Redesigned Technical Study Plan
Columbia River Gorge
National Scenic Area
Air Quality Study

~7/25/2003~

Developing a Regional Air Quality Strategy for the Columbia River Gorge National Scenic Area

Executive Summary

In July of 2001, the Columbia River Gorge Technical Team and Interagency Coordination Team, with the assistance of national and global experts in air quality science, developed a phased, technical study plan for the Columbia River Gorge National Scenic Area. In 2003, WDOE, ODEQ and SWCAA asked the Technical Team to develop a "stand alone" study, leveraging other studies and within the available resources, that would:

> a) provide an assessment of the causes of visibility impairment in the Columbia River Gorge National Scenic Area; b) identify emission source regions, emission source categories, and individual emission sources significantly contributing to visibility impairment in the Gorge; c) provide predictive modeling tools or methods that will allow the evaluation of emission reduction strategies; d) provide an initial assessment of air quality benefits to the Gorge from upcoming state and federal air quality programs; and e) refine or adapt predictive modeling tools already being developed for visibility or other air quality programs, including but not limited to Regional Haze.

Some of the existing state and federal air quality programs from which emission reduction is expected include:

1) Ozone Strategies: Ozone plan updates for Portland/Vancouver and Seattle.
2) New Source Review: New or expanding major point sources must evaluate air quality impacts on Class I areas. Given the Gorge's proximity to the adjacent Class I areas, the Gorge NSA will benefit indirectly from the New Source Review program.
3) National Programs: Nonroad Engines, including new standards for trains & marine vessels.
4) National Air Toxics Emission Standards: Maximum Achievable Control Technology Standards for some major point sources. (Air Toxics Rules).
5) Washington and Oregon Regional Haze Programs (State Implementation Plan -SIP): with control strategies, if needed, to reduce impacts to Class I areas (Mt. Adams, Mt Hood, etc.).
6) Washington's RACT for the Centralia Coal Fired Power Plant with the full sulfur dioxide scrubbing came online December 31, 2002.
7) National programs affecting mobile emissions. (New tail pipe standards for vehicles and light duty trucks, low sulfur gasoline, low sulfur diesel fuel, heavy-duty diesel vehicle standards, non-road diesels).
8) Oregon and Washington Smoke Management Programs: Designed to reduce smoke impacts from prescribed forestry burning.
9) Washington's Yakima Maintenance Plan status for Carbon Monoxide (CO) and Particulate Matter – Coarse Particles (PM_{10}) and Wallula's non-attainment status for PM_{10}.

The Technical Team reviewed the original Study Plan and prioritized the measurement and modeling elements that would best meet the new charge with the available funding. The Technical Team recognized that not all the objectives identified under the original, phased approach would be reached with the same level of certainty. As a result, the Redesigned Study does not provide the complete suite of measurements that were originally envisioned, nor does it provide for the temporal and spatial resolutions necessary to achieve the same degree of confidence anticipated in the original Technical Foundation Study.

It does enhance, however, our knowledge and understanding of the complex processes that manifest themselves in the form of haze in the Scenic Area with sufficient confidence in the data and results to make management decisions on future activities. The resulting Redesigned Study combines elements from both phases of the original (phased) study approach into a single core study that can begin to inform the Advisory Committee and decision-makers about sources of air pollution influencing visibility in the Scenic Area. The Redesigned Study will provide measurement data to support the understanding of **C**auses **o**f **Ha**ze in the **Go**rge (CoHaGo) assessment and validation of the numerical chemical transport model. It will provide a better understanding of emission regions, categories and possible individual sources that contribute to haze, located both inside and outside the Scenic Area. It will also provide additional certainty about what we know and what we do not know as a result of the CoHaGo assessment and the predictive, numerical modeling activities, and present this information in one clearly organized document.

The scope of the Redesign Study's scientific study program is designed to focus primarily on visibility and the emission sources that contribute to haze in the Scenic Area. The main visibility impairing pollutants include sulfates, nitrates, organic and elemental carbon, and fine soil. These pollutants are created by a wide variety of sources both inside and outside the Scenic Area. These air pollutants that impair scenic vistas and degrade scenic resources in the Gorge can also degrade the natural, recreational, and cultural resources of the Scenic Area.

The scope and funding for this project does not allow for a comprehensive and exhaustive evaluation of all air pollution affects on scenic, cultural, natural, and recreational resources. For example, this study will not evaluate air pollution impacts on the full range of possible ecosystem issues, including Columbia River fisheries and native plants. However, by working to improve visibility in the Gorge; we will both directly and indirectly benefit all the valued resources to be protected under the Scenic Area Act.

Two key visibility impairing pollutants (sulfates and nitrates) are especially significant in the formation of acid rain and fog water that may damage cultural resources, primarily Native American rock art, and natural resources (including culturally significant plants). Given the special historic and cultural value of Native American rock art in the Gorge, the Forest Service has funded an independent special study ($54,000) to perform an initial assessment of the chemistry of fog/cloud water that could pose a risk to Native American rock art and other ecosystem resources.

The fog-water study will not provide a definitive assessment of the risk to cultural resources. It is the first step in this evaluation. It can inform decision-makers as to the next most appropriate step in evaluating impacts to culturally significant resources. This study element is described further in Attachment F.

Impacts to cultural and ecosystem resources will be minimized **by the same measures that protect and enhance visibility in the Scenic Area because the impacts to both are caused by the same suite of pollutants.** To improve visibility, reductions in emissions of precursor gases such as SO_2, NO_X, and VOCs are important. Reductions in primary organic and elemental carbon and fugitive dust would also help improve visibility. Many of these emissions also may contribute to additional air quality impacts. Acidic aerosols containing sulfur and nitrogen can cause damage to cultural and ecosystems resources. NO_X and VOCs contribute to ozone concentrations and ozone can have a detrimental impact on plants. Because small amounts of pollution can have a significant effect on visibility, reducing these pollutants sufficient to protect visibility helps reduce other air quality impacts.

The Redesigned Study will provide information to refine or adapt a numerical chemical transport model specifically for assessing haze conditions in the Scenic Area for a base year (presumably 2004). While not performing "what if" analyses, nor an assessment of emission reduction strategies, it does provide information to run the numerical chemical transport model for a future year (presumably 2018) to determine what significant trend, if any, is apparent for haze in the Scenic Area attributed to the implementation of new state and federal programs.

The Redesigned Study will provide a basis for leveraging opportunities, now and in the future, for such tasks as assessing acid deposition and the associated impacts on cultural artifacts. The additional measurement data will help us understand historic trends and support models to predict future trends from either existing or new state and federal programs yet to be implemented.

Finally, it has been designed to support "add-ons" for additional analysis of measurement data/samples and additional model refinement/model runs. The potential "add-on" components could be recommended by the Advisory Committee if additional funding becomes available, and if for example, the Advisory Committee recommends that the Redesigned Study should: a) be expanded in scope to analyze additional time periods; b) clarify the contribution of specific emission sources; or c) develop and test strategy options if the initial Redesigned Study results do not indicate existing and planned air quality strategies will improve air quality sufficiently to meet the goals of the Gorge Scenic Area Act.

As in the original, phased technical study, the Redesigned Technical Study Plan will not recommend air quality strategies. It will describe the process for gaining scientific knowledge about Gorge air quality and the process to be used in making decisions about the future of air quality in the Gorge.

While not part of this document, the agencies involved recognize the role of economic analysis in developing air quality strategies. Economic and air quality analysis are used together to weigh important cost/benefit questions and develop a recommended air quality strategy that meets the dual purposes of the Scenic Area Act.

Comments on the Redesigned Technical Study were solicited at a public meeting on May 29, 2003 and changes were made to this Study as necessary as a result of comments received at that presentation. If the Commission concurs, results from the redesigned study will be available beginning in 2-3 years. (Approximately 2005-2006). This schedule is contingent on timely funding availability from EPA and the ability to operationally deploy the additional monitoring equipment in the field.

Project Technical Team

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* These individuals have contributed significantly to the original and Redesigned Study Plan. As of July 1, 2003, the Washington Department of Ecology has disinvested in active involvement in visibility work statewide.

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The Technical Team wishes to express its gratitude to those local and national experts in air science who contributed to the original Technical Study Plan. The Technical Team also acknowledges facilitator, Sam Imperati, J.D., Executive Director of the *Institute for Conflict Management, Inc*., for his editing suggestions.

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Attachments

I. Overview

In July of 2001, the Columbia River Gorge Technical Team (Technical Team) and Interagency Coordination Team (Coordination Team), with the assistance of national and global experts in air quality science, developed a phased, technical study plan for the Columbia River Gorge National Scenic Area (Scenic Area). (See, "Columbia River Gorge Visibility and Air Quality Study – Working Draft: Existing Knowledge and Recommended Scientific Assessment to Consider", June 2001, Green et al). The Study Plan was submitted to the Columbia River Gorge Commission and concurred in August of 2001.

The phased approach called for an initial Technical Foundation Study (TFS) that would characterize the physical, meteorological and chemical processes governing air quality in the Scenic Area, and the development of an initial conceptual model of causes of haze and other air quality issues, such as the effect of acid deposition on Native American cultural artifacts. The TFS was not designed, by itself, to lead to the development of a regional air quality control strategy. It was designed to better understand key processes that are important in modulating air quality in the Scenic Area; thus guiding the final development of the second phase of study.

The second phase of the original Study Plan would have been designed, based on what was learned in the TFS, to: a) verify the conceptual model of air quality, b) identify contributing pollution sources and source areas, and c) do final development, testing, validation and selection of an air quality predictive model to be used later by air quality managers for strategy development.

WDOE, ODEQ and SWCAA asked the Technical Team to develop a "stand alone" study that would:

> a) provide an assessment of the causes of visibility impairment in the Columbia River Gorge National Scenic Area; b) identify emission source regions, emission source categories, and individual emission sources significantly contributing to visibility impairment in the Gorge; c) provide predictive modeling tools or methods that will allow the evaluation of emission reduction strategies; d) provide an initial assessment of air quality benefits to the Gorge from upcoming state and federal air quality programs; and e) refine or adapt predictive modeling tools already being developed for visibility or other air quality programs, including but not limited to Regional Haze.

Attachment A provides the Redesigned Technical Study Plans at a Glance.

The Technical Team reviewed the original Study Plan and prioritized the measurement and modeling elements that would best meet the new charge with the available funding. It was recognized that we would not be able to reach all the objectives identified under the original phased approach with the same level of certainty. However, the redesigned study could provide additional certainty in our understanding of haze in the Scenic Area that we do not have today because it focuses on the two, most important seasonal periods. From this information, we will be in a position to consider, what, if anything further, needs to be done to achieve the purposes of the Gorge Scenic Act.

