Complexities of Air Quality Permit Issuance for an Iron Foundry near Great Smoky Mountains National Park

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ABSTRACT

The issuance of air quality construction permits for new industrial projects is often a complex and time consuming process. This complexity increases dramatically when the project is subject to the Prevention of Significant Deterioration air quality regulations and particularly if the site is located near Class I air quality areas such as national parks and wilderness areas. The permitting experience for a new 160 ton per hour iron foundry located in eastern Tennessee is reviewed. This overview presents aspects of the project which will be useful for similar permitting projects. These aspects include air quality siting studies; interaction with state and federal air quality regulatory agencies including the National Park Service and U.S. Forest Service; development of Best Available Control Technology; use of the ISC3, VISCREEN, and CALPUFF air quality models to determine effects on air quality standards, visibility and acid deposition; and, development of a seven state emissions inventory to assess cumulative increment consumption at Class I and Class II air quality areas. While eastern Tennessee provided a desirable project site for logistical and economic reasons, it presented a complex and challenging situation for the issuance of a construction air quality permit. Preliminary ISC3 and CALPUFF modeling analyses were performed for several potential sites to assess their air quality impacts on nearby Class I air quality areas such as Great Smoky Mountains National Park and the Cohutta National Wilderness Area. After these analyses, the final site was selected for submission of the permit application. During the two year time period required to select a site and obtain an air quality permit, long-range modeling policies for Class I areas changed, resulting in the need for greater emission reductions beyond Best Available Control Technology to assure an insignificant and acceptable air quality impact on Class I areas.

INTRODUCTION

The issuance of air quality construction permits for new industrial projects is often a complex and time consuming process. This complexity increases dramatically when the project is subject to the Prevention of Significant Deterioration air quality regulations and particularly if the site is located near Class I air quality areas such as national parks and wilderness areas. The permitting experience for a new 160 ton per hour iron foundry located in eastern Tennessee is reviewed. This overview presents aspects of the project which will be useful for similar permitting projects.

AIR QUALITY PERMIT REQUIREMENTS

The siting of new industrial facilities requires the consideration of many factors such as access to customers, availability of raw materials and energy resources, and presence of a skilled workforce. Another important consideration is the ability to obtain required environmental permits in a timely manner which do not adversely affect the economic viability of a project.

As the air pollution emissions from a project increase, the complexies of applicable air quality regulations increase as well. Smaller projects require only the issuance of a state air quality construction permit. Larger projects, with emissions greater than the 100 and 250 ton per year thresholds of the Prevention of Significant of Deterioration of Air Quality (PSD) regulations, must comply with another level of requirements. These regulations are provided under 40 CFR 51.21 and repeated in the administrative rules of most states. Further guidance is provided in the 1990 USEPA PSD guidance draft document, *New Source Review Workshop Manual*.[1] The PSD requirements include the following:

- Use of Best Available Control Technology (BACT) to control project emissions;
- Dispersion modeling analyses to verify compliance with the National Ambient Air Quality Standards and PSD Class II Area increments;
- Evaluation of impacts on visibility, industrial growth, and soils and vegetation.

While permits issued under the PSD regulations are typically received from state air quality agencies, they receive additional oversight and scrutiny by the appropriate regional office of the USEPA.

For PSD projects located within 200 kilometers of Class I areas such a national park and wilderness area, there is another level of requirements. These include the following:

- Analyses to verify compliance with the PSD Class I Area increments;
- Analyses to verify protection of air quality related values.

For these projects, issuance of an air quality permit will also require involvement and oversight of the federal land managers (FLM) responsible for the Class I areas. For national parks, the FLM are provided by the National Park Service, and for wilderness areas, the FLM are provided by the U.S. Forest Service.[1,2,3]

It is a reasonable simplification to conclude that a PSD permit will require at least twice the time and effort required for a non-PSD construction permit, and a PSD permit which affects a Class I area, will require four times the time and effort required for the non-PSD construction permit. These application approval time frames should be incorporated into the site selection criteria.

PROJECT DESCRIPTION

The construction of a new iron foundry was proposed for eastern Tennessee. This foundry would have the capacity to produce 160 tons per hour of grey and ductile iron. Operations which generate air pollution emissions at the foundry include the following:

- Melting of iron in coke-fired cupolas
- Mold sand mixing and handling
- Core sand mixing and handling
- Pouring and cooling of molten iron in the sand molds
- Separation or shakeout of iron castings from the sand molds
- Cleaning and grinding of finished castings

Emissions would be controlled using BACT for the foundry industry. Project emissions and the thresholds at which the PSD regulations apply are summarized in Table 1. The project was subject to the PSD requirements for the following air pollutants:

Total suspended particulates (TSP)
Particulate matter less than 10 microns in diameter (PM_{10})
Sulfur dioxide (SO_2)
Nitrogen oxides (NO_x)
Carbon monoxide (CO)
Volatile organic compounds (VOC)
Lead (Pb)

Table 1. Foundry Project Emissions Summary

Air Pollutant	Project Emissions (TPY)	PSD Threshold (TPY)	PSD Applicability
TSP/PM_{10}	475	25/15	Yes/Yes
SO_2	188	40	Yes
NO_x	416	40	Yes
CO	4,481	100	Yes
VOC	543	40	Yes
Pb	2.6	0.6	Yes

INITIAL SITING STUDY USING ISC3 DISPERSION MODEL

A rule of thumb for selecting new industrial sites based on air quality permit requirements is to avoid the following locations which complicate and slow down the issuance of an air quality permit:

- Areas of complex terrain which require on-site weather data for dispersion modeling;
- Sites near Class I air quality areas; and,
- Nonattainment areas for the NAAQS which require emission offsets and additional control.

Due to other logistical and economic siting considerations, the new foundry project was to be located in eastern Tennessee. Since this area is both mountainous and near several Class I areas, it presented a challenge for issuance of an air quality permit.

Project scheduling allowed time for consideration of several sites and their anticipated air quality permit requirements. There was little difference in the local air quality conditions of each site. Emphasis was instead placed on estimating the impacts on nearby Class I areas. These included Great Smoky Mountains National Park, Joyce Kilmer Wilderness Area, Shining Rock Wilderness Area, and Linville Gorge Wilderness Area.

