

BART Modeling Protocol: DSM Chemicals North America, Inc.

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1.0 Introduction

1.1 Objectives

The Regional Haze Rule requires Best Available Retrofit Technology (BART) for any BART-eligible source that “emits any air pollutant which may reasonably be anticipated to cause or contribute to any impairment of visibility” in any mandatory Class I Federal area. Pursuant to federal regulations, states have the option of exempting a BART-eligible source from BART requirements based on dispersion modeling demonstrating that the source cannot reasonably be anticipated to cause or contribute to visibility impairment in a Class I Federal area.

There are numerous sources on the DSM Chemicals North America, Inc. (DCNA) site, located in Augusta, Georgia, which is owned and operated by DSM Chemicals, which have been identified as BART-eligible sources. The purpose of the document is to summarize the procedures by which modeling analysis will be conducted for these sources. The modeling procedures outlined will be used to determine whether the sources are subject to BART requirements (exemption modeling). If it is determined that the sources are subject to BART, then the procedures will be used to evaluate the visibility improvement factor in the BART determination step (determination modeling). The modeling procedures are consistent with those outlined in the updated final VISTAS common BART modeling protocol (dated December 22, 2005, revision 2 – 3/9/06), available at http://www.vistas-sesarm.org/BART/BARTModelingProtocol_rev2_9Mar2006.pdf. This source specific BART modeling protocol references relevant portions of the common VISTAS modeling protocol. DCNA has chosen to use the free VISTAS 12-km modeling as its initial model to exempt the BART regulations. If DCNA fails to meet the BART requirements using the free VISTAS 12-km modeling, then DCNA will use the refined 4-km determination modeling to exempt the BART requirements.

1.2 Location of sources vs. relevant Class I areas

The Georgia Environmental Protection Agency (EPD), which is in charge of the state’s BART program, has determined that sources in the DCNA plant site are BART-eligible. Figure 1-1 shows a plot plan of the DCNA plant site relative to nearby Class I areas. There are eight Class I areas within 300 km (1) of the DCNA plant site:

1. Cape Romain Wilderness (SC) – 219.2 km
2. Shining Rock Wilderness Area (NC) – 227.6 km
3. Wolf Island Wilderness Area (GA) – 236.9 km
4. Great Smokey Mountains national Park (NC) – 259.7 km
5. Okefenokee Wilderness Area (GA) – 266.0 km
6. Linville Gorge Wilderness Area (NC) – 266.7 km
7. Joyce Kilmer-Slickrock Wilderness Area (TN) – 281.5 km
8. Cohotta Wilderness Area (GA) – 288.7 km

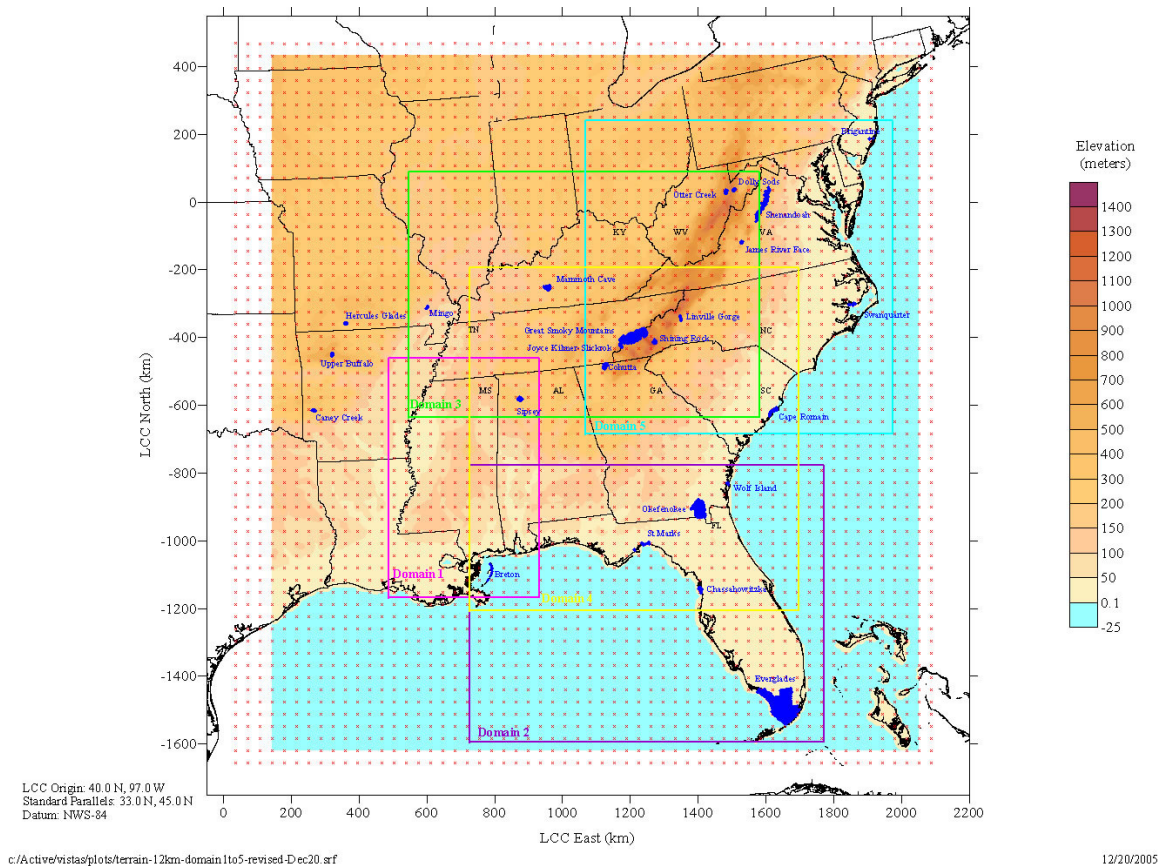
(1) Distances of Class I areas to DCNA plant site obtained from Pete Courtney, EPD Air Protection Branch on 5/4/06

