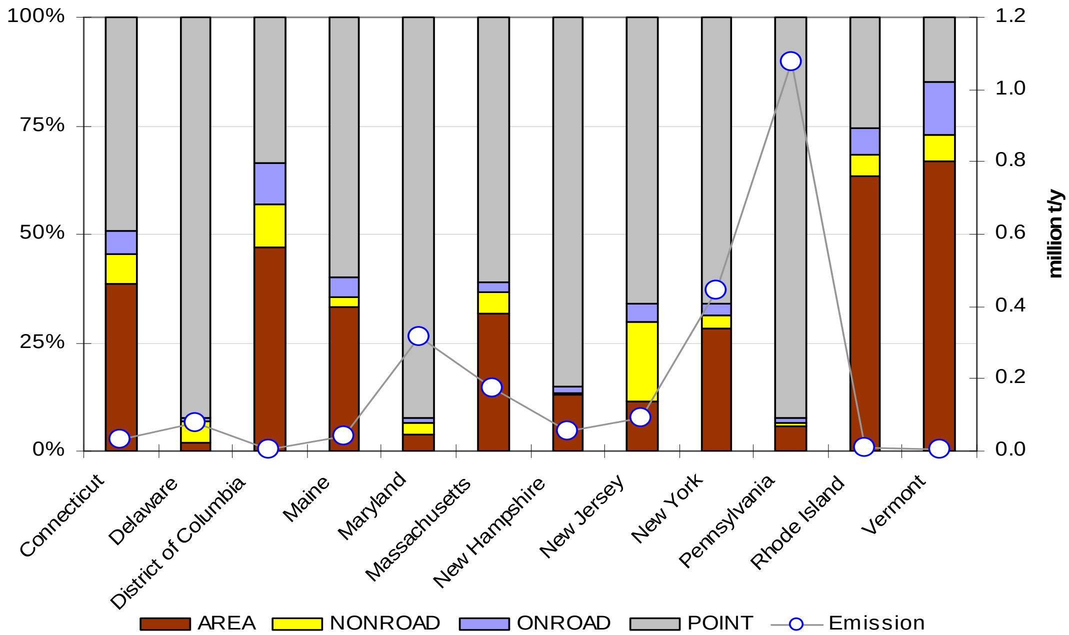


Source: Figure 4-1 from the Contribution Assessment (Appendix K)

Figure 6.5 shows that emissions from the District of Columbia are much smaller than emissions from other MANE-VU states except Rhode Island and Vermont.

Figure 6.6 shows the percent contribution from four source categories to overall annual 2002 SO_2 emissions in the MANE-VU states. The chart shows that in most states point sources dominate SO_2 emissions; however, in the District, the largest category is area sources. Point sources primarily consist of stationary combustion sources for generating electricity, industrial energy, and heat. Smaller stationary combustion sources, called area sources, such as commercial and residential heating and smaller industrial facilities, are particularly important in small states such as the District of Columbia. By contrast, onroad and nonroad mobile sources make a relatively small contribution to overall SO_2 emissions in the region (NESCAUM, 2001a).

Figure 6.6. 2002 Annual Anthropogenic SO_2 Emissions by State and Percent by Source Type



Source: Figure 4-2 from the Contribution Assessment (Appendix K)

In sum, total SO_2 emissions from sources located in the District are a very small part of the regional total and declined from 1996 to 2002. Area sources comprise the largest portion of SO_2 emissions in the District.

6.3.2. Volatile Organic Compounds (VOC)

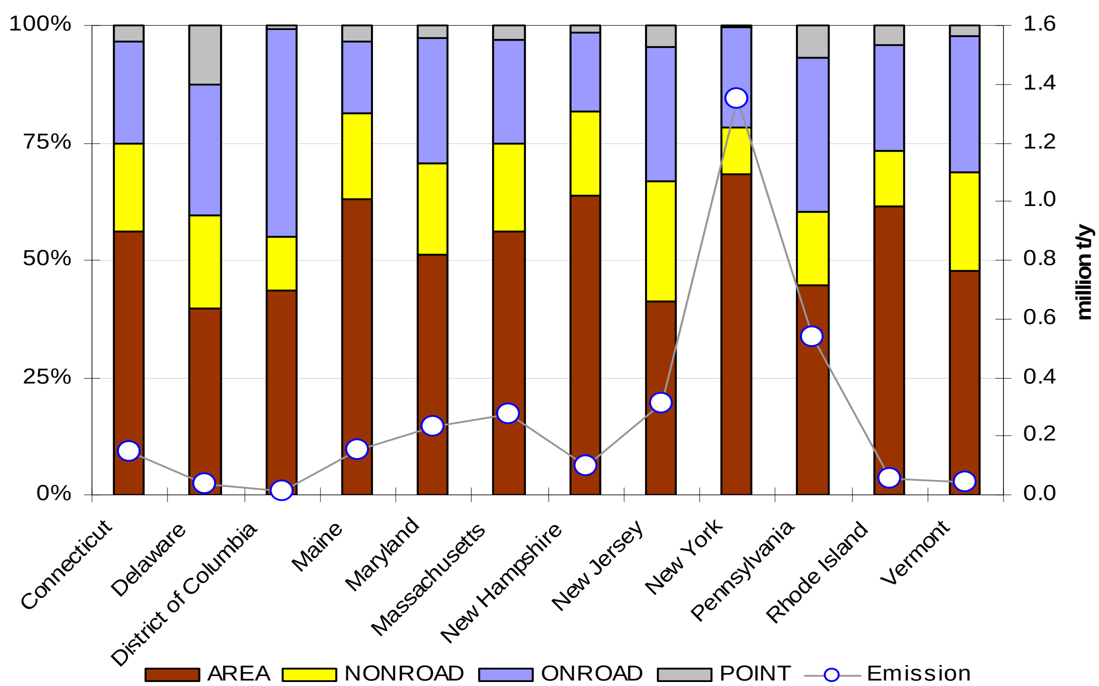
From a regional haze perspective, condensation and oxidation processes act on VOCs to form secondary organic aerosols (SOA). Thus, the VOC inventory category can contribute to the organic carbon portion of $PM_{2.5}$.

After sulfate, organic carbon generally accounts for the second largest share of fine particle mass and particle-related light extinction at northeastern Class I sites. The term “organic carbon” encompasses a large number and variety of chemical compounds that may come directly from emission sources as a part of primary PM or may form in the atmosphere as secondary pollutants. The organic carbon present at Class I sites comprises a mix of species, including pollutants originating from anthropogenic sources as well as biogenic hydrocarbons emitted by vegetation. Recent efforts to reduce manmade organic carbon emissions have been undertaken primarily to address summertime ozone formation in urban centers. Future efforts to further reduce organic carbon emissions may be driven by programs that address fine particles and visibility. This is explained in more detail on pages 4-2 through 4-5 of the *Contribution Assessment* (Appendix K), which also states that, “we need further work to characterize the organic carbon contribution to regional haze in the Northeast and Mid-Atlantic states and to develop emissions inventories that will be of greater value for visibility planning purposes.”

Understanding the transport dynamics and source regions for organic carbon in northeastern Class I areas is more complex than for sulfate. This is due to the large number and variety of organic carbon species. Each of these species has its individual and widely variable transport characteristics and complex atmospheric chemical reaction. Thus, the organic carbon contribution to visibility impairment at most Class I sites in the East is likely to include both biogenic and manmade pollution. The manmade component may be transported from a distance or originate from nearby sources.

Based on available information as shown in Figure 6.7, VOC emissions from sources in the District are a small portion of the regional total and are dominated by onroad mobile and area sources.

Figure 6.7. 2002 Annual Anthropogenic VOC Emissions by State and Percent by Source Type



Source: MANE-VU Contribution Assessment, Figure 4-3 (Appendix K)

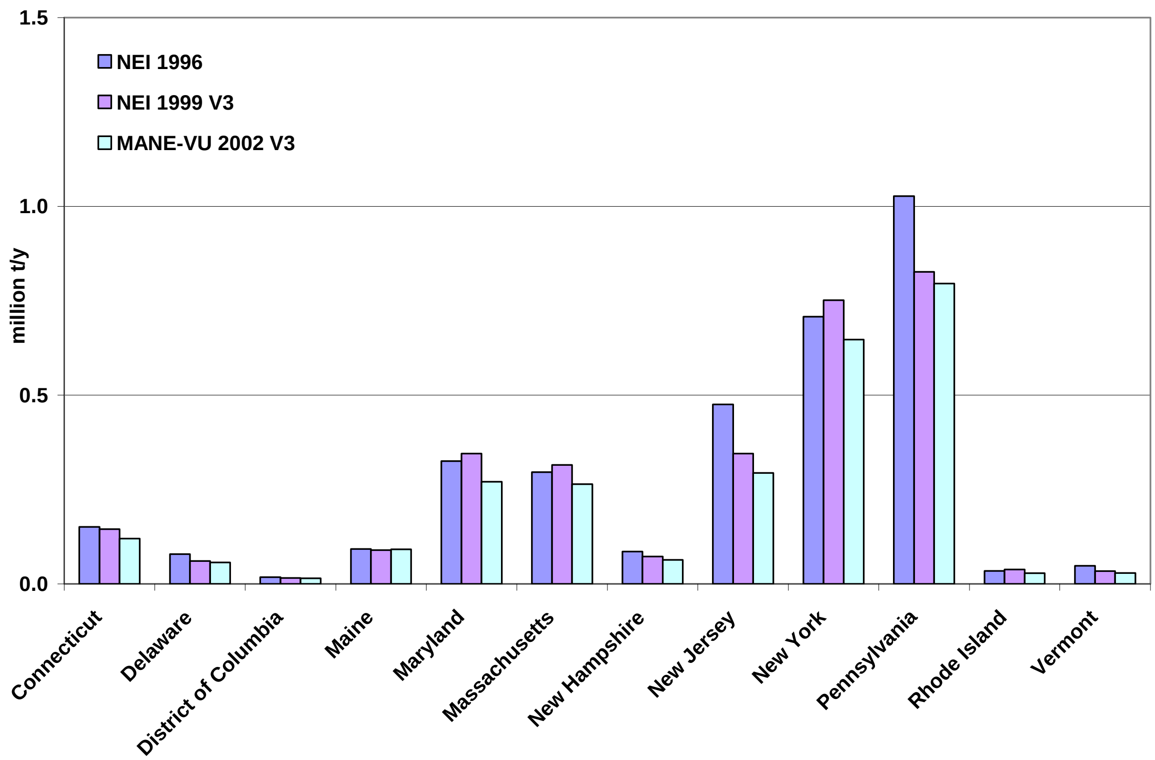
The same sources predominate in the entire MANE-VU region. Onroad mobile sources of VOCs include both evaporative and exhaust emissions from gasoline passenger vehicles and diesel-powered heavy-duty vehicles as well as evaporative emissions from the transportation of fuels. Nonroad sources include vehicles such as boats, planes, and locomotives as well as vehicles and equipment used in agriculture, construction, and other off-road operations. Area sources contributing to VOC emissions include solvents, architectural coatings, and dry cleaners. Point sources that emit VOCs include industrial facilities and petroleum refineries.

6.3.3. Oxides of Nitrogen (NO_x)

NO_x emissions contribute to visibility impairment in the eastern U.S. by forming light-scattering nitrate particles. Nitrate generally accounts for a substantially smaller fraction of fine particle mass and related light extinction than sulfate and organic carbon at northeastern Class I sites. Notably, nitrate may play a more important role at urban sites and in the wintertime. In addition, NO_x may have an indirect effect on summertime visibility by virtue of its role in the formation of ozone, which in turn promotes the formation of secondary organic aerosols (NESCAUM, 2001a).

Figure 6.8 shows NO_x emissions in the MANE-VU region at the state level. Since 1980, nationwide emissions of NO_x from all sources have shown little change. Emissions increased by only 2 percent between 1989 and 1998 (EPA, 2000a). This increase is most likely due to industrial sources and the transportation sector, as power plant combustion sources implemented modest emissions reductions during that time period. Most states in the MANE-VU region experienced declining NO_x emissions from 1996 through 2002, except Massachusetts, Maryland, New York, and Rhode Island, which show an increase in NO_x emissions in 1999 before declining to levels below 1996 emissions in 2002.

Figure 6.8. State Level Nitrogen Oxides Emissions

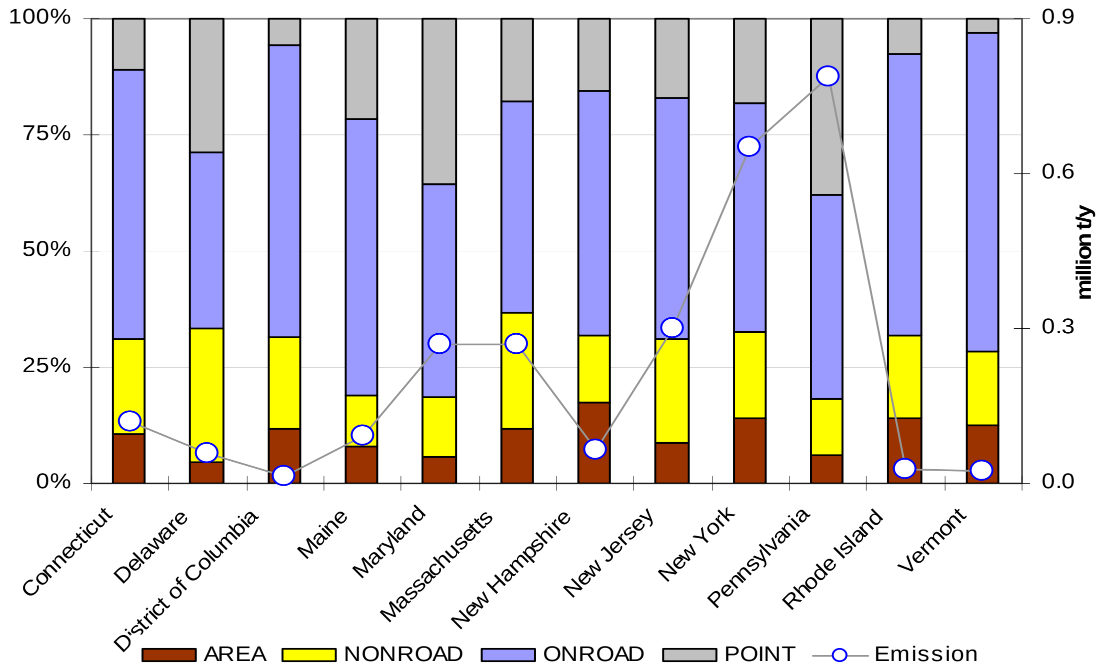


Source: MANE-VU Contribution Assessment, Figure 4-4 (Appendix K)

NO_x emissions from the District are the smallest portion of total regional emissions. The chart above illustrates that relationship and shows that NO_x emissions from the District decreased steadily from 1996 to 2002.

Figure 6.9, below, shows that in the District, mobile sources are the most important source of NO_x emissions. In general, power plants and mobile sources dominate state and national NO_x emissions inventories. Nationally, power plants account for more than one quarter of all NO_x emissions, amounting for over six million tons.

Figure 6.9. 2002 Annual Anthropogenic NO_x Emissions by State and Percent by Source Type



Source: MANE-VU Contribution Assessment, Figure 4-5 (Appendix K)

By contrast, onroad mobile sources – a category that mainly includes highway vehicles – dominate the NO_x inventories for more urbanized Mid-Atlantic and New England states, as shown in Figure 6.9. Emissions from nonroad mobile sources, primarily diesel-fired engines, also represent a substantial fraction of the MANE-VU 2002 NO_x inventory. Area sources are less important with respect to NO_x.