Approval of the project by FLM for the Class I areas is dependent on two criteria: compliance with the PSD increments for PM_{10}, SO_2 and NO_x at each of these areas; and, protection of the air quality related values or AQRV at each of these areas. An initial siting study was conducted to determine the impacts of each site at these Class I areas. The goal of this study was to determine if the project could be designed to have an insignificant impact at any of the nearby Class I areas with respect to both PSD increments and AQRV.

Approval of an air quality permit for the project would especially depend on impacts at Great Smoky Mountains National Park. According to the National Park Service, this park is "the most visited park in the National Park System. The 520,000 acre park is world-renowned for its prominent mountain ridges and deep cliff valleys, its scenic beauty, and the diversity of its plant and animal resources."[4] In 1992, the Department of Interior published a Federal Register notice announcing that air pollution was adversely impacting the AQRV's of the park. Adverse air pollution impacts included degradation of visibility, ozone induced foliar injury and growth reductions of native vegetation, and acidification and other chemical changes in the soils and surface waters due to nitrate and sulfate deposition. Until control strategies were implemented for existing emission sources, the National Park Service intended to emphasize the review of new sources to assure they did not worsen existing adverse conditions.[4,5]

For the first phase of the siting study, the ISC3 model was used to predict air pollutant concentrations for each potential project site.[6] The ISC3 model is the workhorse of modeling analyses for air quality permits throughout the U.S. Support and guidance for this model are readily available, making it the preferred model for regulatory work.

To assess compliance with the PSD increments, the ISC3 results were compared with the significant impact levels (SIL). The current Class I area SIL for PM_{10}, SO_2 and NO_x are taken from the new source reform regulations proposed by USEPA on July 23, 1996.[7] If an SIL exceedance is predicted, issuance of the air quality permit would require a demonstration of compliance with the increment for that pollutant. This compliance analysis would require development of a regional inventory of PSD increment consuming sources. These sources would be modeled simultaneously with the project emissions.

From an applicant's perspective, the need for a cumulative Class I area increment compliance analysis is not a desired outcome. Reasons to avoid this requirement are: this type of inventory is rarely developed and there are no firm guidelines to assemble such an inventory; it would require cooperation of several regulatory agencies to obtain the inventory data; and, it is anticipated to be a very time-consuming activity. Additionally, since the number and extent of regional sources is not known, the outcome of the modeling analysis using this inventory is unknown. Issuance of an air quality permit depends on a demonstration of compliance with the PSD increments. The outcome of the analysis and approvability of the project remains unknown, until a significant amount of time and energy has already been spent to assemble the regional inventory and complete the cumulative increment modeling analysis.

For the initial siting study, the ISC3 model was also used to estimate impacts on the AQRV for each of the Class I areas. To assess impacts on the AQRV, the FLM for each of the Class I areas required an evaluation of increased acid deposition and regional visibility degradation due to project emissions. To convert the concentrations predicted by the ISC3 model to values for deposition and visibility, the Level 1 procedures were used as outlined in the USEPA April 1993 document, *Interagency Workgroup on Air Quality Modeling (IWAQM) Phase I Report: Interim Recommendation for Modeling Long Range Transport and Impacts on Regional Visiblity*.[8] The results were compared with the screening level values (SLV) for deposition and visibility to determine if the AQRV of each Class I area would be adversely impacted by the project.

If significant impacts on the AQRV are predicted using the ISC3 Level I procedure, a more time-consuming Level II analysis is required using a refined model. For this purpose, the IWAQM Phase I document recommends the use of the MESOPUFF-II long range transport model. However, use of the newer CALMET-CALPUFF models was preferred by the FLM. If significant impacts on the AQRV are still predicted by the refined models, the project might be opposed by the FLM.

The initial siting study results using the ISC3 model are presented in Tables 2 and 3. Table 2 presents the air pollutant concentrations predicted for the potential project sites. The results indicate that both sites would have PM_{10} and SO_2 impacts which exceed the SIL at the Class I areas. For the two remaining Class I areas, the predicted concentrations were below the SIL.

Table 3 presents the AQRV impacts. The results suggest that both sites would have a significant impact on changes to regional visibility and acidic deposition. For the two remaining Class I areas, the predicted AQRV impacts also exceeded the SLV.

Table 2. Initial Siting Study Concentration Impacts using ISC3 Model

Site	Air Pollutant	Averaging Period	Maximum Class I Area Impact (ug/m^3)	USEPA Class I Area SIL (ug/m^3)
A	PM_{10}	24 Hours	0.7*	0.3
		Annual	0.08	0.2
	SO_2	3 Hours	2.1*	1.0
		24 Hours	0.4*	0.2
		Annual	0.05	0.1
	NO_x	Annual	0.08	0.1
B	PM_{10}	24 Hours	0.95*	0.3
		Annual	0.09	0.2
	SO_2	3 Hours	3.0*	1.0
		24 Hours	0.6*	0.2
		Annual	0.05	0.1
	NO_x	Annual	0.08	0.1

* Exceeds the USEPA significant impact threshold for Class I area PSD increments.

Table 3. Initial Siting Study AQRV Impacts using ISC3 Model

Site	AQRV	Units	Maximum Class I Area Impact	Screening Level Value	
				NPS	USFS
A	Regional Visibility	▲Desivue	9.8	0.5	0.5
	SO_4 Deposition	kg/ha/yr	0.118	0.0014	0.05
	NO_3 Deposition	kg/ha/yr	1.482	0.005	0.05
B	Regional Visibility	▲Desivue	13.0	0.5	0.5
	SO_4 Deposition	kg/ha/yr	0.118	0.0014	0.05
	NO_3 Deposition	kg/ha/yr	1.694	0.005	0.05

The initial siting study results summarized in Tables 2 and 3 were presented to representatives for the Tennessee Air Pollution Control Division (TAPCD), and FLM for the National Park Service and U.S. Forest Service. It was acknowledged that the AQRV analysis using the IWAQM Level I procedures predicted impacts above the SLV and a Level II analysis would be required. This would need to be conducted using the more refined CALMET-CALPUFF models.

Rather than wait for preparation of the construction permit application to conduct the refined AQRV analysis, the project schedule allowed the refined analysis to be conducted as part of the site selection process. By conducting this analysis sooner, the results could be used to more accurately determine if the site could receive an air quality permit.

