An Assessment of WRAP Modeling Needs
September 5, 2000

This "Assessment of WRAP Modeling Needs" has been prepared in order to provide the WRAP's technical forums with information needed to finalize their work plans. This document focuses on what is needed, and by when. The question of how these needs will be met will be answered by the WRAP Modeling Forum, Emissions Forum, and other technical forums, in coordination with the Technical Oversight Committee.

Why are Models Needed?

EPA visibility regulations "require States to develop programs to assure reasonable progress toward meeting the national goal of preventing any future, and remedying any existing, impairment of visibility in mandatory Class I Federal areas which impairment results from man-made air pollution" (40 CFR 51.300). Consistent with the Tribal Authority Rule (40 CFR Part 49), Tribes also may assume responsibility for the visibility program.[1] Thus, throughout our paper we assume that regulatory language referring to "States" applies equally also to "Tribes."

Modeling is mentioned explicitly in only two places in EPA's Regional Haze Rule (RHR): (1) in 308(c)(ii), related to interstate transport, and (2) in 308(d)(3)(iii), related to apportionment of interstate emission reduction obligations. However, as demonstrated below, and by the draft work products of the WESTAR Regional Haze SIP/TIP Development Working Group, modeling is implicitly required throughout the Regional Haze Rule in words such as assess, evaluate, identify, analyze, determine, and project. These verbs are generally linked with two types of assessments: (1) a cumulative impact assessment (i.e., "based on the implementation of all measures") and (2) an incremental impact analysis.

Incremental impacts are associated with:

- each haze-producing pollutant, [2]
- each state, tribe, and country in a region,[3]
- various source categories,[4]
- individual sources, and
- controls.

In addition to these explicit and implicit needs mentioned in the RHR, models are needed to support the development and optimization of control strategies, consisting of a suite of individual control measures on specific pollutants, source categories and sources. Such modeling would be able to identify the incremental impacts of individual sources, source categories, states, and haze-

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[1] For example, "...Tribes within the Transport Region may implement the required visibility programs for the 16 Class I areas, in the same manner as States..." (40 CFR 51.309(d)(12))

[2] Haze is produced primarily by particulate matter (PM), which can scatter and absorb light. Fine particles ($PM_{2.5}$) are most efficient at scattering light. $PM_{2.5}$ is generally composed of sulfate, nitrate, organics, elemental carbon, soil, and other. Gaseous precursors to these species include sulfur dioxide (SO_2), nitrogen oxides (NO_x), ammonia (NH_3), and volatile organic compounds (VOCs, some of the larger molecules with six or more carbon atoms; biogenic terpenes are important examples.). Gaseous nitrogen dioxide (NO_2) absorbs light, thus appearing brown.

[3] Although a foreign country may not participate in regional haze planning, its haze producing emissions are transported hundreds of miles, thereby affecting U.S. haze planning.

[4] Source categories include stationary sources, mobile sources, fire, area sources of dust emissions from paved and unpaved roads, and pollution prevention.

producing pollutants on Class I area visibility impairment. It would also be able to assess the relative effectiveness (including cost-effectiveness) of various control options.

To summarize, the types of models needed to implement the RHR are the following (in order of when[5] they are needed and, coincidentally, in order from simpler to more complex):

1. Modeling for Control Strategy Development and Optimization
2. Modeling for Incremental Impact Analysis of Individual Source Categories and States
3. Modeling for Cumulative Impact Analysis

When are Models Needed?

This paper focuses on modeling needs over the next two years because of the urgency of these early deadlines.

The first two regulatory deadlines apply to the States and Tribes in the West that choose to carry out their RHR responsibilities under 40 CFR 51.309 (or simply "Section 309"). Section 309 was derived from the Grand Canyon Visibility Transport Commission (GCVTC) recommendations of 1996. These two deadlines are:

1. By October 1, 2000 the WRAP must submit an Annex to EPA that outlines a backstop sulfur dioxide (SO_2) emission trading program. This program will be defined by SO_2 emission milestones that are designed to ensure (1) "steady and continuing emission reductions for the 2003-2018 time period" and (2) "greater reasonable progress than would be achieved by application of best available retrofit technology (BART)." The modeling work to demonstrate the visibility benefit of the SO_2 milestone program on the 16 Class I areas covered under Section 309 has recently been completed by a consultant utilizing the "IAS" modeling tool developed by the Grand Canyon Commission.