Measurement and modeling tasks proposed in the redesigned study plan not only are intended to cover some of the tasks proposed in the original TFS, but also many of the tasks of subsequent phases envisioned in the original Study Plan - especially those that are needed to attempt to verify our hypotheses. The Redesigned Study Plan consists of a Measurement Program (Section II, below) and a Modeling Program. (Section III, below). **Attachments B and C provide a detailed comparison of the original, phased approach with the Redesigned Study Plan.**

The scope of the Redesign Study's scientific study program is designed to focus primarily on visibility and the emission sources that contribute to haze in the Scenic Area. The main visibility impairing pollutants include sulfates, nitrates, organic and elemental carbon, and fine soil. These pollutants are created by a wide variety of sources both inside and outside the Scenic Area. These air pollutants that impair scenic vistas and degrade scenic resources in the Gorge can also degrade the natural, recreational, and cultural resources of the Scenic Area.

The scope and funding for this project does not allow for a comprehensive and exhaustive evaluation of all air pollution affects on scenic, cultural, natural, and recreational resources. For example, this study will not evaluate air pollution impacts on the full range of possible ecosystem issues, including Columbia River fisheries and native plants. However, by working to improve visibility in the Gorge; we will both directly and indirectly benefit all the valued resources to be protected under the Scenic Area Act.

Two key visibility impairing pollutants (sulfates and nitrates) are especially significant in the formation of acid rain and fog that may damage cultural resources, primarily Native American rock art, and natural resources (including culturally significant plants). Given the special historic and cultural value of Native American rock art in the Gorge, the Forest Service has funded an independent special study ($54,000) to perform and initial assessment of the chemistry of fog/cloud water that could pose a risk to Native American rock art and other ecosystem resources.

The fog-water study will not provide a definitive assessment of the risk to cultural resources. It is the first step in this evaluation. It can inform decision-makers as to the next most appropriate step in evaluating impacts to culturally significant resources. This study element is described further in Attachment F.

Impacts to cultural and ecosystem resources will be minimized by the same measures that protect and enhance visibility in the Scenic Area because the impacts to both are caused by the same suite of pollutants. To improve visibility, reductions in emissions of precursor gases such as SO_2, NO_X, and VOCs are important. Reductions in primary organic and elemental carbon and fugitive dust would also help improve visibility. Many of these emissions also may contribute to additional air quality impacts. Acidic aerosols containing sulfur and nitrogen can cause damage to cultural and ecosystems resources. NO_X and VOCs contribute to ozone concentrations because ozone can have a detrimental impact on plants. Because small amounts of pollution can have a significant effect on visibility, reducing these pollutants sufficient to protect visibility helps reduce other air quality impacts.

Attachment D provides a partial list of the many opportunities for leveraging the technical work being conducted under other projects. (e.g. The model development for the Regional Haze program, AIRPACT, the Vancouver/Portland Ozone Maintenance Plan, the WRAP Causes of Haze Assessment, etc.).

This Redesigned Study will not provide, at its end-point, the same certainty of the causes of haze or the same certainty in the predictive model's ability to mimic air quality conditions that was anticipated under the original, multi-phase study plan. It is important to note, however, that at the conclusion of this Redesigned Study, we will understand much more than we do today, including the identification of key areas of science and modeling, if any, that should be investigated further. This Redesigned Study is designed to support "add-ons" for: a) additional analysis of measurement data/samples if key questions of the causes of haze remain, and b) additional model refinement and model runs if the base case modeling does not indicate existing and planned air quality strategies will improve air quality sufficient to meet the goals of the Scenic Area's Management Plan.

II. Measurement Program

A. Objectives

The measurement program is designed to support three main objectives:

1) *Determine the Current Causes of Haze in the Gorge (CoHaGo)* – A suite of measurements will provide information that will be analyzed to attempt to identify emission source regions (both inside and outside the Scenic Area), emission source types and individual emission sources that significantly contribute to haze in the Scenic Area. Understanding the causes of haze will also allow us to focus predictive, numerical modeling on sources and regions that are most important in contributing to haze in the Scenic Area. These measurements will consist of existing monitors and new monitors to be funded under this project. **Attachment E is a map of the Scenic Area with existing monitoring locations.**

2) *Support Predictive Numerical Model Evaluation* – Provide ambient information about haze conditions that will be used to evaluate the ability of 3D, numerical, predictive models to assess current haze conditions and predict future haze conditions in the Scenic Area. This will increase our certainty that the model can be used to accurately test the effect of emission management scenarios (Control strategy testing). Control strategy testing is not planned or funded under this project, but may be performed later under "add-on" studies if the base case modeling under this project indicates additional strategies are warranted.

3) *Track Long-term Haze Trends* – Long-term, trend monitoring using the existing IMPROVE sites at either end of the Scenic Area is funded under another project and is anticipated to continue. Tracking trends is essential for assessing whether existing control programs are working to protect and/or improve visibility or if additional control programs are warranted. The additional information provided under this study will allow us to verify that these sites are representative of general conditions within the Scenic Area.

The Technical Team examined components of the original Study Plan and focused on those measurements that would be most critical to support the new management charge in the most efficient and cost-effective manner. In some instances, the Technical Team was able to: 1) identify less costly methods for gaining the same information; 2) scale back the number or duration of samples (mostly by focusing on two seasonal intensive periods versus year-round measurements); 3) identify components that were already being conducted by other projects (e.g., enhanced meteorological measurements with SODAR); 4) eliminate components that were of a more research like nature that would not directly lead to the identification of contributing sources and source regions; and 5) eliminate components that did not directly relate to the charge of understanding and modeling haze in the Scenic Area (like acid deposition effects on cultural and ecosystem resources). The Technical Team also focused on measurement components that would best compliment the existing measurements currently being conducted in the Scenic Area, with a special focus on filling some of the knowledge gaps left by the current monitoring program.

It was agreed that the largest deficiencies in the existing measurement network were high time and spatial resolution speciated aerosol and gaseous measurements. Existing measurements are either speciated, 24-hour average samples taken once every three days (low time resolution), or high time resolution measurements without speciation (continuous non-speciated light scattering and light absorption measurements). Therefore, the bulk of the new monitoring will be high time resolution measurements of the key species or precursor species most important in contributing to haze in the Scenic Area or for evaluating the numerical model's performance. These species are SO_4, NO_3, Organic and Elemental Carbon (OC and EC), NO_x, and SO_2.

High time resolution measurements of the key species will be conducted in two, 6-week, seasonal intensive periods that coincide with worst-case visibility at either end of the Scenic Area. (A summer/early fall period for the west end and a winter period for the east end). Also, to determine if the atmosphere is ammonia limited, additional cation analysis of IMPROVE samples will be made. This information, added to the existing measurements, will support an assessment of the causes of haze (CoHaGo) and will support the evaluation of numerical predictive model performance. The two long-term IMPROVE sites at Mt. Zion and Wishram will continue to operate after this study period for use in tracking long-term trends. These sites are funded and operated separate from this study.

What is different about this approach from the original approach is there will be less information on a temporal and spatial basis, although every attempt is made to meet these needs on a seasonal intensive basis. The same basic approaches are being employed with the same basic objectives, but on a less "information dense" level. This could lead to illuminating additional knowledge needs that could be filled by "add-on" measurement studies or additional analysis of information already collected.

Attachment F provides a description of existing and proposed measurements and what those measurements tell us.

B. Assessment of the Causes of Haze

The suite of existing and new measurements established in and near the Scenic Area under the Redesigned Study Plan will allow us to better understand the chemical and physical dynamics of haze in the Scenic Area. Both 24-hour average and high-time resolution (continuous) speciated measurements will be used. The measurements will determine optical, chemical and meteorological properties of air in the Scenic Area and lead to the development of a conceptual understanding of the causes of haze. Once we have a better understanding of those regions, sources and times of year most important in contributing to haze in the Scenic Area, future predictive numerical modeling can focus on those areas and sources, if necessary.

In addition, it will be important that our conceptual understanding of the causes of haze be subject to peer review by national and global experts in the field of atmospheric science. A peer review will be invaluable in illuminating deficiencies in our conceptual understanding of the causes of haze, which could further help focus "add-on" studies or analysis, or it could help by adding a degree of certainty to our conclusions if the scientific community agrees with some or all of our conclusions.

The assessment of the information provided by the measurement program will be designed to answer the following questions:

1) *What aerosol components are responsible for haze?*
    a. What are the major components for best, worst, and average days and how do they compare?
    b. How variable are they episodically, seasonally, inter-annually, spatially?
    c. How do the relative concentrations of the major components compare with the relative emission rates nearby and regionally?
2) *What is meteorology's role in the causes of haze?*
    a. How do meteorological conditions differ for best, worst and typical haze conditions?
    b. What empirical relationships are there between meteorological conditions and haziness?
    c. How does the spatial difference in meteorology and climate between west and east Scenic Area account for the haze differences observed between west and east Scenic Area?
    d. How well can haze conditions be predicted solely using meteorological factors?
    e. How well can inter-annual variations in haze be accounted for by variations in meteorological conditions?
3) *What are the emission sources responsible for haze?*
    a. What geographic areas are associated with transported air that arrives at sites on best, typical and worst haze days?
    b. Are the emission characteristics of the transport areas consistent with the aerosol components responsible for haze?
    c. What do the aerosol characteristics on best, typical and worst days indicate about the sources?
    d. What does the spatial and temporal pattern analysis indicate about the locations and time periods associated with sources responsible for haze?
    e. What evidence is there for urban impacts on haze and what is the magnitude and frequency when evident?
    f. What connections can be made between sample periods with unusual species concentrations and activity of highly sporadic sources (e.g. major fires and dust storms, point source activity changes such as aluminum plant shut-downs, etc.)?
    g. What can be inferred about impacts from sources in other regions?
4) *Are there detectable and/or statistically significant multi-year trends in the causes of haze?*
    a. Are the aerosol components responsible for haze changing?
    b. Where changes are seen, are they the result of meteorological or emissions changes?
    c. Where emissions are known to have changed, are there corresponding changes in haze levels? (E.g., aluminum plant shutdowns or emission controls on the Centralia power plant)?

C. Budget

1)	Equipment purchase and sample/data analysis	$333,000
2)	Operation of new monitoring sites (Air agency staff time)	60,000
3)	Lease extensions and additional site development	8,000
4)	Causes of Haze Assessment (Contract - data analysis and development of conceptual model of causes of haze)	75,000

Measurement Program Total: $476,000

D. Timeline

The following timeline is dependent on receiving the federal funding award in a timely fashion that supports purchase and installation of equipment in this calendar year.

1) Purchase new equipment: 8/03 – 10/03
2) Deploy new equipment: 11/03
3) Conduct measurements for one year with two seasonal intensives: 12/03 – 11/04
4) Validate data, report data and perform the causes of haze assessment: 12/04 – 6/05
5) Provide draft and final report on causes of haze in the Scenic Area: 6/05 – 9/05

III. Numerical Modeling Program

A. Objectives

The numerical modeling program has two main objectives:

1) Refine, adapt and select a predictive computer modeling tool to be used to evaluate visibility conditions in the Columbia River Gorge Scenic Area. The model needs to be run for a current year to demonstrate that the model is capable of reasonably representing visibility conditions in the Scenic Area as compared to monitored data.
2) Provide an initial assessment of air quality benefits from upcoming state and federal air quality, emission reduction programs. (Future year model run). Control strategy testing beyond known upcoming air quality, emission reduction programs is not planned under this project, but may be conducted under "add-on" studies if warranted.