SITING STUDY USING CALMET-CALPUFF MODELS

Following the initial siting study using the ISC3 model, a refined AQRV analysis using the CALMET-CALPUFF models was conducted for three potential sites. FLM for surrounding Class I areas required that impacts be estimated for any Class I areas located within 200 kilometers of the potential project sites. The 200 kilometer distance used to evaluate impacts on Class I areas is larger than the 100 kilometers suggested in the 1990 USEPA PSD guidance draft document, *New Source Review Workshop Manual*.[1] The longer 200 kilometer distance has become the default distance recommended by FLM for the assessment of impacts from new projects. Four Class I areas were evaluated. These areas were Great Smoky Mountains National Park, Cohutta National Wilderness Area, Joyce Kilmer National Wilderness Area and Shining Rock Wilderness Area. The distance from the project site to these areas is provided in Table 4.

Table 4. Distance from Plant 6 to Nearby Class I Air Quality Areas

Class I Air Quality Area	Distance from Project Site (km)
Cohutta National Wilderness Area (Georgia)	39
Joyce Kilmer/Slick Rock Wilderness Area (Tennessee)	46
Great Smoky Mountains National Park (Tennessee)	55
Shining Rock National Wilderness Area (N. Carolina)	146

The refined modeling procedures and results were summarized in an air quality permit application for the project.[9] This was presented in a pre-application meeting with representatives for the TAPCD, and FLM for the National Park Service and U.S. Forest Service. Based on the results of the siting study using the CALMET-CALPUFF models and other criteria, Site A in Etowah, Tennessee was eventually chosen for the foundry project. The final project site is shown in Figure 1 relative to the four Class I areas.

The ISC3 model is a gaussian model recommended for calculating downwind concentrations within 50 kilometers of a project site. The CALMET-CALPUFF models have been recommended for long range transport analysis beyond 50 kilometers. They provide greater accuracy in estimating the movement of air pollutants over complex terrain and incorporate atmospheric reactions during transport.

Figure 1. Project Site and Class I Areas

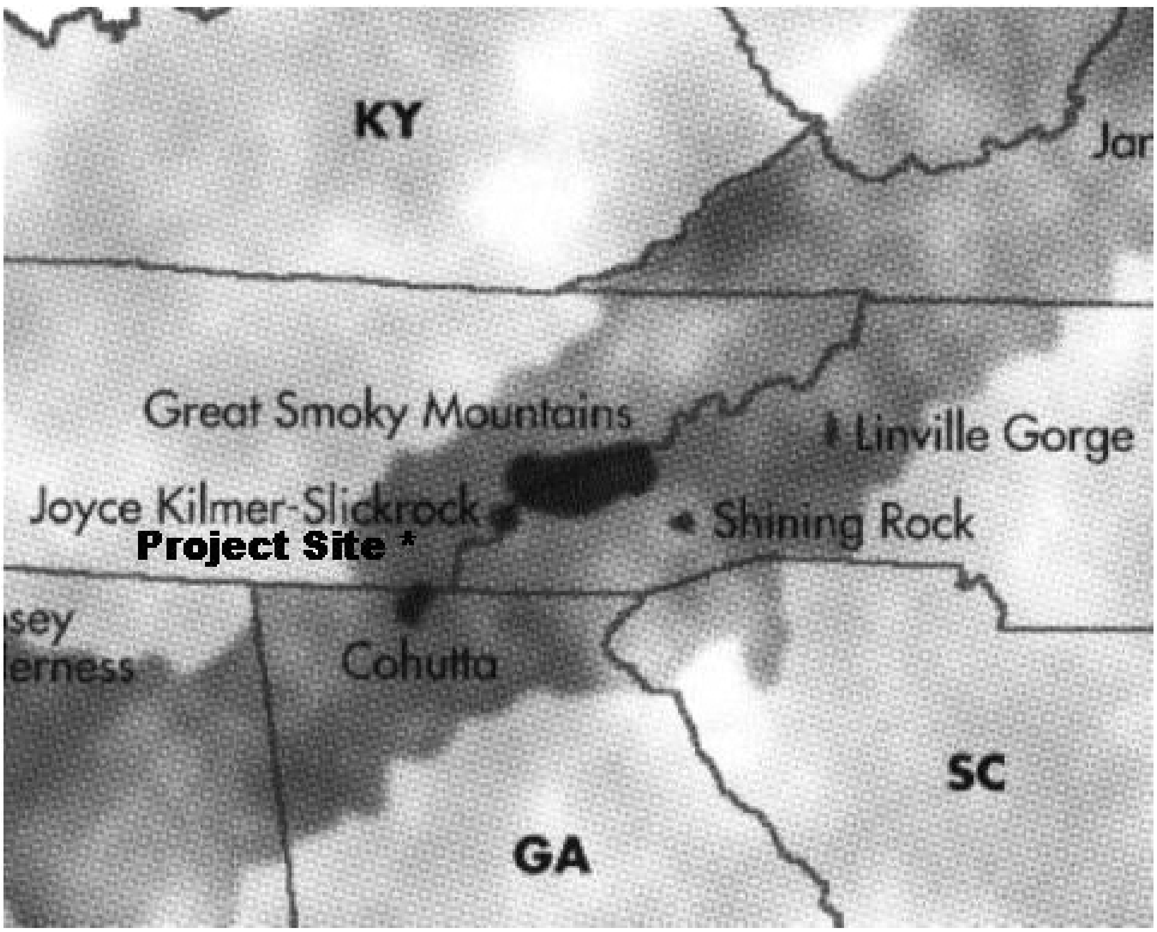

Table 5 presents the maximum air pollutant concentration results from the CALMET-CALPUFF models for all four of the Class I areas evaluated. The results demonstrated that all three potential foundry sites would have PM_{10} and SO_2 impacts which exceed their respective SIL. As a result, any site would be required to develop a regional source inventory and conduct a cumulative Class I area PSD increment analysis.

Table 5. Siting Study Concentration Impacts using CALMET-CALPUFF Models

Site	Air Pollutant	Averaging Period	Maximum Class I Area Impact (ug/m^3)	USEPA Class I Area SIL (ug/m^3)
A	PM_{10}	24 Hours	0.42*	0.3
		Annual	0.02	0.2
	SO_2	3 Hours	0.9	1.0
		24 Hours	0.25*	0.2
		Annual	0.01	0.1
	NO_x	Annual	0.01	0.1
B	PM_{10}	24 Hours	0.47*	0.3
		Annual	0.03	0.2
	SO_2	3 Hours	1.4*	1.0
		24 Hours	0.31*	0.2
		Annual	0.02	0.1
	NO_x	Annual	0.02	0.1
C	PM_{10}	24 Hours	0.38*	0.3
		Annual	0.02	0.2
	SO_2	3 Hours	0.87	1.0
		24 Hours	0.24*	0.2
		Annual	0.01	0.1
	NO_x	Annual	0.01	0.1

* USEPA significant impact threshold exceeded.

