UINTA BASIN AIR QUALITY STUDY
(UBAQS)

Prepared for

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EXECUTIVE SUMMARY

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The Uinta Basin Air Quality Study (UBAQS) model results indicate that average ambient concentrations of criteria pollutants will remain below the National Ambient Air Quality Standards (NAAQS) within the six-county Uinta Basin area. As the predominant industrial activity in the Uinta Basin, future oil and gas development is estimated by the model to produce emissions that will not exceed the maximum levels of air pollutants that can exist in the outdoor air. Unacceptable effects on human health or the public welfare are not estimated to occur.

Because air quality is a concern of the public, regulatory agencies, and oil and gas operators in the basin, the Independent Petroleum Association of Mountain States (IPAMS), in cooperation with the Bureau of Land Management (BLM) and nine other interested government agencies, contracted a nationally recognized air quality consulting company, ENVIRON International Corporation, to estimate changes to air quality and air quality related values (AQRV) within the Uinta Basin that may result from future industrial activity, including oil and gas development.

The goals and methodologies used to develop the UBAQS were cooperatively agreed upon by the group. The goals include:

- Determining possible air quality trends that may result from current and future oil and gas activity in the Uinta Basin in addition to other industrial emission sources;
- Estimating future changes to air quality in the Uinta Basin as concentrations of criteria pollutants and AQRVs;
- Providing federal land managers and regulatory agencies with a mechanism to estimate the possible air quality effects of a proposed project to facilitate informed planning decisions; and
- Providing a tool that can be updated as operational conditions change and monitoring data are collected.

In a series of meetings held during 2008, the UBAQS modeling protocol was developed to incorporate state-of-the-art scientific methodologies to meet the highest standards of analysis and ensure that the results are unbiased and acceptable to all participating parties and independent reviewers. The protocol utilized the Community Multiscale Air Quality (CMAQ) model to estimate changes to all criteria pollutants. The EPA design value methodology was used to estimate changes to ozone and particulate matter. The protocol included three model scenarios: (1) an evaluation of the model's performance; (2) a baseline of typical conditions; and (3) a reasonable estimate of future conditions. The baseline year was chosen as 2006, and the projected future year was chosen to be 2012

The CMAQ model utilized a 12-kilometer (km) grid to evaluate the Uinta Basin and surrounding areas, including Salt Lake City. A 36-km grid encompassed the remainder of the continental United States. The smaller 12-km grid provided greater resolution of effects in the focus area. The focus area includes the six counties that contain the Uinta Basin, which are Carbon, Duchesne, Emery, Grand, Uintah, and Wasatch counties.

Input data to the model consisted of current emissions data compiled by the Western Regional Air Partnership (WRAP) of the Western Governors Association. Data for oil and gas activity in southwest Wyoming were also included. Emissions data from outside of the six counties were incorporated into the model because these "outside" sources may also impact the air quality in the basin. The emissions data were then paired with 2005 and 2006 meteorological data during the modeling process. A model performance evaluation was conducted by following procedures detailed in the EPA's modeling guidance and compared against model performance goals developed, in part, by the EPA to ensure that the results remained within accepted modeling standards.

Although the UBAQS model evaluated criteria pollutants, including particulate matter ($PM_{2.5}$ and PM_{10}), nitrogen oxides (NO_x), ozone, sulfur dioxide (SO_2), and carbon monoxide (CO), the focus of the UBAQS was NO_x and volatile organic compounds (VOC), which are the primary emissions from oil and gas development. These emissions directly relate to ozone formation and visibility impairment due to NO_3 and nitrogen deposition. The UBAQS evaluated AQRVs as changes in visibility and acid deposition.

Ozone: The CMAQ model estimated that the Uinta and Piceance Basins would be in attainment of the 8-hour ozone NAAQS for 2012. The EPA design value methodology predicted that air quality monitors that currently show NAAQS ozone violations would continue to do so. These monitors are located in the Salt Lake City area. Year 2012 design values in rural areas would achieve the 8-hour ozone NAAQS except for an area at the border of Duchesne and Summit counties and three grid cells in Emery County.

NOx: The maximum CMAQ-estimated annual NO_2 concentration would represent up to 33% of the allowable NAAQS, or well below the regulatory standard.

PM: The CMAQ model and EPA design value methodology estimated that the annual average $PM_{2.5}$ concentrations would be well below the NAAQS in 2012. The EPA design value results indicated that $PM_{2.5}$ concentrations would decrease at over 80% of the monitored locations, and the annual $PM_{2.5}$ NAAQS would be attained for 2012 throughout the Uinta Basin. CMAQ estimated that the maximum 24-hour $PM_{2.5}$ concentrations would be below the NAAQS in 2012, except for a few scattered grid cells located at the Utah-Colorado border. CMAQ also estimated that the maximum 24-hour PM_{10} concentrations would exceed the NAAQS at the Utah-Colorado border.

SO_2, CO: The maximum 3-hour, 24-hour and annual SO_2, maximum 1-hour and 8-hour CO concentrations would represent up to 33% of the allowable NAAQS, or well below the applicable regulatory standards.

AQRVs: There are no ambient standards for AQRVs. The BLM has used a 1.0 change in deciview threshold for visibility and the United States Forest Service (USFS) uses 5 kilograms per hectare per year (kg/ha/yr) and 3 kg/ha/yr level of concern (LOC) for, respectively, sulfur and nitrogen annual deposition. The CMAQ model predicted that Dinosaur National Monument would be the sensitive Class II area with the highest visibility impacts. A 1.0 deciview change may occur at the monument over a time period ranging from 21 to 54 days per year. The estimated change in total nitrogen deposition at all Class I and sensitive Class II areas are 97% or more below the USFS LOC value. Sulfur deposition was estimated to decrease between 2006 and 2012 at all of the Class I and sensitive Class II areas.

