Appendix I

2008 Baseline Modeling for the Continental Divide-Creston (CD-C) Project and Assessment of the Estimated Regional Air Quality and AQRV Impacts

APPENDIX I – 2008 BASELINE MODELING FOR THE CONTINENTAL DIVIDE-CRESTON (CD-C) PROJECT AND ASSESSMENT OF THE ESTIMATED REGIONAL AIR QUALITY AND AQRV IMPACTS

1.0. INTRODUCTION

1.1. BACKGROUND AND PROJECT DESCRIPTION

Gary Holsan Environmental Planning is preparing an Environmental Impact Statement (EIS) for the Continental Divide-Creston (CD-C) Natural Gas Development Project located in Sweetwater and Carbon Counties in southwestern Wyoming. The EIS is being prepared for the Bureau of Land Management (BLM). The operators propose to drill approximately 8,950 natural gas wells in addition to the 2,454 wells that currently exist in the Project Area.

As part of the EIS, Carter Lake Consulting (Carter Lake) and ENVIRON International Corporation (ENVIRON) are performing an air quality analysis to assess potential impacts on ambient air quality (AQ) and air quality-related values (AQRVs) from air emissions that could occur from development and production emissions within the CD-C Project Area and from other documented regional emissions sources within a defined study area. AQRVs refer to those resources identified by a federal land management agency that may be adversely affected by a change in air quality and typically include visibility, flora, fauna, water, and soils. Changes in concentrations of air pollutants are analyzed to determine if visibility may be impaired or if increases in atmospheric deposition may cause damage to vegetation or affect soil or surface water chemistry at federally mandated Class I areas or identified sensitive Class II areas.

The methods to be used in the CD-C air impact analysis were documented in a Air Quality Impact Assessment Modeling Protocol (Carter Lake and ENVIRON, 2010) that was provided prior to the air impact assessment to ensure that the approach, input data, and computation methods are acceptable to the Wyoming Department of Environmental Quality – Air Quality Division (WDEQ-AQD), the Bureau of Land Management (BLM) and other air quality stakeholders, and that all air quality stakeholders have the opportunity to review the Protocol and provide input before the impact assessment is performed.

1.2. OVERVIEW OF AIR QUALITY MODELING APPROACH

The air quality impact assessment for the CD-C EIS is being performed with the photochemical grid model CAMx (Comprehensive Air quality Model with Extensions; ENVIRON, 2010; www.camx.com). The basic modeling strategy used in any EIS that employs a photochemical grid model, such as CAMx, is to first evaluate the ability of the model to reproduce ambient observations of trace pollutants during a recent historical episode (the "current year"); then, once confidence in the model is established, a future year case can be run and the potential project impacts evaluated.

A current year base case is simulated using a comprehensive regional emission inventory of actual emissions from all sources (including motor vehicles, power plants, oil and gas exploration and production sources, biogenic sources, etc.). It is preferable to run the model for more than one year so that as many different meteorological regimes as possible are simulated. Pollutants emitted from Project sources may only influence a particular sensitive receptor under certain conditions (wind direction, atmospheric stability) and a conservative estimate of AQ and AQRV impacts requires that those conditions be simulated. While it is not possible to ensure that all possible meteorological conditions that might lead to transport of pollutants from Project sources to sensitive receptors are simulated, modeling two full years increases the likelihood that the relevant conditions will occur.

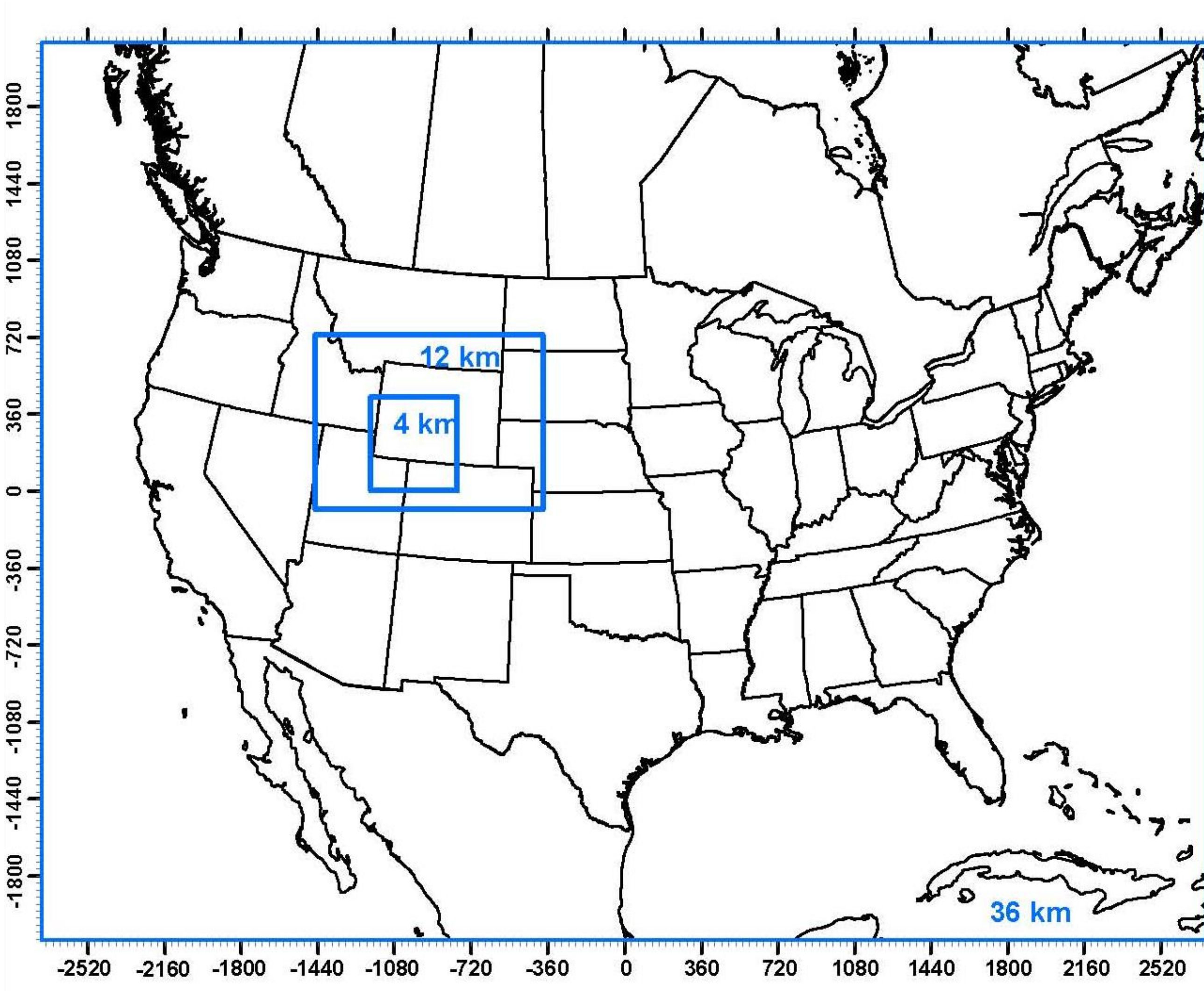
The base case simulation is evaluated with respect to ambient air quality measurements. If the base case simulation reproduces concentrations of observed species with reasonable accuracy, then the model can be used in the future year impact assessment. The next step is to prepare a baseline model for use in future year projections. The only difference between the base case model and the baseline model is that the baseline model uses typical emissions while the base case model uses actual emissions. An example of an emissions source category for which the base case and baseline emissions are different is electrical generating units (EGUs). The base case emission inventory uses hourly EGU emissions derived from continuous emissions monitoring data because the base case model is evaluated against observations to determine whether the model provides a realistic simulation of atmospheric processes. The purpose of the baseline model, on the other hand, is to serve as the base year from which future year projections are made. The baseline EGU emissions are used to represent typical conditions (no shutdowns for maintenance, for example) in order to be consistent with the future year emissions, which also represent typical conditions. The baseline emission inventory, therefore, is usually identical to the base case emission inventory, except for the difference in emissions from EGUs and other source categories with large variability in time, such as drill rigs.

The future year modeling involves development of a future year Project emission inventory as well as a future year regional emission inventory. In the future year regional emission inventory, the emissions from human activities are projected from the base year to the future year and changes such as population growth and planned emissions controls (such as controls on motor vehicle emissions) are accounted for. Emissions that are not controllable, such as biogenics and wildfire emissions, are held fixed. The Project emissions are included in the future year emission inventory. The model is run using the future year regional emission inventory with the rest of the model (meteorological fields, boundary conditions, model settings, etc.) in the same configuration as in the base case. If multiple years were simulated in the base case, then the meteorological conditions for those same years are used together with the future year emissions scenario in the future year modeling. Project AQ and AQRV impacts are determined from the future year simulations.

1.2.1. CD-C 2005 and 2006 Base Case Modeling and Evaluation

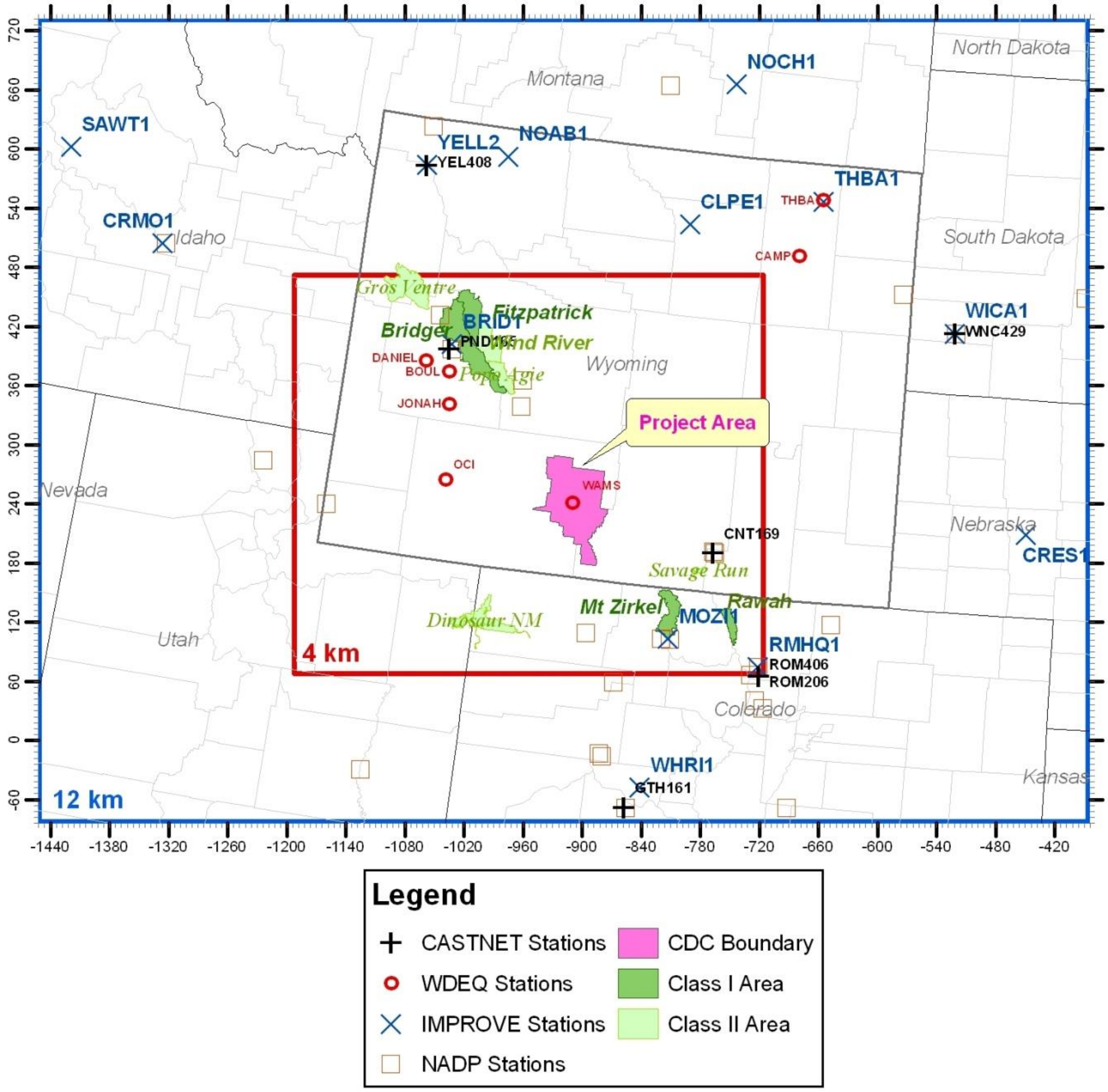
For the CD-C EIS, a base case simulation has been completed. CAMx was applied for the calendar years 2005 and 2006 using a nested-grid modeling domain with horizontal spatial resolution 36/12/4 km (Figures 1-1 through 1-3). The 2005 and 2006 base case model runs used actual emissions of NO_x, SO_2, PM_{10}, $PM_{2.5}$, VOC and CO from all sources for those years and included a comprehensive inventory of oil and gas (O&G) emissions sources within Southwest Wyoming developed by Carter Lake and BP as well as the WRAP Phase III O&G emissions for the Denver-Julesburg, Piceance, and Uinta Basins. The model used 2005-6 MM5 meteorology. The CAMx gas phase and particle phase model estimates were compared against observed ambient values for those two years and a model performance evaluation was conducted (ENVIRON and Carter Lake, 2010). Model performance was determined to be satisfactory and the base case modeling was approved by the CD-C stakeholders at their April

15, 2010 meeting. The next step in the CD-C analysis was to apply CAMx for a baseline emissions scenario.



36/12/4 km Modeling Domain
36 km: 148 x 112 (-2736, -2088) to (2592, 1944)
12 km: 89 x 68 (-1452, -84) to (-384, 732)
4 km: 119 x 101 (-1192, 68) to (-716, 472)

Figure 1-1. 36/12/4 km CAMx air quality modeling domains to be used in the CD-C Project ozone and far-field modeling AQ and AQRV analysis.



12/4 km Modeling Domain
12 km: 89 x 68 (-1452, -84) to (-384, 732)
4 km: 119 x 101 (-1192, 68) to (-716, 472)

Figure 1-2. 12/4 km CAMx air quality modeling domains to be used in the CD-C Project ozone and far-field AQ and AQRV modeling analysis.

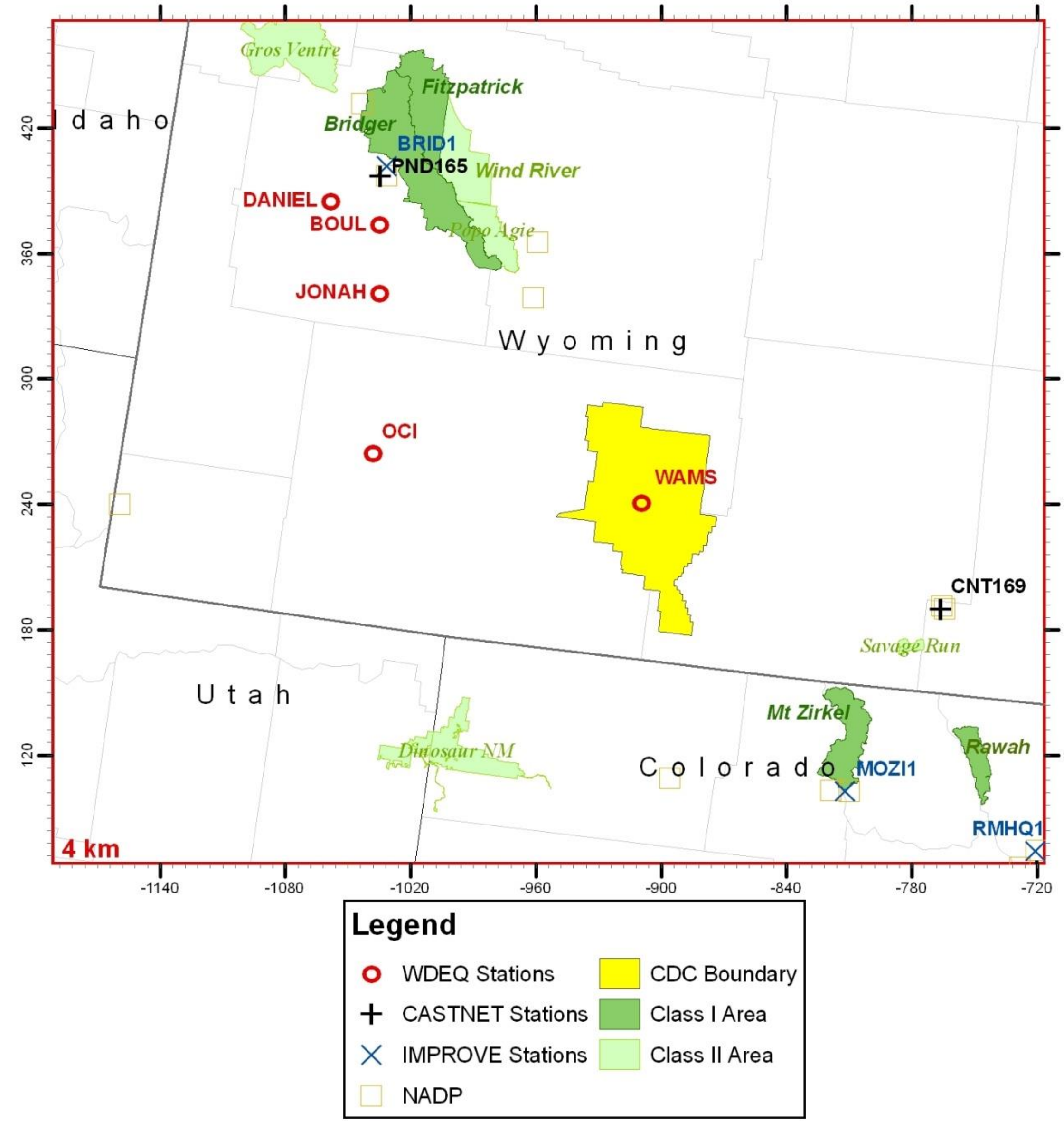


Figure 1-3. 4 km CAMx modeling domain used in the CD-C Project ozone and far-field AQ and AQRV modeling analysis.