Table 6 presents the AQRV results from the CALMET-CALPUFF models. The results suggest that none of the three potential foundry sites would exceed their SLV for regional visibility or acidic deposition.

Table 6. Siting Study AQRV Impacts using CALMET-CALPUFF Models

Site	AQRV	Units	Maximum Class I Area Impact	Screening Level Value	
				NPS	USFS
A	Regional Visibility	Change in B_{ext} (%)	2.3	5	5
	SO_4 Deposition	kg/ha/yr	0.00086	0.005	0.05
	NO_3 Deposition	kg/ha/yr	0.0012	0.0014	0.05
B	Regional Visibility	Change in B_{ext} (%)	2.4	5	5
	SO_4 Deposition	kg/ha/yr	0.00053	0.005	0.05
	NO_3 Deposition	kg/ha/yr	0.00086	0.0014	0.05
C	Regional Visibility	Change in B_{ext} (%)	3.3	5	5
	SO_4 Deposition	kg/ha/yr	0.00052	0.005	0.05
	NO_3 Deposition	kg/ha/yr	0.00063	0.0014	0.05

Based on agency comments on the preliminary permit application and CALPUFF siting study, development of the project construction permit application began, using the final project design and air pollution sources. It would address all PSD requirements including the following:

- Use of Best Available Control Technology (BACT) to control project emissions;
- Dispersion modeling analysis to verify compliance with the National Ambient Air Quality Standards and PSD Class II Area increments;
- Evaluation of impacts on visibility, growth and soils and vegetation.

The Class I area impact analyses would be repeated using the final project design and the CALMET-CALPUFF models. If a PSD increment SIL for the Class I areas was exceeded, compliance with the PSD increments would be demonstrated using a regional inventory of increment consuming sources. This inventory would be developed following procedures agreed upon by both state and federal representatives. As shown in Table 5, the siting studies concluded that a cumulative increment analysis and regional inventory for PM_{10} and SO_2 would be required.

At the same time the siting studies were presented to the regulatory agencies, new guidance documents on the evaluation of impacts on the Class I areas were developed by the agencies. These would be incorporated into the final application.[4,10,11,12,13,14,15]

Under the permitting agreement between Tennessee and the federal agencies, the FLM for the National Park Service and US Forest Service could not oppose issuance of the air quality permit if the results of the refined modeling analysis showed AQRV impacts were below the applicable SLV.[2] As shown in Table 6 siting study results, the project was not expected to exceed any SLV. If the SLV were exceeded, approval of the permit by the FLM would not be assured. Further emission reductions, additional analysis, or regional emission offsets might be necessary to receive FLM permit approval.

BEST AVAILABLE CONTROL TECHNOLOGY ANALYSIS

Project emissions must comply with process-specific emission limitations contained in state air quality regulations. In addition, each pollutant subject to approval under the PSD regulations, must be evaluated for Best Available Control Technology or BACT. The procedures for determining BACT are interpreted by each region of the USEPA and each state. General procedures are currently outlined in the draft 1990 USEPA document, *New Source Review Workshop Manual*.[1]

As defined under federal PSD regulations and repeated in state regulations, BACT is, "an emission limitation based on the maximum degree of reduction determined on a case-by-case basis taking into account energy, environmental, and economic impacts and other costs." As noted in the *New Source Review Workshop Manual*, the top-down policy enforced by USEPA as of 1987 specifies that BACT must be the most stringent control technology. If the applicant demonstrates there are sufficient technical considerations, or energy, environmental, or economic impacts, the most stringent technology may not be achievable, and the next most effective alternative is evaluated.

Results of the project BACT analysis were submitted for agency review with the permit application.[16] The analysis included a review of prior determinations for iron foundries under Process Type 81.004 available at the USEPA BACT/LAER Clearinghouse Internet site.[17] Recent iron foundry BACT determinations not yet included in the clearinghouse were also evaluated.

BACT for each pollutant is summarized in Table 7. Approved emission limitations for each process represented the lowest emission rates achieved in the foundry industry. Baghouses were to achieve outlet PM_{10} emissions of 0.005 gr/acf. Cupola SO_2 emissions would be controlled using a dry injection scrubber prior to its baghouse. Cupola VOC and CO emissions would be controlled using a thermal incinerator prior to the scrubber. Compliance tests were required for all process stacks and continuous emissions monitoring equipment was required for SO_2 and NO_x emissions from the two iron melting cupolas.

Not established as BACT were reductions in emissions of SO_2 and NO_x necessary to assure the project had an insignificant impact on the AQRV of nearby Class I areas. These reductions were to be obtained on an annual basis. In addition, a pilot test on an innovative NO_x control method for the cupola was to be conducted during the initial operation of the foundry. These emission reductions are discussed further with the results of the final project air quality modeling analyses.

Table 7. BACT Air Pollution Control Methods for Foundry Industry

Air Pollutant	Process	BACT
PM_{10}	Sand and casting handling Cupola	Fabric Filter Baghouses
SO_2	Cupola	Dry Reagent Duct Injection
NO_x	Cupola	Low-NOx Burners
CO	Cupola	Thermal Incineration
VOC	Cupola	Thermal Incineration
	Core Making	Packed Bed Scrubber
Pb	Sand and casting handling Cupola	Fabric Filter Baghouses

CLASS II AREA MODELING PROCEDURES

ISC3 and CTSCREEN Models

The Class II area modeling procedures and results were presented for agency review in the permit application for the project.[16] Air pollutant concentrations near the foundry site were evaluated using both the ISC3 and CTSCREEN dispersion models. The ISC3 model and meteorological data from a representative National Weather Station site in Knoxville, Tennessee were considered acceptable for estimating concentrations in areas of simple terrain with elevations lower than the top of the project's shortest stack. Terrain near the site included areas of complex terrain with elevations above the top of the project's shortest stack. Under the USEPA *Guideline on Air Quality Models*, the modeling of complex terrain requires the use of on-site meteorological data.[18] Since on-site weather data was not available for this project, receptors located in complex terrain near the project site were re-evaluated using the CTSCREEN model. CTSCREEN uses screening meteorology data for predictions in complex terrain. These results supplemented those from the ISC3 model.