Relative accuracy of an air model depends on how closely the assumptions used in the model replicate what actually occurs. Although useful as a predictive tool, the ability of a model to predict performance is constrained by the kind of software used, quality and amount of input data, key assumptions, and professional qualifications of the modeling team. The air quality modeling assumptions and parameters used in UBAQS are conservative and designed to ensure oil and gas activity and corresponding emissions levels are not understated. Oil and gas activity and associated emissions may be lower than what was predicted by the model. Modeled exceedances for any pollutant may not correlate with actual measured values in 2012 because of the inherent conservative biases built into the modeling that tend to overestimate pollutant concentrations and effects to AQRVs. Compliance with the NAAQS is determined by measured monitor data. Models use a variety of estimation procedures that can be constrained by monitor data where available. If monitor data are incomplete or unavailable, the conclusions drawn from modeled estimates should be considered reasonable approximations, at best. The distinctions between actual monitor data, which represent measured concentrations of air quality, and model estimates should be considered while evaluating the significance of the model results.

The UBAQS results should not be considered actual measurements. In order to develop more accurate future model results, additional air quality monitoring is needed in the Uinta Basin. Two ambient air quality monitors were installed in the Uinta Basin in December 2008 near Red Wash and Ouray. These monitors will be able to provide actual air quality measurements indicative of real conditions for use as input into future UBAQS model runs. The inclusion of this near-field monitoring data will greatly improve the relative accuracy of future Uinta Basin modeling. Updated model results from a continuing UBAQS effort would ensure that air quality within the Uinta Basin is maintained at levels acceptable by regulators and those who live and work in the communities of the Uinta Basin.

OVERVIEW

OVERVIEW

INTRODUCTION

The hydrocarbon-bearing geologic formations of the Uinta Basin, located in northeastern Utah, have successfully produced oil and gas since the 1920s. Since then, oil and gas development in the Uinta Basin has been, and is expected to continue to be, extensive. Exploration for oil and gas reserves has diminished as known fields have expanded and field development continues. Infill drilling is being conducted on decreased spacing. The machinery used for construction, drilling, and routine oilfield operations generate emissions that are able to alter the qualities of the ambient air. Responding to concerns expressed by the oil and gas industry, the public, and regulatory agencies, the Independent Petroleum Association of Mountain States (IPAMS), in cooperation with the Bureau of Land Management (BLM), contracted a nationally recognized air quality consulting company to utilize a computer model to predict changes to air quality and air quality related values (AQRV) within the Uinta Basin that may result from future industrial activities, including oil and gas field development. The results of the model, finalized in 2009, are included in this report known as the Uinta Basin Air Quality Study (UBAQS). Although the UBAQS model utilized nationwide data, the UBAQS was developed to focus on and provide detailed air quality data for a six-county area that comprises the Uinta Basin.

A cooperative group consisting of representatives from the oil and gas industry and federal and state agencies coordinated by IPAMS provided guidance in developing the UBAQS. The participating agencies either have responsibility over some aspect of air quality within their management authority or have responsibility for preserving the attributes of their managed lands that may be affected by changes in air quality. The group included representatives from:

- Bureau of Land Management (BLM)
- State of Utah (Department of Environmental Quality [UDEQ]/Division of Air Quality [UDAQ])
- U.S. Environmental Protection Agency Region 8 (EPA)
- U.S. Forest Service (USFS)
- National Park Service
- Ute Tribe
- Western Regional Air Partnership (WRAP) of the Western Governors Association
- Uintah and Duchesne Counties
- Colorado Department of Public Health and Environment
- Oil and gas companies with operations and/or interests in the Uinta Basin

The study was funded by the participating oil and gas companies, all of which operate in the Uinta Basin. The procedures utilized in developing the UBAQS model incorporated state-of-the-art scientific methodologies intended to meet the highest standards of analysis to ensure that the results are unbiased and acceptable to all participating parties and independent reviewers.

A detailed explanation of the UBAQS model and results is contained in the Technical Summary section of this report.

GOALS AND OBJECTIVES

The purpose of the UBAQS is to provide quantitative estimates of possible air quality trends that may result from current and future industrial activities, including oil and gas development in the Uinta Basin.

The goals include:

- Determining possible air quality trends that may result from current and future oil and gas activity in the Uinta Basin in addition to other industrial emission sources;
- Estimating future changes to air quality in the Uinta Basin as concentrations of criteria pollutants and AQRVs;
- Providing federal land managers and regulatory agencies with a mechanism to estimate the possible air quality effects of a proposed project to facilitate informed planning decisions; and
- Providing a tool that can be updated as operational conditions change and monitoring data are collected.

Specifically, the objective of the UBAQS is to forecast changes to air quality in the form of predicted changes to concentrations of criteria pollutants and AQRVs. The UBAQS incorporates state-of-the-art atmospheric science and air quality modeling so that the results may be used by agencies to assist in defining and meeting air quality management objectives and by industry to assist in project planning. UBAQS will provide federal land managers and regulatory agencies with the ability to estimate the possible effects of a proposed natural resource action and facilitate better planning decisions. The ability to predict potential cumulative air quality impacts from industrial emissions will enable oil and gas companies to incorporate operational procedures that may alter the qualitative and quantitative nature of potential emissions. The UBAQS is, therefore, a multi-functional tool.

The UBAQS is conceived as a "living" projection of future conditions that will change as the current state of oil and gas development changes and as more accurate air quality data become available. As operational conditions change and as actual monitor data are collected, the results of the UBAQS can be updated by future modeling iterations. The results presented in this report should be interpreted as a "first run" that can be refined over time.

Under the National Ambient Air Quality Standards (NAAQS) regulations, the following compounds are considered to be criteria pollutants: particulate matter ($PM_{2.5}$ and PM_{10}), nitrogen oxides (NO_x), ozone (O_3), sulfur dioxide (SO_2), carbon monoxide (CO), and lead. The EPA has determined that these criteria pollutants can be harmful to public health and the environment. The UBAQS evaluated AQRVs as changes in visibility and acid deposition.