B. Overview

The requirements for the Scenic Area numerical modeling system are:

1) Because haze, ozone, and secondary particle formation operate on a regional scale, a regional scale modeling system is required;

2) The numerical computer model must be able to accurately characterize the complex atmospheric chemistry associated with secondary particle formation and haze;

3) The numerical computer model must be structured for future analysis to be able to identify contributions from individual sources and/or areas; and

4) The numerical computer model must be predictive.

The original Technical Study Plan summarized a number of modeling approaches including receptor modeling, dispersion modeling and three-dimensional (3D) chemical transport modeling. (See, "Columbia River Gorge Visibility and Air Quality Study, Working Draft: Existing Knowledge and Additional Recommended Scientific assessment to Consider" Green et. al, June 7, 2001). Of these modeling approaches, the 3D chemical transport modeling best meets the requirements of the revised modeling program proposed under this plan and have been used for other similar studies in the NW.

Three-dimensional (3D) chemical transport models (CTMs) are photochemical grid models that are usually driven by 3D meteorological fields generated by a meteorological model (e.g., MM5) and can simulate 3D transport and dispersion of pollutants. They require gridded speciated emissions inventories of NOx, SO_2, VOCs, primary PM and secondary PM precursors for all sources. 3D CTMs can be used for evaluating both regional as well as local issues. However, they can only resolve processes down to the grid spacing specified in the emissions inventory and meteorological data. Typically, grid nesting is used when analyzing multiscale issues.

Generally, the latest generation of CTMs use state-of-science chemistry and other algorithms, but some can also use more simplified and numerically efficient approaches. CTMs are typically set up and evaluated for a base year and then, once the model has been judged to be performing adequately, they can be used to assess future-year PM and visibility conditions for a variety of emissions growth and control options.

There are several 3D models systems available:

1) Community Multiscale Air Quality (CMAQ) Modeling System Chemical Transport Model (CTM)
2) Regulatory Modeling System for Aerosols and Deposition (REMSAD);
3) Particulate Matter Comprehensive Air Quality Model with extensions (PMCAMx);
4) Multiscale Air Quality Simulation Platform (MAQSIP); and
5) California Photochemical Grid Model (CALGRID).

These regional modeling systems also require the use of a meteorological model and an emissions inventory model(s) to develop the necessary input files for use by the CTMs. Each of these components is described below.

C. Meteorological Modeling

Most regional-scale air quality modeling systems require time-varying, three-dimensional wind fields in order to simulate the complex spatial and temporal wind flows over a modeling domain (typically several hundreds of kilometers in size). These wind fields are typically generated using meteorological models used in weather forecasting. An example of such a model is the Fifth-Generation NCAR / Penn State Mesoscale Meteorological Model (MM5). The MM5 model is currently being run using a 36, 12, and 4 kilometer (km) resolution grid over the entire Pacific Northwest (e.g., Oregon, Washington and Idaho).

However, because the terrain within the Scenic Area is complex, narrow and deep, it is not known how well 4-km grid spacing will work in resolving the terrain and wind fields within the Scenic Area. A much finer grid resolution (1.33 and/or 0.44 km spacing) may be needed to adequately resolve the terrain so that the wind flow within the Scenic Area may be correctly simulated. At the finest grid resolutions, the full 3D wind field modeling would be quite time and resource intensive. Therefore, it is expected that only a few episodes could realistically be evaluated at the finest scales. If adequate modeling results can be obtained using coarser resolution (e.g., a 36/12/4 km grid), then much longer periods could be modeled.

The meteorological model will be evaluated against new meteorological data collected under this study and meteorological data available but not funded by this study.

D. Emissions Inventory Modeling

A good emissions inventory (EI) is necessary to understand impacts to air quality, perform source attribution, and evaluate alternative emission reduction scenarios. An emissions inventory including SO_2, NO_X, NH_3, speciated VOC, and speciated primary PM is needed. This includes emissions from all potential source types affecting the Scenic Area – point sources (e.g. industry), mobile sources (e.g. vehicles, ships, trains, air craft), area sources (e.g. woodstoves, outdoor burning, solvent use, agriculture), and biogenics (e.g. natural emissions from vegetation).

Proper spatial and temporal distribution of the emissions is also necessary. Temporal resolution is normally hourly, and spatial resolution depends on analysis requirements. In chemical transport models, emissions data is required to have the same spatial resolution as the meteorological data. The emissions are prepared for air quality modeling using one of several emissions models such as the Sparse Matrix Operator Kernel Emissions (SMOKE) emissions processor. Spatial surrogates are obtained and assigned to grids using GIS methods and incorporated into SMOKE along with temporal and chemical speciation profiles.

All the Northwest Regional Modeling Center (NWRMC) EI projects described in the original Scenic Area work plan have been completed. These projects included emissions characterization of locomotives, ships (rivers), woodstoves, residential outdoor burning, and biogenics. There is also an ongoing project to develop a dairy ammonia emissions inventory. The NWRMC is also looking into the most recent research for emission inventories that the Western Regional Air Partnership (WRAP) has produced on fugitive dust sources, and will incorporate their recommendations into the emissions inventory.

It is worth noting that staff members from the air quality agencies in both states participate regularly in the Emissions Forum of the WRAP. WRAP is a Regional Planning Organization formed to address the federal regional haze rules, and is made up of government, tribes, industry, and environmental groups throughout the western US. Technology transfer is part of the WRAP process, and the state emission inventories are expected to benefit from the knowledge gained by WRAP.

Emission inventories are critical for the efforts of state, local and federal agencies to attain and maintain the National Ambient Air Quality Standards (NAAQS) that EPA has established for criteria pollutants such as ozone, particulate matter, and carbon monoxide. Point source inventories are developed each year by the state and local agencies however this information is only required to be submitted to EPA every three years (larger sources annually). In the past, mobile, area and biogenic emission inventories have been completed as needed to support activities such as nonattainment/maintenance planning efforts or as time and resources allowed. The three year cycle is identified as 1996, 1999, 2002, etc. All state air quality agencies are now required to develop detailed comprehensive emission inventories (point, area, mobile and biogenic) every three years with the large point sources still inventoried every year. The next three year interval is for calendar year 2002. The inventory work is currently underway for 2002 and is separate from Scenic Area work to be performed under this Redesigned Study Plan. The most current inventory data available will be used for modeling and haze assessment purposes for the Scenic Area. All EI data are available for presentation for the public and the Advisory Committee once completed.

EPA proposed a Consolidated Emissions Reporting Rule (CERR) in May of 2000 (65 FR No 100 page 33268 May 23, 2000) to consolidate and streamline emission inventory data. The CERR was finalized June 10, 2002 (67 FR No 111 page 39602). In addition, the CERR requires that $PM_{2.5}$ and ammonia (NH_3) be included with the inventory. These pollutants have not been substantially inventoried in the past and play an important role in understanding visibility impairment in the Scenic Area. **Attachment G identifies the activities planned by each state to support the 2002 EI work.** It is intended that the Scenic Area redesigned study will leverage this 2002 inventory work, so that the amount of additional EI work needed under the redesign study is minimized. However, some additional work may be needed to further refine the EI spatial resolution down to 1 km to adequately characterize haze in the Scenic Area. Currently, most of the surrogate EI data is at 4 km grid spacing.

The 2002 EI prepared by the states will need to be projected forward to the base year, assumed to be 2004 to correspond to the primary monitoring period, and into the future year. At this time, the future year has not been identified, but could be 2018 when all currently scheduled, federal programs are expected to be implemented. This future case will also need to incorporate growth factors that impact area, mobile and biogenic emissions to account for the increases in population within the modeling domain.

E. Leveraging Opportunities

Good fiscal stewardship requires leveraging other modeling work that is currently being conducted. Attachment D is a partial list of the leveraging opportunities.

In NW modeling studies, MM5 has been used as the meteorological model of choice. MM5 is currently run twice daily at the University of Washington and the meteorological data is readily available. It is likely that the MM5 model will continue to be the meteorological model of choice for future modeling studies.

In many NW regional modeling studies, CMAQ is being used or is planned for use. In some studies, other 3D CTMs, like PMCAMx and REMSAD are being run along with CMAQ. Because different models implement chemistry algorithms differently, it would be useful to run the base and future case using two models. This dual modeling effort would help bracket the range of uncertainty associated in the modeling process and, if the both models demonstrate the same trends and behaviors, increase the confidence in the results.

It is anticipated that the modeling domain will include all of Oregon and Washington, parts of Idaho and perhaps be extended north to Vancouver BC. The need to include Idaho and Vancouver BC should be apparent as a result of reviewing outputs from studies like AIRPACT, WRAP, and the Forest Service modeling studies.

One of the most promising leveraging opportunities will be with the AIRPACT project, which is currently a real-time air quality forecasting system for the Puget Sound area. The AIRPACT domain is being expanded to cover Western Washington and Oregon and will include the Columbia River Scenic Area. The extended modeling domain for AIRPACT should be operational by fall 2003. AIRPACT currently uses the CALGRID photochemical model for ozone estimates but there are plans to switch to CMAQ for a more complete treatment of the chemistry algorithms. Through the expanded AIRPACT process, the modeled forecasts can be compared with observations for the identification of episodes impacting the Scenic Area, and the modeled forecasts can be used to identify conditions in which the modeling system works well and conditions in which it does not work as well. Because of the extent of the domain, the AIRPACT system would best work for westerly flow patterns and have limited utility for the eastern flow patterns. If this system is successfully implemented, the expanded AIRPACT project should provide considerable information on atmospheric processes within the Scenic Area.

Other studies, like the Portland/Vancouver Ozone Maintenance Plan modeling project, will help address issues relating to modeling the Scenic Area at resolutions less than 4 km grid spacing. The Redesigned Gorge Study will model down to 1 km grid spacing and can be used to identify conditions that may require a finer resolution to get acceptable model performance.

The modeling scenario under the Redesigned Study will include a worst winter time period and a worst summer time period that coincide with the data collection. The number of cases selected will depend on the resolution needed and the resources available.

F. Budget

1) Primary modeling (e.g. CMAQ) (Contract)	$70,000
2) Secondary modeling for comparison with primary (E.g. PMCAMx) (Contract)	40,000
3) Emission Inventory Refinement (Air agency staff time)	14,000
Modeling Program Total:	**$124,000**

G. Timeline

1) Evaluate performance of other models, then select/refine model for use: 12/03 – 6/05
2) Refine emission inventory for model input: 6/04 – 12/04
3) Run base case modeling for current and future year: 6/05 – 12/05
4) Provide draft and final modeling report: 1/06 – 4/06

IV. Redesigned Study Plan: Expected Results

As discussed earlier, the Redesigned Study Plan will not provide, at its end-point, the same certainty of the causes of haze or the same certainty in the predictive model's ability to mimic and predict air quality conditions that was anticipated under the original, multi-phase Study Plan. It is equally important to note that at the conclusion of this Redesigned Study, we will understand much more than we do today, including the identification of key areas of science and modeling that should be investigated more.