1.2.2. CD-C 2008 Baseline Modeling

At their January 7, 2010 meeting, the CD-C stakeholders determined that the baseline year to be used in performing future year modeling and impact analyses would be 2008. Originally, 2006 was to have been the baseline year, but extensive development of oil and gas resources in southwest Wyoming occurred during the 2006-2008 period, and emissions of criteria pollutants and ozone precursors from this source category were significantly larger in 2008 than in 2006. The economic slowdown in 2008-9 leads to a reduction in the pace of development such that 2009 emissions are expected to be smaller than 2008 emissions. 2008 is a National Emission Inventory Year, in which states submit emission inventories to the EPA. Because emission inventories for 2008 for the state of Wyoming are now available, and 2008 is the year of peak emissions from the energy sector in Wyoming, the stakeholders selected 2008 as the baseline year for the impact analysis modeling. Another important factor is that more ambient monitoring was available in 2008 than in 2006. Carter Lake Consulting and ENVIRON have developed a regional emission inventory for the year 2008 for use in CAMx baseline modeling, and the 2008 inventory is described briefly below.

The CD-C 2008 baseline run consisted of two annual runs. Both annual simulations were performed with 2008 emissions; one year was run with 2005 meteorology and the other year was run with 2006 meteorology. CAMx was applied using a 36/12/4 km nested-grid modeling domain as shown in Figure 1-1. The main study area was within the 12/4 km modeling domain shown in Figure 1-2 and includes all sources and receptor areas of interest in the far-field air quality and AQRV assessment of the CD-C Project alternatives and regional emissions. The primary function of the 36 km grid domain is to provide lateral boundary conditions to the 12 km grid domain. The 4 km grid encompasses the CD-C project area and nearby Class I and sensitive Class II areas (Figure 1-3).

In addition to its use as the current year on which future year CD-C modeling will be based, the 2008 baseline modeling is also being used to assess the impacts of the existing CD-C Project on regional air quality. The CD-C Project area contains existing development which must be accounted for in the CD-C modeling in addition to the wells proposed as part of the CD-C Project. The purpose of this assessment was to evaluate the state of regional air quality under the baseline emission scenario and determine whether mitigation measures may need to be considered for the CD-C Project area in advance of the future year modeling. The CAMx output concentration fields were used for the evaluation of regional air quality, and the CAMx probing tools were used to isolate the contribution of existing 2008 CD-C Project area emissions sources to the total modeled concentrations.

1.2.3. Use of CAMx Probing Tools in the 2008 Baseline Modeling

CAMx Particulate Matter (PM) Source Apportionment Technology (PSAT) and the Anthropogenic Precursor Culpability Assessment (APCA) version of the Ozone Source Apportionment Technology (OSAT; ENVIRON, 2010) probing tools were used to obtain the ozone and PM contributions due to different emissions source groups in the 2008 baseline run. APCA is a source apportionment tool similar to OSAT that focuses on determining the contribution to ozone concentrations from human (i.e. controllable) activities. Below, we describe ozone source apportionment in CAMx using OSAT and then discuss how APCA differs from the standard OSAT tool.

OSAT uses multiple tracer species to track the fate of ozone precursor emissions (VOC and NO_X) and the ozone formation caused by these emissions within a simulation. The tracers operate as spectators to the normal CAMx calculations so that the underlying CAMx predicted relationships between emission groups (sources) and ozone concentrations at specific locations (receptors) are not perturbed. Tracers of this type are conventionally referred to as “passive tracers,” however it is important to realize that the tracers in the OSAT track the effects of chemical reaction, transport, diffusion, emissions and deposition within CAMx. In recognition of this, they are described as “ozone reaction tracers.” The ozone reaction tracers allow ozone formation from multiple "source groupings" to be tracked simultaneously within a single simulation. A source grouping can be defined in terms of geographical area and/or emission category. So that all sources of ozone precursors are accounted for, the CAMx boundary conditions and initial conditions are always tracked as separate source groupings. This allows an assessment of the role of transported ozone and precursors in contributing to high ozone episodes within the CD-C modeling domain.

The methodology is designed so that all ozone and precursor concentrations are attributed among the selected source groupings at all times. Thus, for all receptor locations and times, the ozone (or ozone precursor concentrations) predicted by CAMx is attributed among the source groupings selected for OSAT. The methodology also estimates the fractions of ozone arriving at the receptor that were formed en-route under VOC- or NO_x-limited conditions. This information indicates how ozone concentrations at the receptor will respond to reductions in VOC and NO_X precursor emissions, and can be useful in the event that an exploration of mitigation strategies is required.

APCA differs from the standard CAMx Ozone Source Apportionment Tool in recognizing that certain emission groups are not controllable (e.g., biogenic emissions) and that apportioning ozone production to these groups does not provide information that is relevant to development of control strategies. To address this, in situations where OSAT would attribute ozone production to non-controllable (i.e., biogenic) emissions, APCA re-allocates that ozone production to the controllable portion of precursors that participated in ozone formation with the non-controllable precursor. For example, when ozone formation is due to biogenic VOC and anthropogenic NO_X under VOC-limited conditions (a situation in which OSAT would attribute ozone production to biogenic VOC), APCA re-directs that attribution to the anthropogenic NO_X precursors present. The use of APCA instead of OSAT results in more ozone formation attributed to anthropogenic NO_X sources and less ozone formation attributed to biogenic VOC sources, but generally does not change the partitioning of ozone attributed to local sources and the transported background for a given receptor.

The PM Source Apportionment Technology (PSAT) uses reactive tracers to apportion primary PM, secondary PM and gaseous precursors to secondary PM among different source categories and source regions. The PSAT methodology is described below. PSAT was developed from the related ozone source apportionment method (OSAT) already implemented in CAMx (Dunker at al., 2002b). PSAT is designed to source apportion the following PM species modeled in CAMx:

- Sulfate (SO_4)
- Particulate nitrate (NO_3)
- Ammonium (NH_4)
- Particulate mercury (Hg(p))
- Secondary organic aerosol (SOA)
- Six categories of primary PM
  - Elemental carbon (EC)
  - Primary organic aerosol (POA)
  - Crustal fine

- Other fine
- Crustal coarse
- Other coarse

PSAT "reactive tracers" are added to the model for each source category/region. In general, a single tracer can track primary PM species whereas secondary PM species require several tracers to track the relationship between gaseous precursors and the resulting PM.

At the direction of the WDEQ-AQD (Personal communication from Kelly Bott, WDEQ-AQD, July 23, 2010), the 2008 baseline emission inventory modeling was carried out so that the following emissions source categories were processed separately and tracked as separate emissions source groups using the CAMx APCA and PSAT probing tools:

1. CD-C Project-related oil and gas sources within the physical boundary of the CD-C Project area;
2. Non- CD-C Project -related oil and gas sources within the physical boundary of the CD-C Project area. Note that this category includes gas plants and compressor stations which are located within the CD-C Project area, but do not process gas produced by CD-C Project wells.
3. Biogenic sources;
4. All other sources.

1.2.4. 2008 Emissions Development

In this section, we briefly describe the 2008 emission inventory. The 2005-6 base case inventory uses actual measured electric generating unit (EGU) emissions and monthly drill rig emissions because the base case model is evaluated against observations to determine whether the model provides a realistic simulation of the atmospheric processes related to ozone and PM formation, transport, and removal. The purpose of the 2008 baseline model, on the other hand, is to serve as the base year from which future year projections are made and against which future year project alternative and cumulative emissions impacts will be evaluated. The 2008 inventory, therefore, uses typical rather than actual emissions for some source categories in order to be consistent with the future year emission inventories. For example, baseline EGU emissions represent typical conditions (no shutdowns for maintenance, for example) in order to be consistent with the future year emissions, which also represent typical conditions and would have no maintenance shutdowns. The base case emission inventory would have a period of zero emissions during a maintenance shutdown. If base case EGU emissions were used rather than typical emissions, a period when a plant was shut down for maintenance would show up as an impact due to an apparent emissions increase in the future year, which would use a typical inventory and would not contain the period of zero emissions from the shutdown. The two source categories for which 2008 typical emissions were developed are EGUs and drilling rigs. The method for calculating emissions from these source categories is described below.

Several source categories of the 2008 regional inventory (e.g. non-O&G area sources, non-road mobile) were linearly interpolated from the latest WRAP 2002 and WRAP 2018 emission inventories. The most recent WRAP emission databases currently available are the "2002 Plan

D" and "2018 PRP18b" emissions databases. The 2018 PRP18b database recently developed for Preliminary Reasonable Progress was built from the WRAP 2002 inventory by projecting the impacts of activity growth and emission controls. As noted above, the methodology for projecting emissions is described in the WRAP PRP Technical Memorandum (Fields and Wolf, 2007), and information on the WRAP 2002 emission inventory can be found in Tonnesen et al. (2006).

ENVIRON and Carter Lake developed a detailed inventory of point source emissions for the 2008 year for Wyoming. Year 2008 is a national emissions inventory reporting year and emission inventories for Wyoming major and minor point sources have recently been made available by the State. These inventories had not been quality-assured by the WDEQ, but were quality-assured by ENVIRON and Carter lake and then prepared for processing through SMOKE to create CAMx-ready emissions inputs.

For Wyoming and other states, Continuous Emissions Monitor (CEM) data from the U.S. EPA's Clean Air Markets Division (CAMD) was used to supply hourly emissions for electric generating utilities (EGUs). The hourly emissions were then be used to form quarterly averages for each of the 24 hours in a day. These quarterly averages constitute typical emissions for a particular EGU; they are averages that retain information about the typical temporal profile of emissions for that facility during a given season. Use of typical EGU emissions is one important difference between the base case and baseline inventories.

For on-road mobile source emissions within the 36/12/4 km domains, 2008 Vehicle Miles Travelled (VMT) were developed by interpolating between the 2006 VMT developed for the base case modeling and VISTAS 2009 VMT. 2005 and 2006 MM5 meteorological data were used with the SMOKE-MOBILE6 processor to generate the gridded speciated day-of-week emissions required as input to CAMx. For each month, emissions were generated for a representative weekday, Saturday and Sunday in 2008. Holidays were treated as Sundays.

Carter Lake and ENVIRON developed a 2008 emission inventory for Wyoming oil and gas sources. A detailed emission inventory was prepared for the 5-county area of southwest Wyoming that is similar in scope to the 2005-6 southwest Wyoming oil and gas inventory. The 2008 5-county southwest Wyoming inventory was developed using the oil and gas emissions information available from the Wyoming 2008 inventory and from operator provided emissions assumptions. For oil and gas sources in Wyoming outside the 5-county area of southwest Wyoming emissions were developed from the Wyoming 2008 point source inventory and from available WRAP inventories. In order to be consistent with future year emission inventories, drill rig emissions were annualized rather than reported by month, as was done for the 2005-6 base case emission inventory. Emissions for oil and gas sources within the 12 km domain but outside Wyoming were estimated through interpolation of the 2006 and 2012 WRAP Phase III inventory where possible and through interpolation of the 2005 and 2018 WRAP Phase II inventories elsewhere.

For the 2008 baseline simulations using 2005 and 2006 meteorology, the corresponding 2005 and 2006 emission inventories for wildfires, wind-blown dust, biogenics, and ammonia were used. As noted above, the 2008 baseline emission inventory modeling was carried out so that emissions source categories selected by the WDEQ AQD were processed separately so that they could be run as separate emissions source groups in the CAMx probing tools.

The WDEQ-AQD reviewed the 2008 baseline emission inventory and approved the use of the inventory for the CD-C 2008 baseline modeling (Personal Communication from Kelly Bott, WDEQ-AQD, July 7, 2010).

1.2.5. Model Configuration

CAMx was configured for the 2008 baseline runs in a manner essentially similar to the 2005-6 base case modeling. The model was run on the 36/12/4 km domains shown in Figures 1-1 through 1-3 and the same 34 layer vertical structure (with no collapsing of meteorological model layers) used in the base case model was used again in the baseline modeling. An important difference from the base case modeling is that a new version of CAMx was used that corrects a model error introduced when the vertical velocity algorithm was updated in 2009 to reduce excessive vertical transport. This error did not affect the core model results that were relied upon in the model performance evaluation, but made the source apportionment results unreliable. The problem was resolved in CAMx v5.30, which was used in the 2008 baseline modeling. The model configuration for the 2008 baseline modeling is summarized in Table 1-1 below.

Table 1-1. CAMx air quality model configuration for the CD-C 2008 baseline simulation.

Science Options	CD-C Baseline Configuration
Model Code	CAMx V5.30 with Vertical Velocity Update
Horizontal Grid Mesh	36/12/4 km
36 km grid	148 x 112 cells
12 km grid	89 x 68 cells
4 km grid	119 x 101 cells
Vertical Grid Mesh	34 Layers
Grid Interaction	One-way 36/12 km Two-Way 12/4 km
Initial Conditions	~10 days full spin-up
Boundary Conditions	Day-specific 2005 and 2006 3-hourly GEOS-CHEM w/ 2002 GEOS-Chem monthly average for PM species
Emissions	
Baseline Emissions Processing	SMOKE V2.4
NH3 Inventory	WRAP Ammonia Model with updated seasonal adjustments
Chemistry	
Gas Phase Chemistry	CB05
Aerosol Chemistry	ISORROPIA
Mineral Nitrate	Yes
Secondary Organic Aerosols	SOAP
Aqueous Chemistry	RADM
Meteorological Processor	MM5CAMx
Horizontal Transport	
Eddy Diffusivity Scheme	K-theory with Kh grid size dependence
Vertical Transport	
Advection Scheme	Vertical Velocity Update
Eddy Diffusivity Scheme	CMAQ-like

Science Options	CD-C Baseline Configuration
Diffusivity Lower Limit	Kzmin = 0.1 to 2.0 w/ kv100
Dry Deposition Scheme	Zhang
Numerics	
Gas Phase Chemistry Solver	Euler Backward Iterative (EBI) solver
Horizontal Advection Scheme	PPM)
Simulation Periods	2005 and 2006 using 2008 emissions
Integration Time Step	Determined by met conditions

1.3. APPENDIX ORGANIZATION

This Appendix presents results of the CD-C 2008 baseline CAMx runs. In Section 2, we evaluate regional ozone levels under a 2008 emissions scenario with 2005 and 2006 meteorology and quantify the ozone contribution of CD-C Project Area emissions sources. In Section 3, we summarize the impacts at the distant Prevention of Significant (PSD) Class I areas and sensitive Class II areas, which include AQRV impacts, (visibility, nitrogen and sulfur deposition and sensitive lake acidity), and impacts to PSD increments. In Section 4, we present an evaluation of the modeling results for criteria pollutants other than ozone: NO_2, SO_2, CO, $PM_{2.5}$, and PM_{10}. In Section 5, we provide a summary of the results of the CD-C 2008 baseline modeling.