BACKGROUND

To be useful as a management and planning tool, IPAMS took reasonable steps to ensure that the UBAQS was implemented in a way that ensured impartiality of the results. This was successfully accomplished by asking for and receiving input from all members of the cooperating group. The concept for the project was developed in the spring of 2007 and formalized that summer. IPAMS presented an initial modeling protocol to interested government agencies in a meeting on January 24, 2008. Written comments were subsequently accepted from the government agencies. As a result of the comments, changes were made to the modeling protocol. When requested changes could not be included within the scope of the project, the rationale was provided to all government agencies. IPAMS held another interested government agencies meeting on March 26, 2008 to review the revised protocol. Even though most substantive concerns were addressed, the EPA was concerned that the scope of the area of analysis was too small. IPAMS met with the BLM, the UDAQ, and the EPA on August 12, 2008, to better understand the EPA's concerns. At that meeting, IPAMS agreed to increase the study boundary area to include southwestern Wyoming. IPAMS met with the EPA again in November 2008 to provide an update on the project. At that meeting, the EPA considered the project design parameters to be scientifically sound, and the UBAQS moved forward.

ENVIRON International Corporation (ENVIRON) was chosen to perform the modeling because of its past experience with the kinds of models suitable for meeting the objectives of the UBAQS and estimating air quality impacts for a regional study area. For example, ENVIRON completed the WRAP Phase II emissions inventory and performed regional haze modeling for the Western Governors Association. In addition, ENVIRON is working on the WRAP Phase III oil and gas inventories.

PROTOCOL OVERVIEW

The UBAQS modeling "protocol" followed the highest scientific standards to estimate potential future effects of oil and gas emissions to ambient air quality. Protocol development included:

- developing a schedule;
- determining the kind of modeling program to be used for the study;
- defining the area to be modeled;
- determining methods for identifying and compiling input data;
- determining procedures for technical configuration of the model and processing; and
- developing model performance evaluation procedures to ensure quality control and quality assurance (QA/QC).

Choice of CMAQ as the Model

The Community Multiscale Air Quality (CMAQ) model was chosen because it is a state-of-the-science photochemical model and is one of the most flexible and reliable air quality modeling systems currently available. CMAQ is capable of modeling tropospheric ozone, fine particles, acid deposition, and visibility degradation, all of which were identified as primary evaluation objectives for the UBAQS by the participating agencies and companies. CMAQ is one of the EPA's modeling tools for atmospheric pollution studies. It was designed to have multi-scale capabilities so that separate models are not needed for smaller and regional scale air quality modeling. CMAQ simulations can be performed to evaluate longer term (annual to multi-year) pollutant climatologies as well as short term (weeks to months) transport from localized sources. The CMAQ modeling system contains three components: (1) a meteorological modeling system for the description of atmospheric states and motions; (2) emission models for man-made and natural emissions that are injected into the atmosphere; and (3) a chemistry-transport modeling system for simulation of the chemical transformation and fate. By making CMAQ a modeling system that addresses multiple pollutants and different spatial scales, CMAQ has a "one atmosphere" perspective.

Oil and gas operations are the dominant industrial activity in the Uinta Basin. The primary atmospheric pollutants resulting from oil and gas operations consist of NO_x and volatile organic compounds (VOCs), which relate to ozone formation and visibility impairment due to NO_3 and nitrogen deposition. CMAQ has the ability to provide results and predict effects to the atmosphere that directly correspond to the characterizations of air quality that are of primary concern.

Study Area

Oil and gas development in the Uinta Basin occurs within portions of six counties: Carbon, Duchesne, Emery, Grand, Uintah, and Wasatch counties. CMAQ model results were estimated for this six county focus area, shown by the gray shaded area in Figure OV-1.

Identifying and Compiling Input Data

Data used as input to the CMAQ model consisted of the most complete, accurate and current emissions and meteorological data available. Emissions data included the WRAP Phases II and III inventories for oil and gas sources in addition to other non-oil and gas emissions sources. Where appropriate, emission inventory data were broken out into general source categories. Other emissions sources included electric generating units, permitted sources other than electrical generation units, area sources (minor emissions sources that are released over a relatively small area but which cannot be classified as point sources, such as multiple flue gas stacks within a single industrial plant), on-road sources (emissions from vehicles), non-road sources (such as emissions from small engines, aircraft), and biogenic sources (natural sources such as plants, trees, and wildfires).

Meteorological data from several years are typically used in a series of model iterations to better assess the effects of different climate characteristics on the results of a model. Although data from three years are typically used, complete meteorological data were available for only two years. Meteorological data from the years 2005 and 2006 were used.

Although the Uinta Basin area was the primary focus of the model, emissions data from outside of the six Uinta Basin counties were incorporated into the model because these “outside” sources may also impact the quality of the atmosphere in the basin. Emissions data were drawn from the most recent available data compiled by the WRAP. The WRAP inventories are comprehensive criteria pollutant emissions inventories for all point and area sources associated with the exploration and production of oil and gas in the major western basins. Emissions data were compiled for the Piceance, Uinta, Denver-Julesburg, and other basins in Colorado, Montana, New Mexico, North Dakota, Utah and Wyoming, for the year 2006. Emissions data for oil and gas activity in southwest Wyoming were also incorporated into the model, as appropriate. These emissions data were compiled from other models being used to assess air quality, such as the Continental Divide-Creston area of Wyoming. The emissions data were then paired with 2005 and 2006 meteorological data during the UBAQS modeling process.