The following is a list of what the Redesigned Study, will and will not do, and is concluded with some observations of likely add-on activities.

A. Will Provide:

1) Additional measurement data to support the development of a conceptual understanding of the causes of haze in the Gorge; (CoHaGo);

2) Additional measurement data to evaluate the predictive numerical model's ability to mimic and predict haze in the Scenic Area;

3) Additional certainty about what we know and what we do not know as a result of the CoHaGo assessment and the predictive, numerical modeling activities;

4) An assessment of what we know today (based on previous and planned additional measurements) and present this information in one clearly organized document;

5) Refine, adapt and select a predictive numerical model specifically for assessing haze conditions in the Scenic Area;

6) Modeled results for a base case; (Presumably 2004) based on two, 6-week intensives that will characterize the worst-case seasons of the year;

7) Predictive numerical model results for a future year (presumably 2018) to determine what trend, if any, is apparent for haze in the Scenic Area that can be attributed to the implementation of new state and federal programs;

8) Leveraging of current knowledge and studies;

9) A new data set from which future studies can leverage;

10) Additional measurement data that will help us understand historic trends and support models to predict future trends from either existing or new state and federal programs not yet implemented;

11) Enhanced knowledge and understanding of the complex processes that lead to the formation of haze in the Scenic Area so that informed management decisions can be made regarding any needed future measurement and modeling tasks;

12) A better understanding of emission regions, categories and possible individual sources located both inside and outside the Scenic Area, that contribute to haze; and

13) An independent Forest Service study to sample and analyze fog and cloud water chemistry as a first step in a process for assessing potential risks or impacts to culturally significant artifacts and ecosystems in the Scenic Area.

B. Will Not Provide:

1) The complete suite of measurements that were envisioned under the original study plan;

2) The temporal and spatial resolutions that are necessary to achieve the same degree of confidence anticipated in the original study plan;

3) The independent Forest Service cloud and fog water study will not provide a definitive assessment of the risk or impacts to rock-art or cultural resources. It is a first step in a process and the results of the assessment can help inform decision-makers as to the next steps that could be undertaken in evaluating this issue;

4) The generation of a complete set of meteorological data for the Scenic Area for use in validating the meteorological model. The Redesigned Study relies on the ability of the meteorological model (MM5) to accurately simulate wind fields with less data than would have been generated by the original study plan;

5) A full year of analysis via the predictive numerical model; instead, it will use two, seasonal intensive 6-week periods (summer and winter) that represent the two worst periods of the year; and

6) An assessment of the impacts or benefits from additional emission reduction strategies beyond those existing, but not yet fully implemented, state and federal programs.

C. Potential "Add-ons"

The following potential "add-on" components could be recommended by the Advisory Committee if additional funding becomes available, and if for example, the Advisory Committee recommends that the Redesigned Study should: a) be expanded in scope to analyze additional time periods; b) clarify the contribution of specific emission sources; or c) develop and test strategy options if the initial Redesigned Study results do not indicate existing and planned air quality strategies will improve air quality sufficient to meet the goals of the Gorge Scenic Area Act. *The following items are not ranked in order of priority.*

1) Model refinements – e.g. chemistry algorithm updates.

2) Additional model evaluation – e.g. compare MM5 predictions to observational data.

3) Sensitivity analyses – e.g. dependency of model outputs on input parameters.

4) Emission inventory enhancements – e.g. sea salts and ammonia.

5) Meteorological data enhancements – e.g. 4 to 5 temporary profilers.

6) Additional lab analysis of samples – collected under this study.

7) Additional analysis of data collected – e.g. CMB, PMF, and source footprint.

8) Additional new measurements or additional periods of measurement – e.g. new types of measurements, extension of intensive periods, new year-round measurements.

9) Additional periods of numerical modeling – e.g. extension of intensives or other periods

10) Studies to assess the potential risk or impact that acid deposition poses to cultural and ecosystem resources. This would require an actual study of the artifacts and mineral characteristics of the rock in order to determine the long-term risks and impacts on these resources. Other studies would be necessary to determine the full extent of impacts on the ecosystem.

11) Additional model runs that test strategy options to increase our certainty in identifying source types, regions, or individual sources that contribute to haze.

V. PROJECT MANAGEMENT, REPORTING, BUDGET and TIMELINE

A. Management

The Redesigned Technical Study Plan will be managed by the Southwest Clean Air Agency (SWCAA). SWCAA will serve as the grant administrator. SWCAA will provide management oversight over all aspects of this study. SWCAA will host meetings when necessary and will also make arrangements for meetings, as necessary, at remote locations including holding public meetings and updates as requested by the Gorge Commission.

It is anticipated that contracts will be prepared for the Causes of Haze Assessment, purchase of additional monitoring equipment, sample analysis and data collection, including possible monitoring location leases and for modeling work.

B. Reporting

Reports will be provided for several of the activities. These will include at a minimum:

1) The Causes of Haze Assessment, (CoHaGo). (Contractor)

2) Data reports on an annual or episode basis depending on the sampling method.

3) Detailed modeling protocol document for primary and secondary model. (Technical Team)

4) Primary modeling results for base year and out year with sensitivity analysis. (Contractor)

5) Secondary modeling results for base year and out year with sensitivity analysis. (Contractor)

6) Outside comment and peer review of each of the modeling analysis. (Contractors)

7) Summary Report and Management Recommendations to Gorge Commission, annually and at project end. (Technical Team)

C. Budget

Project management duties – staff time and incidental charges $70,600

Incidental charges may include but are not limited to telephone charges, report preparation, rental of meeting halls, copying of data and reports, preparation and management of contracts, and managing project funds.

D. Timeline

SWCAA will provide project management duties for the duration of this study plan. The time line is estimated to be from June 1, 2003 to December 31, 2006.

VI. OVERALL PROJECT BUDGET AND TIMELINE

A. Project Budget

1) Previously Funded	$683,000
2) Measurements/Monitoring/Studies	476,000
3) Modeling/Emission Inventory	124,000
4) Project Management/Reports	70,600
Grand Total:	$1,353,600

B. Project Timeline

The following timeline is dependent on receiving the federal funding award in a timely fashion (8/03) that supports purchase and installation of equipment in calendar year 2003. In addition, this schedule is dependent upon being able to operationally deploy this equipment in the intended locations in the field.

1) Purchase new equipment: 8/03 – 10/03

2) Deploy new equipment: 11/03

3) Evaluate performance of other models, then select/refine model for use: 12/03 – 6/05

4) Conduct measurements for one year with two seasonal intensives: 12/03 – 11/04

5) Refine emission inventory for model input: 6/04 – 12/04

6) Validate data, report data and perform the causes of haze assessment: 12/04 – 6/05

7) Run base case modeling for current and future year: 6/05 – 12/05

8) Provide draft and final report on causes of haze: 6/05 – 9/05

9) Provide draft and final modeling report: 1/06 – 4/06

Attachment A
Redesigned Technical Study at a Glance
(Note: Shaded items are already funded or completed)

Measurement or Task	What it tells us	Cost (In thousands)
A. Ambient monitoring and assessment: Characterization of air quality, chemical processes and basic meteorology		
1. Speciated $PM_{2.5}$ (24 hr avg., 1 day in 3), continuous dry light scatter and surface meteorology within the Scenic Area (Mt Zion and Wishram – ongoing)	General spatial and temporal characteristics of light scatter and haze producing aerosols within the Scenic Area. Supports CoHaGo and model evaluation. Tracks long-term trends.	$164
2. Continuous ambient nephelometers (light scatter) at Mt. Zion and Wishram – ongoing	Comparison of dry and ambient light scattering to assess water growth effects. Supports CoHaGo and model evaluation	$48
3. Continuous aethalometers (light absorption) at Mt. Zion and Wishram, Mt. Zion - ongoing	High time resolution light absorption-impact of local sources. See Portland material moving through. Supports CoHaGo and model evaluation.	$42
4. Haze Gradient Study - Additional heated nephelometers with surface meteorology horizontally along the Scenic Area and vertically in two Scenic Area locations.	Horizontal light scatter gradient along Scenic Area, see material moving through Scenic Area. Vertical mixing/light scatter gradients. Meteorology and transport mechanics into and within the Scenic Area. Supports CoHaGo and model evaluation.	$223
5. Ozone monitoring at Wishram	Assessment of ozone levels and risk to environment in eastern Scenic Area	$31
6. Continuous SO_4, NO_3 and OC/EC analyzers for each seasonal intensive. At Mt. Zion and Bonneville Dam (summer/early fall) and Wishram and Memaloose (late fall/winter).	Local versus regional contribution to haze, diurnal dynamics, and possibly identify specific sources. High-resolution temporal dynamics of the 3 major constituents of haze in the Scenic Area. Supports CoHaGo and model evaluation.	$167 equipment (Assumes using 1 loaner OC/EC) $30 consumables
7. Continuous NOx and SO_2 for each seasonal intensive. At Mt. Zion and Bonneville Dam (summer/early fall) and at Wishram and Memaloose (late fall/winter).	Local versus regional pre-cursors to haze, plus diurnal dynamics. Supports CoHaGo and model evaluation.	$48 equip $2 consumables
8. 2 DRUM samplers per seasonal intensive. At Mt. Zion and Bonneville Dam (summer/early fall) and Wishram and Memaloose (late fall/winter).	High time resolution species and species gradient. Supports CoHaGo and model evaluation.	$50
9. Portable short-term IMPROVE-like speciated $PM_{2.5}$. Two locations each seasonal intensive. 1 outside Scenic Area (west of Scenic Area for summer intensive and east of Scenic Area for winter intensive) and 1 mid-Scenic Area. (10 sample days analyzed per each intensive)	Speciated information and gradient for regional transport into and through the Scenic Area. Supports CoHaGo and model evaluation.	$15
10. Organic speciation of IMPROVE samples of interest using GC-MS (10 days at each site, Mt. Zion and Wishram)	Apportion organic aerosol to key source types. Supports CoHaGo and model evaluation.	$10
11. Analyze for NH_4^+, Na^+, K^+ on IMPROVE samples for I year at each site (Mt. Zion and Wishram)	Determine if atmosphere is ammonia limited. Supports CoHaGo and model evaluation.	$8
12. Miscellaneous supplies, lease extensions and additional site development	Extending measurement period with new measurements will entail extending leases. New equipment will require additional site development like power and space.	$8
13. Site operation for new measurements described in items 6 – 9.	Note: assumes USFS, SWCAA and ODEQ will continue to absorb operation of existing measurements in items 1 – 5 and 14.	$60 (split between SWCAA and ODEQ)
14. Fog/cloud water deposition sampling and chemical analysis in eastern Scenic Area – winter seasonal	Independent Forest Service study to sample and analyze chemistry of fog and cloud water that may be affecting ecosystem and Native American cultural resources. Data should be available for use in Redesign Study and CoHaGo.	$54