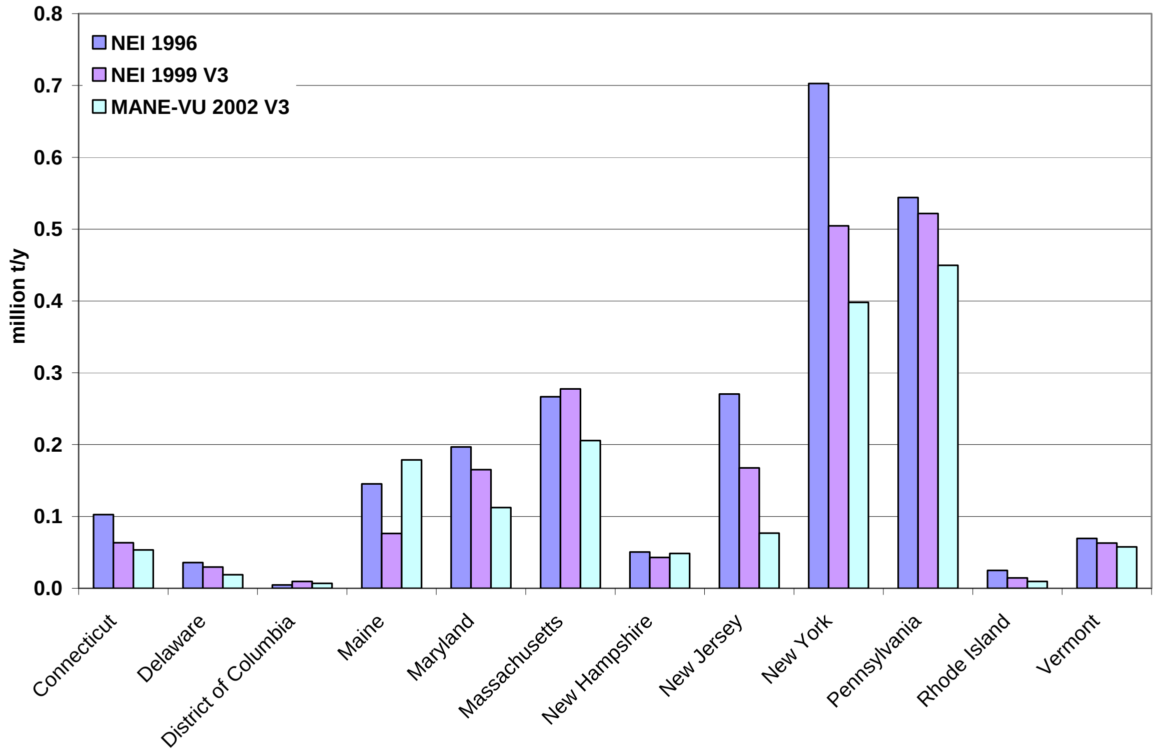
6.3.4. Primary Particulate Matter (PM_{10} and $PM_{2.5}$)

Directly emitted or "primary" particles (as distinct from secondary particles that form in the atmosphere through chemical reactions involving precursor pollutants such as SO_2 and NO_x) can also contribute to regional haze. For regulatory purposes, a distinction is made between particles with an aerodynamic diameter less than or equal to 10 micrometers and smaller particles with an aerodynamic diameter less than or equal to 2.5 micrometers (i.e., primary PM_{10} and $PM_{2.5}$, respectively).

Figure 6.10 and Figure 6.11 show PM_{10} and $PM_{2.5}$ emissions for the MANE-VU states for the years 1996, 1999, and 2002. Except Maine, states show a steady decline in annual PM_{10}

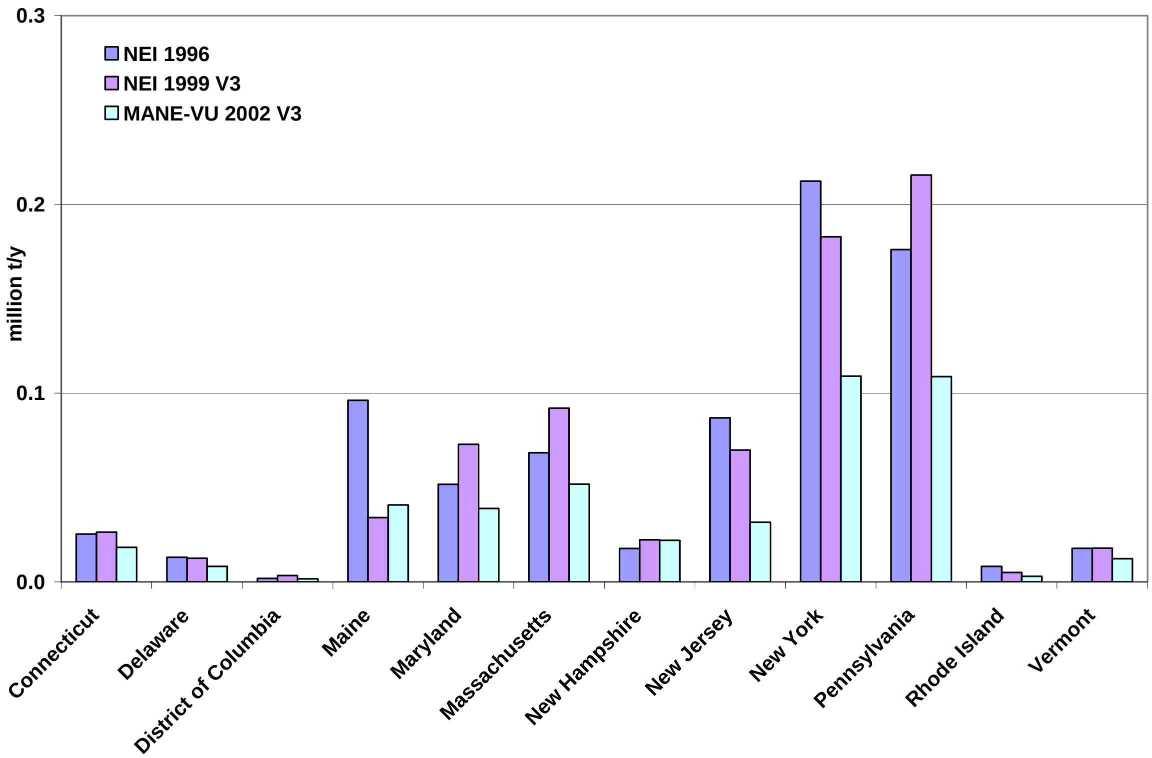
emissions over this time period. By contrast, emission trends for primary $PM_{2.5}$ are more variable. Emissions of PM_{10} and $PM_{2.5}$ from sources in the District represent a very small portion of total regional emissions. Emission of these pollutants in the District increased slightly between 1996 and 1999 and then decreased in 2002.

Figure 6.10. State Level Primary PM_{10} Emissions



Source: MANE-VU Contribution Assessment, Figure 4-6 (Appendix K)

Figure 6.11. State Level Primary $PM_{2.5}$ Emissions



Source: MANE-VU Contribution Assessment, Figure 4-7 (Appendix K)

Crustal sources are significant contributors of primary PM emissions. This category includes fugitive dust emissions from construction activities, paved and unpaved roads, and agricultural tilling. Comparisons between estimated emission rates for fine particles and observed concentrations of crustal matter in the ambient air at downwind receptor sites suggest that physical or chemical processes remove a significant fraction of crustal material relatively quickly. As a result, it rarely entrains into layers of the atmosphere where it can transport to downwind receptors. Because of this discrepancy between estimated emissions and observed ambient concentrations, modelers typically reduce estimates of total $PM_{2.5}$ emissions from all crustal sources by applying a factor of 0.15 to 0.25 to the total $PM_{2.5}$ emissions before including it in modeling analyses.

From a regional haze perspective, crustal material generally does not play a major role. On the 20 percent best-visibility days during the baseline period (2000 to 2004), it accounted for six to eleven percent of particle-related light extinction at MANE-VU Class 1 sites. On the 20 percent worst-visibility days, however, crustal material generally plays a much smaller role relative to other haze-forming pollutants, ranging from two to three percent. Moreover, the crustal fraction includes material of natural origin (such as soil or sea salt) that is not targeted under the Haze Rule.

Figure 6.12 and Figure 6.13 show that area sources dominate primary PM emissions.

Figure 6.12. 2002 Annual Anthropogenic Primary PM_{10} Emissions by State and Percent by Source Type

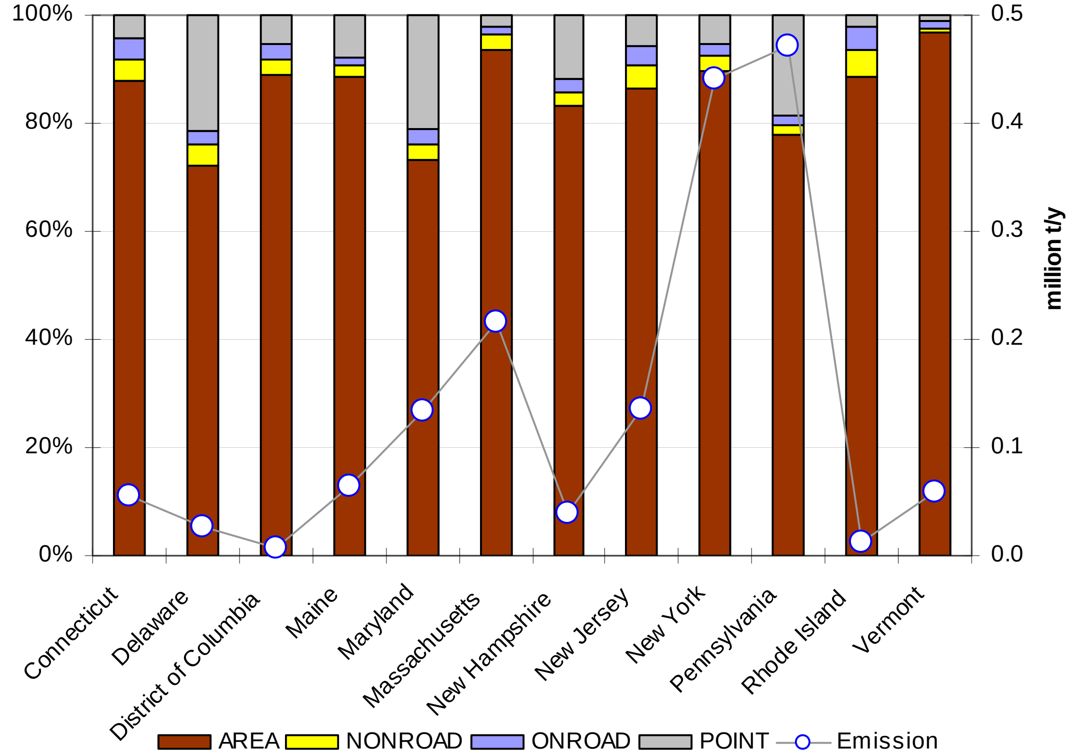
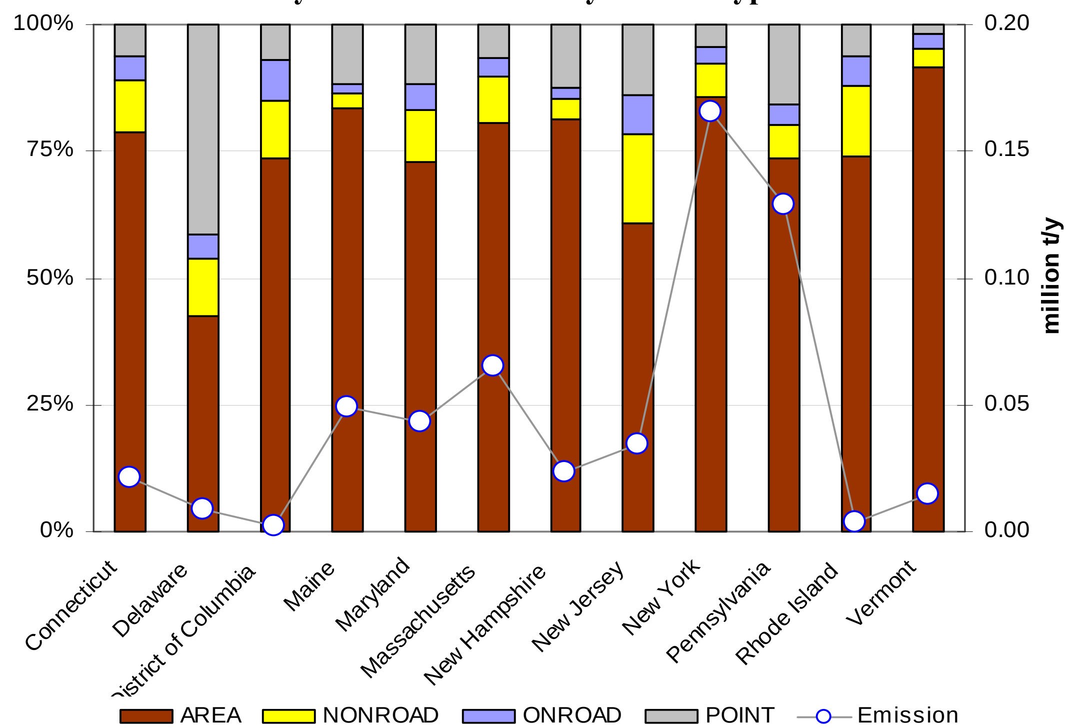


Figure 6.13. 2002 Annual Anthropogenic Primary $PM_{2.5}$ Emissions by State and Percent by Source Type



Source: MANE-VU Contribution Assessment, Figures 4-8 and 4-9 (Appendix K)

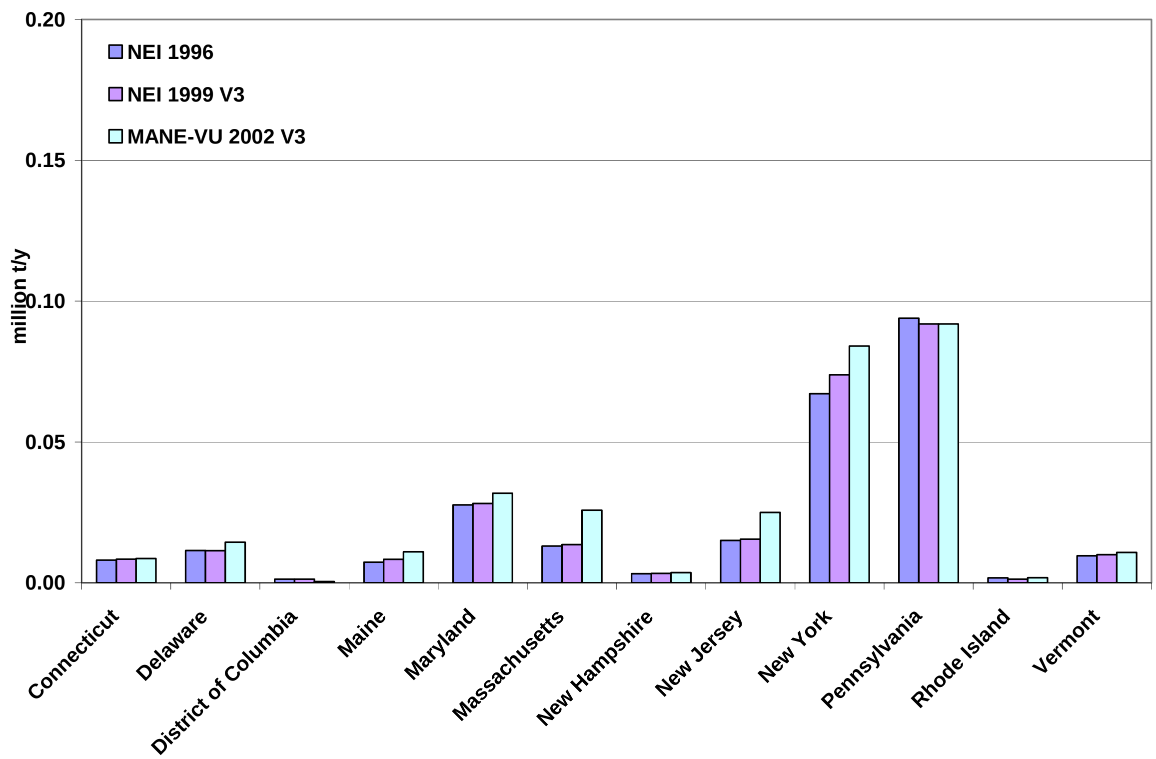
The relative contribution of point sources is larger in the primary $PM_{2.5}$ inventory than in the primary PM_{10} inventory since the crustal component (which consists mainly of larger or "coarse-mode" particles) contributes mostly to overall PM_{10} levels. At the same time, pollution control equipment commonly installed at large point sources is usually more efficient at capturing coarse-mode particles.

6.3.5. Ammonia Emissions

Ammonia emissions play an important role in the formation of particles in the atmosphere. Ammonium ion (formed from ammonia emissions to the atmosphere) is an important constituent of airborne particulate matter, including ammonium sulfate and ammonium nitrate. Ammonium typically accounts for 10 to 20 percent of total fine particle mass.

Figure 6.14 shows that estimated ammonia emissions were fairly stable in the 1996 NEI, 1999 NEI, and 2002 Version 3 MANE-VU inventories for MANE-VU states, with some slight increases observed for most states in MANE-VU.

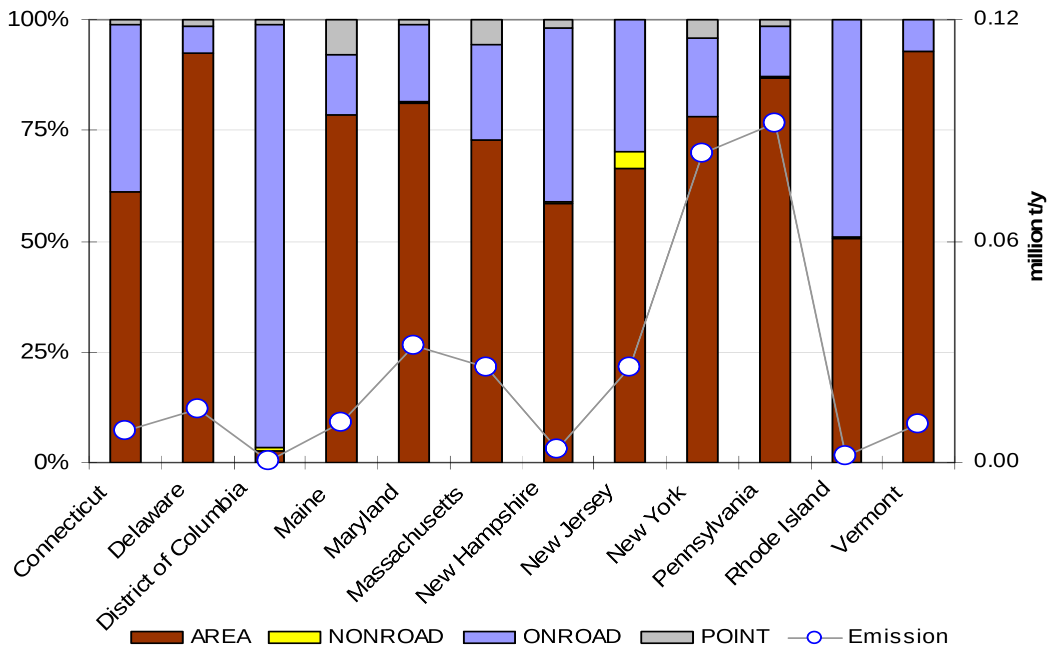
Figure 6.14. State Level Ammonia Emissions



Source: MANE-VU Contribution Assessment, Figure 4-10 (Appendix K)

Area and onroad mobile sources dominate, as found in Figure 6.15.