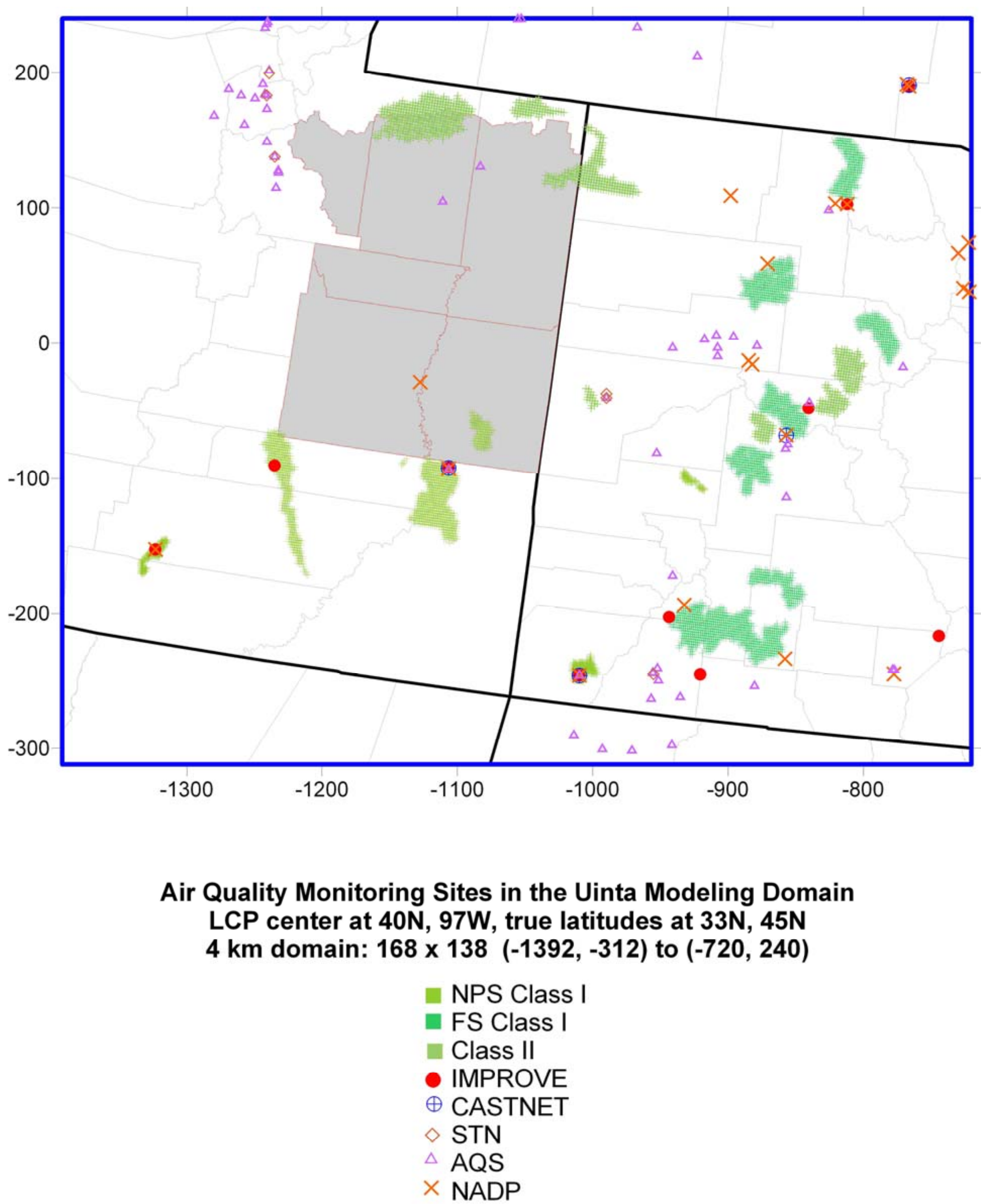


Figure OV-1: Six-County UBAQS Focus Area.

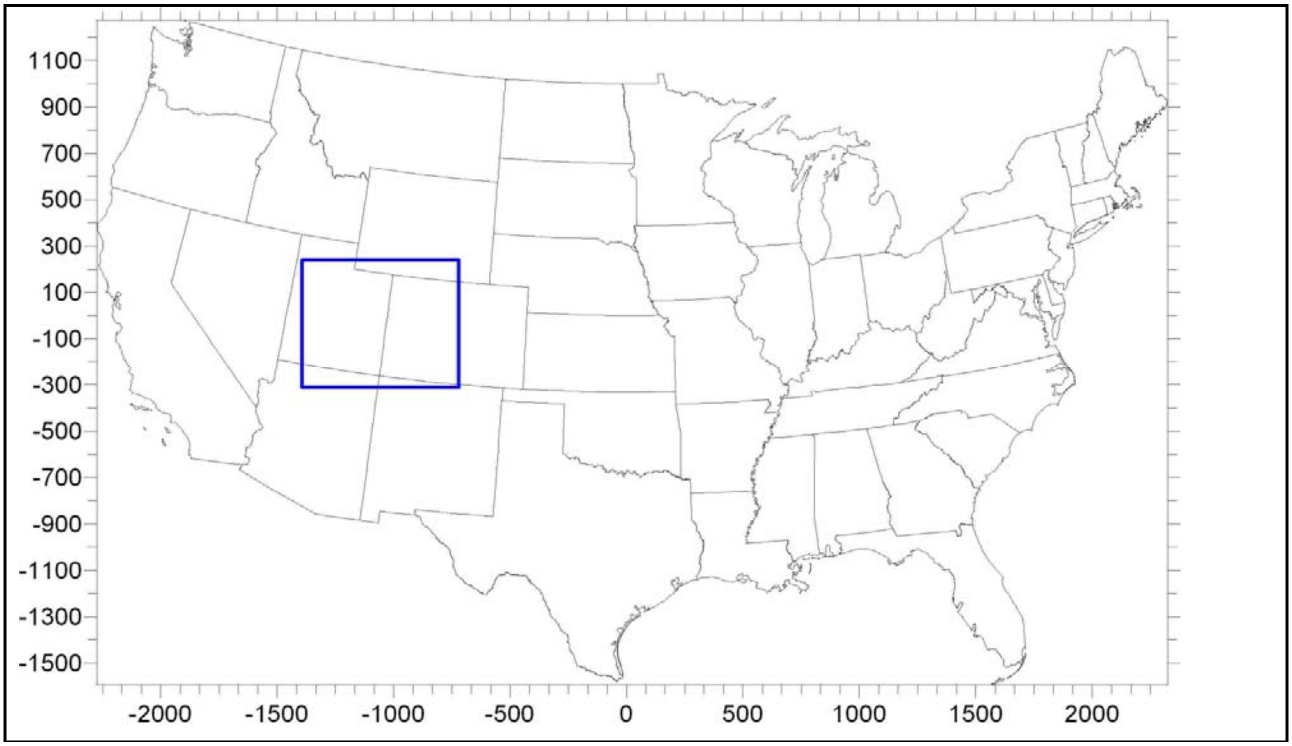
CMAQ Technical Configuration and Processing

Technical Configuration

The CMAQ model required pre-processing the meteorological and emissions data with other modeling systems capable of transforming inventory data set into CMAQ emission input data. The meteorological pre-processing system was used to predict future meteorological conditions. The CMAQ model requires input data in the form of gridded, hourly, chemically speciated emissions of criteria pollutants, including NO_x, SO_2, CO, PM, and VOCs. The model utilized a 12-kilometer (km) grid to include the Uinta Basin, the affected six counties, and surrounding areas, including Salt Lake City, and a 36-km grid to encompass the remainder of the continental United States. The smaller 12-km grid provided greater resolution of effects.