B. Enhanced Meteorology: Characterization of physical processes		
15. SODAR at 1 site, 1 year	Vertical wind/temperature profiles. Supports CoHaGo and model evaluation.	$50
16. Analysis of existing west and east end SODAR measurements to determine best placement of mid-Scenic Area SODAR		$3
C. Emissions Inventory		
17. Refine emission inventory for use in predictive model for Scenic Area.	Supports model evaluation and model inputs.	$14
D. Causes of Haze Assessment (CoHaGo)		
18. CoHaGo assessment.	Analysis of measurement data and develop a conceptual understanding of the causes of haze in the Scenic Area.	$75
E. Modeling Studies		
19. Initial CMB modeling	Help identify general source categories contributing to impacts. Supports CoHaGo.	$25
20. Initial ISOPART modeling	Help identify chemical processes and evaluate emission inventory. Supports CoHaGo and model evaluation.	$25
21. Calpuff "footprint" modeling using MM5 data	Help identify potential source regions. Supports CoHaGo.	$25
22. Modeling of base case current (2004) and future year (2018). (Assumes model performance evaluation and limited refinement of model is done under other projects with no cost to Scenic Area grant)	Future air quality levels under current control strategies. Determine whether additional control strategies are necessary. (Additional control strategy modeling not included in this study plan)	$110
F. Project Management and Reporting		
23. Project management and reporting (SWCAA)	Provide management and oversight of overall project. Prepare and manage sub-contracts for modeling, data analysis and assessment. Purchase equipment. Arrange and host meetings to update Gorge Commission and public. Provide an overall final report synthesizing reports from sub-contractors.	$70.6
	Total Cost	**$1,362.6**
	Already Funded	**692.0**
	Cost of new measurements, modeling, EI development, data analysis and assessment and project management and reporting	**670.6**
	Congressional Grant	**670.6**
	Balance Needed	**None**

Attachment B
Comparison of Redesigned Tasks with the Original TFS Tasks
(Note: Shaded items are already funded)

Original TFS Study Plan Measurement/Task	What it tells us	Cost (in 1,000s)	Redesigned Study Comparison (See Attachment A for details/costs)
a. Ambient monitoring: Characterization of air quality, chemical processes and basic meteorology			
1. Speciated $PM_{2.5}$, light scatter and surface meteorology within the Gorge - 2 sites. Mt Zion and Wishram - ongoing	General spatial and temporal characteristics of light scatter and haze producing aerosols within the Gorge.	$164	Fully covered
2. Ambient nephelometers at Wishram, Mt. Zion - minimum 1 year	Light scattering including water growth effects	$48	Fully covered
3. Aethalometers at Wishram, Mt. Zion - minimum 1 year	High time resolution light absorption- impact of local sources, determine if sites are representative. See Portland material moving through.	$42	Fully covered
4. Additional heated nephelometers with surface meteorology horizontally along Gorge (5 minimum e.g. Cascade Locks, another below Hood River, between Hood River and The Dalles) and heated nephelometers with surface meteorology at 3 vertical levels (river, above river, and Gorge rim)	Horizontal light scatter gradient along Gorge. See material moving through Gorge and determine if sites are representative. Vertical mixing/light scatter gradients	$223	Fully covered
5. PM_{10} speciation at Wishram, Mt. Zion. Include NH_4+, SO_2 IMPROVE schedule, 1 year	Speciation for comparison with coarse particle scattering-aerosol neutralization. Supports model evaluation	$100	Not covered. This task was more research in nature vs. leading to identifying source types and regions.
6. Optical particle sizers at Wishram and Mt. Zion - 1 year	Size resolved high time resolution particle scattering, comparison with $PM_{2.5}$ and PM_{10} speciation data, helps with extinction budget closure.	$50	Partly covered by using size resolved DRUM sampling, (Redesign task # 8), but only done on a seasonal intensive basis and not all species covered.
7. NH_3, HNO_3 (g), SO_2, Noy at two sites (Mt. Zion and Wishram) for one year IMPROVE schedule, 1 day in 6, 4-6 samples per day for NH_3, HNO_3, SO_2. Continuous Noy and low level CO. Add O_3 at Mt. Zion	Determine if atmosphere is ammonia limited- evaluate emissions inventory. Supports modeling (inputs, evaluate, validate, reconcile, etc.). Assessment of ozone levels and risk to environment in western Gorge.	$200	Ammonia limitation question partly covered using cation analysis. (Redesign task # 11). NOx and SO_2 partly covered (redesign task # 7) but only seasonal. Low-level CO and assessment of O_3 in western Gorge not covered.
8. Ozone monitoring at Wishram	Assessment of ozone levels and risk to environment in eastern Gorge	$31	Fully covered
9. Scene Monitoring (Camera). Digital Image Acquisition and Time Lapse Video. Two sites, one western and one eastern Scenic Area	Digital scene images to visually illustrate visibility conditions, and time-lapse video to capture dynamics of formation and movement of haze.	$42	Not Covered. Original task was only of qualitative value and is not needed to support CoHaGo and model evaluation.
b. Enhanced Meteorology: Characterization of physical processes			
10. Portable radar wind profiler and/or tethersonde and ceilometer deployed at key areas - e.g. mouth of Gorge, mid-Gorge, side canyons, and eastern Gorge for exploratory measurements.	Basic information on structure of atmospheric flow in Gorge - depth of flows, side-canyon importance, etc. Help to design more detailed, meteorological measurements. Supports modeling (inputs, evaluate,	$100	Not covered. SODARS previously deployed at each end of the Scenic Area will help meet some of this need. Mid-Scenic Area site proposed in the redesigned study will help too.

	validate, reconcile, etc.)		
11. Radar wind profiler/SODAR/RASS 1 site, 1 year	Vertical wind/temperature profiles. Year round @ 1 site. Supports modeling (inputs, evaluate, validate, reconcile, etc.)	$100	Partly covered by another project (Redesign task # 14) but just SODAR.
c. West of Gorge Sources: Characterization of Emissions			
12. Speciated $PM_{2.5}$ west of Gorge (upwind of Portland). IMPROVE 1 day in 3 schedule.	Regional aerosol species gradient (transport site.)	$60	Partly covered. (Redesign task # 9). Will be done on seasonal intensive basis vs. year round. Regional background can be determined using other IMPROVE network sites and Portland speciated $PM_{2.5}$.
d. East of Gorge Sources: Characterization of Emissions			
13. Speciated $PM_{2.5}$ east of Gorge (Columbia Basin). IMPROVE 1 day in 3 schedule.	Regional aerosol species gradient (transport site).	$60	Partly covered (redesign task # 9). Will be done on seasonal intensive basis vs. year round. Regional background can be determined using other IMPROVE network sites and Portland speciated $PM_{2.5}$.
14. Precipitation and fog water sampling and chemical analysis- Boardman power plant area, central Gorge as possible during 45 day period	Determine existing acidic pollutant levels and assess potential risk or impacts to ecosystem and cultural resources	$150	Partly covered. Independent Forest Service measurement program to sample and analyze water chemistry will be conducted, but the second step of assessing potential risk or impact to resources is not covered
e. Emissions Inventory			
15. Complete NW RTC Demo Project inventory, and grid at 5 km resolution	Supports modeling (inputs, evaluate, validate, reconcile, etc.)	$50	Fully covered
f. Modeling Studies			
16. Initial CMB modeling	Help identify general source categories contributing to impacts	$25	Fully covered
17. Initial ISOPART modeling	Help identify chemical processes and evaluate emission inventory	$25	Fully covered
18. Calpuff "footprint" modeling using MM5 data	Help identify potential source regions	$25	Fully covered
19. Limited cases of high-resolution CMAQ + SCAPE (chemical modeling)	Assess NH_3 limitation issue. Define physical processes within Gorge.	$125	Partly covered. (Redesign task # 22). CMAQ and CAMx will be used to model base case for current and future year worst-case haze.
20. Review of applicable 3D modeling practices	Documents pros and cons of various modeling approaches. Candidate models will be identified for overall modeling system	$10	A range of acceptable model types has been defined under other projects.
g. Data QA, Data Analysis, Data Management			
21. QA, analyze, and manage monitoring data to better understand physical/chemical conceptual model		$125	Partly covered, (Redesign task #18), but scaled back a bit. Some of the tasks in a CoHaGo will be done by existing Tech Team staff (e.g., CMB and PMF modeling)
h. Project Management and Reporting			
22. Project management/reporting		$75	Mostly covered, (Redesign task # 23) but scaled back a bit.
	Total cost of TFS	**$1,830**	
	Already funded	**- 633**	**Plus $50 for a SODAR**
	Net funding needed for TFS	**$1,197**	**Therefore, $1,147**

Attachment C
Comparison of Redesign Tasks with the Post -TFS Phases of the Original Study Plan

(Note: The post-TFS phases of the original plan were only suggested at that time. Final design of post-TFS phases would have been done after the original TFS.)

Original one-year expanded measurement program: additional horizontal and vertical gradients in Gorge year-round, in-Gorge vs. out-of Gorge sources			**How the Redesigned Study Plan Compares (See Attachment A for details and costs)**
Additional PM monitoring site collocated with mid-Gorge nephelometer site. Speciated $PM_{2.5}$ and PM_{10}, with NH_{4+}, NH_3, SO_2,	Characterize central Gorge. Compare with measurements at east and west end of Gorge. Some gradient information.	$40K + $80K/yr= $120K 1-year	Partly covered. (Redesign task # 8 and 9). Scaled back number of sample days and species analyzed.
Gas and particle phase speciated organic aerosol using GCMS. 2 sites, one in six days for 1 year	Identification of key organic species in gas and particle phase. Contribution of biogenics, burning, gasoline, diesel, and meat-cooking to organic carbon with CMB	$160K	Partly covered. (Redesign task # 10). Scaled back number of sample days, seasonal intensive vs. year round. Aerosol only.
Radar wind profiler/SODAR/RASS 1 site, 1 year	Vertical wind/temperature profiles	$100K	Partly covered, (Redesign task # 14), but just SODAR.
Speciated $PM_{2.5}$ 2 nephelometer sites along Gorge- IMPROVE schedule, 1 year	Species gradient along Gorge/local city effects	$30K+$80K /yr=$110K	Partly covered, (Redesign task # 8 and # 9), but scaled back number of sites and just seasonal intensive.
DRUM samplers vertical nephelometer sites 1 year, analyze periods of interest	Vertical gradients of species (at least sulfur)	$75K	Partly covered, (Redesign task # 8), but seasonal intensive only.
Speciated $PM_{2.5}$ at nephelometer site at top of Gorge, IMPROVE schedule, 1 year	In Gorge/above Gorge species gradient	$15K+$40K /yr=$55K	Not covered
2 Additional aethalometers either side of City of Hood River – year round	Help determine presence of emissions from Gorge cities, especially winter wood burning	$68K	Not covered
High –time resolution SO_4, NO_3, EC/OC 1-3 sites (Wishram, Mt. Zion, mid-Gorge site) 1 year	Year-round knowledge of chemical species changes in time	$100K/site+ $100K/yr per site= $200-$600K	Partly covered, (Redesign task # 6) but seasonal intensive only
Original summer intensive period studies – effects of Portland/Vancouver Continue measurements as appropriate from TFS and one-year expanded network study and add:			**How the Redesigned Study Plan Compares (See Attachment A for details and costs)**
Nephelometers and surface meteorology upwind (downriver) of Portland (one or more), Portland (3)	Change in light scattering due to Portland urban area	$25K/site 4 sites= $100K	Fully Covered (Redesign task # 4)
Speciated aerosol upwind of Portland (3)/ Portland (3), along Gorge sites (5), top of Gorge (1 or more) Daily for 30 days July-August.	Chemical speciation changes due to Portland urban area – relate to light scattering changes	$140K +$110K/ Month (6 new sites)	Partly covered, (Redesign task # 8 and 9), but fewer sites and days