2.0. OZONE IMPACT ANALYSIS

2.1. INTRODUCTION

The CAMx modeling outputs from the two annual simulations using 2008 emissions and 2005 and 2006 meteorology were post-processed to derive ozone concentrations for comparison to the ambient air quality standards (WAAQS, CAAQS and NAAQS) across the 4 km domain, including each far-field sensitive area. In Section 2, we present CAMx modeling results for comparison with the applicable air quality standards in two ways:

1. following EPA's modeling guidance for projecting current-year Design Values for criteria pollutants that are compared against the NAAQS, WAAQS and CAAQS (EPA, 2007); and
2. using the absolute modeling results that are averaged in accordance with the form of the standard and then compared directly with NAAQS, WAAQS and CAAQS.

EPA has developed guidance for modeled attainment tests for both ozone and $PM_{2.5}$. CAMx 2008 baseline run ozone was analyzed using the EPA (2007) guidance, but insufficient monitoring data were available within the 4 km domain for projection of $PM_{2.5}$, so $PM_{2.5}$ was not evaluated using method (1). Method (2), the evaluation of absolute modeling results against the ambient air quality standards, was carried out for the following criteria air pollutants: NO_2, SO_2, $PM_{2.5}$, PM_{10}, ozone and CO. The evaluation of ozone is presented in this section, and the evaluation of the remaining criteria pollutants is presented in Section 4.

In method (1), 2008 ozone concentrations for the 2005 and 2006 meteorological years were projected using procedures in EPA's latest modeling guidance (EPA, 2007c). An overview of the EPA method is given in the next section. These procedures use the modeling results together with observed ozone design values to derive an interpolated current year ozone design value field which can then be compared to the NAAQS, which are identical to or more stringent than the CAAQS and WAAQS for 8-hour ozone." Wyoming has not revised the standard for 8-hour ozone, and still retains the standard of 0.08 ppm. In method (2), the 4^{th} high daily maximum 8-hour ozone was calculated for each grid cell for both 2005 and 2006, and then the 2005 and 2006 results were averaged and compared to the results of method (1) and the NAAQS.

For days and locations in which the absolute model-estimated daily maximum 8-hour ozone concentrations or observed 2005-6 daily maximum 8-hour ozone concentrations exceeded a threshold, the CAMx APCA ozone source apportionment contributions were used to estimate the contribution of emissions from 2008 existing CD-C project emissions sources to the exceedances of that threshold. Several thresholds were used to examine the CD-C Project contribution to high modeled and observed ozone: the 2008 ozone standard (75 ppb) and two values (60 ppb and70 ppb) that bracket the 60-70 ppb range of the NAAQS proposed by EPA in January, 2010. The modeling results were evaluated in light of the 2008 NAAQS of 75 ppb that was in effect at the time of the CD-C Baseline simulation.

2.2. EPA GUIDANCE OZONE PROJECTION APPROACH

The ozone NAAQS are formulated in terms of a Design Value, which is calculated as the 3-year average of the fourth highest monitored daily maximum 8-hour concentration at each monitoring site. To attain the 2008 ozone standard, the Design Value for a given monitor must not exceed 75 ppb. EPA's modeling guidance (EPA, 2007) for projecting future year 8-hour ozone Design Values recommends the use of modeling results in a relative sense to scale the observed current year 8-hour ozone Design Value (DVC) to obtain a future year 8-hour ozone Design Value (DVF). The model-derived scaling factors are referred to as Relative Response Factors (RRF) and are defined as the ratio of daily maximum 8-hour ozone concentrations near a monitor averaged over several days of modeling results for the future year emissions scenario to the current year base case:

$$RRF_{monitor\ i} = \frac{\sum_{days}\left(daily\ \max\ 8-hour\ ozone\right)_{future\ year}}{\sum_{days}\left(daily\ \max\ 8-hour\ ozone\right)_{current\ year}}$$

$$DVF_{monitor\ i} = DVC_{monitor\ i} \times RRF_{monitor\ i}$$

This technique is used to minimize the effect of model uncertainty on future year ozone projections. For example, if the model has a bias toward underestimating ozone at a given monitor, using the raw future year ozone predictions may result in an underestimate of future year ozone at that monitor. However, if the ratio of the future year to base year modeled ozone values at that monitor is multiplied by the observed base year design value to produce a predicted future year value, that future year value will better reflect the change in ozone due to changes in emissions between base and future year cases, and the effect of the model's bias toward lower ozone values will have been reduced.

For the CD-C 2008 baseline modeling, DVCs were calculated for comparison with the 2008 NAAQS of 75 ppb and these results are presented later in this Section. The 2008 DVCs will also be used as the basis for the CD-C Project impact analysis once the CD-C future year modeling runs are completed. The model output from the future year CAMx runs that include the CD-C Project will be used to construct the RRFs, which will then be used with the DVCs calculated using the 2008 baseline run to produce DVFs for the future. The DVFs will be used to evaluate future year compliance with the 2008 ozone NAAQS. Below, we describe the EPA guidance for performing these DVC and future year calculations as well as the procedure for calculating the 2008 DVC across the entire modeling domain based on the DVCs at the monitors.

The basic steps in performing future year 8-hour ozone projections using EPA's recommended projection approach are summarized as follows:

1. Develop observed current year 8-hour ozone Design Values (DVC) at each monitoring site as the starting point for the ozone projections. EPA guidance recommends using a three year average of three consecutive years of Design Values centered on the modeling year. For the CD-C modeling, this means Design Values from the five year period of 2006-2010 are required to calculate the observed DVCs for the 2008 modeling year.
2. Select the maximum modeled 8-hour ozone concentrations near a monitor for several days from the base year and future year emission scenarios and take the ratio of their averages to construct the monitor-specific RRFs:

a. EPA guidance defines “near a monitor” to be an array of 7 x 7 grid cells centered on the monitoring location for modeling that uses a 4 km grid resolution as in the CD-C modeling.

b. EPA recommends that RRFs be based on at least 10 modeled days and recommends selecting days in which the base year base case maximum daily (i.e. 2005-6 for the CD-C modeling) maximum 8-hour ozone concentrations near a monitor are greater than an ozone threshold (cut off). This is done so that the model response to future changes in emissions is considered only on high ozone days with conditions comparable to those days that produced the design values. Initially, an ozone threshold of 85 ppb is used. If less than 10 modeling days are obtained the threshold is reduced by 1 ppb until at least 10 days are obtained for the RRF. When the 70 ppb threshold floor is reached and there are at least 5 days then the RRF is used. In the CD-C 4 km modeling domain, many sites did not meet this 5 day minimum. To ensure that the greatest number of monitors possible were used to constrain the DVC field, this requirement was relaxed so that the minimum number of days above the threshold was 1 day.

- Note that this modeling day selection approach for the RRFs automatically eliminates using modeling days in which the model is greatly underestimating the observed ozone concentrations when constructing the RRFs.

3. The RRF is applied to the DVC to obtain the projected DVF at each monitoring site for the future year emission scenarios. The projected DVF is truncated to the nearest ppb.
4. If the future year ozone projections are carried out as part of an attainment demonstration, DVFs are compared with the NAAQS for ozone. If the DVFs at all monitoring sites are less than or equal to the ozone NAAQS, then the modeled attainment demonstration test is passed. If a DVF at any monitor exceeds the ozone NAAQS, the modeled attainment test is not passed. [Note that the current EPA guidance (EPA, 2007) addresses the 84 ppb 8-hour ozone NAAQS and we address the 2008 8-hour ozone NAAQS of 75 ppb that was in effect at the time of the CD-C baseline modeling].
5. The method of projecting future year design values discussed above applies only to grid cells containing monitors, and it is necessary to project future ozone values for areas in the domain that lie between the monitors. This is known as an unmonitored area analysis and is performed by interpolating DVCs from monitoring sites to each grid cell in the modeling domain using the Voronoi Neighbor Averaging technique. The modeled ozone gradients are taken into account in the interpolation in order to reflect modeled higher and lower ozone areas in the interpolated DVC field.

An unmonitored area analysis was performed that interpolates the 2008 DVCs across the modeling domain and performs ozone projections in each grid cell using the procedures given above, except using the modeling results within each grid cell only rather than using the surrounding grid cells in addition to the grid cell itself. For the CD-C 2008 DVC ozone calculations, the unmonitored area analysis is important given the paucity of ozone observations in the region. EPA provides two caveats to be considered when interpreting an unmonitored area analysis:

a. EPA believes that the unmonitored area analysis is more uncertain than the monitor-based ozone projections. EPA indicates that additional emissions reductions are likely required to eliminate any projected monitored ozone exceedances, while the same is not true in the unmonitored area test.

b. EPA recommends that the reasons behind any unmonitored area test exceedances be understood and explained.

To facilitate the implementation of EPA's recommended ozone projections approach, EPA has developed the Modeled Attainment Test Software (MATS; Abt, 2009) that codifies the EPA recommended projection approach. EPA's MATS tool includes observed ozone data from which DVCs can be calculated along with several options that can be specified in making the ozone projections.

2.2.1. Issues Associated with Applying EPA's MATS Procedures to Southwest Wyoming

There are several issues associated with using the EPA-recommended ozone projection procedure for making future year projections in southwestern (SW) Wyoming. These issues are primarily related to the fact that EPA's procedures were designed for making projections for ozone State Implementation Planning (SIP) modeling that in the past occurred primarily in urban areas where there are relatively dense monitoring networks for ozone. The MATS software includes ozone design value data that is used to construct DVCs for monitors in the region of interest. The monitoring network is relatively sparse in SW Wyoming (see Table 2-1 and Figure 2-1) and for many of these monitors, the monitoring history is relatively short. For example, many of the WDEQ SW Wyoming industrial monitoring sites started operation from late 2004 through 2007 and therefore may not have the five year record needed to construct the EPA default DVCs. For CD-C, the EPA projection procedure was therefore adapted to use additional available data to construct the DVC field for the 2008 baseline modeling.

In addition to the scarcity of monitoring data and the short data record for some SW Wyoming monitors, another issue that needs to be addressed in making the DVC calculations projections is the portion of the calendar year to be included in the analysis. The WDEQ-AQD has determined that the simulation of winter ozone is a research area that is not appropriate for inclusion in a NEPA analysis. Therefore, winter ozone will not be analyzed as part of the CD-C EIS. However, ozone Design Values are based on the three-year average of the annual fourth highest daily maximum 8-hour ozone concentrations that, by definition, include the high winter ozone concentrations for the affected monitors. In developing the 2008 DVC values, we have used data for the full year in calculating the DVCs at the monitors. This ensures that the calculations for the enhanced MATS (EMATS) sites are consistent with those from the base MATS (BMATS) sites (which are included with the EPA MATS tool and which use data for the full year). However, for the unmonitored areas (i.e. grid cells that do not contain a monitor), the model output-based gradients that were used to interpolate ozone design values between monitors use data from the April 1-October 31 ozone season only.

2.2.2. Enhanced Ozone Projection Approach

In order to address the issues noted in the previous section, the following approach was used to develop 2008 DVCs in the 4 km CD-C domain for evaluation against the NAAQS. The DVC was calculated in two ways: the first method uses only the DVC data included with the MATS tool (BMATS sites in Table 2-1) and the second method relaxes requirements regarding length of data record and includes additional WDEQ industrial monitors and CASTNet monitoring sites in the analysis. These additional monitors are listed as EMATS sites in Table 2-1. In the discussion to follow, we refer to these two methods as the BMATS and EMATS methods. Note that the EMATS method uses both BMATS and EMATS monitors listed in Table 2-1, while the BMATS method uses only the BMATS monitors shaded in blue in Table 2-1. Both the EMATS and BMATS site DVCs are calculated using data from the full year, but in unmonitored grid cells, both methods use modeling results from April 1-October 31 in the to derive DVCs based on the MATS interpolation procedure that uses gradients in the modeled ozone output.

Table 2-1. Monitors used in the 2008 CD-C Baseline modeling analysis. Three-year average design value (DVC) data used in base MATS (BMATS; blue color) and enhanced MATS (EMATS; green color) for the CD-C 4 km modeling domain.

Site ID	SiteName	State	County	LAT	LONG	3-year average DV 2007	3-year average DV 2008	Data Available for DV Calculcation
080690007	Rocky MTN NP	CO	Larimer	40.277	-105.545	76	74	2006-2009
560350098	Jonah	WY	Sublette	42.429	-109.696	73	75	2006-2007 and Jan 1- Sep 30, 2008
560350099	Boulder	WY	Sublette	42.721	-109.753	80	78	2006-2009
560350100	Daniel	WY	Sublette	42.793	-110.056	71	67	2006-2009
560370200	Wamsutter	WY	Sweetwater	41.678	-108.068	65	63	Mar 7 - Dec 31, 2006 and 2007-2009
560410101	Murphy Ridge	WY	Uinta	41.373	-111.042	67	64	2007-2009
CNT169	Centennial	WY	Albany	41.364	-106.240	68	67	2006-2009
PND165	Pinedale	WY	Sublette	42.929	-109.788	66	64	2006-2009
ROM206	Rocky Mtn NP Collocated	CO	Larimer	40.278	-105.545	77	71	2006-2009
ROM406	Rocky Mtn NP	CO	Larimer	40.278	-105.545	76	74	2006-2009
560130099	South Pass	WY	Fremont	42.528	-108.720	68	72	Mar 15 - Dec 31, 2007 and 2008 - 2009
560070099	Atlantic Rim	WY	Carbon	41.536	-107.546	73	61	2008 and Jan 1 - Feb 24, 2009
560070100	Sun Dog	WY	Carbon	41.397	-107.619	No Data	46	Nov 1 - Dec 31, 2009-Site not used in MATS
560130232	Spring Creek	WY	Fremont	43.082	-107.549	No Data	59	Feb 6 - Dec 31, 2009
560370898	OCI	WY	Sweetwater	41.737	-109.639	69	66	2007-2008 and Jan 1 - Sep 30, 2009

Note DV year represents the middle year, e.g. 2008 representing 2007-2009.

The Sun Dog monitor was not used in the EMATS analysis due to its short 2009 data record that included only winter months, but is included in this table because it is used in the source apportionment analysis discussed later in this section.

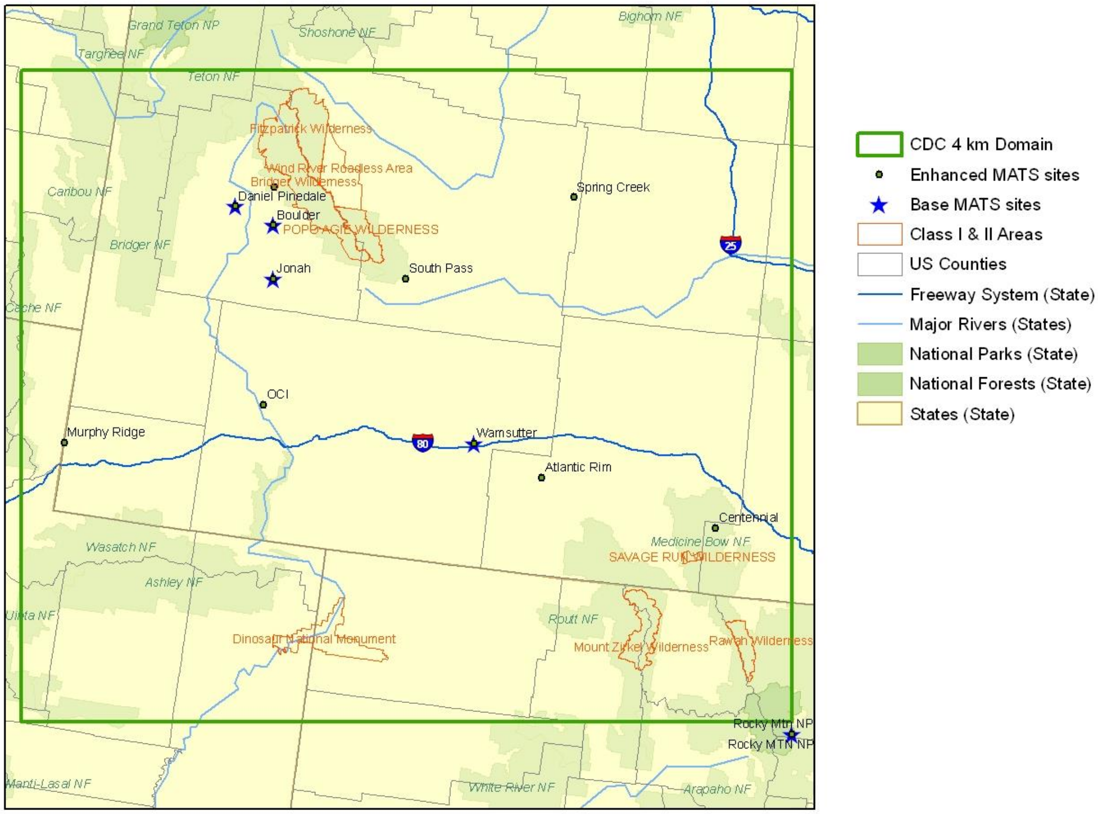


Figure 2-1. Southwest Wyoming ozone monitors used in the Enhanced and Base MATS analyses.