Figure 6.15. 2002 Annual Anthropogenic NH_3 Emissions by State and Percent by Source Type



Source: MANE-VU Contribution Assessment, Figure 4-11 (Appendix K)

Exhaust from highway vehicles are the major source of ammonia emissions in the District, and as with other pollutants, the emissions from the District are a small portion of the regional total. Except in the District, area source emissions from agricultural sources and livestock production account for the largest share of estimated ammonia emissions in the MANE-VU region. The remaining area sources with a significant emissions contribution is wastewater treatment systems.

6.4. References for Section 6

Ansari, A. S., and Pandis, S.N., "Response of inorganic PM to precursor concentrations," Environ. Sci. Technol., 32, 2706-2714, 1998.

Davidson, C., Strader, R., Pandis, S., and Robinson, A., Preliminary Proposal to MARAMA and NESCAUM: Development of an Ammonia Emissions Inventory for the Mid-Atlantic States and New England. Carnegie Mellon University, Pittsburgh, PA. 7-Jan. 1999.

Coutant, B., Kelly, T., Ma, J., Scott, B., Wood, B., and Main, H. 2002. Source apportionment analysis of air quality monitoring data: Phase I final report. Prepared for the Mid-Atlantic/Northeast Visibility Union and Midwest Regional Planning Organization by Battelle Memorial Institute and Sonoma Technology, Inc.

Duyzer, J., “Dry Deposition of Ammonia and Ammonium Aerosols over Heathland,” J. Geophys. Res., 99(D9):18,757 – 18,763, 1994.

NESCAUM, “Regional Haze and Visibility in the Northeast and Mid-Atlantic States,” January 2001.

NESCAUM, “Development of an Improved Ammonia Emissions Inventory for the United States,” December 2001.

Odum, J.R., Jungkamp, T.P.W., Griffin, R.J., Flagan, R.C., and Seinfeld, J.H., “The Atmospheric Aerosol-forming Potential of Whole Gasoline Vapor,” Science, 276, 96-99, 1997.

Poirot, R.L., P.R. Wishinski, P.K. Hopke and A.V. Polissar, Comparative application of multiple receptor methods to identify aerosol sources in northern Vermont, *Environ. Sci. Technol.* 35: 4622-4636 (2001).

Strader, R., Anderson, N., and Davidson, C., Development of an Ammonia Inventory for the Mid-Atlantic States and New England, Progress Report, October 18, 2000, available online: http://marama.org/rt_center/MARAMAprogress10-18-00.pdf, 2000.

US EPA, National Air Quality and Emission Trends Report, 1998, EPA 454/R-00-003, available online: http://www.epa.gov/oar/aqtrnd98/, 2000a.

US EPA, National Air Pollutant Trends, 1900 – 1998, EPA 454/R-00-002, available online: http://www.epa.gov/ttn/chief/trends/trends98/trends98.pdf, 2000b. EPA 2005, http://www.epa.gov/ttn/chief/eiinformation.html

7. Class I Areas which May be Affected by Emissions from Within the District

Section 51.308(d) of EPA's Regional Haze Rule requires the State to address regional haze in each mandatory Class I Federal area located within the State and in each mandatory Class I Federal area located outside the State which may be affected by emissions from its facilities.

One way to consider which Class I areas are affected by emissions from within the District is to determine which Class I areas are within 300 km. Figure 1.1 illustrates that there are 5 Class I areas within 300 km of the District:

- Shenandoah National Park
- Dolly Sods Wilderness
- Otter Creek Wilderness
- Brigantine Wilderness
- James River Face Wilderness

Shenandoah National Park is within the Blue Ridge mountain range in the southern Appalachians, approximately 75 miles west of the District of Columbia in Virginia. The park contains a mix of diverse habitats, forests and wildlife. The Appalachian Trail, a popular East Coast footpath from Georgia to Maine, meanders through the park. Skyline Drive was built along the mountain crests in the 1930s by the Civilian Conservation Corps. It allows visitors to enjoy views of the peaks and valleys that surround the area.

Dolly Sods Wilderness, part of the Monongahela National Forest in West Virginia, contains wide-open views among high-elevation plateaus. In previous times, these open fields, or "sods", were used for grazing. The wind and boggy soils ultimately made the area uninhabitable. Restoration efforts have since created a diverse wilderness, heavily influenced by being located downstream of a creek through the Allegheny Mountains, considered the eastern continental divide.

Otter Creek Wilderness, very close and similar to Dolly Sods and also within the Monongahela National Forest, lies within a bowl formed by mountains, the confluence of mountain streams, and floods. It is a second-generation forest and recovering habitat, currently managed for wild turkey, black bears, and similar species.

Brigantine Wilderness in New Jersey contains undeveloped barrier beaches, tidal wetlands, and dunes. The nutrient-rich estuarine environment is significant for migrating and wintering birds, including the Federally endangered peregrine falcon and Federally threatened piping plover, and fisheries. Brigantine is part of the Edwin B. Forsythe Wildlife Refuge.

James River Face Wilderness contains a river gorge and typical Appalachian hardwood forest. The longest Virginia river traverses from the Blue Ridge mountains in the west and through the Wilderness towards the Chesapeake Bay. The area contains opportunities for hiking along trails, including the Appalachian Trail, solitude, and enjoyment of the exceptionally diverse vegetation.

7.1. States Affecting Visibility at Class I Areas Near the District

A general view of the areas that impact visibility at Class I areas near the District can be obtained by considering modeling results documented in the *Contribution Assessment.* (Details were presented in the previous section.) REMSAD modeling of the annual average impact of individual state's SO_2 emission sources on the sulfate fraction of $PM_{2.5}$ over the northeastern United States helped identify the most important source regions.

Results of MANE-VU's tagged REMSAD runs on an annual basis indicate that elevated point sources in Pennsylvania, Ohio, and New York contribute significantly to sulfate concentrations at all MANE-VU Class I areas. Northern MANE-VU sites (e.g., Acadia) are more influenced by sources in upper Midwestern states (e.g., Wisconsin and Michigan), whereas sites further south and to the east within MANE-VU like Brigantine are more influenced by sources in more southerly states such as West Virginia, Maryland, and Virginia. Shenandoah, a VISTAS Class I site in the western mountain region of Virginia, appears to be most strongly influenced by sources in Ohio, Pennsylvania, and West Virginia, followed by other nearby Southeast and Midwest states. Section 6 documented analyses conducted by MANE-VU to assess the emissions impact on Class I areas near the District and in MANE-VU.

As a result of MANE-VU's analysis, on June 20, 2007, the MANE-VU states with Class I areas adopted a statement (Appendix V) that became known as the "Ask". It was shared with other RPOs as part of MANE-VU's emissions reduction strategy:

> *STATEMENT OF THE MID-ATLANTIC/ NORTHEAST VISIBILITY UNION (MANE-VU) CONCERNING A REQUEST FOR A COURSE OF ACTION BY STATES OUTSIDE OF MANE-VU TOWARD ASSURING REASONABLE PROGRESS*
>
> *The Federal Clean Air Act and the Regional Haze rule require States that are reasonably anticipated to cause or contribute to impairment of visibility in mandatory Class I Federal areas to implement reasonable measures to reduce visibility impairment within the national parks and wilderness areas designated as mandatory Class I Federal areas. Most pollutants that affect visibility also cause unhealthy concentrations of ozone and fine particles. In order to assure protection of public health and the environment, air pollutant emission reductions required to meet the 2018 reasonable progress goal for regional haze should be achieved as soon as practicable.*
>
> *To address the impact on mandatory Class I Federal areas within the MANE-VU region, the Mid-Atlantic and Northeast States request that States outside of the MANE-VU region that are identified as contributing to visibility impairment in the MANE-VU mandatory Class I Federal areas pursue a course of action designed to assure reasonable progress toward preventing any future, and remedying any existing, impairment of visibility in mandatory Class I Federal areas and to leverage the multi-pollutant benefits that such actions may provide for the protection of public health and the environment. This request for action includes pursuing the adoption and implementation of the following control strategies, as appropriate and necessary:*
>
> - *Timely implementation of BART requirements; and*
> - *A 90 percent or greater reduction in sulfur dioxide (SO_2) emissions from each of the electric generating unit (EGU) stacks identified by MANE-VU (Attachment 1 – comprising a total of 167 stacks – dated June 20, 2007) as reasonably anticipated to cause or contribute to impairment of visibility in each mandatory Class I Federal area in the MANE-VU region. If it is infeasible to achieve that level of reduction from a unit, alternative measures will be pursued in such State; and*

- *The application of reasonable controls on non-EGU sources resulting in a 28 percent reduction in non-EGU SO_2 emissions, relative to on the books, on the way 2018 projections used in regional haze planning, by 2018, which is equivalent to the projected reductions MANE-VU will achieve through its low sulfur fuel oil strategy; and*

- *Continued evaluation of other measures including measures to reduce SO_2 and nitrogen oxide (NO_x) emissions from all coal-burning facilities by 2018 and promulgation of new source performance standards for wood combustion. These measures and other measures identified will be evaluated during the consultation process to determine if they are reasonable.*

This long-term strategy to reduce and prevent regional haze will allow each State up to 10 years to pursue adoption and implementation, of reasonable NO_x and SO_2 control measures.

These strategies are similar to the strategies the MANE-VU region agreed to pursue by 2018, as discussed later in Section 10.6.2 and 10.6.3,.

The District supports this MANE-VU "Ask" of states in other RPOs.

7.2. DC's Contribution to Visibility Impairment in Class I Areas

For all techniques described in the MANE-VU *Contribution Assessment*, the District's contribution to regional haze at nearby Class I areas in 2002 was less than one tenth of a percent of the total modeled sulfate impact. Table 7.1 summarizes the results.

Table 7.1. Percent Annual Average Sulfate Contribution from DC Sources in 2002

Class I Area	Contribution from DC Sources			
	REMSAD	Q/D	CALPUFF (NWS)	CALPUFF (MM5)
Acadia	0.01%	0.01%	0.02%	0.01%
Brigantine	0.04%	0.05%	0.07%	0.07%
Dolly Sods	0.01%	0.02%	0.02%	N.A.
Great Gulf	0.01%	0.01%	0.03%	N.A.
Lye Brook	0.02%	0.02%	0.02%	0.02%
Moosehorn	0.01%	0.01%	0.02%	N.A.
Shenandoah	0.04%	0.09%	0.05%	0.03%

Source: Appendix K (REMSAD: Table 8-1, p. 8-2; Q/D: Table 8-2, p. 8-3; CALPUFF (NWS): Table 8-3, p. 8-4; CALPUFF (MM5): Table 8-4, p. 8-5)

As summarized in Section 6.2, other analysis techniques documented in the *Contribution Assessment* also indicate that the impact of emissions from sources in the District on nearby Class I areas is very small.

8. Reasonable Progress Goals

8.1. Requirement

Since there are no Class I areas within the District of Columbia, the District is not required to establish reasonable progress goals for any Class I areas.

Under 40 CFR Section 51.308 (d)(1)(iv), States with Class I areas must consult with other States as they develop reasonable progress goals for their Class I areas. The rule reads as follows:

> *In developing each reasonable progress goal, the State must consult with those States which may reasonably be anticipated to cause or contribute to visibility impairment in the mandatory Class I Federal area. In any situation in which the State cannot agree with another such State or group of States that a goal provides for reasonable progress, the State must describe in its submittal the actions taken to resolve the disagreement. In reviewing the State's implementation plan submittal, the Administrator will take this information into account in determining whether the State's goal for visibility improvement provides for reasonable progress towards natural visibility conditions.*

As a member of MANE-VU, the District consulted with New Jersey and other MANE-VU Class I states as those states established reasonable progress goals for their Class I areas. MANE-VU also sponsored meetings and conference calls to facilitate consultation with states in the VISTAS RPO, including Virginia and West Virginia. Consultation is discussed in more detail in Section 3.

The District supports the reasonable progress goals set by the MANE-VU Class I states, as well as those set by Virginia and West Virginia through the VISTAS process.

8.2. Relationship to Long-Term Strategy

The reasonable progress goals established for Class I areas represent an estimate of the visibility improvements that will result by 2018 from implementation of a regional long-term strategy for reducing emissions that contribute to visibility impairment. The District of Columbia has agreed with other MANE-VU members to pursue adoption of a coordinated long-term strategy that is expected to result in the achievement of the reasonable progress goals established by states in MANE-VU and by Virginia and West Virginia of the VISTAS region. This coordinated long-term strategy is described in Section 10. Section 10.9 describes the estimated impacts of the District's long-term strategy on visibility.

8.3. Effect of Remand of Clean Air Interstate Rule

All of the reasonable progress goals set for eastern states are based on regional modeling that predicts emissions in 2018, as required by EPA guidance. The emissions projections used in setting reasonable progress goals for the Class I areas potentially affected by emissions from the District assume the implementation of EPA's Clean Air Interstate Rule (CAIR). This rule established a cap and trade program in the eastern United States intended to reduce emissions of SO_2 and NO_x from electricity generating units (EGUs). The rule was issued on March 10, 2005, but on July 11, 2008, the U.S. Court of Appeals for the District of Columbia Circuit vacated the rule. EPA requested a rehearing, and, after reviewing briefs on the issues, on December 23, 2008, the Court decided to remand rather than vacate the rule, allowing CAIR to remain in effect while EPA formulated a replacement rule.

The states with Class I areas potentially affected by emissions from sources in the District have not revised their reasonable progress goals as a result of the remand of CAIR. EPA is developing a replacement rule and is communicating with the states and other stakeholders as it formulates the rule so that it will meet the requirements of the Court while fulfilling the goals of the original CAIR. In the meantime, the original CAIR is in effect. Therefore, the District believes that EPA rules will require substantially similar emissions reductions to those projected for 2018 as the basis of reasonable progress goals.

9. Best Available Retrofit Technology

9.1. Introduction

The Best Available Retrofit Technology (BART) requirement of Section 169A of the Clean Air Act (42 U.S.C.§7491(b)(2)(A)) and implementing rules (40 CFR §51.308(e) and 40 CFR §51 Appendix Y) are intended to reduce emissions specifically from large sources that, due to age, were exempted from other requirements of the Clean Air Act. The District of Columbia is required to submit an implementation plan containing emission limitations representing Best Available Retrofit Technology (BART) and schedules for compliance with BART for each BART-eligible source that may reasonably be anticipated to cause or contribute to any impairment of visibility in any mandatory Class I Federal area, unless it can demonstrate that an emissions trading program or other alternative will achieve greater reasonable progress toward natural visibility conditions. Visibility impairing pollutants are defined by the EPA as sulfur dioxide (SO_2), oxides of nitrogen (NO_x), and particles with an aerodynamic diameter less than or equal to 10 and 2.5 μm (i.e., PM_{10} and $PM_{2.5}$, respectively). (40 CFR Part 51, Appendix Y; 70 Fed. Reg. 39160)

States are required to undertake three key steps to comply with the BART requirements of the Regional Haze Rule:

1. Determine if a source is BART-eligible;
2. Determine if a source reasonably causes or contributes to visibility impairment in any Class I area (is "subject to BART");
3. Determine if additional controls or emission limits are necessary (BART determination).

9.2. BART Eligibility

BART eligibility is based on three conditions. First, it is limited to sources in one of 26 stationary source categories under the Federal Clean Air Act:

1. Fossil-fuel fired steam electric plants of more than 250 million BTUs per hour heat input;
2. Coal cleaning plants (thermal dryers);
3. Kraft pulp mills;
4. Portland cement plants;
5. Primary zinc smelters;
6. Iron and steel mill plants;
7. Primary aluminum ore reduction plants;
8. Primary copper smelters;
9. Municipal incinerators capable of million BTUs per hour heat input, charging more than 250 tons of refuse per day;
10. Hydrofluoric, sulfuric, and nitric acid plants;
11. Petroleum refineries;
12. Lime plants;
13. Phosphate rock processing plants;
14. Coke oven batteries;
15. Sulfur recovery plants;

16. Carbon black plants (furnace process);
17. Primary lead smelters;
18. Fuel conversion plants;
19. Sintering plants;
20. Secondary metal production facilities;
21. Chemical process plants;
22. Fossil-fuel boilers of more than 250 million BTUs per hour heat input;
23. Petroleum storage and transfer facilities with a capacity exceeding 300,000 barrels;
24. Taconite ore processing facilities;
25. Glass fiber processing plants; and
26. Charcoal production facilities.