Areas near but outside the Uinta Basin where oil and gas activity occurs and specially designated areas protected for AQRVs were included in the 12-km grid. Areas regulated to ensure preservation of certain levels of AQRVs are called a "Prevention of Significant Deterioration (PSD)" Class I or sensitive Class II areas. Such areas are granted special air quality protections under Section 162(a) of the federal Clean Air Act. PSD Class I areas include federal lands such as national parks, national wilderness areas, and national monuments. PSD Class I and sensitive Class II areas allow additional, well-controlled industrial growth through the incremental addition of some area-specific pollutants. Specific increments exist for NO_x, SO_2, and PM. The increments vary depending upon the pollutant and classification of an area. Some Class I or sensitive Class II areas near the Uinta Basin include the Dinosaur National Monument, Arches National Park, Canyonlands National Park, and Colorado National Monument. Figure OV-1 displays some of the Class I and sensitive Class II areas (shades of green) and the locations of various kinds of air quality monitoring stations, which are designed to acquire different types of data. For example, IMPROVE monitoring stations measure pollutants at Class I areas. CASTNET monitoring stations measure acid deposition including rural ozone and PM. AQS monitors are positioned near cities and towns, and NADP monitoring stations are located in rural areas.

The function of the national-scale 36-km grid was to provide boundary conditions to the 12-km grid so that the effects of sources outside the 12-km grid are incorporated into the UBAQS results. Figure OV-2 displays the 12-km grid area in comparison to the entire national 36-km grid.



Note: 12-km domain outlined in blue, 36-km domain outlined in grey with outside tick marks

Figure OV-2: 36-km and 12-km modeling domains for CMAQ modeling in the UBAQS**.**

Processing

The final UBAQS protocol included three model scenarios that were intended to: (1) provide an evaluation of the model's performance; (2) develop a baseline of typical conditions; and (3) provide a reasonable estimate of future conditions. The baseline year was chosen as 2006 because it was characterized by a thorough air emissions inventory and meteorological data set. The projected future year was chosen to be 2012 because it was most likely to yield a realistic future projection for oil and gas emissions. Inventoried emissions from 2006 were projected to future years 2012. The emissions projections were based on an anticipated rate of development of oil and gas resources in the Uinta Basin. The projected emissions estimates represent future emissions based on the current regulatory framework and economic conditions at the time when this project was initiated.

Scenario 1 ("actual" model) was developed to evaluate how accurately the CMAQ model predicted ambient concentrations in comparison to actual data collected from known sources. This scenario effectively served as a calibration to assess model performance. Actual emissions data and meteorological data for 2005 and 2006 were used for this model scenario. When available, data were used from sources monitored by a Continuous Emissions Monitoring System (CEMS) to record emissions of NO_x and SO_2 on an hourly basis. The results of the actual model simulation were compared against available ambient air quality and related observations to provide a model performance evaluation.

Scenario 2 (2006 "typical" emissions base year model) was developed to establish baseline information without CEMS data. The emissions without the CEMS data were considered "typical annual emissions." Typical emissions data from 2006 and meteorological data for 2005 and 2006 were used for this model scenario.

Scenario 3 (2012 "future year" emissions model) was developed to estimate changes to air quality and AQRVs in future year 2012. Meteorological data for 2005 and 2006 were modeled with 2006 typical emission rates projected out to 2012. The resultant differences in air quality and AQRVs in 2012 directly reflected differences due to winds, average ambient temperatures, precipitation, fire, and biogenic emissions in 2005 and 2006.

Evaluation Procedures and QA / QC

Actual Model Performance Evaluation

The UBAQS actual model performance evaluation followed the procedures in the EPA's modeling guidance, and evaluation results were compared against model performance standards developed, in part, by the EPA. Fractional bias metrics were used to statistically compare the modeled results to actual measurements. The model results satisfied the EPA's performance goals because they remained within a pre-determined range and were concluded to be valid representations of predicted effects of emissions in most cases during most times of the year.

The focus of the UBAQS evaluation was on ozone and PM components (such as sulfates, organic matter, nitrates). Because oil and gas generated emissions can result in ozone formation and visibility impairment due to NO_3 and nitrogen deposition, the CMAQ actual emissions Scenario 1 simulation results were compared against measured values of ozone, PM components, and NO_3 acquired by monitoring stations nearest to the Uinta Basin.

To evaluate the model's ability to predict ozone formation, the Scenario 1 results were compared to the actual daily maximum 8-hour ozone concentrations and to the actual 4^{th} highest daily maximum 8-hour ozone concentrations, which are historically comparable to the values measured by monitors. The CMAQ actual Scenario 1 results predicted daily maximum 8-hour ozone concentrations within EPA-accepted limits of the observed value 90% and 83% of the time for the 2005 and 2006 modeling years, respectively. The modeled 4^{th} highest daily maximum 8-hour ozone concentrations at the locations of the ozone monitors were usually higher than the monitor values. Therefore, in general, the 2012 model results will predict values that exceed actual observed values of ozone.

Both the monitor values and Scenario 1 model results show that NO_3 is higher in the winter and lower in the summer; however, at measured concentrations greater than 0.1 $\mu g/m^3$, the predicted NO_3 concentrations are from 50% to 100% higher than the monitor values. During the summer both the observed and predicted NO_3 approach zero. Two conclusions were drawn: (1) NO_3 is not important to $PM_{2.5}$ formation or visibility impairment in the summer in the UBAQS six-county area; and (2) the 2012 model results will predict values that will exceed actual observed values of NO_3 and will overestimate effects to visibility.

Measured concentrations of PM components that are likely to make the greatest contributions to visibility impairment achieved the PM performance goals.

Typical and Future Year Results Evaluation Methodology

The most current accepted evaluation methodologies were used to estimate pollutant concentrations for the typical year 2006 and future year 2012 emission scenarios. Future year 2012 concentrations were estimated in two different ways for comparisons with the NAAQS:

1. using the model in a relative fashion to scale the current year design values to estimate 2012 future year design values; and
2. using the absolute 2012 CMAQ modeling results.