2.3. MATS MODELING RESULTS

In this section, we present MATS current year Design Values (DVC) using CAMx results for the 2008 emissions scenario with 2005 and 2006 meteorology in order to compare with the 2008 ozone NAAQS of 0.075 ppm (75 ppb). An 8-hour ozone Design Value attains the NAAQS if it is 75 ppb or lower. As 8-hour ozone Design Values are expressed to the nearest ppb and the EPA convention is to truncate to the nearest ppb, then exceedances of the 8-hour ozone NAAQS occur when ozone is 76.0 ppb or higher and attainment is achieved with 8-hour ozone Design Values of 75.9 ppb or lower. We also evaluate the MATS results in light of EPA's January 2010 announcement that they plan to lower the NAAQS to be within the 60-70 ppb range.

Figure 2-2 shows the BMATS design values for all grid cells in the 4 km domain for the 2005 meteorological year. In the BMATS configuration, there are very few monitoring stations within the 4 km domain. The BMATS results show values higher than the 2008 NAAQS (75 ppb) in a region extending from the Salt Lake City metropolitan area northward through Uinta, Lincoln and Sweetwater Counties up into in Sublette and Fremont Counties. This broad region of high DVCs is in part due to the interpolation of high ozone of the Salt Lake City area to the northeast into SW Wyoming. The DVC values also exceed 75 ppb in the southeastern corner of the domain in the Fort Collins, Colorado metropolitan area that lies within the Denver/North Front Range ozone nonattainment area. DVCs exceed 60 ppb everywhere within the 4 km domain, and the DVCs exceed 70 ppb across most of the western half of the domain as well as in the Fort Collins area.

When additional EMATS sites are used in the analysis (Figure 2-3), they supply additional data and prevent high urban ozone values from being interpolated into rural areas of SW Wyoming. Generally lower ozone is projected in EMATS as compared to BMATS. Only a few grid cells in the Fort Collins, CO area exceed the 75 ppb ozone standard in the BMATS figure. The EMATS figure shows that the design values for parts of Sublette, Sweetwater, Fremont, Uinta and Lincoln Counties exceed 65 ppb and/or 70 ppb and that most of SW Wyoming exceeds 60 ppb. The region where the 70 ppb threshold is exceeded is far smaller in the EMATS case than in the BMATS case.

The BMATS plot for the 2006 meteorological year (Figure 2-4) shows lower ozone over the Salt Lake City area and in Lincoln, Sweetwater and Uinta Counties compared to the 2005 BMATS plot. The 2006 BMATS design values exceed the 75 ppb NAAQS in the Fort Collins, CO area and in Sublette, Fremont, and Lincoln Counties in Wyoming. In the 2006 EMATS plot, ozone is generally lower across the domain than in the 2006 BMATS plot. Comparison of the 2006 and 2005 EMATS plots shows that design values were generally higher domain-wide in 2006 and that peak ozone design values were higher in Sublette County in 2006 than in 2005. Parts of Sublette, Uinta, Sweetwater, Fremont and Lincoln Counties exceed 65 ppb and/or 70 ppb in the 2006 EMATS case, and design values across much of SW Wyoming exceed 60 ppb.

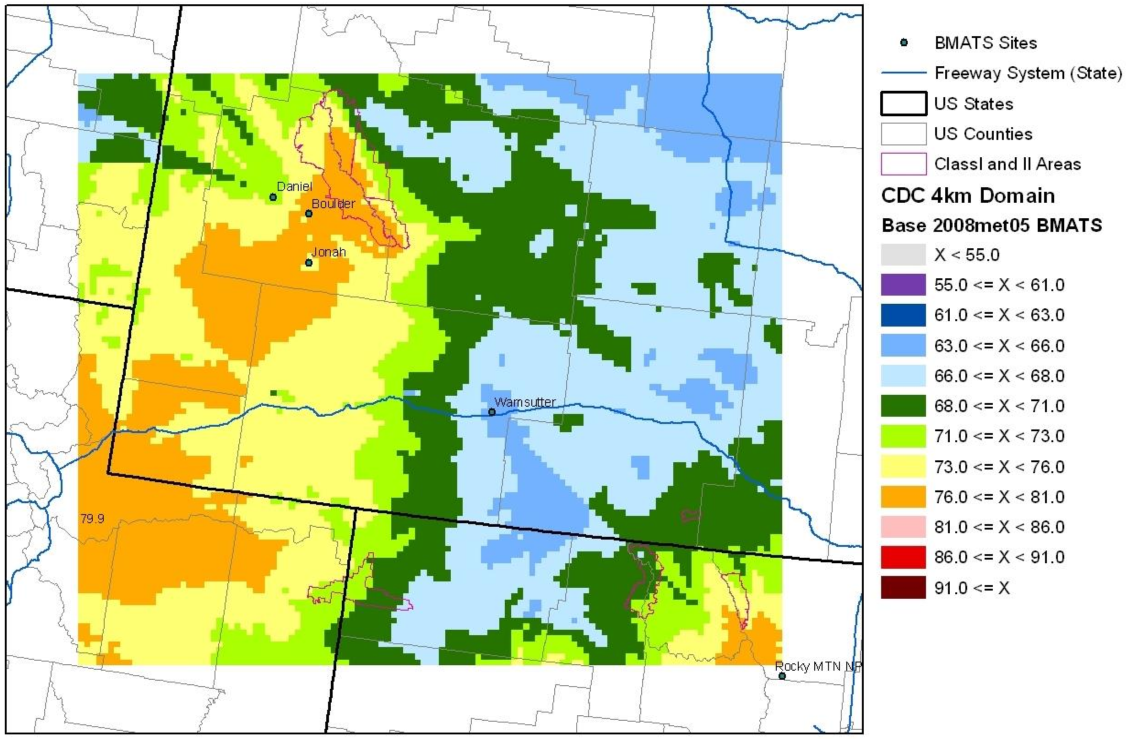


Figure 2-2. Base MATS (BMATS) DVCs for the 2008 emissions scenario using 2005 meteorology.

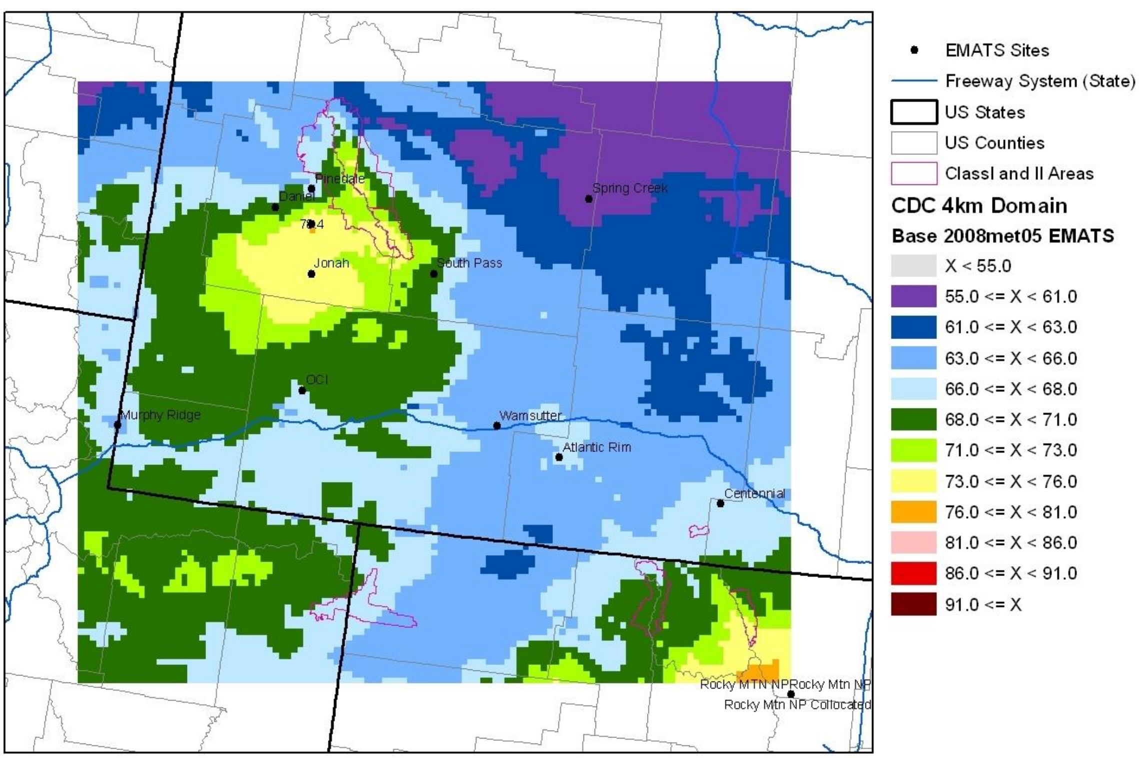


Figure 2-3. Enhanced MATS (EMATS) DVCs for the 2008 emissions scenario using 2005 meteorology.

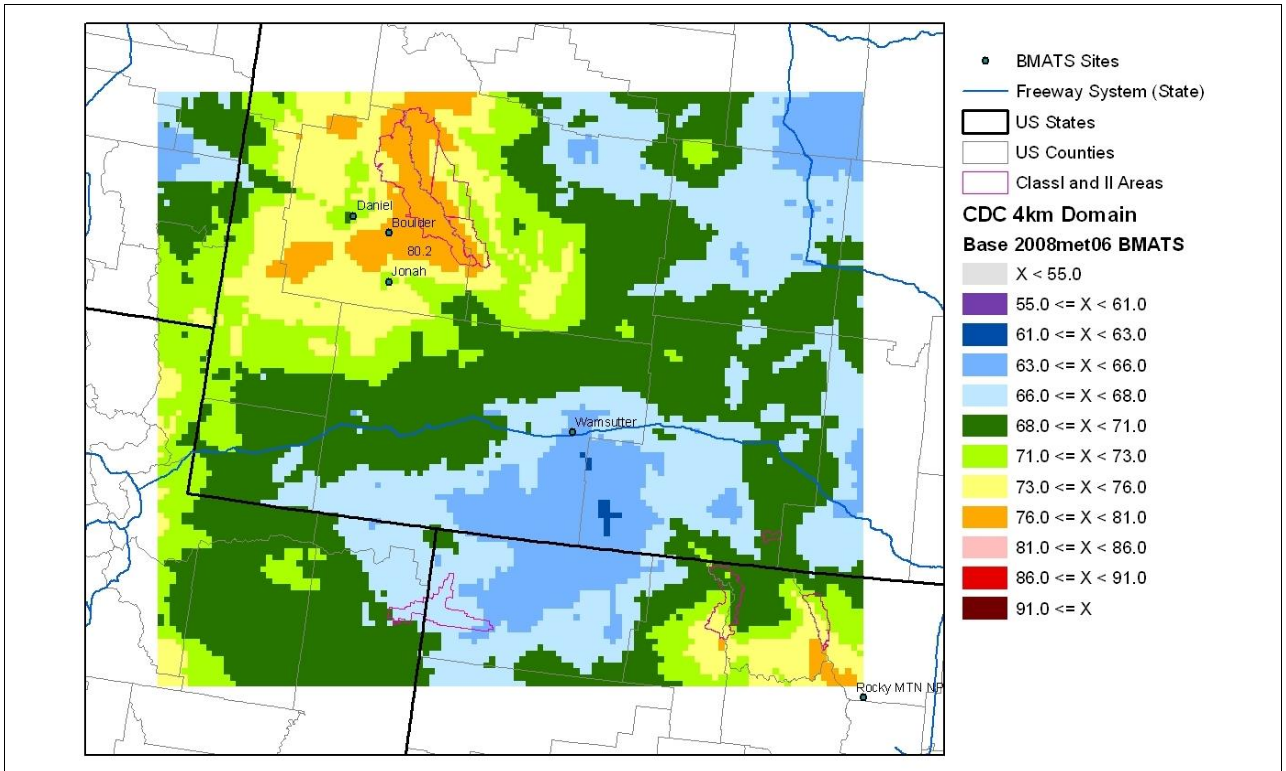


Figure 2-4. Base MATS (BMATS) DVCs for the 2008 emissions scenario using 2006 meteorology.

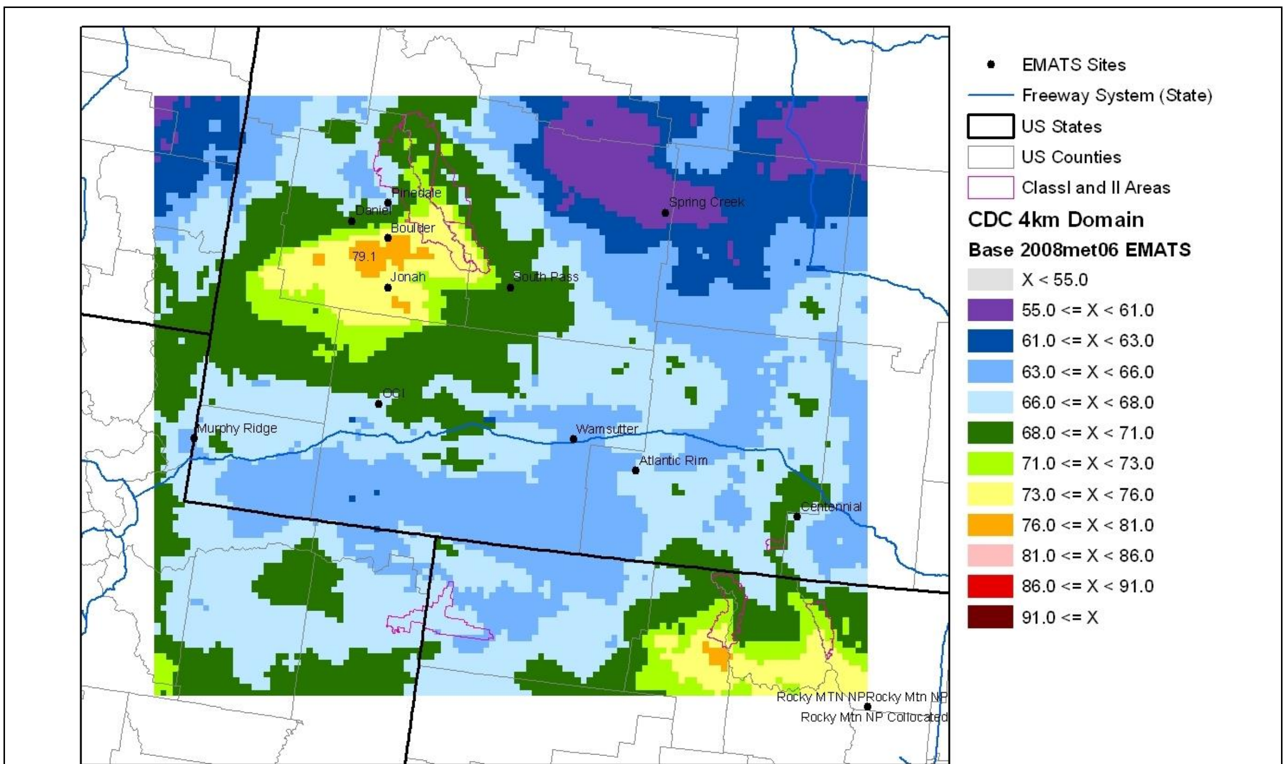


Figure 2-5. Enhanced MATS (EMATS) DVCs for the 2008 emissions scenario using 2006 meteorology.