Second, eligible sources have units installed and operating between 1962 and 1977. Such sources pre-date passage of the Clean Air Act Amendments of 1990, which "grandfathered" some sources from new source review permitting requirements in parts C and D of title I of the Clean Air Act.

Third, eligible sources have a potential to emit of more than 250 tons per year of a visibility impairing pollutant.

9.3 Sources Subject to BART

According to Section III of the 2005 Regional Haze Rule preamble, once the state has compiled its list of BART-eligible sources, it needs to determine whether to make BART determinations for all of the sources or to consider exempting some of them from BART because they may not reasonably be anticipated to cause or contribute to any visibility impairment in a Class I area, such as under the following conditions.

9.3.1. Cap-Outs and Shutdowns

Many potentially BART-eligible sources are relatively small emissions sources with potential emissions that exceed the statutory threshold of 250 tons per year or more, but with actual emissions of visibility impairing pollutants of well under 250 tons in any year. A facility may accept a Federally enforceable permit limitation restricting their potential emissions by law to less than 250 tons per year. In other words, an otherwise BART-eligible facility may "cap-out" to avoid being considered BART-eligible.

9.3.2. Small Source Exemption

According to §51.308(e)(1)(ii)(C) of the Regional Haze Rule, "a State is not required to make a determination of BART for SO_2 or for NO_x if a BART-eligible source has the potential to emit less than 40 tons per year of such pollutant(s), or for PM_{10} if a BART-eligible source emits less than 15 tons per year of such pollutant." A BART-eligible facility may restrict actual emissions to less than these *de minimis* levels using a Federally enforceable permit emission limit, thus making the facility no longer "subject to BART".

9.3.3. CAIR

Section 51.308(e)(2) of the Regional Haze Rule provides that "a State may opt to implement an emissions trading program or other alternative measure rather than to require sources subject to BART to install, operate, and maintain BART. To do so, the State must demonstrate that the emissions trading program or other alternative measure will achieve greater reasonable progress than would be achieved through the installation and operation of BART." To make this demonstration, the State must submit an implementation plan containing the elements listed in Section (e)(2).

Specific criteria for comparing programs were proposed in the BART Guidelines (40 CRF 51, Appendix Y) in 2001. These criteria, sometimes referred to as the "better-than-BART-test", consist of the following. First, if the geographic distribution of emissions reductions from the two programs is expected to be similar, the comparison can be made based on emissions alone. Second, if the distribution of emissions reductions is anticipated to be significantly different, then a two-pronged visibility improvement test is employed. The first prong is that the alternative program must not result in a degradation of visibility at any Class I area. The second prong is that the alternative program must result in greater visibility improvement overall, based on an average across all affected Class I areas.

According to Section IV of the Regional Haze Regulations and Guidelines for Best Available Retrofit Technology (BART) Determinations Preamble,

> *In June 2004, in the Supplemental Notice of Proposed Rulemaking (SNPR) for the Clean Air Interstate Rule (CAIR), we proposed to conclude that the CAIR will achieve greater reasonable progress than would BART for SO_2 and NO_x at BART-eligible EGUs in CAIR affected States and therefore may be treated as a program in lieu of BART for those sources. In doing so, we discussed the Regional Haze Rule Section 308(e)(2) as precedent for the policy of allowing trading programs to substitute for BART. However, noting that the CAIR trading program affected only one category of BART-eligible sources (EGUs), rather than all BART-eligible categories as envisions for State-developed BART-alternative programs under Section 308(e)(2), we proposed adding a 308(e)(3) applicable only to CAIR. This section would provide that States that comply with the CAIR by subjecting EGUs to the EPA administered cap and trade program may consider BART satisfied for NOx and SOx from BART-eligible EGUs. In the CAIR SNPR and supporting documentation, we provided analyses demonstrating that CAIR would achieve greater emission reductions than BART, and would make greater reasonable progress according to the two-pronged visibility test previously proposed in the BART guidelines.*

According to §51.308(e)(4) of the Regional Haze Rule, a State that opts to participate in the CAIR cap and trade program under Part 96AAA-EEE need not require affected BART-eligible EGUs to install operate, and maintain BART.

9.4. BART Determination

According to §51.308(3)(ii)(A), once a source has been identified as BART-eligible and subject to BART, it must conduct an analysis to determine the "best system of continuous emission control technology available and associated emission reductions achievable."

9.4.1. Five-Factor Analysis

Section 169A(g)(7) of the Clean Air Act, as codified in 40 CFR 51.308(e)(1)(ii)(B), directs States to consider five factors in making BART determinations:

- **Step 1 – Identify all available control technologies** for the unit including improvements to existing control equipment or installation of new add-on control equipment.
- **Step 2 – Eliminate technically infeasible options** considering the commercial availability of the technology, space constraints, operating problems and reliability, and adverse side effects on the rest of the facility.
- **Step 3 – Evaluate the control effectiveness** of the remaining technologies based on current pollutant concentrations, flue gas properties and composition, control technology performance, and other factors.
- **Step 4 – Evaluate the annual and incremental costs** of each feasible option in accordance with approved EPA methods, as well as the associated energy and non-air quality environmental impacts.
- **Step 5 – Determine the visibility impairment** associated with baseline emissions **and the visibility improvements** provided by the control technologies considered in the engineering analysis using the EPA-recommended CALPUFF model.

States have flexibility in how they carry out the BART analysis and evaluate the five factors.

9.4.2. BART Compliance

According to §51.308(3)(1)(iv), once the SIP is approved by the EPA, the District may allow the BART facility up to five years to install the appropriate controls and comply with the emission levels which result from the BART determination. Where BART is not already in place, the state can set a compliance date on a case-by-case basis through the operating permit revision process, and with single source SIP revisions. The BART process is discussed in more detail in the *MANE-VU Five-Factor Analysis of BART-Eligible Sources* (Appendix Q).

9.5. Description of BART-Eligible Sources in the District

Based on a review of emissions inventory data, air quality permits, and other data on the air pollution sources, there are two BART-eligible sources in the District located at one facility: the Benning Road Generating Station (BRGS). BRGS is a peaking power plant that meets the electrical demand of the District of Columbia, nearby counties in Maryland, and the mid-Atlantic electric grid. The plant typically operates only during high demand periods (mostly during hot spells in the summer or perhaps during very cold conditions of the winter months).

BRGS has two oil-fired steam generators, Units 15 and 16, which operate to produce electricity, and thus fall under the first of the 26 source categories eligible for BART ("fossil-fuel fired steam electric plants of more than 250 million BTUs per hour heat input"). Units 15 and 16 were installed in 1968 and 1972, respectively, thus meeting the in-service date for BART eligibility, and both have a potential to emit of more than 250 tons per year of a visibility impairing pollutant.

Table 9.1. BART-Eligible Sources in the District of Columbia

Source and Unit	Pollutant	Location	AFS Facility I.D
Oil-fired steam generating unit #15	PM, NO_x, SO_2	PPR Benning Road facility	11/001/00001
Oil-fired steam generating unit #16	PM, NO_x, SO_2	PPR Benning Road facility	11/001/00001

Potomac Power Resources, LLC ("PPR") owns the BRGS. PPR is a wholly owned but unregulated subsidiary of Pepco Energy Services, Inc. ("PES"), which manages the assets of BRGS on behalf of PPR. PES is a subsidiary of Pepco Holdings, Inc. ("PHI"), one of the largest energy delivery companies in the mid-Atlantic region. PHI companies supply energy to PJM Interconnection, LLC ("PJM"), the regional transmission organization that coordinates the movement of wholesale electricity through the regional electricity grid.

9.6. BART for BRGS

Based on the collective importance of BART sources, in June 2004, the MANE-VU Board decided that, "if any source in MANE-VU is eligible for BART, it is also subject to BART (i.e., no exceptions will be given)." As an active participant of MANE-VU, the District agreed to implement the policy decision made by the MANE-VU Board and collaborated with PES, EPA, and the FLMs to explore numerous BART options for BRGS.

- In 2008, the District completed a draft BART analysis that concluded that BART controls were not justified due to cost. The analysis was considered insufficient because it did not include modeling.
- In August of 2008, the District made a formal request to PES to review the BART eligibility criteria in 40 CFR Part 51 and:
  - Provide information to demonstrate that units are not BART-eligible;
  - Consider a permitted emission cap limiting combined emissions from all BART-eligible units to less than 250 tons per year;
  - Accept a Federally enforceable permit condition to shut down; or
  - Conduct a full 5-factor top-down BART analysis for SO_2, NO_x, and PM.

Since BRGS is a peaking plant used specifically during high demand periods when electricity needs are unpredictable, PES has generally been unwilling to accept voluntary caps.

- *CAIR was vacated by the courts on July 11, 2008.*
- On September 2, 2008, PES offered a permit condition to shut down by December 31, 2012. The draft permit condition suggested that if PPR would propose to modify the

permit, they would accept a cap on or after January 1, 2013, until the completion of a BART determination. This was not considered adequate because a BART condition or cap must be in the District's Regional Haze SIP upon submittal and prior to public hearing.

- PES submitted a BART analysis to DDOE on October 9, 2008. EPA and the FLMs reviewed the BART analysis and considered it to be insufficient. DDOE provided feedback to PES on December 18, 2008.
- *CAIR was temporarily remanded on December 23, 2008, until a replacement rule is finalized. The CAIR reinstatement restored the policy of the EPA BART rule (70 FR 39104) to establish CAIR as satisfying the BART requirements for SO_2 and NO_x emissions.*
- A second BART analysis for PM only (not SO_2 or NO_x) was requested.
- PES submitted a second BART analysis to DDOE in April of 2009. EPA and the FLMs reviewed the analysis and considered it to be insufficient. DDOE provided feedback to PES on September 4, 2009.
- On November 13, 2009, the District reiterated PES's options to:
  - Accept a PTE cap of 250 tpy per pollutant;
  - Accept an actual emissions cap of 40 tpy SO_2, 40 tpy NO_x, and 15 tpy PM_{10} (considered *de minimis* levels for getting out of BART);
  - Revise BART and switch fuels by January 2011[6]; or
  - Shut down by the time the SIP is approved.

9.6.1. Two Insufficient BART Analyses

As mentioned, at the District's request, PES submitted two draft BART analyses. Neither was considered to be sufficient to meet BART requirements.

The first analysis primarily failed to analyze all technically feasible control options, and therefore was not considered a full top-down five-factor analysis.

The second analysis assumed a four-year remaining life for the plant, but PES was unwilling to accept an enforceable permit condition to shut down by the presumed closure date of May 2012. They wanted to retain flexibility to remain open to maintain reliability of the grid if necessary. There were also concerns about the accuracy of the $/ton and $/deciview calculations, and about the details of the modeling. Vendor quotes for cost estimates were not included with the analysis. Based on the estimates provided, both EPA and the FLMs expressed interest in fuel switching as a BART option. But, once again, the analysis as written was not considered approvable as part of a SIP submission.

In February of 2010, the District requested that PES provide specific information on what it would take to implement a fuel switch by January 2011.

6 In January of 2009, the District was notified by USEPA of a failure to formally submit a Regional Haze SIP to meet its obligations under the Clean Air Act. They published a rulemaking notice in the Federal Register (74 FR 2392; January 15, 2009) announcing a finding of failure to submit, as required under 40 CFR §51.308. In order to avoid having EPA issue a Federal Implementation Plan (FIP), this SIP needs to be approved by January of 2011.

9.6.2. Grid Reliability

PES's response to DDOE's request for information on what it would take to switch fuels began by reiterating the company's intent to retire the Benning Road Plant as of June 1, 2012. In December of 2007, PJM (operators of the regional electricity grid) received a deactivation notice from PPR (a subsidiary of PES) for most units at Benning Road and nearby Buzzard Point generating stations. The request included deactivating BRGS units 15 and 16 (total 550 MW) by May 31, 2012. At that time, PJM indicated that the Benning Road units would not be needed after May 31, 2012, based on the estimated in-service dates of the transmission system upgrades required to maintain reliability of the regional grid. PJM also indicated that they would communicate any changes to PPR that might allow them to retire units sooner.

In October of 2008, PES shared with DDOE an analysis by PJM, prepared at the request of the Public Service Commission of the District of Columbia ("PSC"), where PJM projected that deactivations would occur by May 31, 2012. In the event of any delay in plans to resolve regional reliability issues, PJM suggested that they could make small-scaled enhancements at existing facilities, use advanced technologies to shift flows as needed, reconfigure the transmission system, or host additional auctions to minimize reliability risk. Any "Reliability-Must-Run" contracts with existing facilities, such as BRGS, would be temporary.
Since that time, PJM and PEPCO (a regulated utility company of PHI) have identified a number of necessary upgrades to the transmission and distribution system to compensate for the shutdown of the Benning Road Plant, which are listed with their status on the PJM website[7]. PES says they have been in contact with both PJM and PEPCO to confirm that the planned upgrades are on schedule. The District also contacted the District's PSC, who informally did not express concern about reliability of the grid due to shutdown of the Benning Road Plant, suggesting also that demand for electricity has gone down because of a current soft economy.

9.6.3. Actions Required to Switch Fuels

In their March 5, 2010, memo to DDOE, PES indicated that implementation of a fuel switch by January 2011 would not be practically feasible due to the following technical and scheduling considerations:

Identify a vendor – According to PES, to successfully complete a fuel conversion, it would be necessary to identify experienced engineering companies to assess the necessary modifications for switching fuels. PES would then begin soliciting bids for an engineering study that would identify parts, equipment, instrumentation, and controls that would need to be purchased or modified. Equipment changes would lead to changes in current operations and maintenance procedures, changes to fuel oil purchase and delivery contracts, and re-training of plant employees. Time for preparing procedures and re-training employees would also have to be considered in the project schedule. It could take at least three months to identify experienced engineering companies, solicit bids, and select a vendor.

7 The status of PJM grid projects can be found on the PJM Website at: http://www.pjm.com/planning/generation-retirements/gr-summaries.aspx.

Conduct an engineering study – Then, PES estimates that it would take approximately four weeks for a consulting company to complete an engineering study for both boilers. This time frame takes into account that the two Benning Units are significantly different, #15 being a Combustion Engineering Tangentially Fired Unit, and #16 being a Babcock & Wilcox Frong and Rear Wall Fired Unit. In addition to requiring more fuel on a volume basis to fire at Maximum Continuous Rating (MCR), the difference in viscosity and resultant flow characteristics would need to be reviewed and compensated for.

Order parts – Following the engineering study, requests for proposals (RFPs) for parts, equipment and controls would be released to vendors for bid. A due date would be included for vendor bids to be considered. Once bids are received, they would be reviewed by on-site personnel as well as the engineer performing the study to assure that all parts, equipment and controls are compatible with the recommendations of the engineer. Once a vendor is selected and purchase orders (POs) are issued, it would likely take 8 to 12 weeks for equipment to be delivered to the site. This assumption is based on typical delivery times for equipment the size of Booster Pumps, which is a larger piece of equipment that provides fuel at the appropriate pressure to the burner tip.

Install equipment – After equipment is received, the process of setting equipment (rough-in piping, trim piping, foundations, supports, controls, conduits, insulation, etc), detailed fitting, installing controls, and making final cut-ins could occur. PES estimates that installation would take approximately 20 weeks to complete.

A key issue identified by PES is how a break in work would impact the installation of parts. During the summer (June 1 to August 31) and winter (December 1 to February 28) operating months, under contract, PJM requires the availability of the Benning Road Plant. Work related to a retrofit that would potentially compromise unit availability cannot be performed because incidental forced outages could have significant financial consequences. The majority of this work can only be performed in the spring (March 1 to May 31) or fall (September 1 to November 30) under a "Planned Outage" granted for approval by PJM. It is possible that some work, such as rough-in piping, could be performed during a winter or summer operating season, provided the work does not compromise unit availability.

Since the duration of a planned outage is approximately 12 weeks, all of the work (estimated at 20 weeks) cannot be performed during one planned outage. The engineering study would have to address how or if the work could be performed in stages without affecting unit availability.

Test equipment – Once construction is finished, commissioning, testing, troubleshooting and tuning can be started. The project would be considered "complete" once all parts, equipment, and controls demonstrate safe and reliable operation at MCR of 275 MW Net.

PES anticipates that the project duration, from commissioning an engineering study to completion and to accommodate a summer or winter operating season, would be more than 400 days.

9.6.4. The District's Decision to Exempt PES from BART for PM

On November 30, 2009, PES verbally offered to either accept a permit condition to shut down or switch to ultra-low sulfur diesel (ULSD) fuel by June 1, 2013.

On April 7, 2010, DDOE and PES met to discuss a permit condition to shut down units 15 and 16 by December 17, 2012. In the District's view, this action would exclude BRGS from service by the time the Regional Haze Rule states that BART would need to be in place.