Radiosondes 4/day for 30 days 2 sites, one mid-Gorge, one mouth of Gorge (e.g., PDX)	Vertical profiles of stability and wind (mixing, transport speed)	$60K	Not covered
High –time resolution SO_4, NO_3, EC/OC Mt. Zion or central Gorge site.	Chemical species change in time –relate to nephelometer data	$140K	Fully Covered (Redesign task # 6)
DRUM samplers 5 along Gorge sites 30 days- analyze periods of interest	High-time res. speciation- Track movement of Portland plume	$50K	Partly covered, (Redesign task # 8), but fewer sites
Radar wind profilers and sodars 6 sites	Vertical wind profiles	$200K	Not covered
Organic gas and aerosol speciation, at additional sites or times if TFS studies warrant	Spatial pattern of organic speciation	$100K	Partly covered, (Redesign task # 10), but only aerosol
Extinction cell, photoacoustic absorption, light scattering one site	Extinction budget closure	$70K	Not covered
Original Winter Intensive period studies – Boardman plant, CR Basin sources, in-Gorge, fog water Continue measurements as appropriate from TFS study and add:			**How the Redesigned Study Plan Compares (See Attachment A for details and costs)**
Nephelometers near and away from river either side- eastern Gorge minimum 3 sites	Extent of channeling of emissions eastern Gorge	$10K/site Assumes have equipment $30K 3 sites	Partly covered, (Redesign task # 4), but no away from river site
Speciated aerosol near and away from river Eastern Gorge/Hood River drainage/CR Basin- 5 sites 45 days, reporting	Species channeled vs. regional	$35K+$33K /month= $85K 45 days	Partly covered, (Redesign task # 8 and 9), but fewer number of sites and days analyzed
Speciated aerosol 5 along Gorge sites, 1 above Gorge site 45 days, reporting	Gradient within Gorge, upwind/ downwind of Gorge cities	$10K+ $51K/month =$86K 45 days	Partly covered, (Redesign task # 8 and 9), but fewer number of sites and days analyzed
Radiosondes 4/day for 30 days 2 sites, one mid-Gorge, one east end of Gorge	Mixed-layer depth, vertical wind (transport) structure	$60K	Not covered
Precipitation and fog water sampling and chemical analysis- Boardman power plant area, central Gorge as possible during 45 day period	Determine existing levels of acidity of fog and cloud water. Potential ecosystem and cultural resources effects	$80K	Partly covered. Independent Forest Service measurement program to sample and analyze water chemistry will be conducted, but the second step of assessing potential risk or impacts to resources is not covered
High –time resolution SO_4, NO_3, EC/OC Wishram	Chemical species change in time –relate to nephelometer data	$50K (assumes instruments available)	Fully Covered (Redesign task # 7)
Radar wind profilers and sodars 6 sites	Continuous vertical wind structure	$200K	Not covered
Extinction cell, photoacoustic absorption, light scattering one site	Extinction budget closure	$70K	Not covered
Organic gas and aerosol speciation, at additional sites if TFS studies warrant	Spatial pattern of organic speciation	$100K	Partly covered, (Redesign task 10), but only aerosol
Ceilometers at 2 wind profiler sites	Cloud base height	$25K	Not Covered

Attachment D
Leveraging Opportunities

The following studies are being performed outside of the activities planned and budgeted under the Redesigned Study Plan. These studies will provide considerable data that will be useful to analyzing and understanding air quality in the Scenic Area. This is not a complete list of studies and is presented to identify several of the studies that will provide a resource in addition to those studies proposed under this Redesigned Study Plan. These studies will continue to be performed even if the Redesigned Study Plan is not implemented because they are funded for different purposes by different organizations. It is important to note the costs that have been associated with several of these studies in that many of these activities represent a significant expenditure of resources that will be leveraged by this Redesigned Study Plan.

1) AIRPACT

The Air Indicator Report for Public Awareness and Community Tracking (AIRPACT) system is a real-time, air quality forecasting system for the Puget Sound area. (http://www.airpact.wsu.edu/index2.html). This forecast system is based upon daily numerical weather forecasts from the Mesoscale Meteorological Model Version 5 (MM5) coupled to automated operation of the CALMET/CALGRID photochemical grid modeling pair. The modeling systems estimate concentrations of CO, NO, $NO_{2,}$ ozone and several classes of organic compounds in a forecast mode. The system is being expanded to include all of Western Washington and much of Western Oregon.

Domain: Currently Western Washington (Bellingham to Longview, and Yakima to coast. Funding is available to expand the domain to Vancouver BC in the north, to Eugene OR in the south, and extended west beyond the coast).
Emissions Inventory: based on 1996
Meteorological Model: MM5 at 4 km grid spacing
AQ Model: CALGRID with plans to move to CMAQ
Estimated Cost:

Current funding continues through 9/30/03. System is set up to continue with minimal intervention, but needs to expand eastward to produce maximum benefit. Participants are in process of writing a charter to form a consortium similar to the one funding the real-time, MM5 forecasts produced at the University of Washington (See, NW Regional Modeling Center Demonstration Project below.)

2) WRAP Regional Haze model development – ongoing now, periodic products thru 6/06

Improved emissions, meteorology, chemistry, spatial resolution, training, capacity.

Domain: Western States including Oregon and Washington
Emissions Inventory: Target year 2002 and 2018
Meteorological Model: MM5 at 36 and 12 km grid spacing
AQ Model: CMAQ (PMCAMx/CAMx4 and REMSAD may also be considered)
Estimated Cost:

3) Forest Service Columbia Basin Visibility and Acid Deposition Project

Refinement of tools for assessing visibility and acid deposition issues from sources in the Columbia Basin.

Domain: Columbia Basin (Eastern Oregon and Washington)
Emissions Inventory: modified 1996 and will add year 2000, point sources
Meteorological Model: MM5 at 4 km grid spacing
AQ Model: Calpuff and CMAQ
Estimated Cost:

4) Vancouver/Portland Ozone Maintenance Plan Project

Modeling for maintenance plan effectiveness. Better resolution (but smaller domain), improved EI for west end. May answer question of resolution needed for Scenic Area study.

Domain: Western Oregon (south to Eugene) and Western Washington (north to Centralia)
Emissions Inventory: based on 1996 (using Mobile 6.x)
Meteorological model: MM5 at 1 and 4 km grid spacing
AQ Model: CMAQ
Evaluate MM5 nudging to improve wind fields
Provides greater detail of emissions
Provides evaluation of model performance during high ozone conditions
Estimated completion: 2nd quarter 2004
Estimated Cost:

5) Northwest Regional Modeling Consortium

Operational, high-resolution, environmental prediction over the Pacific Northwest has been sponsored by a consortium of local, state and federal agencies. The activities include: a) Creation of one of the highest resolution operational weather prediction systems in the US at the University of Washington and built around the Penn State/NCAR mesoscale model (MM5); b) Purchase and maintenance of a 915 kHz radar wind profiler with RASS temperature sounding capability that is located at the NOAA Sand Point facility in Seattle; and c) Gathers real time observational data from operational networks in the NW to evaluate model performance.
Estimated Cost:

6) NW Regional Modeling Center Demonstration Project

Participants are in process of writing a charter to forma a consortium similar to the one funding the real-time MM5 forecasts produced at the University of Washington. Eventually expect to include the ClearSky and BlueSky/RAINS. Initial charter should be adopted by 4th quarter 2003.

Domain: Extreme Northern California to the Queen Charlotte Islands and eastward to include all of Idaho
Emissions Inventory: based on 1996
Meteorological Model: MM5 at 12 km grid spacing
AQ Model: CMAQ
Estimated Cost:

7) Georgia Basin/Puget Sound Characterization Study – Environment Canada

Compare model output with the August 2001 measurement program.

> **Domain:** Northwestern Washington and Southwestern British Columbia
> **Meteorological Model:** MC2 at 2 km grid spacing – similar effort involves WSU using MM5 for comparison
> **AQ Model:** CMAQ
> **Emissions Inventory:** updated to 2001 and estimated for 2018
> Provides evaluation of model performance at small grid spacing
> **Estimated Cost:**

8) Ozone Precursor Study (Oregon DEQ and WSU)

Develop screening approach to be used by new or increased sources of VOC and NOx
Modeling analysis of the effects of NOx and VOC emissions during periods of high ozone Concentrations

> **Domain:** Southwest Washington and Western Oregon
> **Emissions Inventory:** based on 1996 and projected to 2002-2003
> **Meteorological Model:** MM5
> **AQ Model:** CMAQ and CALPUFF
> **Completion:** Phase 1 – 2nd quarter 2003, Phase 2 – 4th quarter 2003
> **Estimated Cost:**

9) ClearSky and BlueSky/RAINS

"Real-time" smoke prediction system for the Pacific NW. Expect to merge with air quality modeling consortium being formed. (See, NW Regional Modeling Center Demonstration Project above.) Continuing predictive modeling:

a) Will provide evaluation of meteorological wind fields ability to correctly transport smoke
b) Has developed, and will continue to improve GIS augmentation of output display

> **Domain:** Washington, Oregon, Idaho, N California, N Utah, N Nevada, and W Montana
> **Emissions Inventory:** current permitted silvicultural and agricultural burns (See, Forest Service Columbia Basin Modeling Project above)
> **Meteorological Model**: MM5
> **AQ Model:** Calpuff
> **Estimated Cost:**

10) Causes of Haze in Class I Areas of the Western United States

A study sponsored by WRAP to assess all available Class I Area data to determine the causes of haze in Class I Areas of the Western States. Knowledge gained and tools developed for this assessment can be used to direct our assessment and aid our understanding of causes of haze in the Gorge.

> **Estimated Cost:**

11) Routine Criteria Pollutant Monitoring

Particulate matter, ozone, carbon monoxide and light scatter monitoring are conducted throughout the region for the purpose of tracking criteria pollutant levels, but are not directly related to the Gorge project. These data from communities like Vancouver, Portland, Longview, Stevenson and The Dalles will supplement the data collected directly under the Gorge project at no cost to the project.