2.4. ABSOLUTE MODELING RESULTS

In the previous section, the modeled ozone results were used together with the EPA MATS tool to calculate current year Design Values based on observed ozone at SW Wyoming monitors and gradients in the modeled ozone fields. In this section, we present the absolute (raw) modeling results. The 4th highest daily maximum 8-hour average was computed for each grid cell from the CAMx runs for both the 2005 and 2006 meteorological years. Only data from the Wyoming ozone season (April 1-October 31) were used in this calculation, per the WDEQ-AQD. This is consistent with the processing of the MATS results. Figure 2-6 shows the average of the results for the 2008 emissions scenario for 2005 and 2006 meteorological years. Figures 2-7 and 2-8 show the results for the individual 2005 and 2006 meteorological years, respectively. The 2005-6 average is an approximation to a Design Value produced with the absolute modeling results and is compared with the EMATS design values in Figures 2-3 and 2-5.

The absolute modeling results show two-year design values that are generally higher than the 2005 and 2006 EMATS DVCs across a larger swath of SW Wyoming, but peak values in Sublette County are lower in the absolute modeling results than in the EMATS DVCs. Values in the Fort Collins area agree reasonably well, but the absolute modeling results are higher than the EMATS DVCs over the Salt Lake City area. The 2005-6 average absolute modeling results show that the 2008 NAAQS (75 ppb) are exceeded only in the Fort Collins and Salt Lake City areas. The full range of the proposed NAAQS of 60-70 ppb is exceeded throughout the 4 km domain in the absolute modeling results in Figure 2-6, while in the EMATS results for both 2005 and 2006, the northeastern portion of the domain has regions where the DVC falls below 60 ppb.

Observed ozone concentrations were generally higher in the 4 km domain during the 2006 meteorological year than in 2005, and this is reflected in the model results shown in Figures 2-7 and 2-8. Comparison of Figure 2-7 with Figure 2-2 and Figure 2-8 with Figure 2-4 shows the role that modeled gradients play in determining the BMATS DVC values, as the overall patterns of high and low ozone are similar in these figures. In the absolute modeling results shown in Figure 2-7 and 2-8, the 2008 NAAQS (75 ppb) are exceeded only in the Fort Collins and Salt Lake City areas in 2005 while in 2006, the 2008 NAAQS (75 ppb) is exceeded over broad areas of SW Wyoming. In both 2005 and 2006 meteorological years, the proposed range of the NAAQS of 60-70 ppb is exceeded everywhere within the 4 km domain in the absolute modeling results.

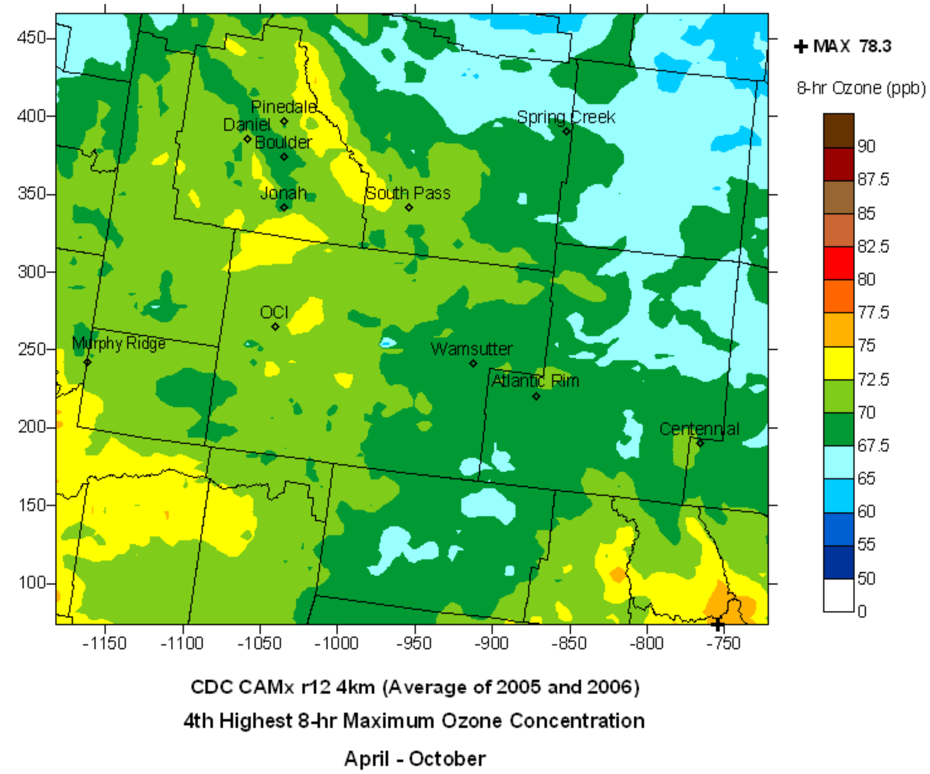


Figure 2-6. Two-year (2005-6) average of 4th highest daily max 8-hour average ozone concentration from the absolute CAMx modeling results.

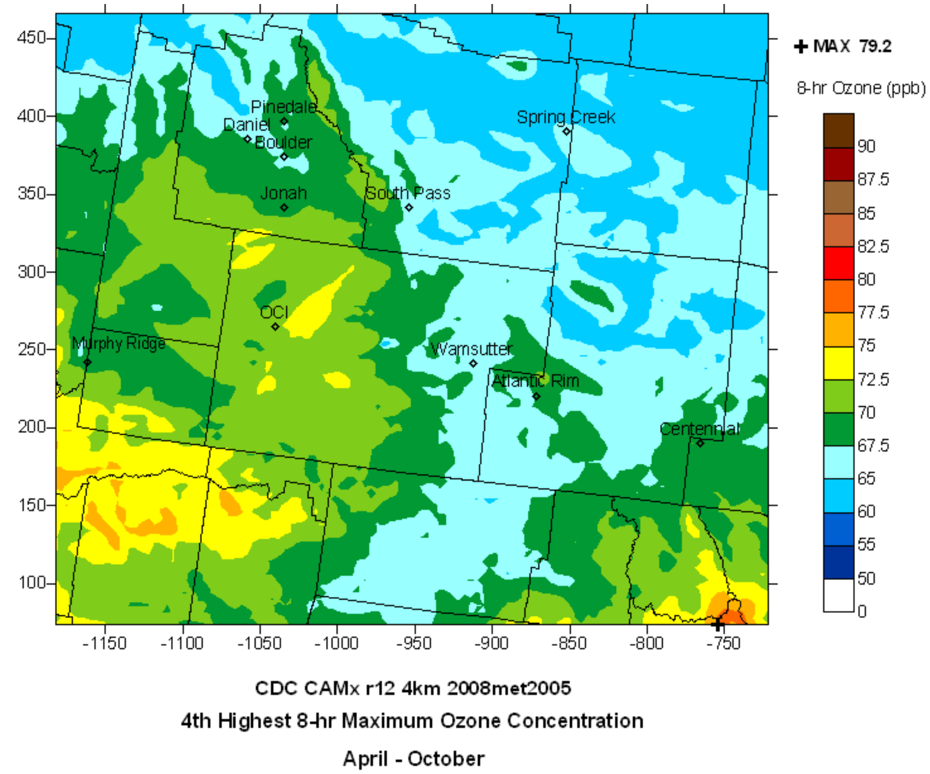


Figure 2-7. 4th highest daily max 8-hour average ozone concentration from the absolute CAMx modeling results for the 2005 meteorological year.

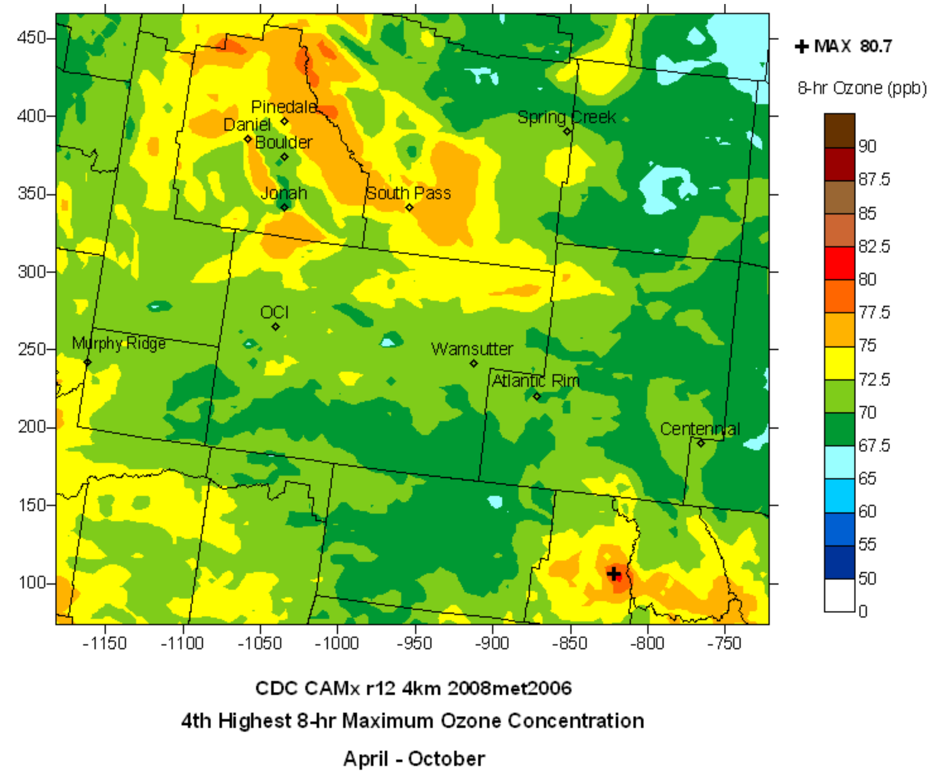


Figure 2-8. 4th highest daily max 8-hour average ozone concentration from the absolute CAMx modeling results for the 2006 meteorological year.

2.5. CD-C PROJECT OZONE CONTRIBUTIONS ON HIGH DAYS

Having analyzed the MATS ozone DV results and the absolute modeling results across the 4 km modeling domain, we now isolate the contribution of emissions from the CD-C Project to high ozone during the two year CAMx simulation. On days during the April 1-October 31 ozone season that had high observed and/or modeled 8-hour ozone at monitors within the 4 km domain, the contribution of CD-C Project area sources to 8-hour ozone at the monitors was determined.

We analyze results for days with high *observed* ozone at the monitors (Tables 2-2 through 2-4) as well as for days with high *modeled* ozone at the monitors (Tables 2-5 through 2-7). If model performance were perfect, so that the modeled ozone always matched the observed ozone, and all monitoring sites were operating during both meteorological years, there would be a need for only one set of tables. However, we include results for both high modeled and high observed days to account for the fact that the model may under- or overpredict ozone. Looking at the results for days with high modeled ozone also allows us to expand the analysis to sites where no monitor was present during that meteorological year (e.g. Wamsutter during 2005). We include results for both high observed and modeled ozone days in order to present a more complete view of the modeling results for CD-C project impacts.

The CAMx APCA ozone source apportionment results were used to isolate the CD-C Project area contribution to 8-hour ozone at each monitor and time. The contributions of both CD-C

Project and non-CD-C Project sources within the CD-C Project area were analyzed. The APCA ozone source apportionment results were also used to calculate the contribution of CD-C Project sources to the MATS design values shown in Figures 2-2 through 2-5.

2.5.1. Contribution of CD-C Project Area Sources to High Ozone at Monitors in the 4 km Domain

Table 2-2 shows the maximum ozone season 8-hour ozone impact at each 4 km domain monitor both as an absolute figure in ppb and as a percentage of the total daily maximum 8-hour average ozone (DM8) at that monitor on days when the observed DM8 > 60 ppb. For each monitor, the maximum value during the 2005 and 2006 meteorological years is shown, and the CD-C Project area contributions are broken down into contributions from CD-C Project and non-CD-C Project sources within the CD-C Project area. The upper left hand panel of Figure 2-9 shows the maximum value of the CD-C Project contribution to high ozone as a percentage of the DM8 during the 2005 and 2006 meteorological years. The percentages are identical to the data in Table 2-2 and are displayed on the map of the 4 km domain in order to illustrate graphically the spatial extent and magnitude of the CD-C Project ozone contribution on high ozone days. The maximum 8-hour ozone impact from CD-C project sources is 1.5 ppb at the Wamsutter monitor in 2006; this value is 2.7% of daily max 8-hour ozone (DM8) at Wamsutter. The maximum impact from non-CD-C sources within the CD-C Project area is 0.09 ppb, corresponding to 0.14% of the DM8 at Centennial during 2006. The largest CD-C impacts occurred within and east (generally downwind) of Project area, while impacts were far smaller in Sublette County, which was infrequently downwind of CD-C during 2006 (see 2006 modeled and observed wind roses for the Wamsutter monitor in the lower right panel of Figure 2-9).

On days when the DM8 at the monitors was higher than 70 ppb (Table 2-3; upper right panel of Figure 2-9), the maximum CD-C Project contributions were 0.08 at the Boulder monitor (0.11% of the modeled DM8) and 0.08 ppb at the Wamsutter monitor (0.13% of the modeled DM8), and the maximum contribution from non-CD-C Project sources within the CD-C Project area was less than 0.01 ppb (0.01% of the modeled DM8).

Only the Centennial, Pinedale and Jonah monitors had days in 2005 or 2006 where the DM8 at the monitors exceeded 75 ppb (Table 2-4; lower left hand panel of Figure 2-9). On these days, the maximum CD-C Project contribution was less than 0.01 ppb at all monitors and less than 0.01% of the modeled DM8 at all monitors.

Table 2-5 shows the maximum ozone season CD-C Project area impact on 8-hour ozone impact at each monitor both as an absolute figure in ppb and as a percentage of the total DM8 at that monitor on days when the modeled DM8 > 60 ppb. For each monitor, the maximum value during the 2005 and 2006 meteorological years is shown. The upper left hand panel of Figure 2-10 shows the maximum value of the CD-C Project contribution to high ozone as a percentage of the DM8 during the 2005 and 2006 meteorological years. The maximum 8-hour ozone impact from CD-C project sources is 2.3 ppb at the Spring Creek monitor in 2006; this value is 3.2% of the DM8 at Spring Creek. This impact occurred on April 22, 2006, and is the result of a southerly wind event which brought ozone from the CD-C Project northward into Fremont and Natrona Counties. HYSPLIT back trajectories using EDAS 40 km resolution meteorology indicate that there was southerly flow on this day (Figure 2-15; this event is discussed in more detail in the next section). Animations of the modeled ozone results (not shown) indicate that, during April 2006, there were several episodes of southerly winds that brought ozone and precursors from the CD-C Project area northward into Fremont and Natrona Counties. There were no similar periods during the rest of the ozone season in 2006 or during the 2005 ozone season. Note that the maximum CD-C Project impact at Spring Creek is less than 0.4 ppb in 2005.

The other monitors that showed impacts greater than 1 ppb when modeled DM8 > 60 ppb were Wamsutter (1.1 ppb; 1.7% of the DM8), Atlantic Rim (1.4 ppb; 2.2% of the DM8), and Sun Dog (1.6 ppb; 2.3% of the DM8). These three sites are located in the vicinity of the CD-C Project area (Figure 2-10). The CD-C Project contribution to high 8-hour ozone at Sublette County monitors was <0.1 ppb. Aside from the April 22, 2006 event, the largest CD-C impacts occurred within and east (generally downwind) of Project area; impacts were far smaller in Sublette County and in the Lincoln and Uinta Counties to the west of the Project area. The maximum impact from non-CDC sources within the CD-C Project area is 0.18 ppb, corresponding to 0.26% of the DM8 at Atlantic Rim during 2006.

On days when the modeled daily max 8-hour average ozone at the monitors was higher than 70 ppb (Table 2-6; upper right hand panel of Figure 2-10), the maximum CD-C Project contribution was 1.1 ppb at the Wamsutter monitor (1.4% of the modeled DM8), and the maximum contribution from non-CD-C Project sources within the CD-C Project area was 0.06 ppb (0.07% of the modeled DM8) at Sun Dog. Modeled and observed ozone were higher in 2006 than in 2005. Table 2-7 shows that there were no days in 2005 in which the DM8>75 ppb at any of the sites. The maximum CD-C Project contribution when modeled DM8>75 ppb was 1.1 ppb at the Wamsutter monitor (1.4% of the modeled DM8), and the maximum contribution from non-CD-C Project sources within the CD-C Project area was 0.06 ppb (0.07% of the modeled DM8) at Sun Dog.