The BART exemption modeling will be conducted for each of these Class I areas in accordance with the referenced VISTAS common BART modeling protocol and the

procedures described in this source specific BART modeling protocol. If necessary, visibility improvement modeling for the BART determination step will be performed for those Class I areas where the exemption modeling shows a greater than 0.5 deciview (dv) impact.

Section 2 of this protocol describes the source emissions that will be used as input to the BART exemption modeling and, if necessary, the BART determination modeling. Section 3 describes the input data to be used for the modeling including the domain, terrain and land use, and meteorological data. Section 4 describes the air quality modeling procedures and Section 5 discusses the presentation of modeling results. Since all of the reference sites are also included in the VISTAS common BART modeling protocol (Section 7.), no additional reference section is included in the document other than the in Section 1.2. (distance of Class I areas to the DCNA site).

Figure 1-1 Location of Class I Areas in relation to the DCNA site



Mandatory Class I Areas

• NPS Units
• FWS Units
• FS Units

* Rainbow Lake, WI and Bradwell Bay, FL are Class 1 Areas where visibility is not an important air quality related value

Produced by NPS Air Resources Division

2.1` Unit-specific source data

The emissions data used to assess the visibility impacts at the Class I areas within 300 km of the DCNA plant site is discussed in this section. VISTAS states intend to follow Option C, which is to determine if the visibility impact from individual sources exceeds a contribution threshold for SO₂, NO_x and PM emissions (VISTAS common BART protocol Section 4.1).

To determine if a source is BART eligible, VISTAS plans to use Q/d as a presumptive indicator that a source is subject to BART. Based on actual 2002 SO₂ emissions provided to the Georgia EPD Air Protection Branch, the Q/d value for the DCNA site is 0.17 (which is less than 10). As indicated in a letter dated March 9, 2006 from the Georgia EPD Air Protection Branch, the DCNA site has been offered the opportunity to use the free VISTAS 12-km initial modeling to determine (a) if a particular source may be exempted from further BART analyses and (b) if a finer 4-km grid CALPUFF analysis should be undertaken. If the DCNA site does not exempt out from further BART requirements using the 12-km grid initial modeling then the finer grid CALPUFF modeling analysis using subregional CALMET domain will be the definitive test as to whether a source is subject to BART. The baseline data for BART eligible sources has been sent via email to the Georgia EPD Air Protection Branch which list all of the sources, UTM coordinates, stack heights, diameter, exit gas velocity and temperature, and emissions data from 2002 on VOC, SO₂, NO_x, NH₃, and PM.

3.0 Input Data to the CALPUFF Model

3.1 General modeling procedures

VISTAS has developed five subregional 4-km CALMET meteorological databases for three years (2001-2003) (VISTAS common protocol Section 4.2). The sub-regional modeling domains are strategically designed to cover all potential BART eligible sources within VISTAS states and all PSD Class I areas within 300 km of those sources (to the nearest edge). The extents of the 4-km subregional domains are shown in Figure 4-4 of the VISTAS common BART modeling protocol. The BART modeling for the DCNA site will be done using the 4-km subdomain _____ (subdomain name to be added later).