EPA guidance recommends the first method for projecting future year ozone and $PM_{2.5}$ levels for comparisons with the NAAQS and has developed the Modeled Attainment Test Software (MATS) tool to make such projections. The MATS tool includes procedures for making projections at actual monitors and also in areas without monitors, typically rural areas. The MATS tool interpolates known values to each grid cell in areas without monitors. Although the standard EPA approach for ozone was modified by the UBAQS because of a lack of monitor data in or near the Uinta Basin, the relative change in the modeling results is believed to be the more accurate method, which is the reason why it is the EPA's preferred approach for making projections. The MATS projection capability, however, has only been implemented for 8-hour ozone and annual $PM_{2.5}$, not the remaining criteria pollutants. The CMAQ absolute modeling results were used to make comparisons with all of the NAAQS for completeness.

The methodologies and criteria standards are summarized in Table OV-1.

Table OV-1: Future Year Evaluation Methodology**.**

Air Quality Component	Evaluation Methodology	Standards
Criteria pollutants	• EPA design value procedures using the enhanced MATS tool for ozone and annual $PM_{2.5}$ • CMAQ modeling results for absolute (4th highest 8-hour O_3 concentration) ozone and $PM_{2.5}$ • CMAQ modeling results for NO_2, SO_2, CO, PM_{10}	NAAQS
PSD Class I and Sensitive Class II area air quality, identified criteria pollutants	CMAQ modeling results	PSD Class I increment and PSD Class II increment
PSD Class I and Sensitive Class II area visibility	IMPROVE methodology	1.0 deciview change
PSD Class I and Sensitive Class II area acid deposition and acid neutralizing capacity (ANC) of sensitive lake receptors	• CMAQ model with limited (CALPUFF) nitrogen species • CMAQ model with all nitrogen species • USFS *Screening Methodology for Calculating ANC Change to High Elevation Lakes* (2000)	• USFS levels of concern (LOC) • USFS levels of acceptable change

SUMMARY OF RESULTS AND ANALYSIS

The discussion of the CMAQ model results is referenced to estimated changes in air quality and AQRVs that may occur from 2006 to 2012 within the six-county area that comprises the Uinta Basin. Unless specified, the described estimates are consistent between the 2005 and 2006 meteorological years. Where air quality components were modeled using different evaluation methodologies (listed in Table OV-1), the results were consistent unless otherwise described.

Compliance with the NAAQS is determined by monitor data. Models use a variety of estimation procedures that can be constrained by monitor data where they are available. If monitor data are incomplete or unavailable, the conclusions drawn from modeled estimates should be considered reasonable approximations, at best. The distinctions between actual monitor data, which represent measured concentrations of air quality, and modeled estimates, should be considered while evaluating the significance of the model results.

Air Quality

2012 Future Emissions Projections

The 2012 future emissions projections apply to the entire 12-km modeling domain. Total organic gas emissions from all sources are projected to increase across the 12-km modeling domain between 2006 and 2012. Increases in emissions were attributed primarily to oil and gas sources. The future emissions projections were consistent between both years of meteorological data.

Projected NO_x emissions within the 12-km modeling domain varied between the 2005 and 2006 meteorological data. Use of the 2005 meteorological data resulted in a 9% decrease of total NO_x emissions; however, the 2006 data resulted in a 1% increase. Although oil and gas NO_x emissions increased by 18% from 2006 to 2012, a decrease in emissions from on-road sources was responsible for the net decrease in NO_x using the 2005 meteorological data.

Projected Emissions Summary by County

Scaling factors were applied to the baseline emissions 2006 inventory, and "on-the-books" regulations were applied to the uncontrolled 2012 emissions projections to generate the final 2012 emissions projections by county for the six-county focus area of the UBAQS that comprises the Uinta Basin. Duchesne and Uintah Counties account for the majority of Uinta Basin projected NO_x emissions in 2012, with small NO_x emissions contributions from Carbon (8%) and Grand counties (4%). Drilling rigs and permitted and unpermitted compressor engines are projected to be the predominant NO_x emissions source categories in 2012, accounting for approximately 67% of total basin-wide NO_x emissions. VOC emissions from glycol dehydrators and flashing emissions from condensate and oil tanks combined may comprise approximately 57% of total VOC emissions in the Uinta Basin in 2012. Projected emissions broken out by county for 2012 are shown in Table OV-2 in units of tons per year (TPY).

Table OV-2: Projected 2012 Oil and Gas Emissions of Criteria Pollutants by County for the Uinta Basin.

County	NO_x (TPY)	VOC (TPY)	CO (TPY)	SO_x (TPY)	PM (TPY)
Carbon	1,351	3,977	1,296	2	50
Duchesne	5,352	35,410	29,756	5	208
Emery	259	559	246	0	10
Grand	736	2,984	687	1	26
Uintah	8,849	84,564	12,940	16	337
Wasatch	0	0	0	0	0
TOTAL	16,547	127,495	44,925	24	631

Source: Final Report, WRAP Phase III, Development of 2012 Oil and Gas Emissions Projections for the Uinta Basin (Environ, 2009).

Comparison to the NAAQS

Ozone Results: Ozone was modeled using two methodologies (see Table OV-1). Using the EPA design value methodology to predict 2012 8-hour ozone concentrations, two types of results were presented: (1) estimates of ozone concentrations at areas where monitors have been installed and (2) estimates where no monitors have been installed; i.e., rural areas. Where monitors have been installed, the emission changes between 2006 and 2012 are not estimated to cause additional monitors to violate the ozone NAAQS or bring any monitors currently violating the ozone NAAQS into attainment. The monitors that currently show NAAQS violations (mainly the Salt Lake City area) were estimated to continue to do so. In the mostly rural areas that include the Piceance and Uinta Basins, 2012 design values achieved the 8-hour ozone NAAQS except for an area at the border of Duchesne and Summit counties and three grid cells in Emery County.   ENVIRON interpreted these elevated concentrations to likely be an artifact of having no observed ozone data in the western portion of the Uinta Basin such that the high ozone readings in the Salt Lake City area have been interpolated across the Wasatch Mountains.