Significant Impact Area Analysis

Project emissions were evaluated using the ISC3 model to determine project-specific impacts for comparison with the Class II area significant impact levels (SIL) and preconstruction monitoring exemption thresholds. The project was predicted to exceed the Class II area SIL for PM_{10}, SO_2 and NO_x. The radius of the project significant impact area ranged from 4 to 11.5 kilometers depending on the air pollutant and averaging period. None of the other project emissions were predicted to exceed their respective SIL based on the ISC3 analysis.

The maximum CO concentrations predicted by ISC3 were below its SIL. However, concentrations predicted in complex terrain using the CTSCREEN model predicted 8-hour average CO concentrations above its SIL. This was based on a regulatory default conversion factor of 0.5 necessary to adjust the 1-hour average concentrations predicted by CTSCREEN to the 8-hour average of the SIL. A 1-hour to 8-hour average conversion factor of 0.42 was necessary to demonstrate the maximum concentrations in complex terrain were less than the SIL. Support was provided to TAPCD to demonstrate that a conversion factor of 0.42 or less was reasonable based on the background information on the CTSCREEN model.[19] As a result, the project was concluded to have CO impacts below its SIL and no further analysis was required for this pollutant.

Project modeling results concluded that only PM_{10} and VOC would exceed their preconstruction monitoring exemption thresholds under the PSD regulations. For the remaining air pollutants, TAPCD did not require monitoring. For PM_{10} and VOC, TAPCD allowed the use of post-construction monitoring in lieu of pre-construction monitoring. Otherwise, pre-construction monitoring would delay project construction by one year or more.

CLASS II AREA NAAQS COMPLIANCE ANALYSIS

The project was predicted to exceed the Class II area SIL for PM_{10}, SO_2 and NO_x. As a result, an evaluation of compliance with the National Ambient Air Quality Standards or NAAQS was required. Project emissions would be modeled concurrently with an inventory of other sources located near the project site. An initial inventory of other sources was provided byTAPCD. It included sources located within the project significant impact area, the county where the project was located and larger sources located outside the county. This inventory included a list of facilities, stacks, processes, allowable/potential emissions for each pollutant, and stack parameters.

The following procedures were used to screen the inventory to determine which sources should be included in the NAAQS modeling analysis:

Step 1 For all sources included in the increment analysis, TAPCD files were reviewed to verify sources, stack parameters, date of construction/modification and allowable emissions. Addresses for all sources were verified by either TAPCD or the project consultant.

Step 2 UTM coordinates were verified using USGS topographic maps;

Step 3 The distance between each source and the project site was calculated;

Step 4 If the distance (D) between the source and project was less than or equal to the Significant Impact Area (SIA) for PM_{10}, SO_2 or NO_x, the source was included in the NAAQS compliance analysis; and,

Step 5 If the total allowable emissions of PM_{10}, SO_2 or NO_x from a facility was equal to or greater than 20 times the distance in kilometers between the source and project (i.e. 20D), the source was included in the NAAQS compliance analysis.

Project emissions of PM_{10}, SO_2 and NO_x were modeled concurrently with those from the NAAQS inventory to verify compliance with the NAAQS. At some receptors, exceedences of the NAAQS were predicted. In these cases, the source contributions for the exceedences were determined. It was concluded that the project did not provide a significant contribution above the Class II area SIL so no further NAAQS compliance analysis was required for the project.

For the maximum concentrations which occurred in simple terrain , the ISC3 results were considered valid, and demonstrated that the project did not contribute significantly to exceedences of the NAAQS. Additional CTSCREEN analyses were conducted. These verified concentrations predicted by ISC3 in complex terrain and project compliance with the NAAQS.

CLASS II AREA INCREMENT CONSUMPTION ANALYSIS

The project was predicted to exceed the Class II area SIL for PM_{10}, SO_2 and NO_x. As a result, an evaluation of compliance with the Class II area increments was required. Project emissions were modeled concurrently with an inventory of other sources located near the project site. The other sources included those which received PSD construction permits for the pollutant under evaluation, or were minor sources constructed after the PSD increment baseline date was established for the pollutant under evaluation in the county. This date is the first time a PSD application was received for a source in the county for that pollutant. For the county in which the project was located, the baseline date had been established for PM_{10}, SO_2 and NO_x. The inventory of other increment consuming sources was provided by the TAPCD. This inventory included facilities, stacks, processes, allowable/potential emissions for each pollutant, and stack parameters. The inventory of regional sources was screened using similar procedures as for the NAAQS inventory.

Project emissions of PM_{10}, SO_2 and NO_x were modeled concurrently with those from the inventory to verify compliance with the Class II area increments. As with the NAAQS compliance analysis, some exceedences of the Class II area increment for PM_{10} were predicted. The culpability for the exceedences was determined. For those exceedences for which the project emissions did not provide a significant contribution above the Class II area SIL, no further analysis was required. For those exceedences for which the project did provide a significant contribution, resolution of the exceedence was required. In these cases, corrections to the source inventory for an adjacent facility was sufficient to resolve these predicted exceedences of the Class II area increment.

For the maximum concentrations which occurred in simple terrain, the ISC3 results were considered valid and demonstrated that the project did not contribute significantly to exceedences of the Class II increment. Additional CTSCREEN analyses were conducted which verified concentrations predicted by ISC3 in complex terrain and project compliance with the Class II area increments.

ADDITIONAL IMPACT ANALYSIS

Another PSD permit application requirement is the additional impact analysis which evaluates impairment to visibility, soils and vegetation, and general commercial, residential, and industrial and other growth resulting from the operation of the project. An interpretation of this Additional Impacts Analysis requirement is described in Chapter D of the 1990 USEPA *New Source Review Workshop Manual* .[1]

Growth Analysis

For the industrial growth analysis, a comparison was made between current and estimated traffic levels on highways adjacent to the project site. This concluded there would be approximately 10% increase in traffic once the project was completed.

Soils and Vegetation Analysis

The soils and vegetation analysis compared the predicted concentrations of SO_2 and NO_x due to the project with thresholds for damage to vegetation. This concluded that no adverse effects on soils and vegetation were expected due to the project.