Figures 2-9 and 2-10 show that the CD-C Project emissions sources contribute less than 3% to the DM8 on any modeled or observed high ozone day during the 2005-6 meteorological years and that aside from the April 22, 2006 event, the largest contributions occur at sites near the Project area. The CD-C Project has its highest contribution when the observed or modeled DM8 is less than 70 ppb. On the days when the observed or modeled ozone exceeded the 2008 75 ppb standard, the highest CD-C Project contribution was 1.4% of the DM8 at Wamsutter. Contributions from the CD-C Project to ozone in Sublette County have a maximum of 0.83% of the DM8 at Boulder when DM8 > 60 ppb. As the DM8 threshold is increased to 70 ppb, this peak contribution drops to 0.11% of the DM8, and then as the threshold moves to 75 ppb, the peak CD-C contribution is less than 0.01% for all Sublette County monitors.

Table 2-2. Contribution to modeled daily max 8-hour average ozone (DM8) at SW Wyoming monitors from CD-C Project and non-CDC Project sources of emissions within the CD-C Project Area on days when the observed DM8 > 60 ppb. Wamsutter was not operating in 2005.

Monitor	2008met2005				2008met2006			
	Max CDC	Max CDC	Max non-CDC	Max non-CDC	Max CDC	Max CDC	Max non-CDC	Max non-CDC
	Absolute (ppb)	%	Absolute (ppb)	%	Absolute (ppb)	%	Absolute (ppb)	%
Pinedale	0.0398	0.0687	0.0024	0.0038	0.0757	0.1171	0.0022	0.0033
Centennial	0.5974	1.0749	0.0355	0.0639	1.0750	1.8368	0.0922	0.1433
Jonah	0.2660	0.4362	0.0130	0.0213	0.1481	0.2281	0.0019	0.0033
Boulder	0.1945	0.3411	0.0104	0.0183	0.4456	0.8286	0.0242	0.0450
Daniel	0.1435	0.2544	0.0084	0.0148	0.0912	0.1437	0.0024	0.0037
Wamsutter	--	--	--	--	1.5410	2.6468	0.0708	0.1216
Max Overall	0.5974	1.0749	0.0355	0.0639	1.5410	2.6468	0.0922	0.1433

Table 2-3. Contribution to modeled daily max 8-hour average ozone (DM8) at SW Wyoming monitors from CD-C Project and non-CDC Project sources of emissions within the CD-C Project Area on days when the observed DM8 > 70 ppb. Sites that did not have DM8 > 70 ppb or were not operating during a given year are indicated by "-". Data for sites that had impacts < 0.00005 ppb or % impacts <0.00005% are shown in gray type.

Monitor	2008met2005				2008met2006			
	Max CDC	Max CDC	Max non-CDC	Max non-CDC	Max CDC	Max CDC	Max non-CDC	Max non-CDC
	Absolute (ppb)	%	Absolute (ppb)	%	Absolute (ppb)	%	Absolute (ppb)	%
Pinedale	0.0000	0.0000	0.0000	0.0000	0.0001	0.0002	0.0000	0.0000
Centennial	0.0026	0.0046	0.0008	0.0013	0.0215	0.0360	0.0072	0.0120
Jonah	0.0003	0.0007	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Boulder	0.0000	0.0000	0.0000	0.0000	0.0751	0.1108	0.0003	0.0005
Daniel	--	--	--	--	0.0001	0.0002	0.0000	0.0000
Wamsutter	--	--	--	--	0.0750	0.1329	0.0000	0.0001
Max Overall	0.0026	0.0046	0.0008	0.0013	0.0751	0.1329	0.0072	0.0120

Table 2-4. Contribution to modeled daily max 8-hour average ozone (DM8) at SW Wyoming monitors from CD-C Project and non-CDC Project sources of emissions within the CD-C Project Area on days when the observed DM8 > 75 ppb. Sites that did not have DM8 > 75 ppb or were not operating during a given year are indicated by "-". Data for sites that had impacts < 0.00005 ppb or % impacts <0.00005% are shown in gray type.

Monitor	2008met2005				2008met2006			
	Max CDC	Max CDC	Max non-CDC	Max non-CDC	Max CDC	Max CDC	Max non-CDC	Max non-CDC
	Absolute (ppb)	%	Absolute (ppb)	%	Absolute (ppb)	%	Absolute (ppb)	%
Pinedale	0.0000	0.0000	0.0000	0.0000	0.0001	0.0002	0.0000	0.0000
Centennial	0.0026	0.0046	0.0008	0.0013	--	--	--	--
Jonah	--	--	--	--	--	--	--	--
Boulder	--	--	--	--	0.0001	0.0002	0.0000	0.0000
Daniel	--	--	--	--	--	--	--	--
Wamsutter	--	--	--	--	--	--	--	--
Max Overall	0.0026	0.0046	0.0008	0.0013	0.0001	0.0002	0.0000	0.0000

60 ppb Threshold

70 ppb Threshold

75 ppb Threshold

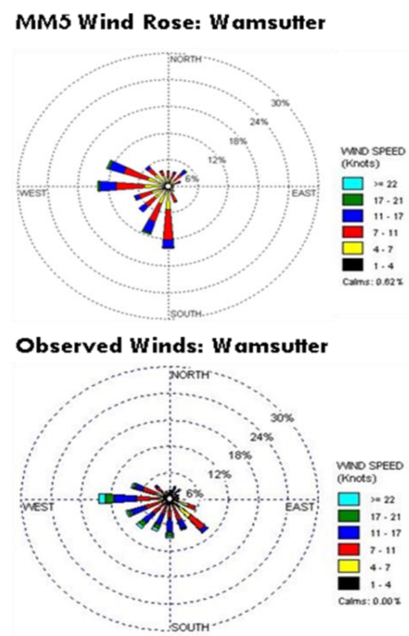


Figure 2-9. Maximum ozone season impact at each monitor as a percentage of total DM8 at the monitor when observed DM8 > 60 ppb during 2005-6. Values less than 0.01% of the DM8 are not shown. If no values are shown on the map, then no monitor had a contribution from the CD-C Project that exceeded 0.01% of the DM8. Lower right hand panel: Modeled MM5 Wind rose for 2006 for the grid cell containing the Wamsutter monitor (top) and observed wind rose for 2006 for the Wamsutter monitor (bottom).

Table 2-5. Contribution to modeled daily max 8-hour average ozone (DM8) at SW Wyoming monitors from CD-C Project and non-CDC Project sources of emissions within the CD-C Project Area on days when the modeled DM8 > 60 ppb. Sites that did not have DM8 > 60 ppb during a given year are indicated by "-". Data for sites that had impacts < 0.00005 ppb or % impacts <0.00005% are shown in gray type.

Monitor	2008met2005				2008met2006			
	Max CDC	Max CDC	Max non-CDC	Max non-CDC	Max CDC	Max CDC	Max non-CDC	Max non-CDC
	Absolute (ppb)	%	Absolute (ppb)	%	Absolute (ppb)	%	Absolute (ppb)	%
Pinedale	0.0373	0.0595	0.0024	0.0038	0.0757	0.1171	0.0022	0.0033
Centennial	0.4866	0.7884	0.0486	0.0733	0.6907	1.0351	0.0956	0.1433
OCI	0.2428	0.3886	0.0120	0.0191	0.3131	0.4874	0.0034	0.0054
Jonah	0.0000	0.0000	0.0000	0.0000	0.1481	0.2281	0.0007	0.0010
Boulder	0.0001	0.0001	0.0000	0.0000	0.0751	0.1108	0.0003	0.0005
Daniel	0.0001	0.0001	0.0000	0.0000	0.0912	0.1437	0.0024	0.0037
Wamsutter	0.8866	1.3506	0.0196	0.0299	1.1485	1.7117	0.0364	0.0527
Murphy Ridge	0.0564	0.0920	0.0043	0.0070	0.1169	0.1866	0.0124	0.0198
Caribou	0.0343	0.0558	0.0024	0.0039	0.1009	0.1454	0.0019	0.0027
Fremont	0.4060	0.5992	0.0075	0.0111	0.3519	0.5591	0.0040	0.0065
South Pass	0.0012	0.0016	0.0000	0.0000	0.2219	0.3319	0.0039	0.0058
Atlantic Rim	1.4208	2.1536	0.0830	0.1355	1.4353	2.0503	0.1763	0.2585
Moxa Arch	0.0491	0.0789	0.0028	0.0045	0.1961	0.3127	0.0092	0.0146
Hiawatha	0.0605	0.0867	0.0020	0.0031	0.3922	0.6237	0.0090	0.0140
Sun Dog	1.5657	2.3154	0.1407	0.2080	1.0177	1.6403	0.1587	0.2520
Spring Creek	0.3069	0.4637	0.0128	0.0194	2.2781	3.2388	0.0375	0.0532
Max Overall	1.5657	2.3154	0.1407	0.2080	2.2781	3.2388	0.1763	0.2585

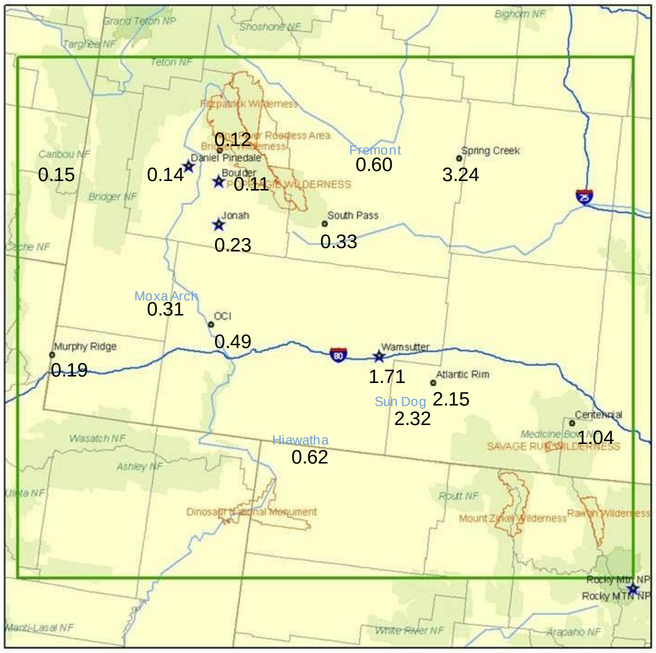
Table 2-6. Contribution to modeled daily max 8-hour average ozone (DM8) at SW Wyoming monitors from CD-C Project and non-CDC Project sources of emissions within the CD-C Project Area on days when the modeled DM8 > 70 ppb. Sites that did not have DM8 > 70 ppb during a given year are indicated by "-". Data for sites that had impacts < 0.00005 ppb or % impacts <0.00005% are shown in gray type.

Monitor	2008met2005				2008met2006			
	Max CDC	Max CDC	Max non-CDC	Max non-CDC	Max CDC	Max CDC	Max non-CDC	Max non-CDC
	Absolute (ppb)	%	Absolute (ppb)	%	Absolute (ppb)	%	Absolute (ppb)	%
Pinedale	0.0000	0.0000	0.0000	0.0000	0.0064	0.0089	0.0004	0.0005
Centennial	0.0769	0.1081	0.0041	0.0058	0.2279	0.3075	0.0359	0.0485
OCI	0.0000	0.0000	0.0000	0.0000	0.0002	0.0003	0.0000	0.0000
Jonah	0.0000	0.0000	0.0000	0.0000	0.0047	0.0063	0.0002	0.0002
Boulder	0.0000	0.0000	0.0000	0.0000	0.0028	0.0037	0.0002	0.0003
Daniel	0.0000	0.0000	0.0000	0.0000	0.0028	0.0037	0.0002	0.0003
Wamsutter	0.1198	0.1584	0.0034	0.0045	1.0588	1.3920	0.0193	0.0253
Murphy Ridge	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0000	0.0000
Caribou	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Fremont	--	--	--	--	0.0039	0.0053	0.0003	0.0005
South Pass	0.0000	0.0000	0.0000	0.0000	0.0045	0.0061	0.0001	0.0002
Atlantic Rim	0.1419	0.1967	0.0203	0.0279	0.5525	0.7282	0.0368	0.0485
Moxa Arch	0.0000	0.0000	0.0000	0.0000	0.0061	0.0080	0.0000	0.0001
Hiawatha	0.0153	0.0215	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Sun Dog	0.0611	0.0836	0.0089	0.0125	0.0561	0.0733	0.0555	0.0724
Spring Creek	--	--	--	--	0.0020	0.0028	0.0005	0.0007
Max Overall	0.1419	0.1967	0.0203	0.0279	1.0588	1.3920	0.0555	0.0724

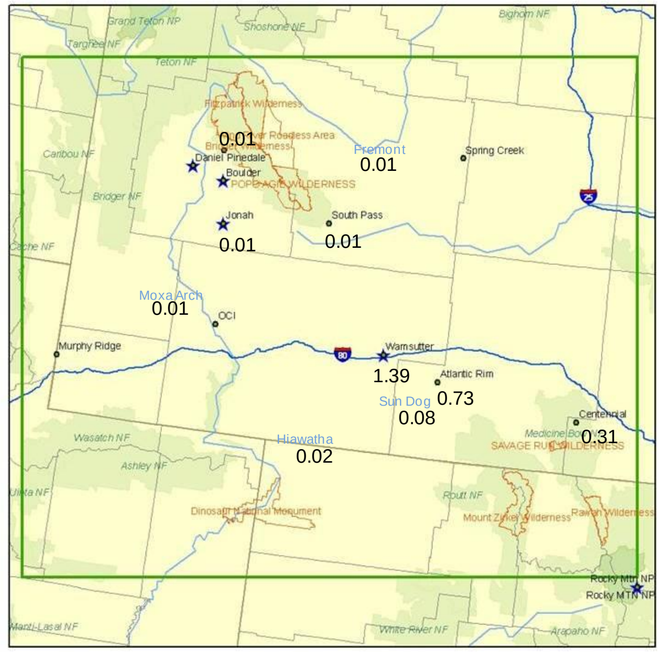
Table 2-7. Contribution to modeled daily max 8-hour average ozone (DM8) at SW Wyoming monitors from CD-C Project and non-CDC Project sources of emissions within the CD-C Project Area on days when the modeled DM8 > 75 ppb. Sites that did not have DM8 > 75 ppb during a given year are indicated by "-". Data for sites that had impacts < 0.00005 ppb or % impacts <0.00005% are shown in gray type.

Monitor	2008met2005				2008met2006			
	Max CDC Absolute (ppb)	Max CDC %	Max non-CDC Absolute (ppb)	Max non-CDC %	Max CDC Absolute (ppb)	Max CDC %	Max non-CDC Absolute (ppb)	Max non-CDC %
Pinedale	--	--	--	--	0.0003	0.0004	0.0002	0.0003
Centennial	--	--	--	--	--	--	--	--
OCI	--	--	--	--	0.0002	0.0003	0.0000	0.0000
Jonah	--	--	--	--	0.0012	0.0016	0.0002	0.0002
Boulder	--	--	--	--	0.0005	0.0007	0.0002	0.0003
Daniel	--	--	--	--	0.0011	0.0014	0.0002	0.0003
Wamsutter	--	--	--	--	1.0588	1.3920	0.0193	0.0253
Murphy Ridge	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001	0.0000	0.0000
Caribou	--	--	--	--	--	--	--	--
Fremont	--	--	--	--	--	--	--	--
South Pass	--	--	--	--	0.0009	0.0012	0.0001	0.0002
Atlantic Rim	--	--	--	--	--	--	--	--
Moxa Arch	0.0000	0.0000	0.0000	0.0000	0.0061	0.0080	0.0000	0.0001
Hiawatha	--	--	--	--	--	--	--	--
Sun Dog	--	--	--	--	0.0561	0.0733	0.0555	0.0724
Spring Creek	--	--	--	--	--	--	--	--
Max Overall	0.0000	0.0000	0.0000	0.0000	1.0588	1.3920	0.0555	0.0724

60 ppb Threshold



70 ppb Threshold



75 ppb Threshold

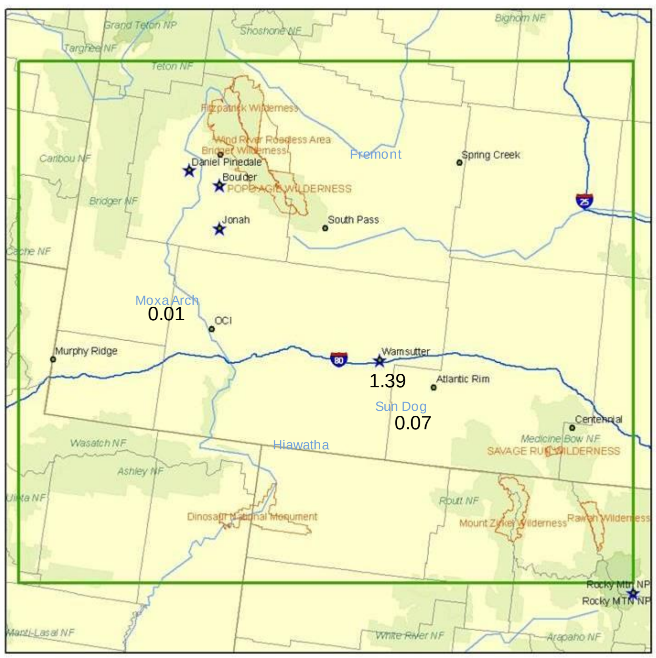


Figure 2-10. Maximum ozone season impact at each monitor as a percentage of total DM8 at the monitor when modeled DM8 > 60 ppb during 2005-6. Values less than 0.01% of the DM8 are not shown. If no values are shown on the map, then no monitor had a contribution from the CD-C Project that exceeded 0.01% of the DM8.