The form of the 8-hour ozone NAAQS is the three year average of the fourth highest observed daily maximum 8-hour ozone concentrations. As only two years of modeling results (2005 and 2006) were available, the two year average of the fourth highest estimated daily maximum 8-hour ozone concentrations were used from the CMAQ model as the closest approximation to the form of the 8-hour ozone NAAQS. The CMAQ absolute model concentrations estimated that the Uinta and Piceance Basins would be in attainment of the 8-hour ozone NAAQS for 2012.

PM results: Annual $PM_{2.5}$ was modeled was modeled using two methodologies (see Table OV-1).   EPA design value methodology was used to predict 2012 $PM_{2.5}$ concentrations near monitored locations and over rural areas without monitoring stations. The results indicated that $PM_{2.5}$ concentrations would decrease at over 80% of the monitored locations, and the annual $PM_{2.5}$ NAAQS would be attained for 2012 throughout the 12-km modeling domain, including the Uinta and Piceance Basins. CMAQ results were in agreement with the results of the EPA design value methodology. The CMAQ model estimated that the annual average $PM_{2.5}$ concentrations would be well below the NAAQS.

Within the Uinta Basin area, maximum CMAQ-modeled 24-hour $PM_{2.5}$ concentrations are below the NAAQS, except for one grid cell located at the Utah-Colorado border near Grand County (2006 meteorological data) and one grid cell at the border of Emery and Wayne counties (2005 meteorological data).

CMAQ estimated that the maximum 24-hour PM_{10} concentrations would exceed the NAAQS at the two grid cell locations where exceedances were estimated for $PM_{2.5}$; however, an additional five grid cells in Grand County showed exceedances using the 2006 meteorological data.

NO_2, SO_2, CO results: The maximum CMAQ estimated annual NO_2, 3-hour, 24-hour and annual SO_2, maximum 1-hour and 8-hour CO concentrations would be lower than the applicable NAAQS by over a factor of three.

The results of the CMAQ absolute model for the six-county Uinta Basin are shown in Table OV-3. All pollutants remained below the NAAQS except for 24-hour PM_{10}, 24-hour $PM_{2.5}$, and ozone (2006 meteorological data only). $PM_{2.5}$ 24-hour and PM_{10} 24-hour NAAQS were exceeded in a few scattered grid cells located near the Utah-Colorado border.

Table OV-3: Maximum Predicted Concentrations within the Six-County Uinta Basin Study Area 12-km Modeling Domain, 2006 and 2012 Emission Scenarios

AQ Metric	NAAQS(1) ($\mu g/m^3$)	2005 Met. Data		2006 Met. Data	
		2006 ($\mu g/m^3$)	2012 ($\mu g/m^3$)	2006 ($\mu g/m^3$)	2012 ($\mu g/m^3$)
NO_2 Annual	100	19.6	32.5	18.3	30.3
SO_2 3-Hour	1,300	52.5	54.8	48.8	38.3
SO_2 24-Hour	365	45.1	25.6	21.4	23.3
SO_2 Annual	80	4.8	4.7	5.1	5.0
$PM_{2.5}$ 24-Hour	35	35.3 (2)	35.1 (2)	35.5 (2)	35.5 (2)
$PM_{2.5}$ Annual	15	4.6	4.5	5.6	5.6
PM_{10} 24-Hour	150	165.6 (2)	165.5 (2)	192.9 (2)	192.9 (2)
PM_{10} Annual	50 (3)	14.0	14.0	22.9	22.9
CO 1-Hour	40,000	6,802.2	6,803.4	3,783.9	3,786.1
CO 8-Hour	10,000	3,077.9	3,079.1	3,201.7	3,204.3
O_3 8-Hour	0.075 ppm	0.0741 ppm (4)	0.0742 ppm (4)	0.0755 ppm (4)	0.0785 ppm (4)

1 PM_{10} 24-hour - Not to be exceeded more than once per year on average over 3 years
$PM_{2.5}$ Annual - The 3-year average of the weighted annual mean $PM_{2.5}$ concentrations from single or multiple community-oriented monitors must not exceed 15.0 $\mu g/m^3$
$PM_{2.5}$ 24-Hour - The 3-year average of the 98th percentile of 24-hour $PM_{2.5}$ concentrations at each population-oriented monitor within an area must not exceed 35 $\mu g/m^3$
O_3 - The 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.075 ppm
2 CMAQ estimated 98th percentile 24-hour $PM_{2.5}$ and PM_{10}
3 The 50 $\mu g/m^3$ annual PM_{10} NAAQS has been revoked, but it is still retained as an UAAQS and CAAQS.
4 Fourth highest daily maximum 8-hour ozone concentration in any grid cell in the 12-km modeling domain.

PSD Incremental Concentrations

Estimated incremental changes in pollutant concentrations in Class I and sensitive Class II areas were predicted to remain below allowable PSD increments. The highest Class I estimates were predicted values were associated with the PM_{10} 24-hour and PM $_{2.5}$ 24-hour for the Eagles Nest Wilderness Area in Colorado and Capital Reef National Park (west and outside of the Uinta Basin), respectively.

AQRVs

Visibility

The model predicted that Dinosaur National Monument would be affected by the highest visibility impacts. A 1.0 deciview change may occur at the monument over a time period ranging from 21 to 54 days per year.

Because CMAQ exhibits an over prediction bias for NO_3 during critical annual time periods, ENVIRON cautioned that the visibility modeling results overstated actual impacts. At observed concentrations greater than 0.1 $\mu g/m^3$, the predicted NO_3 concentrations are from 50% to 100% higher than the observed values. These results indicate that the UBAQS CMAQ model will overestimate the NO3 and visibility impairment associated with future year O&G and other developments in the Uinta Basin. The NO_3 over prediction tendency also needs to be accounted for when interpreting the UBAQS future year modeling results. Thus, the number of days when visibility at Dinosaur National Monument shows impairment over 1.0 deciview may be fewer than the predicted 21 to 54 day range. The results of the model evaluation (Scenario 1) indicated that visibility impairment would most likely occur in the cooler months.