Visibility Analysis

The FLM for the National Park Service and US Forest Service proposed that any Class I area located within 50 kilometers of the project site be evaluated to determine if the foundry plume would be visible at the Class I area. As shown in Table 4, Class I areas within the 50 kilometer evaluation distance were the Cohutta National Wilderness Area (NWA) and the Joyce Kilmer/Slick Rock NWA.

USEPA recommends that PSD applicants conduct this coherent plume visibility analysis following the procedures in the *Workbook for Plume Visual Impact Screening and Analysis*.[20] A Level 1 analysis using conservative assumptions is first conducted. If significant visibility impairment is predicted, a Level 2 analysis using more site-specific information is necessary. The visibility analysis conducted for the closer of the two Class I areas, Cohutta NWA, is presented here.

Level 1 VISCREEN Analysis for Cohutta NWA

The Level 1 analysis inputs include project emissions of PM_{10} and NO_x, and distances between the source and a) the observer, b) the closest Class I area boundary, and c) the most-distant boundary. This analysis uses several conservative assumptions including the following: worst-case meteorological conditions of stable atmospheric conditions (Stability Class F); low wind speed of 1 m/s; and, wind direction transporting the plume directly to the observer at the Class I area.

For the Level 1 screening of visibility impacts, the VISCREEN model was used with total facility emissions of PM_{10} and NO_x and background visual range depending on the season. All other input parameters used the default Level 1 assumptions regarding primary NO_2, soot, primary SO_4, particle characteristics, background ozone, plume source observer angle, meteorology, and visibility threshold. When the shortest background visual range of 52 kilometers was used (i.e. worst background visibility), the screening criteria were exceeded for plume parcels located inside and outside the Class I Area. Based on the Level 1 results, a Level 2 analysis was warranted using less conservative assumptions.

Level 2 VISCREEN Analysis for Cohutta NWA

For the Level 2 screening of visibility impacts, the VISCREEN model was used with the same assumptions as for the Level 1 analysis with the exception of meteorology. For the Level 2 analysis, one year of Knoxville, Tennessee meteorological data was evaluated to determine periods of worst-case weather conditions using procedures recommended by USEPA in the VISCREEN manual. These same meteorological data were used for the dispersion modeling discussed earlier. To conduct the Level 2 analysis, the meteorological data was ranked by combinations of Pasquill Stability Category and wind speed. This was done by determining the product of "Sigma Y times Sigma Z times wind speed" for each combination of category and speed. Sigma Y and Sigma Z are the Pasquill-Gifford dispersion coefficients used in gaussian air quality dispersion models such as ISC3.

Stability category-wind speed combinations are eliminated for wind speeds which would require the plume to travel 12 or more hours to the observer. Due to the distance from the project site to the wilderness area, wind speeds of 1 meter per second or lower were not considered in the cumulative frequency of occurrence.

The meteorological data was first sorted to identify hours for which wind blew toward the observer, who was assumed to be at the closest edge of the Class I area. A vector range of 179° to 191° was selected as the direction where winds blew from the project site toward the Cohutta NWA. Starting with the worst-case Category-Speed combination, the frequency of its occurrence over the year was determined for four periods of each day (i.e., 0-6 hours, 7-12 hours, 13-18 hours, and 19-24 hours). This was done for each successive Category-Speed combination.

Based on the ranking and frequency evaluation, it was determined that only the combination of Stability Class D and wind speed of 3 meters per second occurred with a cumulative frequency of 1 percent or more. This Category-Speed combination was used for the Level 2 analysis.

The Level 2 analysis was conducted using this Category-Speed combination and the Level 1 input assumptions including the shortest and longest visual range of 52 km and 91 km. With the shortest visual range, the screening criteria were not exceeded. For the longest visual range, the screening criteria were exceeded only for plume parcels located outside Cohutta NWA and not inside this Class I area. Visual impacts are predicted only if the integral vista is considered a protected AQRV for this area. The integral vista is a view from a location in the Class I area of landscape features located outside the area. The US Forest Service does not consider impacts on the integral vista. Based on a VISCREEN analysis, it was concluded that emissions from project will not have an adverse visibility impacts on the Cohutta NWA due to a coherent or visible plume. The results of the Level 1 and Level 2 VISCREEN visibility analysis are summarized in Table 8.

Table 8. VISCREEN Analysis Results for Cohutta NWA

Evaluation Level	Meteorological Conditions	Season	Background Visibility (km)	Criteria Exceeded Inside Cohutta NWA?
Level 1	All	Summer	52	Yes
Level 2	D stability class 3 meter/sec wind	Summer	52	No

CLASS I AREA MODELING PROCEDURES

Significant Impact Analysis

The earlier siting study had used the CALMET-CALPUFF models to predict project impact on nearby Class I areas to evaluate compliance with the Class I area increments. These analyses were repeated using the final project design and stack parameters, and presented for review by regulatory agencies in an amendment to the air quality permit application.[21]

The siting study had predicted that project PM_{10} and SO_2 emissions would exceed their respective Class I area SIL. The new analysis using the final project design now demonstrated that only PM_{10} would exceed its SIL at three of the Class I areas, Great Smoky Mountains National Park, Cohutta National Wilderness Area, and Joyce Kilmer Slickrock National Wilderness Area. An analysis of compliance with the Class I area increment at these areas would be required. This would require preparation of a regional source inventory and modeling of all sources to determine cumulative increment consumption. The other air pollutants with Class I area increments, SO_2 and NO_x required no further analysis. The predicted air pollutant concentrations are shown in Table 9.

Table 9. Project Concentration Impacts using CALMET-CALPUFF Models

Air Pollutant	Averaging Period	Maximum Class I Area Impact (ug/m^3)	USEPA Class I Area SIL (ug/m^3)
PM_{10}	24 Hours	0.7*	0.3
	Annual	0.03	0.2
SO_2	3 Hours	0.8	1.0
	24 Hours	0.2	0.2
	Annual	0.01	0.1
NO_x	Annual	0.02	0.1

* USEPA significant impact level exceeded.