According to the Regional Haze Rule (§51.308(b)), regional haze SIPs were due by December 17, 2007. Closure of the BART-eligible units would meet the intent of the rule: that BART be in place "as expeditiously as practicable but **no later than 5 years after EPA approves the SIP**". In fact, closure would occur no later than 5 years after the SIP would have been due, which would technically occur prior to EPA approval. The permit condition would be in the SIP at the time of submittal.

Based on 51.308(e)(1)(ii)(C), this arrangement would exempt units 15 and 16 from any triggered BART requirements. It would mean that BRGS is no longer BART-eligible.

In the same permit condition, PES has agreed that if BRGS continues to operate after December 17, 2012, they will accept *de minimis* caps on actual emissions of PM_{10} of 15 tons per year. The caps would occur on units 15 and 16.

In other words, if BRGS remains open after December 17, 2012, and therefore is BART-eligible, the District has decided to exempt the facility from the BART requirement based on their acceptance of the *de minimis* cap. States are not required to consider less than *de minimis* emissions when deciding whether a facility is "subject to BART".

According to Part III(C) of the Regional Haze Rule preamble:

> *We believe that it is reasonable to give states the flexibility to establish de minimis levels so as to allow them to exempt from the BART determination process pollutants emitted at very low levels from BART-eligible sources.*

The District took great strides towards obtaining a suitable BART analysis, and believes that this final arrangement meets the intent of the Regional Haze Rule and MANE-VU's BART policy. Although it can be argued that action to reduce emissions from units 15 and 16 would not take place "as expeditiously as practicable", the District believes that concluding plant operations is a workable solution to a long, collaborative, and complicated process involving multiple parties. As demonstrated in the emissions inventories, the District's point source contributions to visibility impairment at nearby Class I areas is minimal. Emissions reductions would exceed those established in the reasonable progress goals, as required to meet MANE-VU's long-term strategy.

9.6.5. CAIR Equals BART for SO_2 and NO_x

The BART-eligible electricity generating units (EGUs) in MANE-VU represent the largest emissions reduction potential among the various BART-eligible source categories. The population of BART-eligible EGUs within the MANE-VU domain can be broadly divided into four groups.

- CAIR States (year-round): Those in states eligible for participation in the EPA Clean Air Interstate Rule (CAIR) program on a year round basis (Delaware, District of Columbia, Maryland, New Jersey, New York, and Pennsylvania for SO_2 and NO_x),
- CAIR States (seasonal): Those in states that participate in the seasonal CAIR program only (Connecticut and Massachusetts for summertime NO_x), and
- Opt-out States: Those in states that are not eligible to participate in the annual CAIR program and choose not to participate in the seasonal CAIR program (Rhode Island and New Hampshire), and
- Non-CAIR States: Those in states which are not eligible to participate in the CAIR program (Maine and Vermont).

By requiring a large number of eastern states to reduce emissions of these pollutants from EGUs, the level of transported sulfate and nitrate fine particulate matter as well as ground-level ozone and precursor pollutants is anticipated to be greatly reduced.

EPA has stated that a state's participation in the CAIR program will serve as BART for BART-eligible EGUs that are also subject to the CAIR provisions. The District of Columbia is using its participation in CAIR to exempt Units 15 and 16 from BART for SO_2 and NO_x.

10. Long-Term Strategy

10.1. Requirement for Long-Term Strategy

Under the Clean Air Act, regional haze SIPs must contain measures to make reasonable progress toward the goal of achieving natural visibility. Title 40 CFR Section 51.308(d)(3) of the Regional Haze Rule requires each State submitting a SIP to also submit a long-term strategy that addresses regional haze visibility impairment for each mandatory Class I Federal area which may be affected by emissions from within the State.

The long-term strategy must include enforceable emissions limitations, compliance schedules, and other measures necessary to achieve the reasonable progress goals established by the states where the Class I areas are located. Each state containing a Class I area must consult with other states affecting the Class I area to develop coordinated emission management strategies. Each state must demonstrate that it has included all measures necessary to obtain its share of the emission reductions needed to meet the reasonable progress goals for the Class I areas which are affected by emissions from within the state. A state participating in a regional planning process must include measures needed to achieve its obligations agreed upon through that process.

Section 110(a)(2)D)(i)(II) of the Clean Air Act requires States to include provisions in their implementation plans to prohibit any source or activity from emitting air pollutants in amounts that would interfere with another State's ability to prevent significant deterioration of air quality and visibility.

The long-term strategy described below includes enforceable emissions limitations, compliance schedules, and other measures necessary to achieve the reasonable progress goals established for Class I areas that may be affected by emissions from sources in the District to the extent that it is reasonable for the District to adopt them before the date this SIP is submitted to EPA. It is designed to protect visibility in areas downwind from the District. Additional measures may be reasonable to adopt at a later date after further consideration and review.

As noted in Sections 6 and 7, emissions from sources in the District contribute a small amount to visibility impairment in any downwind Class I areas.

10.2. Documentation of Technical Basis for the District's Emission Reduction Obligations

Title 40 CFR Section 51.308(d)(3)(iii) requires each State submitting a SIP to document the technical basis for the State's apportionment of emission reductions necessary to meet reasonable progress goals in each Class I area affected by the State's emissions.

The District relied on technical analyses developed by MANE-VU to demonstrate that the District's anticipated emission reductions, when coordinated with those of other states and tribes, are sufficient to achieve reasonable progress goals in Class I areas.

MANE-VU's technical documentation of the emission reductions necessary to meet reasonable progress goals in each Class I area is summarized in this SIP and further supported by the following documents:

- *The Nature of the Fine Particle and Regional Haze Air Quality Problems in the MANE-VU Region: A Conceptual Description* (Appendix O)
- *Baseline and Natural Background Visibility Conditions—Considerations and Proposed Approach to the Calculation of Baseline and Natural Background Visibility Conditions at MANE-VU Class I Areas* (Appendix J)
- *Contributions to Regional Haze in the Northeast and Mid-Atlantic United States* (Appendix K)
- *Assessment of Reasonable Progress for Regional Haze in MANE-VU Class I Areas* (called the *Reasonable Progress Report*) (Appendix P)
- *Five-Factor Analysis of BART-Eligible Sources: Survey of Options for Conducting BART Determinations* (Appendix Q)
- *Assessment of Control Technology Options for BART-Eligible Sources: Steam Electric Boilers, Industrial Boilers, Cement Plants and Paper and Pulp Facilities* (Appendix R)
- *MANE-VU Modeling for Reasonable Progress Goals: Model Performance Evaluation, Pollution Apportionment, and Control Measure Benefits* (Appendix H)
- *2018 Visibility Projections* (Appendix I)

In addition, the District relied on analysis conducted by neighboring RPOs, including the following documents, which are available upon request but are not incorporated into this SIP:

- *VISTAS Reasonable Progress Analysis Plan*, dated September 18, 2006
- *Reasonable Progress for Class I Areas in the Northern Midwest-Factor Analysis*, by EC/R, dated July 18, 2007

10.3. Overview of the Long-Term Strategy Development Process

The District participated in the MANE-VU regional strategy development process, which identified reasonable measures that would reduce emissions contributing to visibility impairment in Class I areas by 2018 or earlier. As a participant in MANE-VU, the District supported a regional approach towards deciding which control measures to pursue for regional haze. This regional approach was based on technical analyses documented in the following reports:

- *Contributions to Regional Haze in the Northeast and Mid-Atlantic United States* (Appendix K)
- *Assessment of Reasonable Progress for Regional Haze in MANE-VU Class I Areas* (Appendix P)
- *Five-Factor Analysis of BART-Eligible Sources: Survey of Options for Conducting BART Determinations* (Appendix Q)
- *Assessment of Control Technology Options for BART-Eligible Sources: Steam Electric Boilers, Industrial Boilers, Cement Plants and Paper and Pulp Facilities* (Appendix R)

The MANE-VU regional strategy development process identified reasonable measures that would reduce emissions contributing to visibility impairment at Class I areas affected by emissions from within the MANE-VU region by 2018 or earlier. Section 10.4 describes the process of identifying potential emission reduction strategies.

MANE-VU reviewed a wide range of potential control measures aimed at reducing regional haze by 2018. The process of choosing a set of proposed regional haze control measures started in late 2005 in conjunction with efforts to identify measures to reduce ozone pollution. The Ozone Transport Commission (OTC), of which the District is a member, selected a contracting firm to assist with the analysis of ozone and regional haze control measure options. OTC provided the contractor with a "master list" of some 900 potential control measures, based on experience and previous state implementation plan work. With the help of an OTC control measure workgroup, the contractor also identified available regional haze control measures for MANE-VU's further consideration.

MANE-VU then developed an interim list of control measures for regional haze, which included: beyond-CAIR sulfate reductions from electricity generating units (EGUs), low-sulfur heating oil (residential and commercial), and controls on ICI boilers (both coal and oil-fired), lime and cement kilns, residential wood combustion, and outdoor burning (including outdoor wood boilers).

The next step in the regional haze control measure selection process was to further refine the interim list. The CAIR Plus Report[8] documents the analysis of the cost of additional SO_2 and NO_x controls at EGUs in the Eastern U.S. The *Reasonable Progress Report* (Appendix P) documents the assessment of control measures for EGUs and the other source categories selected for analysis. Further analysis is provided in the NESCAUM document entitled, "*Assessment of Control Technology Options for BART-Eligible Sources: Steam Electric Boilers, Industrial Boilers, Cement Plants and Paper and Pulp Facilities*" (Appendix R). Highlights of these detailed analyses are provided below.

The beyond-CAIR EGU strategy continued to be considered, since EGU sulfate emissions have, by far, the largest impact on visibility in the MANE-VU Class I areas. Likewise, a low-sulfur oil strategy gained traction after NESCAUM initiated a conference with stakeholders, where refiners and fuel-oil suppliers concluded that such a strategy could realistically be implemented in the 2014 timeframe. The low-sulfur heating oil and the oil-fired ICI boiler sector control measures merged into an overall low-sulfur oil regional strategy for #2, #4, and #6 residual oils for both the residential and commercial heating and oil-fired ICI boiler source sectors.

During MANE-VU's internal consultation meeting in March 2007, the District and other member states reviewed the interim list of control measures to make further refinements. States determined, for example, that there may be too few coal-fired ICI boilers in the MANE-VU states for an ICI boiler control strategy to be considered as a "regional" strategy, but ICI boiler controls could be pursued by individual states. MANE-VU states also determined that lime and cement kilns, of which there are few in the MANE-VU region, would likely be handled via the

8 Prepared by ICF Resources, L.L.C., for MARAMA, *Comparison of CAIR and CAIR Plus Proposal using the Integrated Planning Model (IPM®),* May 30, 2007. Can be accessed at: http://www.marama.org/visibility/CAIR/CAIR_CAIRPlus_FDReport_053007v1.pdf.

BART determination process. Residential wood burning and outdoor wood boilers remained on the list for those states where localized visibility impacts may be of concern even though emissions from these sources are primarily organic carbon and direct particulate matter. Finally, outdoor wood burning was determined to also be better left as a sector to be examined further by individual states, due to issues of enforceability and penetration of existing state regulations.

10.4. Key Anthropogenic Sources of Visibility Impairment

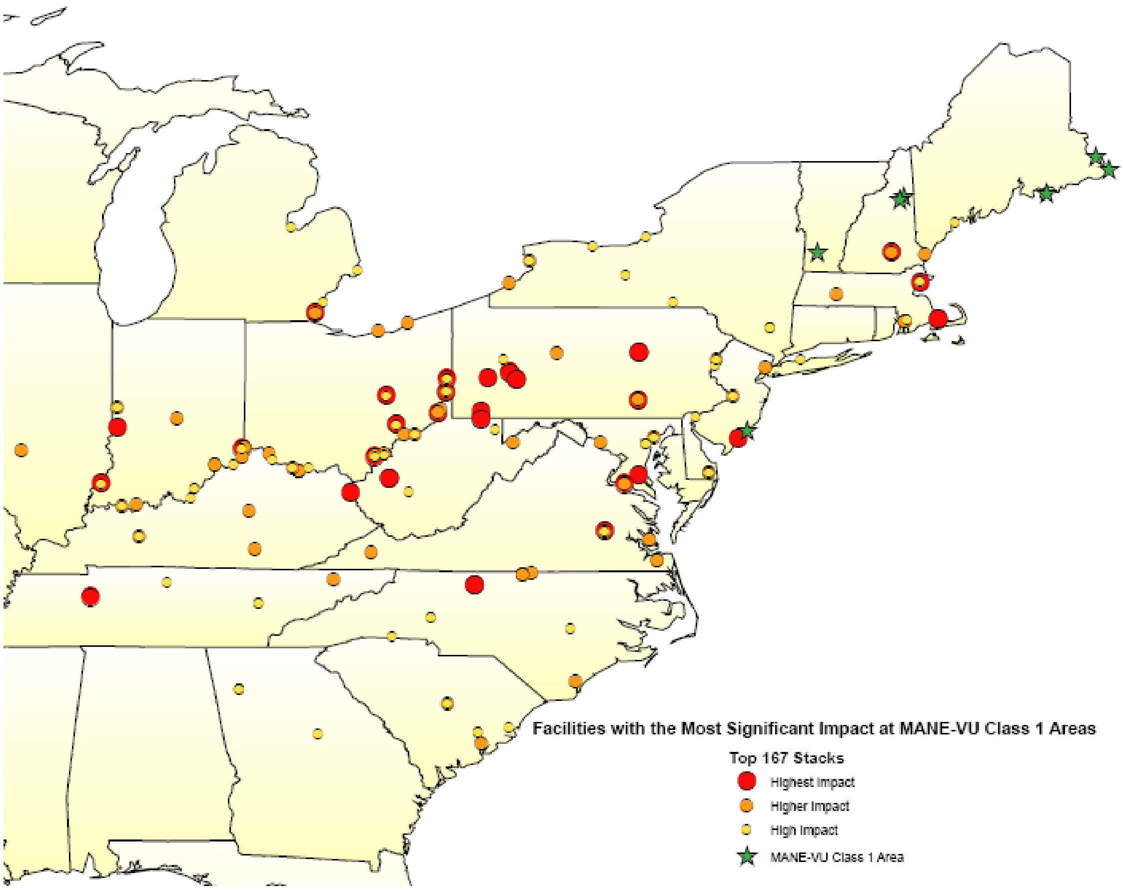
Title 40 CFR Section 51.308(d)(3)(iv) requires the District to identify all anthropogenic sources of visibility impairment considered in developing the long-term strategy.

10.4.1. Sources of SO_2 Emissions

For the reasons described in Section 6.1, the emphasis in developing this SIP was placed on sources of SO_2. Emissions inventory analysis summarized in Section 6.3 shows that point sources dominated the regional 2002 inventory of SO_2 emissions, except in the District, where area sources (primarily commercial and residential heating, and smaller industrial facilities) contributed most to SO_2 emissions. Additional SO_2 source categories analyzed include oil-fired installations at residential, commercial, institutional, or industrial facilities; industrial, commercial, and institutional (ICI) boilers; and cement and lime kilns.

Roughly 70 percent of the 2.3 million tons of SO_2 emission in the 2002 MANE-VU emissions inventory Version 3.0 were from EGUs, making them the largest SO_2 source category in terms of visibility impairing emissions. MANE-VU found through modeling analysis documented in the *Contribution Assessment* (Appendix K) that emissions from specific EGUs were important contributors to visibility impairment in MANE-VU Class I areas in 2002. Figure 10.1 shows the locations of 167 EGU stacks that impair visibility at one or more MANE-VU Class I area. Note that all identified stacks are in the United States, but not all of are in MANE-VU. Some of the stacks identified as important were outside the states identified as contributing at least 2 percent of the sulfate at MANE-VU Class I areas; these were dropped from the list. None of the 167 stacks are located in the District.

Figure 10.1. 167 EGU Stacks Affecting MANE-VU Class I Area(s)



The list of these sources is found in Appendix A of the report *Documentation of 2018 Emissions from EGUs* (Appendix F).

10.4.2. Sources of Other Pollutants

As discussed in Section 6.3, VOCs in the MANE-VU region primarily come from area and onroad mobile sources. Area sources include solvents, architectural coatings, and dry cleaners. NO_x emissions are primarily from power plants and mobile sources. Mobile sources dominate the NO_x inventories for more urbanized parts of the region, including the District. Primary particulate matter (PM_{10} and $PM_{2.5}$) originates mostly from area sources such as construction activities, paved and unpaved roads, and agricultural tilling. Ammonia emissions in the District are primarily from highway vehicles, but throughout the region also come from agricultural sources and livestock production.

Source apportionment documented in Appendix B of the MANE-VU *Contribution Assessment* (Appendix K) also identified biomass combustion as a local source contributing to visibility impairment. Wood smoke is discussed more in Section 10.8.2.

10.5. Emission Reductions Due to Ongoing Air Pollution Programs

Title 40 CFR 51.308(d)(3)(v)(A) requires States to consider emission reductions from ongoing pollution control programs. In developing the long-term strategy, the MANE-VU and the District considered emission control programs being implemented between 2002 and 2018, as discussed below. Significant emissions control programs will be implemented by 2018.