Estimated Cost:

12) IMPROVE Monitoring at Class I Areas of the region

IMPROVE monitoring is conducted at several Class I Areas in the region, such as Mt. Rainier, Mt. Adams, and Mt. Hood. Information from these sites will provide valuable information about the regional background levels of particulate pollution.

Estimated Cost:

13) Long-Term IMPROVE Monitoring at Mt. Zion and Wishram in the Gorge

IMPROVE monitoring is conducted at two locations (Mt. Zion and Wishram) in addition to the monitoring performed in the Class I areas. These sites are permanent sites and continue to provide information about the regional background levels of particulate pollution within the Gorge. These monitors and the data analysis is funded outside of this Redesign Study and will continue for long-term trend purposes.

Estimated Cost: $70k per year

13) Consolidated Emissions Reporting Rule (CERR)

New EPA requirements for states provide for collecting and reporting area, mobile and biogenic emissions in addition to point source emissions on a three year interval. Larger point sources are still to be inventoried on an annual basis. In addition to criteria pollutant emission, $PM_{2.5}$ and ammonia will also be included in the inventory. This work is performed outside of this work plan and is not funded by this work plan. Currently, the inventory data is gridded on a 4 kM basis. It may be necessary to refine portions of the inventory down to a grid spacing of 1 kM or less. This portion of the inventory refinement would be covered by this work plan.

Domain: Washington, Oregon, Idaho
Emissions Inventory: Criteria pollutants plus ammonia and $PM_{2.5}$ for calendar year 2002 and adjusted for the current modeling year (2004)
Meteorological Model: NA
Emission Inventory Model: SMOKE
AQ Model: NA
Estimated Cost: $1.5 million

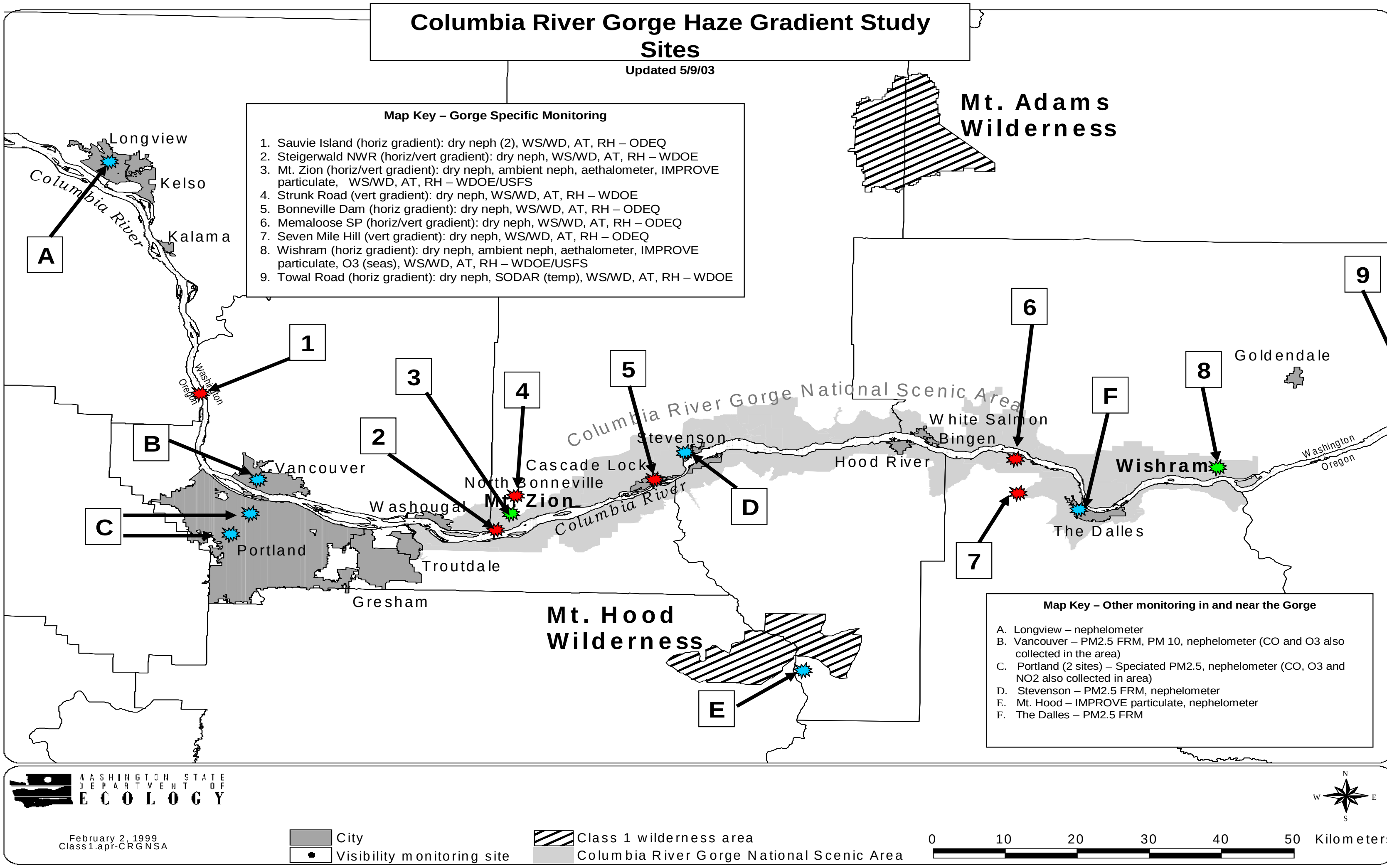
14) Other Regional Planning Organizations

A) Midwest Regional Planning Organization (LADCO)
Practice modeling for regional haze rule
Emissions model: EMS2003
AQ Models: CMAQ, PMCAMx, CAMx4, REMSAD

B) Central States Regional Air Planning Association and other AQ planning associations

Modeling evaluations and lessons learned

AQ models: CMAQ, PMCAMx, REMSAD


Columbia River Gorge Haze Gradient Study Sites
Updated 5/9/03
Map Key – Gorge Specific Monitoring
1. Sauvie Island (horiz gradient): dry neph (2), WS/WD, AT, RH – ODEQ
2. Steigerwald NWR (horiz/vert gradient): dry neph, WS/WD, AT, RH – WDOE
3. Mt. Zion (horiz/vert gradient): dry neph, ambient neph, aethalometer, IMPROVE particulate, WS/WD, AT, RH – WDOE/USFS
4. Strunk Road (vert gradient): dry neph, WS/WD, AT, RH – WDOE
5. Bonneville Dam (horiz gradient): dry neph, WS/WD, AT, RH – ODEQ
6. Memaloose SP (horiz/vert gradient): dry neph, WS/WD, AT, RH – ODEQ
7. Seven Mile Hill (vert gradient): dry neph, WS/WD, AT, RH – ODEQ
8. Wishram (horiz gradient): dry neph, ambient neph, aethalometer, IMPROVE particulate, O3 (seas), WS/WD, AT, RH – WDOE/USFS
9. Towal Road (horiz gradient): dry neph, SODAR (temp), WS/WD, AT, RH – WDOE
Mt. Adams Wilderness
Longview
Kelso
Kalama
Columbia River
A
1
B
Vancouver
C
Portland
Troutdale
Gresham
Washougal
2
3
4
North Bonneville
Mt. Zion
Cascade Locks
Stevenson
5
D
Columbia River Gorge National Scenic Area
Columbia River
Mt. Hood Wilderness
E
Hood River
White Salmon
Bingen
6
7
F
The Dalles
8
Wishram
Goldendale
9
Washington
Oregon
Map Key – Other monitoring in and near the Gorge
A. Longview – nephelometer
B. Vancouver – PM2.5 FRM, PM 10, nephelometer (CO and O3 also collected in the area)
C. Portland (2 sites) – Speciated PM2.5, nephelometer (CO, O3 and NO2 also collected in area)
D. Stevenson – PM2.5 FRM, nephelometer
E. Mt. Hood – IMPROVE particulate, nephelometer
F. The Dalles – PM2.5 FRM
WASHINGTON STATE DEPARTMENT OF ECOLOGY
February 2, 1999
Class1.apr-CRGNSA
City
Visibility monitoring site
Class 1 wilderness area
Columbia River Gorge National Scenic Area
0 10 20 30 40 50 Kilometers
N
S
E
W

Attachment E: Existing Monitoring Sites

Attachment F
Existing and Proposed Measurements

This section presents a listing of existing and proposed measurements that will be employed for this study and a brief description of each. Attachment C lists both the measurement and modeling program tasks and the costs of the redesigned study plan. (Existing or completed tasks are shaded).

I. Optical Measurements

1. Heated nephelometers will be deployed as a non-speciated high time resolution aerosol monitor, while ambient nephelometers will be used to characterize ambient light scattering. Both dry and ambient nephelometers will help characterize the spatial and temporal patterns in the Scenic Area. These will be used in conjunction with meteorological data. (Especially wind speed and direction).

Nephelometers are currently operating at nine sites in and near the Scenic Area and will be operated year round for the duration of this study.

- Ambient nephelometers will give a measure of total light scattering including the effects of water growth. Comparison with collocated heated nephelometers will give an estimate of the importance of water growth. Ambient nephelometers are necessary only at sites where a complete extinction budget is needed. (E.g. Mt. Zion and Wishram).

- Heated nephelometers placed along the Scenic Area will be used to identify effects of sources or source areas propagating through the Scenic Area (e.g. the Portland urban plume) and to consider the effects of in-Scenic Area sources (cities) by the differences in upwind and downwind light scattering. (all year).

- Heated nephelometers placed at different vertical heights will give some understanding of the vertical distribution of aerosol in the Scenic Area and how it changes on a diurnal or seasonal patterns or with different synoptic weather conditions. It will help answer questions of whether material is mixed out of the Scenic Area during the day or due to turbulence or whether material in the Scenic Area stays confined to the Scenic Area (all year).

- Heated nephelometers placed in the Portland/Vancouver urban area and upwind of Portland can give an idea of the increase in light scattering across the Portland area and presumably due to the urban area. (Mainly summer).

- Heated nephelometers placed at some distance (10-20 km away from either end of the Scenic Area) can give an idea of regional material before entering the Scenic Area.

2. Aethalometers measure light absorption through a filter tape. The measurements are typically reported as mass concentration of black carbon, but can also be interpreted as ambient light absorption. The measurements have time resolution of 5 minutes or more depending upon ambient levels; thus, they are useful in determining whether local sources such as diesel emissions are affecting the site. They may also help identify impacts from urban areas, which have elevated light absorption.

Aethalometers placed at the Mt. Zion and Wishram IMPROVE sites would identify any impacts from local sources and add to the characterization of the aerosol and optical properties of the sites. An aethalometer at Mt. Zion may indicate arrival of air from the Portland urban area.

Aethalometers are currently operating at these sites and will be operated year round for the duration of this study.