DEVELOPMENT OF CLASS I INCREMENT SOURCE INVENTORY

Procedures for developing the Class I increment source inventory were developed in conjunction with the TAPCD and federal land managers (FLM) for the affected Class I areas. Initially, sources located upwind of the Class I areas and within 100 km of the Class I areas were to be identified. The FLM subsequently requested that the inventory include sources within 200 km from each Class I area and consider sources located within 360 degrees of the Class I areas. Enlarging the inventory significantly increased the time and effort required to assemble the increment consumption inventory and the modeling resources required. The procedures and results were submitted for review by regulatory agencies as an amendment to the air quality permit application.[22]

States and local air pollution agencies located within 200 km of the Class I areas were contacted to request source emission inventories. The following regulatory agencies were contacted:

- Tennessee Air Pollution Control Division (TAPCD);
- North Carolina Department of Environment and Natural Resources;
- Virginia Department of Environmental Quality;
- Kentucky Department of Environmental Protection;
- Georgia Air Pollution Control;
- Alabama Department of Environmental Management;
- South Carolina Department of Health and Environmental Control;
- Hamilton County Air Pollution Control Bureau, Tennessee;
- Knox County Air Quality Management, Tennessee; and,
- Western North Carolina Regional Air Pollution Control Agency.

The source inventories provided by the regulatory agencies consisted of approximately 4,700 emission points. Screening procedures were developed to eliminate sources which were anticipated to have either an insignificant impact on the Class I areas or which did not consume Class I area increment because they were constructed prior to the PSD Class I area increment baseline date. The following screening procedures were applied:

Distance to Class I Areas	Sources located more than 200 km from the center of the nearest Class I area were eliminated.
County Baseline Date	Sources located in a county where the baseline date had not been established were eliminated from further analysis, since PSD increments will not be consumed until the first PSD application is filed in that county.
Non-PSD Major Sources	Non-PSD major sources were eliminated from the inventory because they were constructed prior to the baseline date for that county. These were defined as non PSD sources with total facility emissions greater than 250 TPY.
1.2D Method	For minor sources, if facility potential annual emissions were less than or equal to 1.2 times the distance between the nearest class I area

and the facility (i.e. TPY x km), the source was eliminated from the inventory. This 1.2D Method was proposed by the project engineering consultant as a modified version of the North Carolina 20D Method used to screen sources in Class II areas. It had previously been used by this consultant for a similar increment consumption analysis at Shenandoah National Park in Virginia. The 1.2D formula was developed based on the ratio of the 24-hour average significant impact levels or SIL for PM_{10} in Class I versus Class II areas. Where:

$$20D \times 0.3\ \mu g/m^3 \div 5\ \mu g/m^3 = 1.2D$$

PSD Sources: The 1.2D Method was not applied to major PSD sources within 200 km. These sources were retained for the final inventory.

Fugitive Sources: Fugitive sources such as quarries and storage piles were eliminated from the inventory due to the inaccuracy of their emission estimates and anticipation that these emissions would settle prior to reaching the Class I areas.

All sources retained after application of the screening procedures comprised the final emissions inventory for the cumulative Class I area increment consumption analysis. The final inventory contained 595 sources.

CLASS I AREA INCREMENT CONSUMPTION ANALYSIS

The project was predicted to exceed the Class I area SIL for PM_{10}. As a result, an evaluation of compliance with the Class I area increments was required. Project emissions were modeled concurrently with the regional inventory of 595 other increment consuming sources located within 200 kilometers of the affect Class I areas.

The CALMET-CALPUFF models were used for this analysis. For the evaluation of project impacts on Class I area AQRV, the modeling domain had the size 320 by 240 kilometers using 2 km resolution. To encompass the 7-state area considered in the increment consumption analysis, an additional larger modeling domain was used with and sized 500 by 448 km using 4 km resolution.

A similar increment consumption analysis had not been previously conducted for these Class I areas and the outcome was not known. However, when modeling was completed, it demonstrated compliance with the Class I area increment for PM_{10}. The results are shown in Table 10.

Table 10. Class I Area Increment Compliance Analysis using CALMET-CALPUFF Models

Air Pollutant	Averaging Period	Class I Area Increment Modeling Results (ug/m^3)	USEPA Class I Area Increment (ug/m^3)
PM_{10}	24 Hours	2.4	8
	Annual	0.3	4

CLASS I AREA AIR QUALITY RELATED VALUES ANALYSIS

Regional Visibility Analysis

The earlier siting study had used the CALMET-CALPUFF models to predict project impact on the AQRV of nearby Class I areas by estimating changes to regional visibility. It was predicted that the project would have an insignificant impact on the Class I areas. The change in visibility was less than the screening level value (SLV) proposed by the National Park Service and U.S. Forest Service. This analysis was now repeated using the final project design and stack parameters. The results were submitted for review by regulatory agencies as an amendment to the air quality permit application.[22]

The final results of the AQRV analysis for regional visibility impacts are presented in Table 11. Both the National Park Service and the U.S. Forest Service used an SLV for visibility impacts as a maximum change in beta extinction or B_{ext} of 5%. This is based on the maximum impact for any 24-hour average period. Final CALPUFF analysis predicted the maximum impact due to project emissions was 4.7%. This occurred at the closest Class I area, Cohutta National Wilderness Area.

Table 11. Visibility AQRV Impacts using CALMET-CALPUFF Models

Class I Air Quality Area	Distance from Project (km)	Units	Maximum Class I Area Impact	Significant Impact Level
Cohutta NWA	39	Change in B_{ext} (%)	4.7	5
Joyce Kilmer/Slick Rock NWA	46		2.8	
Great Smoky Mountains NP	55		2.6	
Shining Rock NWA	146		1.6	

Sulfur and Sulfate Deposition Analysis

The siting study had used the CALMET-CALPUFF models to determine project impact on the AQRV of nearby Class I areas by estimating deposition of sulfur and sulfates. For this study, it was predicted that the project would have an insignificant impact on the Class I areas. Acidic deposition was less than the respective SLV proposed by the National Park Service and U.S. Forest Service.

Based on this conclusion, the final project location was selected. This deposition analysis was now repeated using the final project design and stack parameters.

The results of the AQRV analysis for sulfur (S) and sulfate ($S0_4$) deposition impacts are presented in Table 12. For the U.S. Forest Service, the significant impact level or SLV for $S0_4$ deposition impacts is 0.05 kg/ha/yr. The maximum impact due to project emissions at the three national wilderness areas was 0.0008 kg/ha/yr, well below the SLV.