USGS 90-meter Digital Elevation Model (DEM) files were used by VISTAS to generate the terrain data at 4-km resolution for input to the 4-km subregional CALMET run. Likewise, USGS 90-meter Composite Theme Grid (CTG) files were used by VISTAS to generate the land use data at 4-km resolution for input to the 4-km subregional CALMET run.

Three years of MM5 data (2001-2003) were used by VISTAS to generate the 4-km subregional meteorological datasets. See Sections 4.3.2 and 4.4.2 in the VISTAS common BART modeling protocol for more detail on these issues.

It is intended that all of the modeling at the DCNA site will use 4-km subdomain _____ (subdomain name to be added later). However, if the results indicate that the modeling could be improved with a CALPUFF run using a finer grid, then refinements in the modeling procedures will be considered and the Georgia EPD Air Protection Branch will be asked to approve these refinements.

In the event that a finer grid resolution is used, CALMET must be rerun. Other modifications to inputs of CALMET would include the extent of the modeling domain, the resolution of the terrain and land use data, and other relevant settings. The same MM5 data and observations as used for the 4-km subregional CALMET simulations would be used. The size of the CALMET output is directly proportional to the grid resolution of the run. The domain would be limited to the source and the exclusive Class I area(s) being assessed with a higher grid resolution, including a 50-km buffer in all directions.

If CALMET needs to be run at even a finer grid resolution, then the appropriate model settings/files (specifically the GEO.DAT file) will be modified. A summary of the modifications would be provided to the Georgia EPD Air Protection Branch for review and approval.

3.2 Air quality database (background ozone and ammonia)

Hourly measurements of ozone from all non-urban monitors, as generated by VISTAS and available on the VISTAS CALPUFF page on the Earth Tech web site (http://www.src.com/verio/download/sample_files.htm), will be used as input to CALPUFF. For ammonia, the approach recommended by VISTAS will be followed.

3.3 Natural conditions and monthly f(RH) at Class I Areas

For each of the applicable Class I areas, natural background conditions must be established in order to determine a change in natural conditions related to a source's emissions. The modeling described by this protocol document intends to use annual average natural background light extinction (EPA 2003 values). To determine the input to CALPUFF, it is first necessary to convert the deciviews to extinction using the equation:

$$\text{Extinction (Mm}^{-1}\text{)} = 10 \exp (\text{deciviews}/10)$$

For example, the EPA guidance document indicates for Great Smokey Mountains National Park that the deciview value for the average of the days is 7.60. This is equivalent to an extinction of 21.38 inverse megameters (Mm^{-1}).

This extinction includes the default 10 Mm^{-1} for Rayleigh scattering. The remaining extinction is due to naturally occurring particles, and should be held constant for the entire year's simulation. Therefore, the data provided to CALPOST for Great Smokey Mountains National Park would be the total natural background extinction minus 10 (expressed in Mm^{-1}), or 11.38.

4.0 Air Quality Modeling Procedures

This section provides a summary of the modeling procedures outlined in the VISTAS protocol that will be used for the refined CALPUFF analysis to be conducted for the DCNA site.

4.1 Model selection and features

As noted in the VISTAS protocol (Summary, Recommendations Section II.), VISTAS will use CALPUFF Version 5.754 and CALMET Version 5.7, which can be obtained at http://www.src.com/verio/download/download.htm#VISTAS_VERSION. These versions contain enhancements funded by the Mineral Management Service (MMS) and VISTAS. They were developed by Earth Tech, Inc. and they are maintained on Earth Tech's Atmospheric Studies Group CALPUFF website for public access. This release includes CALMET, CALPUFF, CALPOST, CALSUM, and POSTUTIL as well as CALVIEW.

The major features of the CALPUFF modeling system, including those of CALMET and the post processors (CALPOST and POSTUTIL), are referenced in Section 3 of the VISTAS common BART protocol.

4.2 Modeling domain and receptors

The initial DCNA site BART runs will use the sub-domain _____ (subdomain name to be added later), 4-km CALMET data to be supplied by VISTAS, as discussed above. This domain includes all Class I areas within 300 km of the source, plus a 50-km buffer. If there is a need for a refined analysis with a finer grid, a supplement to this modeling protocol will be provided describing the proposed procedures.

The receptors used for each Class I areas are based on the NPS database of Class I receptors, as recommended by the VISTAS common BART protocol (Section 4.3.3).

4.3 Technical options used in the modeling

CALMET modeling for the VISTAS-provided 4-km subdomains will be performed per the procedures specified in the VISTAS common BART modeling protocol. If it is decided to conduct additional modeling with a finer grid than 4-km, this modeling protocol will be updated to specify the technical options to be used in the CALMET run, in order to allow state agency review and approval.