MANE-VU developed a future base case scenario that included emissions growth and control measures that were either already "on the books" (promulgated as of June 15, 2005) or were considered well "on the way" to being implemented because they were proposed but not yet final (OTB/W).

MANE-VU's 2018 "beyond on the way" (BOTW) inventory was developed based on the MANE-VU 2002 Version 3.0 inventory and the MANE-VU 2018 OTB/W inventory. Inventories used for other RPOs also reflect anticipated emissions controls that will be in place by 2018. The inventory is termed "beyond on the way" because it includes control measures that were developed for ozone SIPs which were not yet on the books in some states. For some states, it also included controls that were under consideration for regional haze SIPs that have not yet been adopted. More information may be found in Section 4 and in the following documents:

- *Development of Emissions Projections for 2009, 2012, and 2018 for Non-EGU Point, Area, and Nonroad Sources in the MANE-VU Region* (Appendix E)
- *Documentation of 2018 Emissions from Electric Generating Units in the Eastern U.S. for MANE-VU's Regional Haze Modeling* (Appendix F)
- *MANE-VU Modeling for Reasonable Progress Goals: Model Performance Evaluation, Pollution Apportionment, and Control Measure Benefits* (Appendix H)
- *2018 Visibility Projections* (Appendix I)

10.5.1. EGU Emissions Controls Expected by 2018 Due to Ongoing Air Pollution Control Programs

The following EGU emissions control strategies other MANE-VU states are to be in place by 2018:

Clean Air Interstate Rule (CAIR). CAIR was intended to permanently cap emissions of sulfur dioxide (SO_2) and nitrogen oxides (NO_x) in the eastern United States by 2015. When fully implemented, CAIR would have reduced SO_2 emissions in the CAIR region by more than 70 percent and NO_x emissions by more than 60 percent from 2003 levels. As noted previously, EPA is developing a new rule to replace CAIR, which is expected to provide emission reduction benefits similar to those estimated for CAIR.

The IPM® model was used to predict future emissions from EGUs after implementation of CAIR.[9] Modifications to the output of IPM® made to better represent anticipated controls are

[9] Although the IPM® model runs also anticipated the implementation of EPA's Clean Air Mercury Rule (CAMR), that rule has since been vacated by the courts. However, it is anticipated the adjustments to the predicted SO_2

described in the report *Documentation of 2018 Emissions from Electric Generating Units* (Appendix F). Controls considered in making these modifications include the following:

Delaware EGU Regulations: Delaware adopted the following regulations governing EGU emissions:

1. *Reg. 1144, Control of Stationary Generator Emissions*, SO_2, PM, VOC and NO_x emission control, State-wide, Effective January 2006.
2. *Reg. 1146, EGUs, Electric Generating Unit (EGU) Multi-Pollutant Regulation,* SO_2 and NO_x emission control, State-wide, Effective December 2007. SO_2 reductions will be more than regulation specifies
3. *Regulation No. 1148, Control of Stationary Combustion Turbine Electric Generating Unit Emissions*, SO_2, NO_x and $PM_{2.5}$ emission control, State-wide, Effective January 2007.

Delaware estimates that these regulations will result in the following emission reductions for affected units:

- SO_2 2002 levels of 32,630 to 8,137 in 2018 (75 percent)
- NO_x 2002 levels of 8,735 to 3,740 in 2018 (57 percent)

Delaware Consent Decree: Valero Refinery Delaware City, DE (formerly Motiva, Valero Enterprises). 2002 SO_2 levels of 29,747 will drop to 608 in 2018 (98 percent). NO_x 2002 levels of 1,022 will fall to 102 in 2018 (90 percent).

Massachusetts EGU Regulations: Based on the Massachusetts Department of Environmental Protection's 310 CMR 7.29, *Emissions Standards for Power Plants,* adopted in 2001, six of the largest fossil fuel-fired power plants in Massachusetts must comply with emissions limitations for NO_x, SO_2, mercury, and CO_2. These regulations will achieve an approximately 50 percent reduction in NO_x emissions and 50 to 75 percent reduction in SO_2 emissions compared to previous emissions. Depending upon the compliance path selected by the affected facilities, the facilities will comply with the output-based NO_x and SO_2 standards between 2004 and 2008.

North Carolina Clean Smokestacks Act: Under the act, enacted in 2002, coal-fired power plants (EGUs) in North Carolina must achieve a 77 percent cut in nitrogen oxide (NO_x) emissions by 2009 and a 73 percent cut in sulfur dioxide (SO_2) emissions by 2013. This legislation establishes annual caps on both SO_2 and NO_x emissions for the two primary utility companies in North Carolina, Duke Energy and Progress Energy. These reductions must be made in North Carolina, and allowances are not saleable.

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emissions from electric generating units (EGUs) used in the air quality modeling, which were based on state-specific comments on the amount of SO_2 controls that will actually be installed due to state specific regulations and the EPA's CAIR rule, will have more of an impact on the air quality modeling analysis conducted for this SIP than the vacature of the CAMR rule. MANE-VU believes the adjustments based on state-specific comments improved the reliability of the inventory and made the modeling results more dependable.

Consent Agreements in the VISTAS region: The impact of the following consent agreements in the VISTAS states was reflected in the emissions inventory used for those states:

- Santee Cooper: A 2004 consent agreement calls for Santee Cooper in South Carolina to install and commence operation of continuous emission control equipment for PM/SO_2/NO_x emissions; comply with system-wide annual PM/SO_2/NO_x emissions limits; agree not to buy, sell or trade SO_2/NO_x allowances allocated to Santee Cooper System as a result of said agreement; and to comply with emission unit limits of said agreement.
- TECO: Under a settlement agreement, by 2008, Tampa Electric in the state of Florida will install permanent emissions-control equipment to meet stringent pollution limits; implement a series of interim pollution-reduction measures to reduce emissions while the permanent controls are designed and installed; and retire pollution emission allowances that Tampa Electric or others could use, or sell to others, to emit additional NO_x, SO_2 and PM.
- VEPCO: Virginia Electric and Power Co. agreed to spend $1.2 billion between by 2013 to eliminate 237,000 tons of SO_2 and NO_x emissions each year from eight coal-fired electricity generating plants in Virginia and West Virginia.
- Gulf Power 7: A 2002 agreement calls for Gulf Power to upgrade its operation to cut NO_x emission rates by 61 percent at its Crest 7 generating plant by 2007 with major reductions beginning in early 2005. The Crest plant is a significant source of nitrogen oxide emissions in the Pensacola Florida area.
- EKPC: A July 2, 2007 consent agreement between the EPA and East Kentucky Power Cooperative requires the utility to reduce its emissions of SO_2 by 54,000 tons per year and its emissions of NO_x by 8,000 tons per year, by installing and operating selective catalytic reduction (SCR) technology; low-NO_x burners, and PM and mercury Continuous Emissions Monitors at the utility's Spurlock, Dale and Cooper Plants. According to the EPA, total emissions from the plants will decrease between 50 and 75 percent from 2005 levels. As with all Federal consent decrees, EKPC is precluded from using reductions required under other programs, such as CAIR, to meet the reduction requirements of the consent decree. EKPC is expected to spend $654 million to install pollution controls.
- AEP: American Electric Power agreed to spend $4.6 billion dollars to eliminate 72,000 tons of NO_x emissions each year by 2016 and 174,000 tons of SO_2 emissions each year by 2018 from sixteen plants located in Indiana, Kentucky, Ohio, Virginia and West Virginia.

CAIR was included in visibility modeling runs for the District.

10.5.2. Non-EGU Point Source Controls Expected by 2018 Due to Ongoing Air Pollution Control Programs

As discussed in Section 4.1.2, control factors were applied to the 2018 MANE-VU inventory to represent the following OTB/W national, regional, or state control measures:

- NO_x SIP Call Phase I (NO_x Budget Trading Program)
- NO_x SIP Call Phase II
- NO_x RACT in 1-hour Ozone SIPs
- NO_x OTC 2001 Model Rule for ICI Boilers
- 2-, 4-, 7-, and 10-year MACT Standards
- Combustion Turbine and RICE MACT
- Industrial Boiler/Process Heater MACT[10]
- EPA's Refinery Enforcement Initiative

Only the NO_x SIP Call Phase I was considered implemented in the District.

In addition, states provided specific control measure information about specific sources or regulatory programs in their state. MANE-VU used the state-specific data to the extent it was available.

For specific states, the measures included in this analysis reduce emissions for the following pollutants and non-EGU point source categories due to strategies developed for purposes of reducing ozone in the Ozone Transport Region (OTR). These measures were included in the BOTW inventory for the states identified:

- NO_x measures:
  - Asphalt production plants in CT, DC, NJ, and NY;
  - Cement kilns in ME, MD, NY, PA;
  - Glass and fiberglass furnaces in ME, MD, NY, PA;
- VOC measure: adhesives and sealants application (all MANE-VU states except NJ and VT).

Asphalt production plants and adhesives and sealants applications were considered implemented for the District for the purposes of modeling.

For other regions, MANE-VU used inventories developed by the RPOs for those regions, including VISTAS Base G2, Moro's Base K, and Conrad's emissions inventory. (Emissions for Central states in the MANE-VU modeling domain were taken from the VISTAS Base G2 inventory.)

Non-EGU source controls incorporated into the modeling included the following consent agreements reflected in the VISTAS inventory:

[10] The inventory was prepared before the MACT for Industrial Boilers and Process Heaters was vacated. Control efficiency was assumed to be at 4 percent for SO_2 and 40 percent for PM.

- DuPont: A 2007 agreement calls for E. I. DuPont Nemours & Company's James River plant to install dual absorption pollution control equipment by September 1, 2009, resulting in emission reductions of approximately 1,000 tons SO_2 annually. The James River plant is a non-EGU located in the state of Virginia.
- Stone Container: A 2004 agreement calls for the West Point Paper Mill in Virginia owned by Smurfit/Stone Container to control with a wet scrubber the SO_2 emissions of the #8 Power Boiler. This control device should result in reductions of over 3,500 tons of SO_2 in 2018.

10.5.3. Area Sources Controls Expected by 2018 Due to Ongoing Air Pollution Control Programs

For area sources within MANE-VU, the District relied on MANE-VU's Version 3.0 Emissions Inventory for 2002. In general, the 2018 inventory for area sources was developed by MANE-VU applying growth and control factors to the 2002 Version 3.0 inventory. OTB/W area source control factors were developed for the following national or regional control measures:

- OTC VOC Model Rules
- Federal On-board Vapor Recovery
- New Jersey Post-2002 Area Source Controls
- Residential Woodstove NSPS

The following additional BOTW control measures were included in the 2018 analysis to reduce VOC emissions for the following area source categories for some states (as identified below):

- Adhesives and sealants (controls added in all MANE-VU states except VT),
- Emulsified and cutback asphalt paving (controls added in all MANE-VU states except DE, ME, and VT),
- Consumer products (controls added in all MANE-VU states except VT), and
- Portable fuel containers (controls added in all MANE-VU states except VT);

All of these measures were applied for the District.

After release of Version 3.0 of the MANE-VU 2002 inventory, Massachusetts revised their inventory of area source heating oil emissions due to two changes: (1) The sulfur percent used to derive the emissions factors was adjusted from 1.0 to 0.3; and (2) use of the latest DOE-EIA 2002 fuel use data instead of the previous version used 2001. These two changes significantly altered the 2002 SO_2 emissions for area source heating oil combustion. Massachusetts provided revised 2002 PE and EM tables, which MACTEC used in preparing the 2009/2012/2018 projection inventories

The District of Columbia discovered a gross error in the 2002 residential, non-residential and roadway construction. As requested by the District, the following values were used for the 2002 base year as the basis for the 2009/2012/2018 projections:

Table 10.1. Corrected Emissions from the District of Columbia

Source Classification Code	Pollutant Code	2002 Annual Emissions (tpy)
2311010000 Residential Construction	PM_{10}-PRI	8.2933
	$PM_{2.5}$-PRI	1.6587
2311020000 Indust/Comm/Inst Const	PM_{10}-PRI	486.1951
	$PM_{2.5}$-PRI	97.239
2311030000 Road Construction	PM_{10}-PRI	289.8579
	$PM_{2.5}$-PRI	57.9716

As noted above, the inventory information used for other regions was obtained from those regions' RPOs.

10.5.4. Controls on Nonroad Sources Expected by 2018 due to Ongoing Air Pollution Control Programs

The District used Version 3.0 of the MANE-VU 2002 Emissions Inventory. The nonroad source control incorporated into the modeling was:

Nonroad Diesel Rule. This rule (http://www/epa/gov/nonroaddiesel/) sets standards that will reduce emissions by more than 90 percent from nonroad diesel equipment, and reduce sulfur levels by 99 percent from current levels in nonroad diesel fuel starting in 2007. This step will apply to most nonroad diesel fuel in 2010 and to fuel used in locomotives and marine vessels in 2012.

Since this was a Federal measure and is Federally enforceable, it was included in MANE-VU modeling for the District.

10.5.5. Mobile Source Controls Expected by 2018 due to Ongoing Air Pollution Control Programs

Mobile source controls incorporated into the modeling include the following:

Heavy Duty Diesel (2007) Engine Standard. EPA set a PM emissions standard for new heavy-duty engines of 0.01 grams per brake-horsepower-hour (g/bhp-hr), to take full effect for diesel engines in the 2007 model year. This rule also includes standards for NO_x and non-methane hydrocarbons (NMHC) of 0.20 g/bhp-hr and 0.14 g/bhp-hr, respectively. These NO_x and NMHC standards will be phased in together between 2007 and 2010 for diesel engines.

Sulfur in diesel fuel must be lowered to enable modern pollution-control technology to be effective on these trucks and buses. EPA will require a 97 percent reduction in the sulfur content of highway diesel fuel from its current level of 500 parts per million (low sulfur diesel, or LSD) to 15 parts per million (ultra-low sulfur diesel, or ULSD).

Tier 2 Motor Vehicle Standards. Tier 2 is a fleet averaging program, modeled after the California LEV II standards. Manufacturers can produce vehicles with emissions ranging from relatively dirty to zero, but the mix of vehicles a manufacturer sells each year must have average NO_x

emissions below a specified value. Tier 2 standards became effective in the 2005 model year and are included in the assumptions used for calculating mobile source emissions inventories used for 2018.

Large Spark Ignition and Recreational Vehicle Rule. EPA has adopted new standards for emissions of NO_x, hydrocarbons (HC), and carbon monoxide (CO) from several groups of previously unregulated nonroad engines. Included in these are large industrial spark-ignition engines and recreational vehicles. Nonroad spark-ignition engines are those powered by gasoline, liquid propane, or compressed natural gas rated over 19 kilowatts (kW) (25 horsepower). These engines are used in commercial and industrial applications, including forklifts, electric generators, airport baggage transport vehicles, and a variety of farm and construction applications. Nonroad recreational vehicles include snowmobiles, off-highway motorcycles, and all terrain vehicles. These rules were initially effective in 2004 and were assumed to be fully phased-in by 2012.

All of these measures are Federally enforceable, so were included for the District.

10.6. Additional Reasonable Strategies Considered for MANE-VU's Long-Term Strategy

Title 40 CFR Section 51.308(d)(3)(v) requires States to consider the following four factors to determine which additional emission control measures are needed to make reasonable progress in improving visibility: 1) costs of compliance, 2) time necessary for compliance, 3) energy and non-air quality environmental impacts of compliance, and 4) remaining useful life of any existing source subject to such requirements. The plan must include reasonable measures and identify the visibility improvement that will result from those measures.

10.6.1. Identification of Key Source Categories

Based on available information about emissions and potential impacts, the District accepts the work of the MANE-VU Reasonable Progress Workgroup, which selected the following source categories for detailed analysis of the four factors the Clean Air Act establishes as the basis for determining how much progress in visibility improvement is reasonable:

- Coal and oil-fired Electric Generating Units, (EGUs);
- Point and area source industrial, commercial and institutional boilers;
- Cement kilns;
- Lime kilns;
- The use of heating oil; and
- Residential wood combustion and open burning.

Prior to making this determination, the District worked with other members of the OTC and MANE-VU, as described in Section 10.3, to consider a wide variety of potential emission reduction strategies covering a wide range of sources of SO_2 and other pollutants contributing to regional haze.

10.6.2. Analysis of the Four Statutory Factors

The District worked with MANE-VU to analyze the four factors that the Clean Air Act requires be considered in determining whether additional controls are reasonable. The analysis developed for MANE-VU applied the four factors to a series of emission control measures. This analysis is described in detail in the *Reasonable Progress Report* (Appendix P). The *Reasonable Progress Report* summarizes MANE-VU's assessment of pollutants and associated source categories affecting visibility in Class I areas in and near MANE-VU, lists possible control measures for those pollutants and source categories, and develops the requisite four factor analysis. Table 10.2 presents a summary of the four factor analysis for the source categories analyzed in the *Reasonable Progress Report*[11].