2.6. CONTRIBUTION OF CD-C PROJECT SOURCES TO MATS 2008 DVC RESULTS

Next, we assess the effect of CD-C Project area emissions sources on 2008 ozone Design Values within the 4 km domain using EPA's MATS tool. The base case EMATS and BMATS results obtained using all sources of emissions within the 4 km domain are shown in Figures 2-2 through 2-5. A second set of MATS results was generated by subtracting the CD-C Project APCA contribution from the CAMx output 8-hour ozone averages and then running MATS on the resulting ozone field. If we subtract the MATS results without the CD-C Project contribution from the MATS results in the base cases shown in Figures 2-2 through 2-5, we obtain the CD-C contribution to the 2008 DVC. This procedure was carried out for both the EMATS and BMATS results, and the results are shown in Figures 2-11 through 2-14.

The CD-C Project 2008 DVC contribution for the BMATS case run with 2005 meteorology is shown in Figure 2-11. The ozone DVCs increase within the CD-C Project area and in its immediate vicinity due to the contribution of CD-C Project emissions. The maximum increase in the Design Value due to CD-C Project emissions is 0.4 ppb. In the EMATS case run with 2005 meteorology (Figure 2-12), increases in the DVC due to CD-C Project emissions occur within and near the CD-C Project area, with maximum value of 0.4 ppb, as in the 2005 BMATS case. In the EMATS case, some apparent ozone Design Value reductions occur in Sweetwater and Carbon counties and south of the Wyoming-Colorado border. These negative values are likely a numerical artifact introduced via the interpolation procedure and their peak value, -0.2 ppb, may serve as an estimate of uncertainty in the CD-C Project MATS design value impact analysis. Therefore, we estimate that there is noise of approximately 0.1-0.2 ppb introduced into this procedure by the interpolation, so that a more realistic estimate of the CD-C ozone design value contribution would be ~0.1-0.2 ppb during the 2005 meteorological year.

For the 2006 meteorological year, the CD-C Project ozone DVC impacts calculated using the BMATS differences are shown in Figure 2-13. The largest increase in the Design Value due to CD-C Project emissions is 0.6 ppb. The highest values occur in the CD-C Project area and in a plume extending to the east of the Project area as well as two maxima in Fremont and Natrona Counties. The Fremont and Natrona maxima are due to the April 22, 2006 event in which southerly winds transported air from the CD-C Project area northward into these counties. Note that there are no such maxima in the 2005 results shown in Figures 2-11 and 2-12. Figure 2-15 displays the 2006 BMATS DVCs alongside the absolute 1-hour CAMx ozone concentrations for 3 pm on April 22, 2006 the CD-C Project APCA ozone contribution for this time. The correspondence between the APCA contribution and the DVC signal is clear. In the lower panel of Figure 2-15, we show trajectory analyses generated using NOAA's HYSPLIT model (Draxler et al., 1997) run with 40 km EDAS meteorological data. Forward trajectories beginning at the Wamsutter monitor on the morning of April 22, 2006 show northward flow toward Fremont/Natrona. Longer back trajectories ending in the Spring Creek area on the afternoon of April 22, 2006 indicate that the wind flow was from the south-southwest. While these trajectories must be interpreted with caution given the limitations of the HYSPLIT model and the coarse resolution of the EDAS meteorology, they suggest that the model's transport of ozone/precursors from the CD-C project northward to Fremont/Natrona Counties is not unreasonable. Animations of the CAMx ozone outputs show that ozone precursors were transported northward overnight and that high ozone formed in situ in Fremont Natrona after sunrise on April 22; this fact, together with the fact the MATS isolates high ozone values, is why the high DVCs in Fremont and Natrona appear isolated and are not associated with a plume extending northward from the CD-C Project area.

As in 2005, there are apparent decreases in the 2006 DVC that are likely to be numerical artifacts; the peak negative value is 0.2 ppb, indicating an uncertainty of 0.2 ppb, so that the increase in design values due to CD-C Project sources within the 4 km domain can be taken to be ~0.4 ppb or less. The 2006 EMATS DVCs are similar in pattern to the 2006 BMATS DVCs, with slightly smaller magnitude; the peak increase is 0.5 ppb for the EMATS case. In summary, the peak increase in design value during the 2005-6 meteorological years due to the CD-C Project emissions is approximately 0.4 ppb.

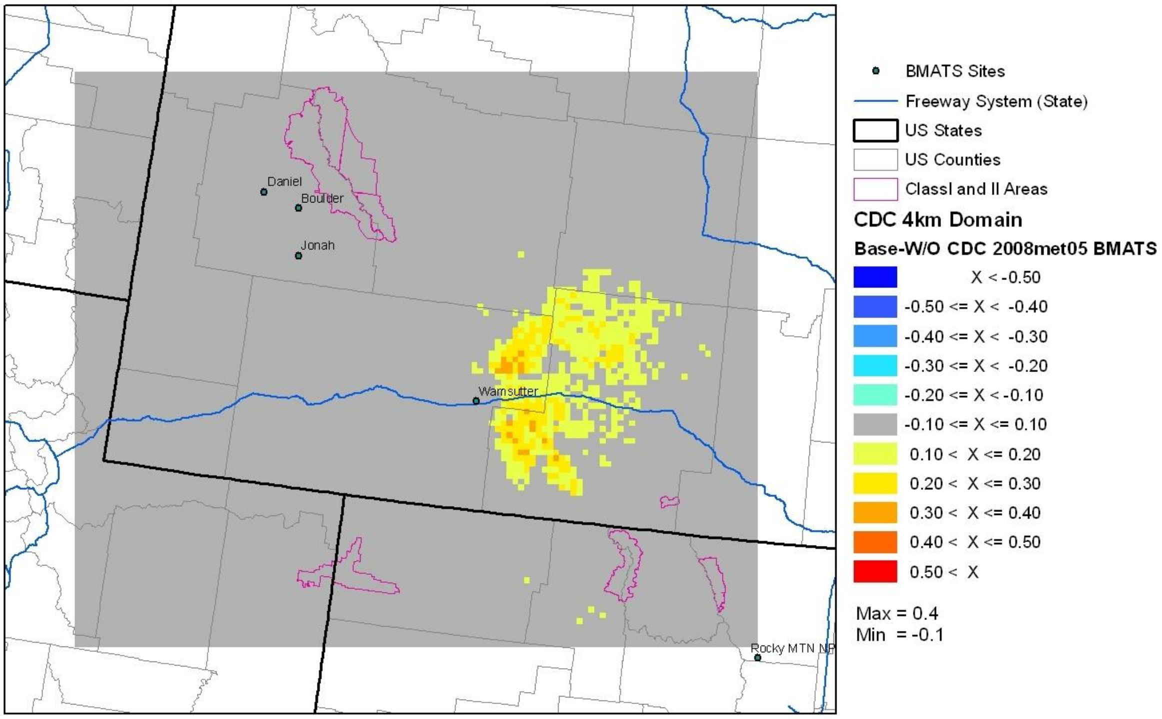


Figure 2-11. 2005 meteorological year MATS ozone DVC contribution from the CD-C Project emissions sources within the CD-C Project area (Base BMATS – Base BMATS without CD-C).

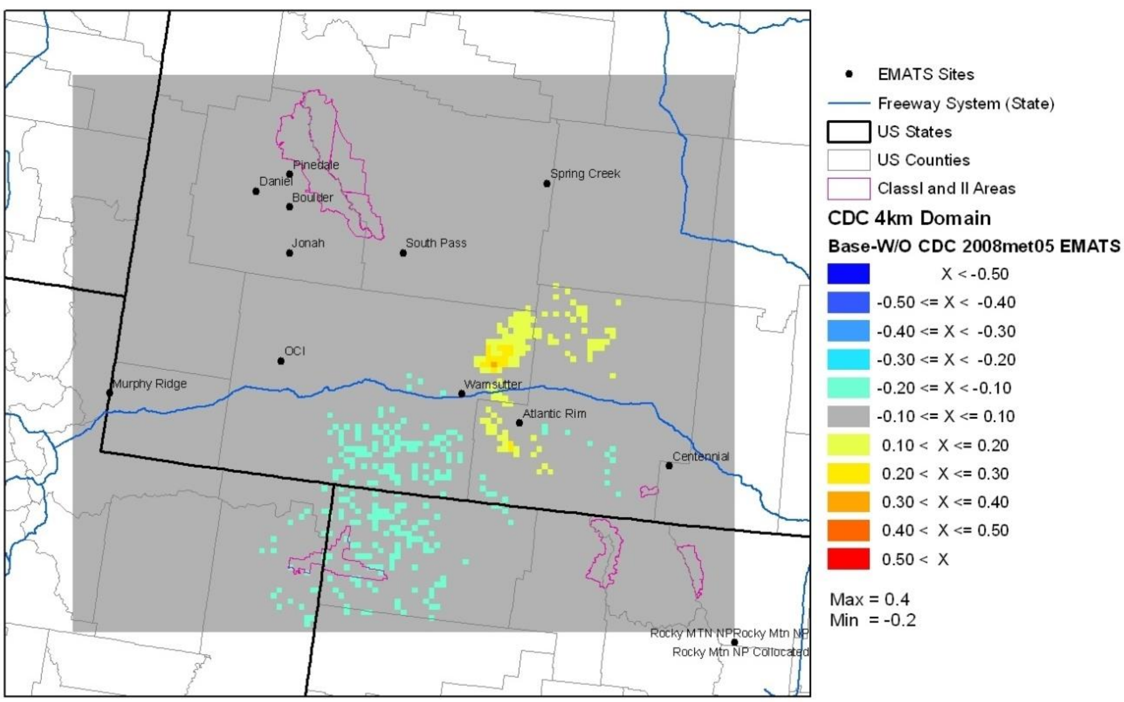


Figure 2-12. 2005 meteorological year MATS ozone DVC contribution from the CD-C Project emissions sources within the CD-C Project area (Base EMATS – Base EMATS without CD-C).

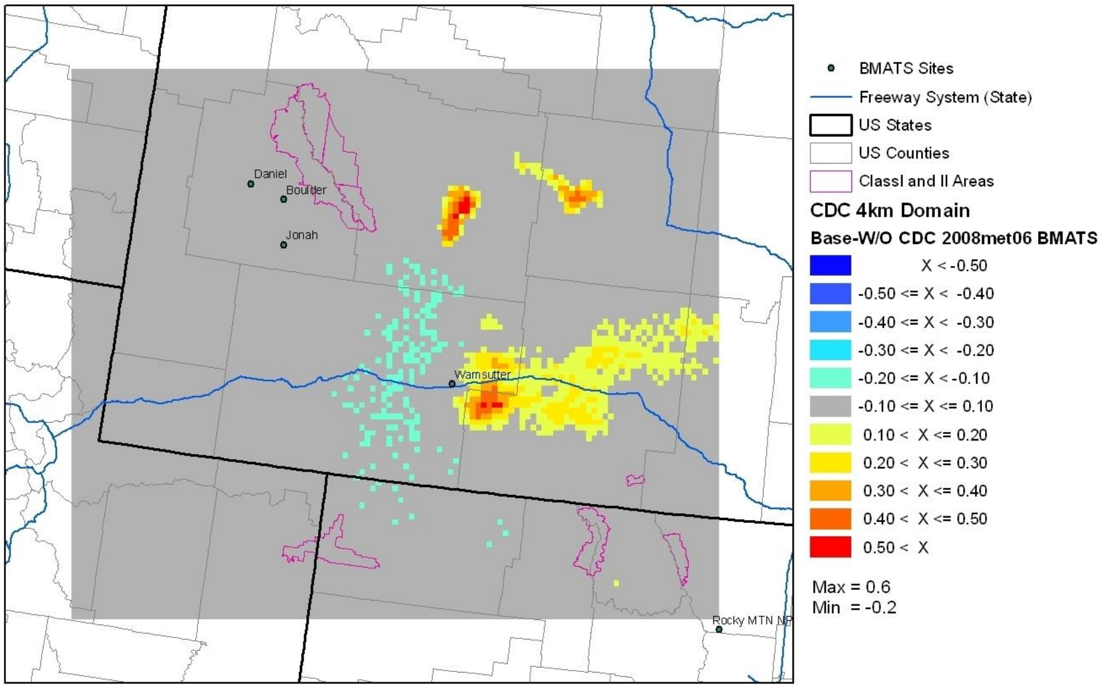


Figure 2-13. 2006 meteorological year MATS ozone DVC contribution from the CD-C Project emissions sources within the CD-C Project area (Base BMATS – Base BMATS without CD-C).

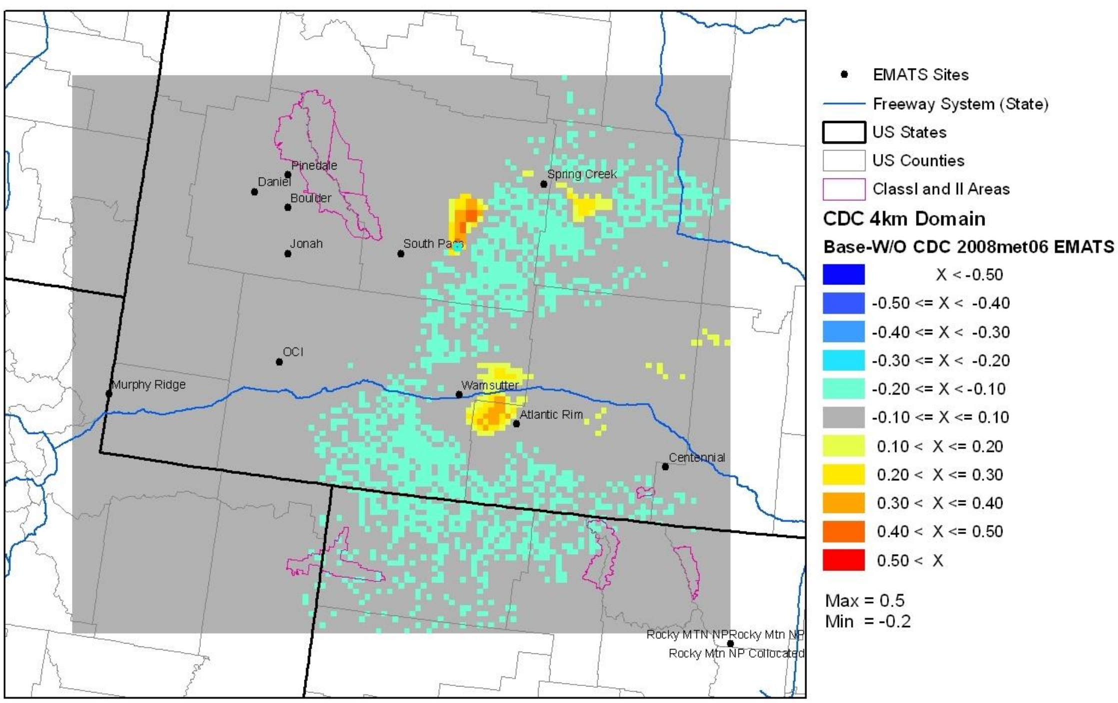


Figure 2-14. 2006 meteorological year MATS ozone DVC contribution from the CD-C Project emissions sources within the CD-C Project area (Base EMATS – Base EMATS without CD-C).