Acid Deposition and Acid Neutralizing Capacity (ANC)

The estimated values of total nitrogen deposition at all Class I and sensitive Class II areas were far below the USFS level of concern (LOC) values. The maximum incremental nitrogen deposition increase comprised 3% of the USFS LOC. Sulfur deposition was estimated to decrease between 2006 and 2012 at all of the Class I and sensitive Class II areas resulting in negative sulfur deposition increments.

The acid neutralizing capacities of all sensitive lakes in the 12-km modeling domain were predicted to decrease. Although nitrogen deposition was predicted to increase, the decrease in predicted sulfur deposition offset the effects of the increased nitrogen.

WHY MODEL RESULTS MAY VARY FROM MEASURED MONITOR VALUES

Models are useful as predictive tools when highly complex photochemistry, such as air quality, require analyses of industrial activities related to operational performance and context of use. The ability of a model to predict performance is constrained by the kind of software used, quality and amount of input data, key assumptions, and professional qualifications of the modeling team. Several factors could result in emissions, and thus air quality and AQRVs, that differ substantially from the 2012 projections from the model. At a minimum, these factors include:

- The inherent uncertainties in the model and mainly overestimation bias in the model evaluation;
- Climate data in the future may reflect trends that are not consistent with the meteorological data years for the model;
- Error while pre-processing the 2006 meteorological data, resulting in over estimation of emissions and impacts from ozone and NO_x and to AQRVs;
- Available use of only two years of meteorological data rather than the typical use of three years of data.
- Oil and gas emissions inventories that presented future oil and gas development, and therefore the emissions that would result, as a maximum;
- Lack of sufficient monitoring data across the basin necessary to verify the model assumptions and results;
- Uncertainty regarding the effect of future regulatory actions on oil and gas development and operations; and
- Oil and gas development growth projections that were developed when market prices were at record high levels.

Relative accuracy of an air model depends on how closely the assumptions used in the model replicate what actually occurs. The air quality modeling assumptions and parameters used in UBAQS are very conservative and designed to ensure activity and corresponding emissions levels are not understated. As cautioned by ENVIRON, care must be taken in the interpretation of the CMAQ absolute modeling results, which may indicate spuriously high concentrations where none actually exist.

Future regulatory actions also have the potential to impact the rate of future emissions. Specifically, the EPA is in the process of promulgating new regulations for the permitting of minor emission sources within Indian Country. The proposed regulations could require the installation of emission controls on new sources that are currently not required, nor considered in the 2012 projection methodology. Furthermore, through approved Resource Management Plans, the BLM is requiring the use of best management practices (BMPs) to reduce emissions from oil and gas operations. BMPs and possible future regulatory requirements were not considered in the UBAQS.

Oil and gas activity and associated emissions may be lower than what was evaluated by the model. Economics, particularly the market price for oil and gas, may significantly alter the rate of oil and gas development. Due to low commodity prices, the severe economic downturn afflicting the entire national economy, the associated lack of capital to sustain the previous (prior to late 2008) level of drilling and production activity, constrained take-away capacity, and the difficulty obtaining permits to drill, oil and gas activity levels may be overestimated. IPAMS believes this is a conservative downward revision. A slowdown in activity over 40% was already evident in December 2008. Production can drop off very quickly because of the combined factors of well decline and reduced drilling during the downturn. The volatility of commodity prices and uncertainties about when the economy may recover mean that a recovery and the level of exploration and development cannot be predicted with accuracy. Once the economy does recover, considerable time is required to bring production levels back up to the levels that had been projected due to the time to remobilize.

CONCLUSIONS

The UBAQS was a cooperative effort undertaken by agencies with authority to regulate or manage air quality in the Uinta Basin and vicinity and oil and gas companies that operate in the Uinta Basin. The objective was to gather information and use the most current data to accurately predict effects to air quality from future activities. The goal was to provide a means for ensuring that the NAAQS would be met. The ongoing results of the UBAQS may assist in providing a tool for performance-based regulatory oversight.
The model results estimated that the six-county Uinta Basin area would meet the NAAQS and remain in attainment for all criteria pollutants throughout most of the basin. The UBAQS determined that the potential for elevated levels of ozone in the future exists. Exceedances of the 24-hour PM_{10} and $PM_{2.5}$ concentrations NAAQS for scattered grid cells within the six-county Uinta Basin area require further investigation. Two strategically placed monitors in the Uinta Basin have provided continuous measurements of ozone, NO_x, and $PM_{2.5}$ since December 2008. The data being acquired by these monitors will provide a quantitative verification of the CMAQ model estimates.

The model estimates should be interpreted with caution because the use of even the most stringent of protocols may provide model results that are subject to variation and open to interpretation. Estimated changes to air quality may not correlate with the actual values that will be measured in 2012 because of inherent biases built into the modeling that tend to overestimate pollutant concentrations and effects to AQRVs. The results of the UBAQS are useful as long the assumptions made remain valid and the extent and accuracy of the data available for input into the model. UBAQS modeling assumptions were very conservative and intentionally developed to provide “worst case” estimations. Other sources of variability between actual future conditions and the estimated modeled results include climate data that may not be reflected in the years chosen for the model, refinement in model methodologies that may yield more accurate results, incorporation of data from near field ambient monitoring sites established in late 2008, and development scenarios that differ from those used as input.

The UBAQS was conceived as an iterative study, the results of which would be updated through future models as new data are acquired. The 2009 UBAQS is considered to be a reference point, a benchmark at this point in time. Future model results from a continuing UBAQS effort would ensure that air quality within the Uinta Basin is maintained to levels determined to be acceptable by regulators and those people who live and work in the communities of the Uinta Basin. To be able to develop accurate future model results, additional air quality monitoring is needed in the Uinta Basin. Two ambient air quality monitors have been installed in the Uinta Basin near Red Wash and Ouray. These monitors will be able to provide actual air quality measurements indicative of real conditions for use as input into future UBAQS model runs. The inclusion of this near-field monitoring will greatly improve the relative accuracy of a future Uinta Basin model.

Responsible energy development will provide for the continuation of a viable regional and national standard of living while ensuring that human heath, the environment, and the quality of the human experience are maintained and protected. The 2009 and future UBAQS will contribute to the maintenance of clean air in the Uinta Basin and nearby areas of the Rocky Mountain west.