[11] Assessment of Reasonable Progress for Regional Haze in MANE-VU Class I Areas by MACTEC

Table 10.2. Summary of Results from the Four Factor Analysis

Source Category	Primary Regional Haze Pollutant	Control Measure(s)	Average Cost in 2006 dollars (per ton of pollutant reduction)	Compliance Timeframe	Energy and Non-Air Quality Environmental Impacts	Remaining Useful Life
Electric Generating Units	SO_2	Switch to a low sulfur coal (generally <1% sulfur), switch to natural gas (virtually 0% sulfur), coal cleaning, Flue Gas Desulfurization (FGD)-Wet, -Spray Dry, or -Dry.	IPM® * v.2.1.9 predicts $775-$1,690. $170-$5,700 based on available literature	2-3 years following SIP submittal	Fuel supply issues, potential permitting issues, reduction in electricity production capacity, wastewater issues	50 years or more
Industrial, Commercial, Institutional Boilers	SO_2	Switch to a low sulfur coal (generally <1% sulfur), switch to natural gas (virtually 0% sulfur), switch to a lower sulfur oil, coal cleaning, combustion control, Flue Gas Desulfurization (FGD)- Wet, -Spray Dry, or -Dry.	$130-$11,000 based on available literature. Depends on size.	2-3 years following SIP submittal	Fuel supply issues, potential permitting issues, control device energy requirements, wastewater issues	10-30 years
Cement and Lime Kilns	SO_2	Fuel switching, Dry Flue Gas Desulfurization-Spray Dryer Absorption (FGD), Wet Flue Gas Desulfurization (FGD), Advanced Flue Gas Desulfurization (FGD).	$1,900-$73,000 based on available literature. Depends on size.	2-3 years following SIP submittal	Control device energy requirements, wastewater issues	10-30 years
Heating Oil	SO_2	Lower the sulfur content in the fuel. Depends on the state.	$550-$750 based on available literature. There is a high uncertainty associated with this cost estimate.	Currently feasible. Capacity issues may influence timeframe for implementation of new fuel standards	Increases in furnace/boiler efficiency, Decreased furnace/boiler maintenance requirements	18-25 years
Residential Wood Combustion	PM	State implementation of NSPS, Ban on resale of uncertified devices, installer training certification or inspection program, pellet stoves, EPA Phase II certified RWC devices, retrofit requirement, accelerated changeover requirement, accelerated changeover inducement.	$0-$10,000 based on available literature	Several years - dependent on mechanism for emission reduction	Reduce greenhouse gas emissions, increase efficiency of combustion device	10-15 years

Guided by this analysis, the list of measures was further refined (see Section 10.3 for details). MANE-VU arrived at a suite of suggested control measures that the MANE-VU states agreed to pursue as a region. The corollary was that the MANE-VU Class I states (Maine, New Hampshire, Vermont, and New Jersey) also asked states outside of MANE-VU that also contribute to visibility impairment to pursue similar strategies for reducing sulfate emissions from source sectors, or equivalent sulfate reductions if not from the source sectors that MANE-VU has identified for its own sulfate reductions. A similar MANE-VU statement to other RPOs, referred to as the "Ask", can be found in Section 7.1.

10.6.3. MANE-VU Statement of June 20, 2007

The reasonable progress goals adopted by the MANE-VU Class I States represent implementation of the regional course of action set forth by MANE-VU on June 20, 2007, and entitled, "*Statement of the Mid-Atlantic/Northeast Visibility Union (MANE-VU) Concerning a Course of Action within MANE-VU toward Assuring Reasonable Progress*." As such, these reasonable progress goals are intended to reflect the pursuit by MANE-VU States of a course of action, including pursuing the adoption and implementation of the following "emission management" strategies, as appropriate and necessary:

1. Timely implementation of BART requirements; and

2. A low sulfur fuel oil strategy in the inner zone States (New Jersey, New York, Delaware, and Pennsylvania, or portions thereof) to reduce the sulfur content of:
   - Distillate oil to 0.05 percent sulfur by weight (500 ppm) by no later than 2012,
   - #4 residual oil to 0.25 percent sulfur by weight by no later than 2012,
   - #6 residual oil to 0.3 – 0.5 percent sulfur by weight by no later than 2012, and
   - Further reduce the sulfur content of distillate oil to 15 ppm by 2016; and

3. A low sulfur fuel oil strategy in the outer zone States (the remainder of the MANE-VU region) to reduce the sulfur content of:
   - Distillate oil to 0.05 percent sulfur by weight (500 ppm) by no later than 2014,
   - #4 residual oil to 0.25 percent-0.50 percent sulfur by weight by no later than 2018,
   - #6 residual oil to no greater than 0.5 percent sulfur by weight by no later than 2018, and
   - Further reduce the sulfur content of distillate oil to 15 ppm by 2018 depending on supply and availability; and

4. A 90 percent or greater reduction in sulfur dioxide (SO_2) emissions from each of the 167 electric generating unit (EGU) stacks identified by MANE-VU as reasonably anticipated to cause or contribute to impairment of visibility in each mandatory Class I Federal area in the MANE-VU region. If it is infeasible to achieve that level of reduction from a unit, alternative measures will be pursued in such State; and

5. Continued evaluation of other control measures including energy efficiency, alternative clean fuels, and other measures to reduce SO_2 and nitrogen oxide (NO_x) emissions from all coal-burning facilities by 2018 and new source performance standards for wood combustion.

This long-term strategy to reduce and prevent regional haze will allow each state up to 10 years to pursue adoption and implementation of reasonable and cost-effective NO_x and SO_2 control measures as appropriate and necessary.

10.6.4. Best Available Retrofit Technology

BART controls are among the reasonable strategies included in this SIP. To assess the impacts of MANE-VU states' implementation of the BART provisions of the Regional Haze Rule, NESCAUM included estimated reductions anticipated for select BART-eligible facilities in the MANE-VU region in the final 2018 CMAQ modeling analysis. A survey of state staff indicated that eight non-CAIR facilities in MANE-VU would likely be controlled under BART alone. These states provided potential control technologies and levels of control, which were in turn incorporated into the 2018 emission inventory projections. Table 10.3 lists affected facilities and emissions assumptions used in the modeling. None of the facilities listed in Table 10.3 are located in the District.

For facilities subject to CAIR, the modeling assumed that CAIR fulfilled the BART requirement for SO_2 and NOx.

Additional visibility benefits are likely to result from installation of controls at other non-CAIR BART-eligible facilities located in adjacent RPOs. These benefits were not accounted for in the MANE-VU modeling, since information about final BART determinations was not available.

BART controls pursued by the District (see Section 9 of this SIP) were not included in the MANE-VU modeling, and therefore would result in additional visibility benefits.

Table 10.3. Estimated Emissions from Non-EGU BART-Eligible Facilities Located in MANE-VU Used in Final Modeling

State	Facility Name	Unit Name	SCC Code	Plant ID (from the MANE-VU Inventory)	Point ID (from the MANE-VU Inventory)	Facility Type	Fuel	2002 Emissions (tons)	2018 Emissions (tons)
MD	EASTALCO ALUMINUM	28	30300101	021-0005	28	Metal Production		1506	1356
MD	EASTALCO ALUMINUM	29	30300101	021-0005	29	Metal Production		1506	1356
MD	LEHIGH PORTLAND CEMENT	39	30500606	013-0012	39	Portland Cement		9	8
MD	LEHIGH PORTLAND CEMENT	16	30500915	021-0003	16	Portland Cement		1321	1,189
MD	LEHIGH PORTLAND CEMENT	17	30500915	021-0003	17	Portland Cement		976	878
MD	WESTVACO FINE PAPERS	2	10200212	001-0011	2	Paper and Pulp		8923	1338
ME	Wyman Station	Boiler 3	10100401	2300500135	004	EGU	Oil	616	308
ME	SAPPI Somerset	Power Boiler #1	10200799	2302500027	001	Paper and Pulp	Oil/ Wood Bark/ Process Gas	2884	1442
ME	IP Jay	Power Boiler #2	10200401	2300700021	002	Paper and Pulp	Oil	3086	1543
ME	IP Jay	Power Boiler #1	10200401	2300700021	001	Paper and Pulp	Oil	2964	1482
NY	KODAK PARK DIVISION	U00015	10200203	8261400205	U00015	Chemical Manufacturer		23798	14216
NY	LAFARGE BUILDING MATERIALS INC	41000	30500706	4012400001	041000	Portland Cement		14800	4440

10.6.5. Low-Sulfur Oil Strategy

The assumption underlying the MANE-VU low-sulfur fuel oil strategy is that refiners can, by 2018, produce home heating and fuel oils that contain 50 percent less sulfur for the heavier grades (#4 and #6 residual), and a minimum of 75 percent and maximum of 99.25 percent less sulfur in #2 fuel oil (also known as home heating oil, distillate, or diesel fuel) at an acceptably small increase in price to the end user. As much as 75 percent of the total sulfur reductions achieved by this strategy come from using the low-sulfur #2 distillate for space heating in the residential and commercial sectors. While costs for these emissions reductions are somewhat uncertain, they appear reasonable in comparison to costs of controlling other sectors as documented in the MANE-VU *Reasonable Progress Report*, estimated at $550 to $750 per ton.

Section 801 of Title 20 District of Columbia Municipal Regulations, Sulfur Content in Fuel Oils, limits sulfur to 1 percent by weight (Appendix U). The District agrees to pursue additional sulfur in fuel measures included in the long-term strategy to determine whether they are reasonable to adopt and implement by 2018 and expects to make that determination in the SIP revision due in five years.

10.6.6. EGU Strategy

MANE-VU identified emissions from 167 stacks at EGU facilities as having visibility impacts in MANE-VU Class I areas that make controlling emissions from those stacks crucial to improving visibility at MANE-VU Class I areas.

MANE-VU's agreed regional approach for this source sector is to pursue a 90 percent control level on SO_2 emissions from these 167 stacks by 2018 as appropriate and necessary. MANE-VU has concluded that pursuing this level of sulfur reduction is both reasonable and cost-effective. Even though current wet scrubber technology can achieve sulfur reductions greater than 95 percent, historically a 90 percent sulfur reduction level includes lower average reductions from dry scrubbing technology. The cost for SO_2 emissions reductions will vary by unit, and the MANE-VU *Reasonable Progress Report* (Appendix P) summarizes the various control methods and costs available, ranging from $170 to $5,700 per ton, with site-specific factors such as size and type of unit, fuels, etc. influencing the cost.

None of the 167 stacks at EGU facilities are located in the District of Columbia.

10.7. Additional Control Measures Considered

In addition, the following control measures have been considered by MANE-VU region:

10.7.1. Source Retirement and Replacement Schedules

Title 40 CFR Section 51.308(d)(3)(v)(D) requires States to consider source retirement and replacement schedules in developing reasonable progress goals. Retirement and replacement must comply with existing Federal requirements, including those pertaining permitting programs such as New Source Review (NSR) and Prevention of Significant Deterioration (PSD), which are not part of this SIP.

Source retirement and replacement were considered in developing the 2018 emissions inventory described in *Development of Emissions Projections for 2009, 2012, and 2018 for Non-EGU Point, Area, and Nonroad Sources in the MANE-VU Region* (Appendix F). None of the sources considered are in the District.

10.7.2. Measures to Mitigate the Impacts of Construction Activities

Section 40 CFR Section 51.308(d)(3)(v)(B) requires States to consider measures to mitigate the impacts of construction activities.

MANE-VU's consideration of measures to mitigate the impacts of construction can be found in the MANE-VU document entitled, *Technical Support Document on Measures to Mitigate the Visibility Impacts of Construction Activities in the MANE-VU Region* (Appendix T).

MANE-VU's *Contribution Assessment* (Appendix K) found that, from a regional haze perspective, crustal material generally does not play a major role. On the 20 percent best visibility days during the 2000 to 2004 baseline period, crustal material accounted for 6 to 11 percent of particle-related light extinction at MANE-VU Class I Areas. On the 20 percent worst-visibility days, however, the ratio was reduced to 2 to 3 percent. Furthermore, the crustal fraction is largely made up of pollutants of natural origin (e.g., soil or sea salt) that are not targeted under the Regional Haze Rule. Nevertheless, the crustal fraction at any given location can be heavily influenced by the proximity of construction activities; and construction activities occurring in the immediate vicinity of MANE-VU Class I Areas could have a noticeable effect on visibility.

Section 605 of Title 20 District of Columbia Municipal Regulations, Control of Fugitive Dust, requires reasonable precautions to minimize emissions of fugitive dust into the atmosphere (Appendix U). Additional measures to mitigate the impact on Class I areas of construction emissions are not needed in the District's SIP.

10.7.3. Agricultural and Forestry Smoke Management

Title 40 CFR Section 51.308(d)(3)(v)(E) requires States to consider smoke management techniques for the purposes of agricultural and forestry management in developing reasonable progress goals.

The MANE-VU *Technical Support Document on Agricultural and Forestry Smoke Management in the MANE-VU Region* (Appendix S) concluded that fire from land management activities was not a major contributor to regional haze in MANE-VU Class I areas, and that the majority of emissions from fires were from residential wood combustion. According to Appendix B of the document, wood smoke also contributes to visibility impairment, with contributions typically higher in rural areas than urban areas, winter peaks in northern areas from residential wood burning, and occasional large summer impacts at all sites from wildfires. Wood smoke impacting MANE-VU Class I areas is more local in origin than sources of SO_2, except for major transport events. Fires that are covered under smoke management plans, including agricultural and prescribed forest burning, constitute less than one percent of total wood smoke emissions in MANE-VU.

Section 604 of Title 20 District of Columbia Municipal Regulations prohibits open burning within the District (Appendix U). Being an urban environment, the District does not have a smoke management plan. Additional measures to mitigate the impact on Class I areas of smoke emissions from agricultural and forest fires are not needed in the District's SIP.

10.8. Estimated Impacts of Long-Term Strategy on Visibility

Title 40 CFR 51.308(d)(3)(v)(G) requires the District to address the net effect on visibility resulting from changes projected in point, area and mobile source emissions by 2018.

The Class I states affected by emissions from within the District have or will have established reasonable progress goals for each of their Class I areas for 2018. The control measures included in this SIP represent the reasonable efforts of the District, in conjunction with efforts of other MANE-VU states, toward achieving the reasonable progress goals established by the affected states by 2018.

The starting point for indicating progress achieved by measures included in this SIP and other MANE-VU-member SIPs is the 2000 to 2004 baseline visibility at affected Class I areas. To calculate the baseline visibility for affected Class I areas, using 2000 to 2004 IMPROVE monitoring data, the deciview value for the 20 percent best days in each year were averaged together, producing a single average deciview value for the best days. Similarly, the deciview values for the 20 percent worst days in each year were averaged together, producing a single average deciview value for the worst days.
Initial modeling to assess the impact of potential control measures is documented in *MANE-VU Modeling for Reasonable Progress Goals: Model Performance Evaluation,*

Pollution Apportionment, and Control Measure Benefits (Appendix H). Results of the reasonable progress modeling showed that sulfate aerosol – the dominant contributor to visibility impairment in the Northeast's Class I areas on the 20 percent worst visibility days – has significant contributions from states throughout the eastern U.S. that are projected to continue in future years from all three of the eastern regional planning organizations (RPOs). An assessment of potential control measures identified a number of promising strategies that would yield significant visibility benefits beyond the uniform rate of progress and, in fact, significantly beyond the projected visibility conditions that would result from OTB/W air quality protection programs.

Additional "best and final" modeling was conducted by NESCAUM after consultation with states in and outside of MANE-VU. Final modeling to document the impacts of the long-term strategy on visibility at affected Class I areas can be found in *2018 Visibility Projections* (Appendix I). Emissions inventory adjustments were made for this modeling in order to better represent the likely outcome of efforts to pursue the BART, low sulfur fuel, and EGU control measures included in the MANE-VU June 20, 2007, statements and described above in Section 10.6.

Based on the most recent MANE-VU modeling, the proposed control measures will reduce sulfate levels at affected Class I areas by about one-third on the worst visibility days and by 6 to 31 percent on the best visibility days by 2018. Nitrate and elemental carbon levels will also show substantial reductions across all areas for both best and worst days, while smaller reductions in organic carbon levels will occur. Small increases are predicted for the fine soil component of regional haze. There is a possibility that the predicted increases in this component are not real but, rather, related to structural differences in the data sets used in the modeling for the baseline and future years. (Specifically, the fire emissions inventory used in VISTAS for the base year relied on an earlier version of fire emissions data than the one used for the 2018 inventory.) No changes are predicted for sea salt because the model does not track this component.

To create the series of visibility graphs which follow, 2018 visibility estimates were made in accordance with EPA modeling guidance. First, 2002 daily average baseline concentrations were multiplied by their corresponding relative reduction factors to obtain 2018 projected concentrations for each day. The 2018 projected concentrations were then used to derive daily visibility in deciviews. As a final step, the deciview values for the 20 percent of days having best visibility were averaged, and the process repeated for the 20 percent of days having worst visibility. The resulting averages represent the projected upper and lower quintiles of visibility in 2018.