2. December 31, 2003 is when the Section 309 SIPs are due to EPA. These SIPs include much more than the SO_2 milestone program; they address all sources and all pollutants.

The only states that have the option of submitting a 309 SIP are the 9 GCVTC transport region states (CA, OR, ID, NV, UT, AZ, WY, CO, NM). All other states in the West (including WA, MT, ND, SD, AK, HI) do not have the 309 option and must submit Section 308 SIPs in the 2006-2008 timeframe. Furthermore, all but one of these 9 transport region states have "additional" Class I areas beyond the 16 on the Colorado Plateau covered by the GCVTC recommendations. These States must make a separate SIP demonstration for these other Class I areas, but they have the option of deferring this work until 2008 under section 309, or by submitting a separate SIP under section 308 in the 2006-2008 timeframe.

Modeling is needed well in advance of the December 31, 2003 deadline for the 309 SIPs for the 16 Class I areas. WRAP States and Tribes have requested that technical work must be finished 18 months prior to this deadline to allow time to finalize control strategies and any laws, rules, and regulations required to implement them, and to take and respond to public comment on their SIPs/TIPs. This suggests June 30, 2002 as the deadline for completing the modeling in support of the Section 309 plans.

[5] As discussed below, some modeling will be done in parallel or with some overlap.

Additional modeling work is required after this date to support the 308 SIPs and the 309 SIP supplements for "additional" Class I areas. For the purposes of this paper, we focus solely on the absolute minimum requirements for the June 2002 modeling deadline. Others may wish to add the substantial modeling requirements associated with determining control strategies needed to achieve rates of progress consistent with meeting the RHR's 60-year glide path to natural conditions. However, since this analysis is not required until much later, our focus is on short-term needs. It needs to be pointed out that we believe that the longer term needs can be met with the tools discussed here.

Minimal Modeling Requirements for June 2002

The specific modeling needs for the June 2002 technical deadline are called out as follows in Section 309 of the RHR:

1. Projection of Visibility Improvement. "For each of the 16 mandatory Class I areas located within the Transport Region State, the plan must include a projection of the improvement in visibility conditions (expressed in deciviews, and in any additional ambient visibility metrics deemed appropriate by the State) expected through the year 2018 for the most impaired and least impaired days, based on the implementation of all measures as required in the Commission report..." (40 CFR 51.309 (d)(2)) This is the cumulative impact (or improvement) analysis referred to above.

2. Treatment of Clean Air Corridors. The States must identify CACs for all 16 Class I areas. "If impairment of air quality in [CAC] is identified ... an analysis of the effects of increased emissions, including provisions for the identification of the need for additional emission reductions measures...." (40 CFR 51.309 (d)(3)) .

3. Provisions for Stationary Source NO_x and PM. "The plan submission must include a report which assesses emissions control strategies for stationary source NO_x and PM, and the degree of visibility improvement that would result from such strategies." (40 CFR 51.309 (d)(4)(v)). A full analysis is not required until 2008.

4. Mobile Sources. "The plan submission must provide for.... a determination whether mobile source emissions in any areas of the State contribute significantly to visibility impairment in any of the 16 Class I Areas, based on the statewide inventory of current and projected mobile source emissions" (40 CFR 51.309 (d)(5)(ii)).

5. Programs Related to Fire. "The plan must provide.... documentation that all Federal, State, and private prescribed fire programs within the State evaluate and address the degree visibility impairment from smoke in their planning and application." It also requires the "evaluation of smoke dispersion" (40 CFR 51.309 (d)(6)(i)).

6. Road Dust Emissions. "The plan must include an assessment of the impact of dust emissions from paved and unpaved roads on visibility conditions in the 16 Class I Areas. If such dust emissions are determined to be a significant contributor to visibility impairment in the 16 Class I areas, the State must implement emission management strategies to address the impact as necessary and appropriate" (40 CFR 51.309 (d)(6)(i)).

7. Pollution Prevention. "The plan must provide for.... projections of the short- and long-term emissions reductions, visibility improvements, cost savings, and secondary benefits associated with the renewable energy goals, energy efficiency and pollution prevention

activities." (40 CFR 51.309 (d)(8)(5)) To the extent that P^2 programs displace energy production from haze-producing facilities, they will have an effect.