For CALPUFF model options, DCNA will follow the VISTAS common BART modeling protocol (Section 4.4.1), which states that we should use IWAQM (EPA, 1998) guidance. The VISTAS protocol (Section 4.3.3) also notes that building downwash effects are not required to be included unless the state directs the source to include those effects. Since the DCNA site is tens of kilometers from the nearest Class I area, building downwash effects will not be included in the CALPUFF modeling.

The POSTUTIL utility program (VISTAS common BART protocol Section 4.4.2) will be used to repartition HNO₃ and NO₃ using VISTAS-provided ammonia concentrations derived from previous 2002 CMAQ modeling conducted by EPA or the alternate ammonia concentrations approach recommended by VISTAS, if the CMAQ data is unavailable.

4.4 Light extinction and haze impact calculations

The CALPOST postprocessor will be used as prescribed in the VISTAS protocol for the calculation of the impact from the modeled source's primary and secondary particulate matter concentrations on light extinction. The formula used is the existing (not the November 2005 revised) IMPROVE/EPA formula, which is applied to determine the change in light extinction due to increases in the particulate matter component concentrations. Using the notation of CALPOST, the formula is the following:

$$B_{\text{ext}} = 3 f(\text{RH}) [(\text{NH}_4)_2\text{SO}_4] + 3 f(\text{RH}) [\text{NH}_4\text{NO}_3] + 4[\text{OC}] + 1[\text{Soil}] + 0.6[\text{Coarse Mass}] + 10[\text{EC}] + b_{\text{Ray}}$$

The concentration, in square brackets, are in ug/m³ and b_{ext} is in units of Mm⁻¹. The Rayleigh scattering term (b_{Ray}) has a default value of 10 Mm⁻¹, as recommended in EPA guidance for tracking reasonable progress (EPA, 2003a). However, as recommended in the VISTAS protocol (Section 6.2.4), for refined 4-km grid (or smaller) CALPUFF runs, the Rayleigh scattering term will be modified for the specific elevation of the Class I area receptors. The Rayleigh term for estimating natural background will also be adjusted to be consistent with this approach.

The BART rule significance threshold for the contribution to visibility impairment is 0.5 deciviews. The VISTAS protocol (Section 4.3.2) indicates that with the use of the 4-km subregional CALMET database, a source does not cause or contribute to visibility impairment if the 98th percentile (or 8th highest) day's change in extinction from natural conditions does not exceed 0.5 deciviews for any of the modeled years (an added check is: the 22nd highest prediction over the three years modeled should not exceed 0.5 deciviews for a source to be exempted from a BART determination).

The haze index (HI) is calculated from the extinction coefficient via the following formula:

$$HI = 10 \ln (b_{\text{ext}}/10)$$

where HI is in units of deciviews (dv) and b_{ext} is in Mm^{-1} . The impact of a source is determined by comparing HI for estimated natural background conditions with the impact of the source and without the impact of the source.

If the exemption modeling demonstrates that the DCNA site does not cause or contribute to visibility impairment, then the source will not be subject to BART requirements, and no further analysis is needed. Otherwise, the DCNA will proceed to perform BART determination modeling for the baseline each control option in a similar manner as has been described in this document.

5.0 Presentation of Modeling Results

The BART exemption and, if necessary, the BART determination modeling results for the DCNA site will be provided to the state agency in a manner as described in the VISTAS protocol (Section 4.5). A report will be produced that includes the following elements (as suggested in the VISTAS protocol):

- A map of the source location and Class I areas within 300 km of the source.
- For the CALPUFF modeling domain, a table listing all Class I areas in the VISTAS domain and those in neighboring states and impacts from the BART 4-km grid exemption modeling at those Class I areas within 300 km of the source, as illustrated in Table 4.3 of the VISTAS protocol.
- A discussion of the number of Class I areas with visibility impairment due to source emissions for the 98th percentile days each year (and the 98th percentile over all three years modeled) greater than 0.5dv.
- For the Class I area with the maximum impact, a discussion of the number of days beyond those excluded (e.g., the 98th percentile for refined analyses) that the impact of the source exceeds 0.5 dv, the number of receptors in the Class I area where the impact exceeds 0.5 dv, and the maximum impact.
- For any finer grid CALPUFF exemption modeling, results for those Class I areas for which impacts of the source exceeded 0.5 dv in the 4-km initial modeling. We would report the same type of results as provided for 4-km exemption modeling.
- For control option modeling, each control option tested will be listed in tabular format. For each control option and for each Class I area where the impact of the source exceeded 0.5 dv, a report in the change in pollutant emissions and the change in visibility impact from the source as a result of the control option. The effectiveness of candidate control options are to be compared to each other, not to a specific target improvement.