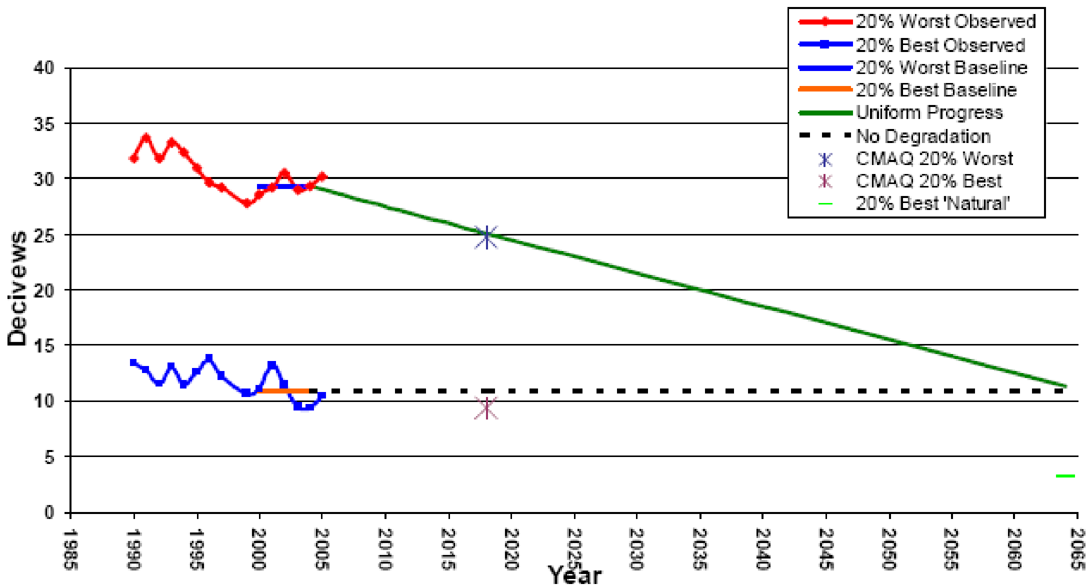
The following is provided to assist with interpretation of the line graphs in Figures 10.3 and 10.5. Note that lower deciview values indicate better visibility.

- The irregular blue line (~) represents the 20 percent best visibility average value as determined from monitoring data for each year for the period 2001-2005.
- The irregular red line (~) represents the 20 percent worst visibility average value as determined from monitoring data for each year of the period 2001-2005.

- The straight orange line (▬) represents the 20 percent best visibility average value as determined from monitoring data for the 5-year period of 2000-2004. (This line represents the *20 percent best visibility baseline condition*.)
- The straight blue line (▬) represents the 20 percent worst visibility average value as determined from monitoring data for the 5-year period of 2000-2004. (This line represents the *20 percent worst visibility baseline condition*.)
- The straight broken line (▪▪▪) is a continuation of the 20 percent best visibility baseline, representing the 20 percent best visibility condition as it would be with no further degradation or improvement.
- The straight green line (▬) represents the 20 percent worst visibility values that establish the uniform rate of progress for the period 2004 to 2064. (This line is sometimes referred to as the *uniform progress line*, or *"glide slope."* It was created by linear interpolation between the 20 percent worst visibility baseline value in 2004 and the 20 percent worst visibility value under natural conditions in 2064. If visibility improvements match this rate of progress, actual visibility will return to natural conditions in 2064.)
- The light-green dash (–) shown at 2064 represents the theoretical 20 percent best visibility value under natural conditions (i.e., no anthropogenic emissions).
- The purple star (*) represents the 20 percent best visibility value in 2018 after implementation of MANE-VU's long-term strategy, as predicted by the CMAQ model.
- The blue star (*) represents the 20 percent worst visibility value in 2018 after implementation of MANE-VU's long-term strategy, as predicted by the CMAQ model.

Figure 10.3 illustrates predicted visibility improvements at Shenandoah National Park resulting from the implementation of the MANE-VU regional long-term strategy by the District and other states.[12] Observe that the blue star lies below or on the green line, indicating that, by 2018, the long-term strategy of this SIP will result in visibility improvements surpassing the uniform rate of progress on days of worst visibility. Similarly, the position of the purple star below the dashed line indicates that visibility requirements will be met, i.e., there will be no further degradation from baseline conditions on days of best visibility.

Figure 10.2. Projected Visibility Improvement at Shenandoah National Park Based on Most Recent Modeling

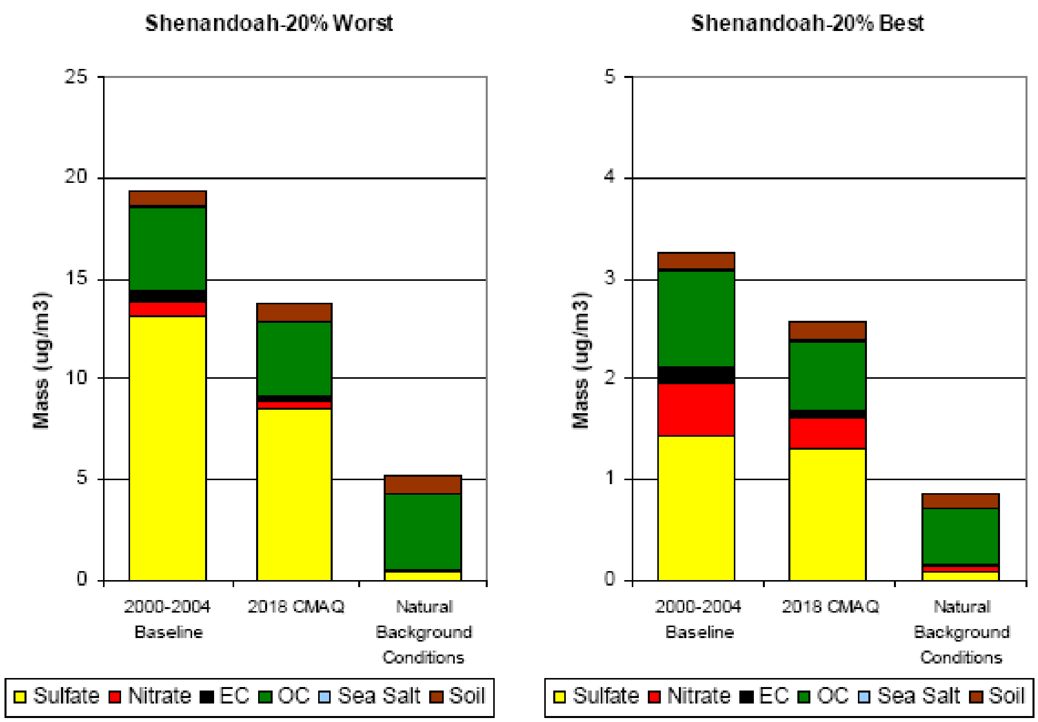


Source: 2018 Visibility Projections (Appendix I)

12 There is a concern that MANE-VU modeling results used to evaluate progress are based on emissions assumptions for MRPO and VISTAS states that differ from the emissions assumptions made by those states. As a result, regional model projections for MRPO and VISTAS differ from projections made by MANE-VU. However, at the time of submittal of the District's draft implementation plan, Virginia's final Regional Haze SIP, based on VISTAS assumptions, was not available as a reference. This is why MANE-VU results are sited for Shenandoah in this SIP.

Figure 10.4 presents bar graphs depicting expected improvements in haze-causing pollutant levels at the Shenandoah National Park. The graph on the right shows concentrations of visibility-impairing pollutants on days of best visibility for the 2000 to 2004 baseline period, 2018 modeled year, and natural background condition. The graph on the left is a similar plot for days of worst visibility. The graphs show that almost all of the expected improvements will result from reductions in sulfate concentrations.

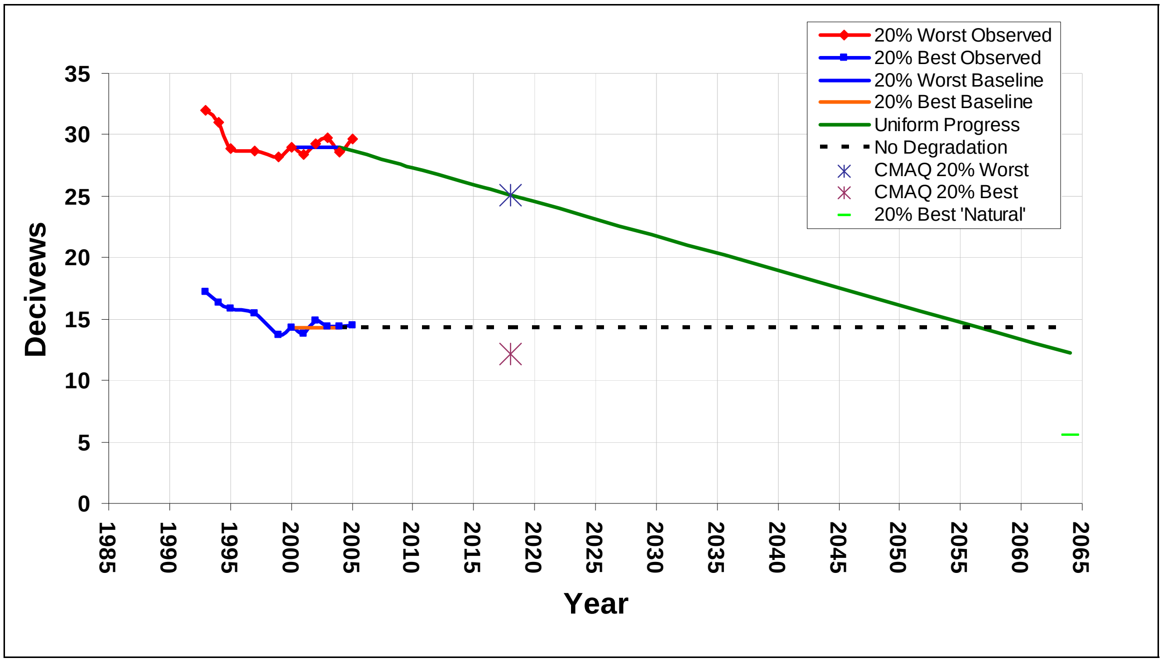
Figure 10.3. Observed Baseline, CMAQ-Projected and Estimated Natural Speciated $PM_{2.5}$ Mass Values for Shenandoah National Park



Source: 2018 Visibility Projections (Appendix I)

Figure 10.5 illustrates the predicted visibility improvement by 2018 at Brigantine Wilderness resulting from the implementation of the MANE-VU regional long-term strategy by the District and other states. This improvement is compared to the Uniform Rate of Progress for affected Class I areas. This and all other MANE-VU sites are projected to meet or exceed the uniform rate of progress goal for 2018. In addition, no site anticipates increases in best day visibility relative to the baseline.

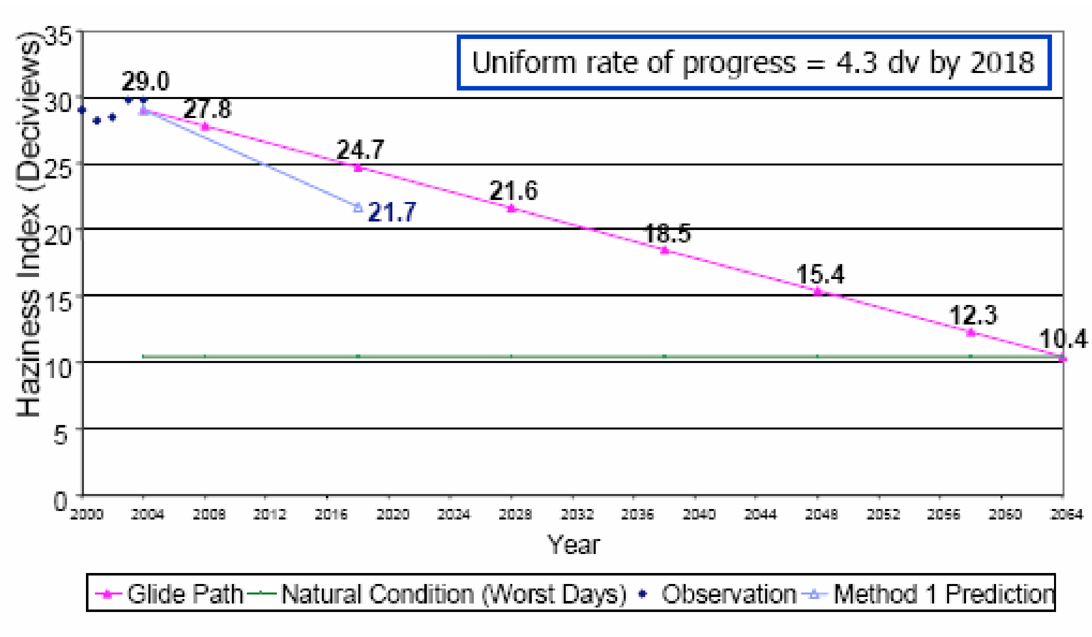
Figure 10.4. Projected Visibility Improvement at Brigantine National Wildlife Refuge Based on Best and Final Modeling



Source: 2018 Visibility Projections (Appendix I)

Figure 10.6 shows projected visibility improvement at Dolly Sods Wilderness resulting from measures included in the West Virginia SIP, which is based on the VISTAS modeling protocol. Figure 10.6 is from the West Virginia Regional Haze SIP proposed in April 2018. West Virginia worked with the southeastern states to develop its regional haze plan and analysis and has indicated that for the first control period (five years), no neighboring state is asked to do more than already planned by that state in order to reduce impacts on Dolly Sods and Otter Creek Wilderness Areas. Emissions from the District were included in the modeling prepared for West Virginia, and expected reductions in emissions from sources located in the District, in conjunction with emissions reductions in West Virginia and other states, will help ensure that visibility continues to improve at West Virginia's Class I areas.

Figure 10.5. Uniform Rate of Progress Glide Path for Dolly Sods Wilderness (Base G2a Projections)



Source: West Virginia Regional Haze SIP, proposed April 2008, p. 71.

10.9. Share of Emission Reductions

Title 40 CFR 51.308(d)(3)(ii) requires the District to demonstrate that its implementation plan includes all measures necessary to obtain its fair share of emission reductions needed to meet reasonable progress goals.

The District has agreed to pursue the following long-term strategy actions as appropriate and necessary:

- Timely implementation of BART
- An outer zone low-sulfur fuel oil strategy
- Additional control measures

The MANE-VU and VISTAS analyses described above demonstrated that the District's long-term strategy, when coordinated with other states' strategies, is sufficient to meet reasonable progress goals. (See also Appendices H and I for further documentation of MANE-VU modeling results.)

The statement agreed to by MANE-VU on June 20, 2007, provided that each state will have up to ten years to pursue adoption and implementation of these reasonable NO_x and SO_2 control measures. This SIP is consistent with that statement.

10.9.1. Changes to Emissions by 2018

The emission inventory for the District projects changes to point, area, and mobile source inventories by the end of the first implementation period resulting from population growth; industrial, energy and natural resources development; land management; and air pollution control. A summary of SO_2 emissions changes in the MANE-VU region is given in Table 10.4 and for the District in Table 10.5. More detail is provided in:

- *Development of Emissions Projections for 2009, 2012, and 2018 for Non-EGU Point, Area, and Nonroad Sources in the MANE-VU Region* (Appendix E), and
- *Documentation of 2018 Emissions from Electric Generating Units in the Eastern U.S. for MANE-VU's Regional Haze Modeling* (Appendix F).

Table 10.4. Emissions from Point, Area, and Mobile Sources in MANE-VU (SO_2 tpy)

Type of Source	Baseline 2002	2018 (with additional measures for RPG)
EGU Point	1,643,257	368,584
Non-EGU Point	264,377	211,320
Area	316,357	129,656
Onroad Mobile	40,091	8,757
Nonroad Mobile	57,257	8,643

These estimates are similar to those in Tables 4.4 (2002) and 4.8 (2018).

Table 10.5. Emissions from Point, Area, and Mobile Sources in the District (SO_2 tpy)

Type of Source	Baseline 2002	2018 (with additional measures for RPG)
EGU Point	345	83
Non-EGU Point	618	481
Area	1,337	159
Onroad Mobile	271	41
Nonroad Mobile	375	5

These estimates can be found in Tables 4.1 (2002) and 4.3 (2018).

The differences between the 2002 and 2018 totals reflect measures in the MANE-VU statement, which are the region's reasonable progress goals, of which MANE-VU states and the District have agreed to pursue as appropriate and necessary by 2018.

10.10. Enforceability of Emission Limitations and Control Measures

Title 40 CFR 51.308(d)(3)(v)(F) requires the District to ensure that emission limitations and control measures used to meet reasonable progress goals are enforceable.

The following sections of the DC Municipal Regulations are already included in the DC SIP and are therefore Federally enforceable:

- Section 604 of Title 20 District of Columbia Municipal Regulations prohibits open burning within the District (Appendix U).

- Section 605 of Title 20 District of Columbia Municipal Regulations, Control of Fugitive Dust, requires reasonable precautions to minimize emissions of fugitive dust into the atmosphere (Appendix U).
- Section 801 of Title 20 District of Columbia Municipal Regulations, Sulfur Content in Fuel Oils, limits sulfur to 1 percent by weight (Appendix U).

The District is continuing to evaluate the additional sulfur in fuel measures included in the long-term strategy to determine whether they are reasonable to adopt and implement by 2018 and expects to make that determination in the SIP revision due in five years.

The District is awaiting guidance from EPA concerning a replacement for the CAIR program.