It is recommended that the Modeling Forum concentrate its efforts in the near term to providing deliverables addressing the regulatory needs stated above for the 309 option, but to include in addition the following:

8. Additional Class I Areas: a) a demonstration that the milestones contained in the SO2 Annex satisfy the "greater reasonable progress than BART" requirement for all Class I areas in the 9 transport region states, thereby satisfying the regional haze BART requirement for the sources of sulfur dioxide participating in the milestone and backstop trading program of the Annex; and b) information on the visibility benefit of the Section 309 SIPs for all Class I areas within the modeling domain.

Criteria to Guide Modeling Work

Criteria that are important to guide development of the work plan that will meet the minimum modeling requirements for June 2002 are listed below. We recognize that the Modeling Forum and other technical forums are faced with balancing these criteria one against the other to achieve the best possible work scope, but recommend that the limitations of the selected approach be identified so that it is clear what is being delivered.

1. Assurance. The States and Tribes need to be assured that tools will be available for both design and evaluation of regional haze control strategies in the above-mentioned timeframe.
2. Redundancy. To the extent possible, it is desirable to base design and assessment on more than one tool to provide checks and balances and an idea of uncertainties.[6]
3. Reliability. Modeling tools and results must reliably support the SIP/TIP process.
4. Accuracy. Models must be demonstrated to be accurate within specified limits by comparing calculations with measurements. Model reconciliation may be required.[7]
5. Capacity Building. States and Tribes need to develop the capability to do their own modeling work. Consultants can provide training, hardware, and software to the States, Tribes, and a Regional Modeling Center (RTC) to "jump-start" the process.
6. Cost. Modeling work is limited by the current budget (extending through June 2001) of about $1.3 million.
7. Time. As mentioned before, work must be done by June 30, 2002.
8. Consistency. The modeling strategy ultimately adopted by the Modeling Forum must insure that there is consistency between the methods used to meet the short-term needs (2002-03) and the methods that will be used to meet the long-term needs (2006-08). It is critical that the technical work need not be repeated depending on the tool used.

[6] One of us has recently performed a comparison of regional modeling related to the impact of the WRAP SO_2 milestone program on visibility improvement. Different groups applied four different models, ranging from simple to complex. Surprisingly, the model results were within 20%. (The models were speciated rollback, S-R matrix, IAS/VARED, and REMSAD.) This sort of agreement should not necessarily be expected in future work, but the comparison shows the value of redundancy.

[7] Instead of relying solely on models, an approach, being proposed by OAQPS for regional haze modeling, could be used, whereby the model is used to calculate Relative Reduction Factors (RRFs). RRFs are simply the modeled ratios of controlled-to-baseline concentrations. If the RRF is multiplied by the *measured* concentration, it is believed that a more accurate prediction of future conditions is obtained.

As noted above, there are three types of modeling required: (1) for control strategy development, (2) for incremental impact analysis of sources, source categories, and states, and (3) cumulative impact analysis. We believe that dozens of model runs will necessary. If cost optimization is needed, many more runs are required. To be sure, a comprehensive model is likely the "best" model available when it comes to state-of-the-science representation of all of the physics and chemistry associated with regional haze (transport, diffusion, wet and dry deposition, photochemistry, etc.). But is it really "best" if it cannot provide the endpoints required for regional haze SIP development? Therefore, it is important to consider the wisdom of two clichés: (1) "Don't put all your eggs in one basket!" and (2) "Don't use a Cadillac if a Ford will do!"

A committee of the National Academy of Sciences[8] in 1993 wrote the following about the modeling needs associated with regulating regional haze:

> "Visibility impairment can be attributed to emission sources on a regional scale through the use of several kinds of models. In general, the best approach for evaluating emission sources is a nested progression from simpler and more direct models to more complex and detailed methods. The simpler models are available today and could be used as the basis for designing regional visibility programs; the more complex models could be used to refine those programs over time.
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> "After identifying which pollutants are impairing visibility for a given region, it is useful to apportion visibility impairment among contributing sources to the extent possible so that the relative effectiveness of alternative control measures can be evaluated. Source apportionment models of varying degrees of accuracy and complexity can be used to analyze regional haze problems, although no single source-apportionment method is necessarily best for all visibility problems. Simpler methods are most effective in the early stages of source apportionment, with the more complex methods being applied, if necessary, to resolve difficult technical issues."

We believe that these statements precisely describe our recommended endpoint philosophy: "...a nested progression from simpler... models to more complex....Simpler methods are most effective in the early stages.....with more complex methods being applied, if necessary, to resolve difficult technical issues."

[8] *Protecting Visibility in National Parks and Wilderness Areas,* Committee on Haze in National Parks and Wilderness Areas, National Research Council, 1993.