Table 12. Sulfur and Sulfate Deposition AQRV Impacts using CALMET-CALPUFF Models

Class I Air Quality Area	Maximum Class I Area Impact (kg/ha/yr)			SLV (kg/ha/yr)	
	$S0_4$	S ($S0_4$ only)	S (All forms)	NPS	USFS
Cohutta NWA	0.0003	0.0001	0.0060	0.005	0.05
Joyce Kilmer/Slick Rock NWA	0.0008	0.0003	0.0080		
Great Smoky Mountains NP	0.0008	0.0003	0.0077		
Shining Rock NWA	0.0004	0.0001	0.0013		

The National Park Service SLV for Great Smoky Mountains National Park is 0.005 kg/ha/yr of sulfur deposition. The predicted impact was 0.0003 kg/ha/yr based on S derived from SO_4, and 0.0077 based on S derived from all forms, including sulfur dioxide (SO_2) and SO_4.

It can be concluded that project impacts are below the SLV if only S from SO_4 is considered. However, if S derived from SO_2 is also considered, project impacts exceed the SLV, and support for issuance of the PSD air quality permit to the project by the National Park Service is not assured. While the permit applicant supported the lower estimate of S deposition, the National Park Service based their findings on the higher estimate. It was argued by the applicant that while the SLV was the same used for the initial siting study, the modeling procedures expected by the Park Service had changed to now incorporate additional forms of S deposition.

The disagreement on the S deposition modeling procedures was understandable. The use of only SO_4 for estimating S deposition was the approach recommended in the IWAQM Phase I report on modeling long range transport to Class I areas; the method used for the project initial siting study presented to and approved by permitting agencies; and, was consistent with the form of the SLV used by the U.S. Forest Service. Additionally, background documents presenting the SLV did not clearly specify the forms of S to be considered in the deposition analysis or the appropriate modeling procedures.

As a result of the disagreement over the procedures for estimating S deposition and compliance with the National Park Service SLV, voluntary reductions of 35% or 65 tons per year in annual SO_2 emissions were proposed by the permit applicant. This reduction in emissions reduced project impacts below the SLV and assured the National Park Service would not oppose issuance of the air quality permit due to S deposition impacts of the project.

Nitrogen and Nitrate Deposition Analysis

The earlier siting study had used the CALMET-CALPUFF models to predict project impact on the AQRV of nearby Class I areas by estimating deposition of nitrogen and nitrates. It was predicted that the project would have an insignificant impact on the Class I areas. Deposition was less than the screening level values (SLV) proposed by the National Park Service and U.S. Forest Service. This analysis was now repeated using the final project design and stack parameters.

The results of the AQRV analysis for nitrogen (N) and nitrate (NO_3) deposition impacts are presented in Table 13. For the U.S. Forest Service, the significant impact level or SIL for NO_3 deposition impacts is 0.05 kg/ha/yr. The maximum impact due to project emissions at the three national wilderness areas was 0.0029 kg/ha/yr, well below the SIL.

Table 13. Nitrogen and Nitrate Deposition AQRV Impacts using CALMET-CALPUFF Models

Class I Air Quality Area	Maximum Class I Area Impact (kg/ha/yr)			SLV (kg/ha/yr)	
	NO_3	N (NO_3 only)	N (All forms)	NPS	USFS
Cohutta NWA	0.0017	0.0003	0.0052	0.0014	0.05
Joyce Kilmer/Slick Rock NWA	0.0029	0.0006	0.0069		
Great Smoky Mountains NP	0.0031	0.0007	0.0065		
Shining Rock NWA	0.0009	0.0002	0.0010		

The National Park Service SLV for nitrogen deposition at Great Smoky Mountains National Park is 0.0014 kg/ha/yr. The maximum impact due to project emissions was 0.0007 kg/ha/yr based on N derived from NO_3, and 0.0065 based on N derived from all forms, including ammonium nitrate (NH_4NO_3), ammonium sulfate ($(NH_4)2SO_4$), nitric acid (HNO_3), and nitrogen oxides (NO_x).

It can be concluded that project impacts are below the SLV if only N from NO_3 is considered. However, if N derived from all other forms is considered, project impacts exceed the SLV, and support for issuance of the PSD air quality permit by the National Park Service is not assured. As with S deposition analysis, the disagreement of the N deposition modeling procedures was understandable based on the lack of clarity in SLV support documents.

As a result of the disagreement over the procedures for estimating N deposition and compliance with the National Park Service SLV, a voluntary reduction of 53% or 312 tons per year in annual NO_x emissions were developed for the project. This reduction was expected to reduce project impacts below the SLV if the N contribution from all forms of N except ammonia. In addition, the applicant agreed to conduct a pilot test on an innovative NO_x emission control system, and if successful, incorporate a full scale system into the final facility design. This pilot test requirement was incorporated into the final permit not as BACT, but as a means to further reduce NO_x emissions and project impacts at Smoky Mountains National Park. Both the voluntary NO_x emission reductions and the pilot test assured the National Park Service would not oppose issuance of the air quality permit due to N deposition impacts of the project.

PERMIT ISSUANCE

The construction permit application and supporting analyses for the iron foundry was reviewed by several agencies including the TAPCD, the National Park Service, the U.S. Forest Service, and USEPA Region 4. A draft permit was issued for the project incorporating the BACT emission control systems, post-construction monitoring requirements, and voluntary emission reductions developed in conjunction with the National Park Service. At the end of the 30-day comment period, a public hearing was held with all hearing participants supporting issuance of the permit. There were no objections raised against issuance of the permit by any of the reviewing agencies. The final construction permit was issued approximately two years after the initial meeting with regulatory agencies to introduce the project and the initial siting study.[23]

CONCLUSIONS

The issuance of air quality construction permits for new industrial projects is often a complex and time consuming process. This complexity increases dramatically when the project is subject to the Prevention of Significant Deterioration air quality regulations and particularly if the site is located near Class I air quality areas such as national parks and wilderness areas. The permitting experience for a new 160 ton per hour iron foundry located in eastern Tennessee demonstrates that while the permitting procedure is complex, issuance of an air quality permit is achievable. Key techniques used to assure success of this project included the following:

- Early and continued contact with appropriate regulatory agencies;
- Preliminary modeling analyses of the project design to assure acceptable impacts;
- Agreement on all aspects of BACT and air quality impact analysis procedures.

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KEY WORDS

Permit, foundry, PSD, Class I Area, increment, BACT, MACT, AQRV, ISC3, CTSCREEN, VISCREEN, CALPUFF, federal land manager, FLM, National Park Service, U.S. Forest Service, Great Smoky Mountains National Park, national wilderness area, Cohutta, Joyce Kilmer/Slick Rock, Shining Rock, Tennessee, Tennessee Air Pollution Control Division