II Aerosol and Gaseous Measurements

As light scattering and light absorption by aerosols is the main cause of visibility impairment, aerosol measurements are critical to understanding haze, including the source types and source areas responsible. A wide-variety of aerosol measurements are proposed, covering time-scale of minutes to a day and from chemical speciation of most elements to identification of individual compounds and organic aerosol speciation. As with nephelometers, aerosol measurements can be used to determine gradients in the horizontal and vertical, with high time resolution for some measurements. The added benefit of speciated aerosol measurements over nephelometers is identification of which chemical components are changing in time or space. However, high time resolution aerosol speciation is more costly and difficult than high time resolution light scattering from nephelometers. High time resolution aerosol in conjunction with nephelometer data can be very effective for assessing the causes of haze.

Measurements of the cations ammonium (NH_4+), potassium (K+) and Sodium (Na+) are useful to help evaluate the emissions inventory and to determine availability of ammonia for full neutralization of SO_4 and NO_3 aerosol.

Gaseous measurements are especially useful for validating the air quality models. SO_2 in conjunction with SO_4 measurements give a measure of the fraction of gas-to-particle conversion. NOx measurements can help in the evaluation of the predictive air quality (chemical transport) models.

Aerosol and gas measurements proposed include:

1. $PM_{2.5}$ and PM_{10} IMPROVE monitoring at Wishram and Mt. Zion with full chemical speciation of $PM_{2.5}$. PM_{10} is only done on Teflon to determine non-speciated mass and is not analyzed for chemical species. The monitoring should be done for one-year on the IMPROVE schedule and days of interest for seasonal intensive studies. These measurements are needed for calculation of the extinction budget. The analysis should also include NH_4+, Ka+, Na+, which are not currently done, to help answer the question on whether the atmosphere is ammonia limited.

   $PM_{2.5}$ and PM_{10} IMPROVE monitoring at Wishram and Mt. Zion currently exists and will continue during and after this study. Additional sample analysis for NH_4+, K+, Na+ is proposed on a year round basis for the duration of this study only.

2. Deployment of DRUM size-resolved impactors at a minimum of Mt. Zion and Wishram (season of interest), and one mid-Scenic Area site. These can give 3-hour time resolution, speciated aerosol in 3 or 8 size ranges. Sites need to be visited once per six weeks. Inexpensive sampling can be done for long periods and analyzed later for exceptional events.

These measurements, in conjunction with nephelometer data and meteorological data will help in the identification of which sources impact a site at a given time. They also give information on size of aerosol needed for Mie-theory calculations and will give additional information regarding the water growth of aerosols.

DRUM sampling is proposed as two 6-week seasonal intensives (summer and winter) for this study only, and will be discontinued after this study.

3. Organic speciation of IMPROVE samples using GCMS at a minimum of Mt. Zion and Wishram. This, in conjunction with Chemical Mass Balance modeling (CMB) and Positive Matrix Factorization (PMF) will allow us to apportion organic aerosol to key source types (burning, diesel, gasoline vehicles, and meat cooking).

Organic speciation is proposed for a selection of sample days of interest in each seasonal intensive of this study only, and will be discontinued after this study.

4. Speciated aerosol with portable IMPROVE-like samplers at a few locations along the Scenic Area and outside the Scenic Area, best if situated with nephelometers and surface meteorology sites. In conjunction with the permanent IMPROVE samplers at Mt. Zion and Wishram, this will allow us to see how chemical component concentrations change with distance outside the Scenic Area and moving into and through the Scenic Area. If the ratio of the mix changes, then certain compounds must be added due to sources or chemical transformation (e.g. SO_2 to SO_4) (or selectively removed, which is less likely). This will help tell what sources in the Scenic Area are contributing versus regional contribution. These will be deployed on a seasonal intensive basis with periods of interest analyzed later.

Speciated aerosol with portable samplers is proposed for a selection of sample days of interest in each seasonal intensive of this study only, and will be discontinued after this study.

5. High-time resolution particulate analyzers for SO_4, NO_3, OC/EC at Mt. Zion and a mid-Scenic Area site in summer and Wishram and a mid-Scenic Area site in winter. Can help evaluate local versus regional scale of impacts to sites, possibly identification of specific sources impacting sites, and could help with refining scattering efficiency and water growth factors when used with other instruments (e.g. wet/dry nephelometers).

These analyzers are proposed for the two seasonal intensives of this study only, and will be discontinued after this study.

6. Measurements of additional gas-phase compounds, especially NOx, SO_2, and O_3. Useful for air quality modeling, determination of limited species for chemical reactions. NOx and SO_2 measurements will be deployed on a seasonal intensive basis at two sites for each intensive. O_3 will be measure at one site only. (Wishram).

These NOx and SO_2 measurements are proposed for the two seasonal intensives of this study only, and will be discontinued after this study. O_3 will continue on a seasonal basis after the duration of this study.

7. Additional out-of-Scenic Area IMPROVE monitoring sites will continue to routinely collect speciated $PM_{2.5}$ and non-speciated PM_{10} data. This includes sites at Mt. Hood, The Three Sisters Wilderness, Mt. Ranier, Snoqualamie Pass, White Pass and other IMPROVE monitoring sites. This data can help specify regional background conditions for the Scenic Area. In addition, speciated $PM_{2.5}$ monitors from the $PM_{2.5}$ health based network in the Portland area will be used.

These IMPROVE sites are funded separate from this study and will continue to operate after this study is completed.

III. Meteorological Measurements

Meteorological measurements, especially wind speed and direction are needed to understand source-receptor relationships. Analysis of data from meteorological measurements will help understand flows into and out of the Scenic Area and vertical mixing. They are also necessary for input to and evaluation of meteorological models. They are also useful for interpretation of other measurements such as light scattering and speciated aerosol.

Proposed measurements include:

1. Surface meteorology: wind speed, direction, temperature, relative humidity at main aerosol monitoring sites and all nephelometer sites. Wind speed and direction will help identify and confirm the sources that may be contributing to the measured light scattering or aerosol concentrations. Relative humidity (RH) is needed for estimated water growth used for reconstructed scattering calculations. Temperature at different vertical levels in the Scenic Area can give an idea of stability and vertical mixing of aerosol. Surface meteorological data can also be used for input to or evaluation of meteorological models.

Surface meteorology sites are currently operating at nine sites in and near the Scenic Area and will be operated year round for the duration of this study.

2. SODAR (Sonic Detection And Ranging) systems are used to remotely measure the vertical turbulence structure and the wind profile of the lower layer of the atmosphere. A SODAR placed in mid-Scenic Area will give basic information on vertical structure of atmospheric flow in the Scenic Area above the surface.

A SODAR is currently operating just outside the east end of the Scenic Area and another SODAR just outside the west end operated for part of a year but was recently discontinued and moved to another project. This project proposes to move the east end SODAR to a mid-Scenic Area site and operate the SODAR at the mid-Scenic Area location for the duration of this study.

IV. Fog/Cloud Water Measurements

The US Forest Service is engaging in an independent fog and cloud water study to sample and analyze water chemistry from water deposited as a result of stagnant events. The following description is from the Forest Service Study Plan.

In the Columbia Basin in winter (November to early March) air stagnation episodes are a relatively frequent event. During these events, which can last for days to weeks, air pollution emitted in the basin is trapped by the geographic barriers around the basin and capped by a temperature inversion which settles over the region preventing vertical mixing or transport of the trapped air mass. The Columbia River Gorge is the primary outlet for this polluted air mass. The cold dense and very humid air settles into the lowest areas – particularly the river bottom and in the eastern end slowly drains westward out of the basin thru the Gorge. This cold air mass drainage flow is often accompanied by low clouds and fog which has entrained the trapped air pollutants.

The chemistry of the cloud and fog water during these events is unknown. From studies of other similar regions it is logical to believe that this moisture laden air mass is high in sulfur, nitrogen and ammonium and it is potentially acidic. Lichen sampling in the area would further suggest the potential for fog and cloud water being acidic.

Fog/cloud water sampling and chemical analysis are needed to understand the ambient acidic concentrations. Once ambient acidity is determined then the potential for risk to cultural and ecosystem resources can be better understood. Under the redesigned study, ambient acidity will be determined for the winter 2003/2004 period. Assessing the risk to cultural and ecosystems resources under the measured ambient conditions is not part of this study but is a candidate for add-on studies.

Fog/cloud water chemistry and deposition will be sampled using three primary methods: (1) An active (electric power) fog collector will be installed at one or two sites to collect fog or cloud water during shorter intervals (e.g., 2-6 hours), (2) passive fog line collectors that collect fog or cloud water and from which ions are adsorbed onto ion exchange resin columns for determination of pollution deposition rates, and (3) throughfall collectors (also using ion exchange resin columns) for determining deposition fluxes under plant canopies. In the latter case plant canopies in essence function as effective fog collectors, resulting in elevated ionic deposition to the soil under the canopy. Thus, these plants receive the brunt of concentrated pollutant deposition in fog or cloud water.

It is anticipated that atmospheric deposition sampling will be done at a network of approximately 10-12 sites along the Columbia River Gorge. Sites will be selected in a field trip in August 2003. Samplers will be installed in the first week of October 2003. The sites selected for monitoring will be coordinated with sites where lichen monitoring for atmospheric deposition effects has been reported.

Attachment G
Planned 2002 State Emission Inventory Activity

(Priority: 1 – 4 with 1 = highest)

Source	WA Priority*	OR Priority*
Area Sources		
Agricultural Tilling	3	4
Agricultural Windblown Dust	3	4
Ammonia Sources	2 (livestock, soils, fertilizer)	3
Asphalt Paving	No	3
Construction Site Emissions	No	No
Consumer and Commercial Products	2	2
Dry Cleaning	4	1
Fossil Fuel Combustion - area source	No	1
Gasoline Stations/ Bulk Stations and Terminals	3 (gas stations)	2
Graphic Arts	3	3
Health Services, Hospitals, Sterilization	No	3
Industrial Wastewater	No	4
Municipal Landfills	No	2
Open Burning		
Agricultural Burning	1	1
Land Clearing Burning	?	No
On-site Incineration	2 (residential)	3 (comm./Industrial)
Orchard Heating, Pruning Burning	No	3
Prescribed Burning	1	1
Residential Outdoor Burning	2	1
Paved and Unpaved Road Dust	2	4
Commercial Pesticides	No	No
Publicly Owned Treatment Works	No	2
Residential Wood Combustion	1	1
Restaurant Emissions	No	3
Structural Fires	No	2
Surface Cleaning	3	2
Surface Coating	2	2
Wildfires	2	1
Natural Sources		
Biogenics	2	4
Saltwater Associated Emissions	No	No
Nonroad Mobile Sources		
Airport Emissions	4	1
Locomotives	2	1
Other Nonroad Mobile	2	1
Ships	2	1
On-road Mobile Sources		
On-road Mobile	1	1
Point Sources		
Point Sources Emissions	1	1
Point Sources Stack Parameters	1	2

* Priority is used to identify those activities that need to be done or have not been completed recently that need to be updated. Priority does not indicate the relative importance to the Redesigned Study Plan.