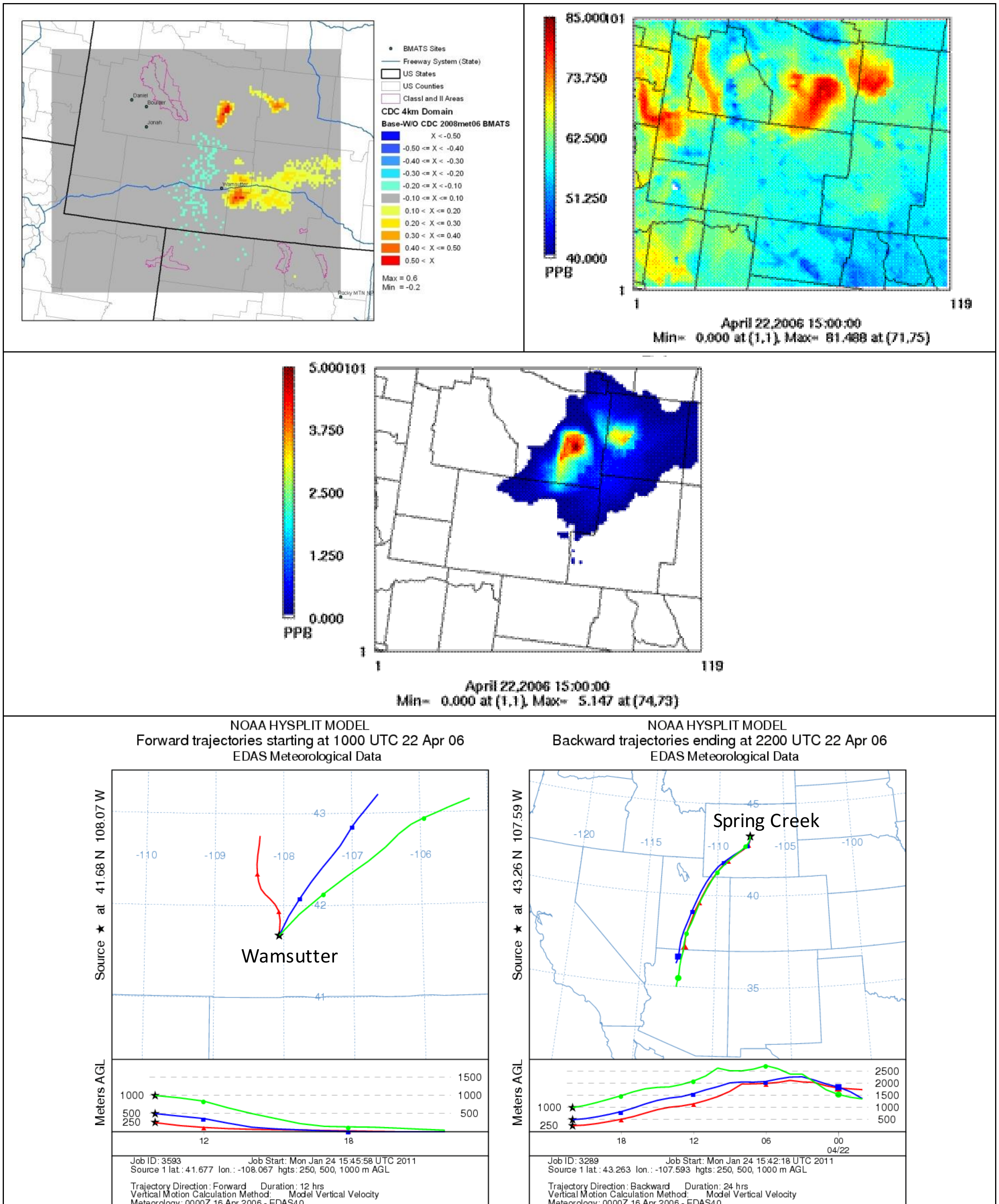


Figure 2-15. Upper left panel: as in Figure 2-13. Upper right panel: 1 hour absolute CAMx ozone at 3 pm (LST), April 22, 2006. Middle panel: CAMx APCA ozone contribution from CD-C Project emission sources at 3 pm (LST), April 22, 2006. Lower left panel: HYSPLIT 12-hour forward trajectories for 250 m, 500 m and 1000 m beginning at Wamsutter monitor at 3 am (LST) April 22, 2006. Lower right panel: HYSPLIT 24-hour backward trajectories for 500 m, 1000 m and 2000 m ending at the Spring Creek monitor at 3 pm (LST) April 22, 2006.

2.7. SUMMARY OF OZONE SOURCE APPORTIONMENT RESULTS

Analysis of the APCA ozone source apportionment results from the CD-C 2008 baseline CAMx runs indicates that the impact of emissions from existing CD-C Project is 0.4 ppb or less to 8-hour ozone Design Values across the 4 km domain. The CD-C contribution to 8-hour ozone at monitors on observed and modeled DM8 > 75 ppb days and DM8 > 70 ppb days is 1.1 ppb or less and 1.4% or less of the DM8 value. The CD-C contribution to 8-hour ozone at monitors on observed and modeled DM8 > 60 ppb days is 2.3 ppb or less and 3.2% or less of the DM8 value. The largest CD-C ozone impacts occur at monitors near and generally downwind of the CD-C Project area; these are Wamsutter, Atlantic Rim, Sun Dog, and Centennial. In 2006 only, there is a comparable impact at the Spring Creek monitor due to an episode of southerly winds on April 22, 2006 that brought ozone and precursors northward from the CD-C Project area to Fremont and Natrona Counties.

The non-CD-C project contribution to high observed and modeled 8-hour ozone at Sublette County monitors was 0.2 ppb or less and less than 0.3% of the DM8. The contribution of CD-C Project sources was larger than that of non-CD-C Project sources within the CD-C Project area.

3.0. FAR FIELD ANALYSIS

3.1. INTRODUCTION

The results of the 2008 Baseline CAMx model simulations were evaluated to assess the air quality (AQ) and air quality-related values (AQRVs) impacts of the 2008 CD-C Project area emissions and the cumulative impacts of the 2008 CD-C Project area emissions taken together with the impacts of all other 2008 regional emissions. In Section 3, the CAMx-estimated AQRV impacts due to existing 2008 CD-C Project area emissions sources are compared with Prevention of Significant Deterioration (PSD; described below in Section 3.2) Class I and II area increments, visibility thresholds, and deposition analysis thresholds.

The PSD Class I areas and sensitive Class II areas analyzed are:

- Bridger Wilderness Area, Wyoming (Class I);
- Fitzpatrick Wilderness Area, Wyoming (Class I);
- Savage Run Wilderness Area, Wyoming (Federal Class II, Wyoming Class I)
- Mount Zirkel Wilderness Area, Colorado (Class I);
- Rawah Wilderness Area, Colorado (Class I);
- Popo Agie Wilderness Area , Wyoming (Class II);
- Wind River Roadless Area, Wyoming (Class II); and
- Dinosaur National Monument, Colorado-Utah (Federal Class II, Colorado Class I (SO_2 only).

In addition, 12 lakes that are designated as acid sensitive and are located within the sensitive PSD Class I and Class II Wilderness areas are assessed for potential lake acidification from atmospheric deposition impacts. These lakes are:

- Deep Lake in the Bridger Wilderness Area, Wyoming;
- Black Joe Lake in the Bridger Wilderness Area, Wyoming;
- Hobbs Lake in the Bridger Wilderness Area, Wyoming;
- Upper Frozen Lake in the Bridger Wilderness Area, Wyoming;
- Lazy Boy Lake in the Bridger Wilderness Area, Wyoming;
- Ross Lake in the Fitzpatrick Wilderness Area, Wyoming;
- Lower Saddlebag Lake in the Popo Agie Wilderness Area, Wyoming;
- Lake Elbert in the Mount Zirkel Wilderness Area, Colorado;
- Seven Lakes in the Mount Zirkel Wilderness Area, Colorado;
- Summit Lake in the Mount Zirkel Wilderness Area, Colorado;
- Island Lake in the Rawah Wilderness Area, Colorado; and
- Rawah Lake #4 in the Rawah Wilderness Area, Colorado.

The grid cell locations of the far-field Class I and II receptor areas analyzed are shown in Figure 3-1 below. The maximum incremental concentration, deposition or visibility impact in any CAMx grid cell that intersects with the Class I or II receptor area of interest was used to represent the impact at that receptor area. The CAMx incremental concentration and deposition output was post-processed in order to:

- Compare against the PSD Class I and II increments at the Class I and II receptor areas, respectively.
- Determine total nitrogen and sulfur deposition impacts and compare to deposition analysis thresholds.
- Analyze for changes in Acid Neutralizing Capacity (ANC) at sensitive lakes in the region.
- Analyze for visibility impacts and compare against visibility thresholds.

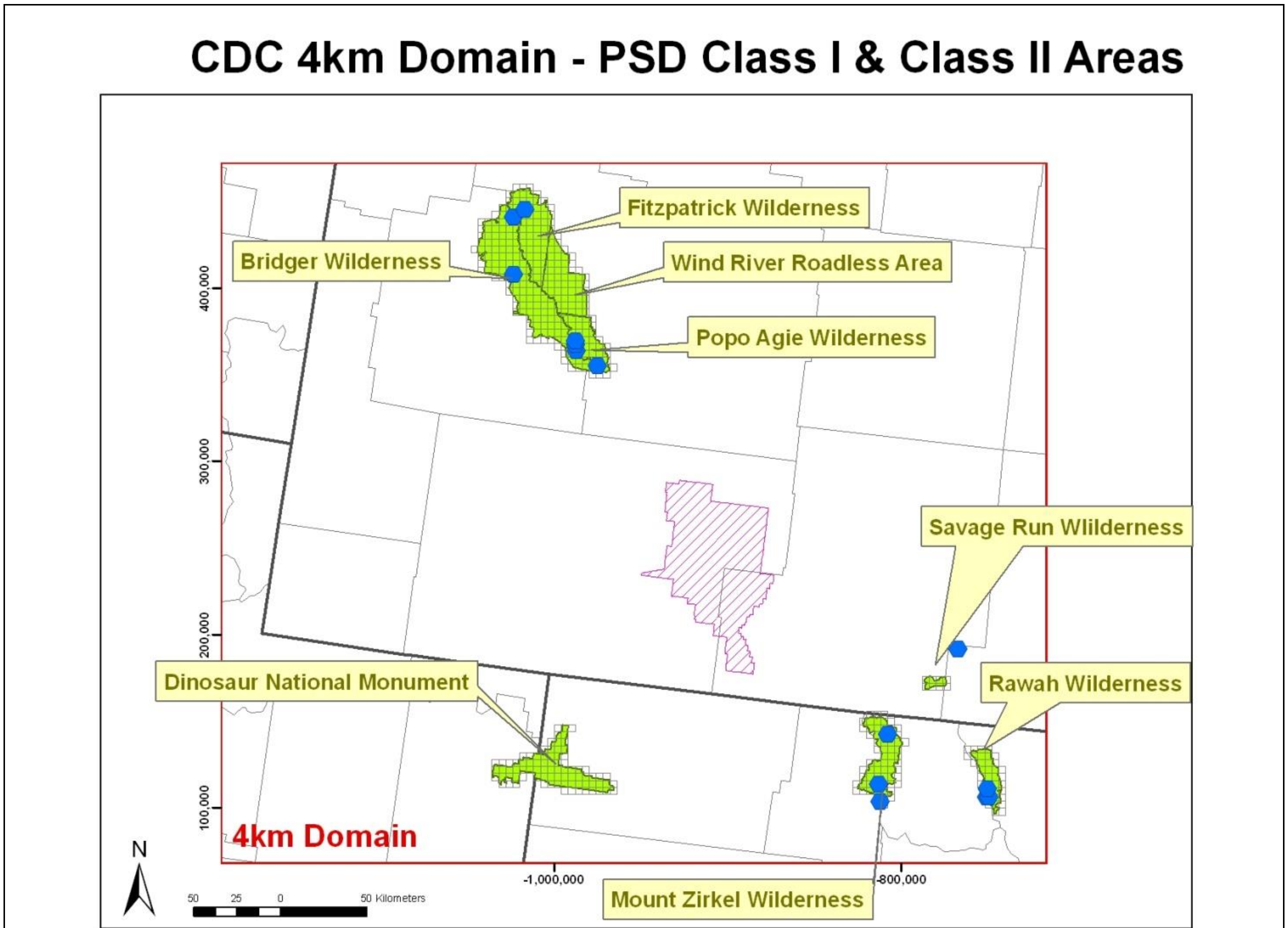


Figure 3-1. Locations of CAMx grid cells within the 4 km grid that contain Class I and sensitive Class II receptors. Blue circles indicate the locations of sensitive lakes.

3.2. PSD CLASS I AREA CONCENTRATION INCREMENTS

Areas regulated to ensure the preservation of certain levels of AQRVs are called "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 NOx, SO_2, and PM. The increments vary depending upon the pollutant and classification of an area. The PSD Class I and II Increments are shown in Table 3-1.

Table 3-1. NAAQS, CAAQS, WAAQS, and PSD Class I and Class II Increments for comparison to far-field analysis results (μg m^{-3}).

Pollutant/Averaging Time	NAAQS	CAAQS	WAAQS	PSD Class I Increment[1]	PSD Class II Increment[1]
CO					
1-hour[2]	40,000	40,000	40,000	--[3]	--[3]
8-hour[2]	10,000	10,000	10,000	--	--
NO_2					
1-hour[8]	188				
Annual[4]	100	100	100	2.5	25
O_3					
8-hour[6]	147	147	157	--	--
PM_{10}					
24-hour[2]	150	150	150	8	30
Annual[4]	--[5]	50	50	4	17
$PM_{2.5}$					
24-hour[7]	35	35	35	--[3]	--[3]
Annual[4]	15	15	15	--	--
SO_2					
1-hour[9]	196				
3-hour[2]	1,300	700	1,300	25	512
24-hour[2]	365	365	260	5	91
Annual[4]	80	60	60	2	20

1 The PSD demonstrations serve information purposes only and do not constitute a regulatory PSD increment consumption analysis.
2 No more than one exceedance per year.
3 No PSD increments have been established for this pollutant.
4 Annual arithmetic mean.
5 The NAAQS for this averaging time for this pollutant has been revoked by EPA.
6 An area is in compliance with the standard if the fourth-highest daily maximum 8-hour ozone concentrations in a year, averaged over 3 years, is less than or equal to the level of the standard.
7 An area is in compliance with the standard if the 98th percentile of 24-hour PM2.5 concentrations in a year, averaged over 3 years, is less than or equal to the level of the standard.
8 An area is in compliance with the standard if the 98th percentile of daily maximum 1-hour NO_2 concentrations in a year, averaged over 3 years, is less than or equal to the level of the standard.
9 An area is in compliance with the standard if the 99th percentile of daily maximum 1-hour SO_2 concentrations in a year, averaged over 3 years, is less than or equal to the level of the standard.

The CAMx estimates of incremental concentrations attributable to the CD-C Project were compared against PSD Class I and II area increments for the 2008 emissions scenario using the 2005 and 2006 meteorological years. These demonstrations are for informational purposes only and are not regulatory PSD Increment consumption analyses, which are completed as necessary during the permitting process by the state of Wyoming.

Tables 3-2 and 3-3 compare the maximum CD-C Project impacts against the Class I PSD increments for NO_2 and PM_{10} (Table 3-2) and SO_2, (Table 3-3) within the Class I areas in the 4 km domain. 2005 and 2006 results were calculated for each pollutant and averaging time and the higher of the 2005 and 2006 results is presented in Tables 3-2 and 3-3. Note that although PSAT does not track NO_2, it does track NOx (NO_2+NO). We have compared the CD-C Project NOx contribution with the NO_2 PSD; if the CD-C NOx contribution is smaller than the PSD increment, then the CD-C NO_2 contribution must also be less than the PSD increment.

For all Class I and sensitive Class II areas, the maximum 2008 CD-C Project impacts are less than the relevant PSD increments for all pollutants and averaging times. For NO_2, all Class I and Class II areas are many orders of magnitude less than the applicable PSD increment. For annual average PM_{10}, the Class I area with the largest impact is Savage Run WA, for which the CD-C Project impact is 0.05% of the PSD increment. The Class II area with the largest annual average PM_{10} impact is Dinosaur NM, with 0.01% of the Class II annual average PM_{10} increment. For 24-hour average PM_{10}, the Class I area with the largest impact is Mount Zirkel WA, for which the CD-C Project impacts is 0.48% of the PSD increment; the largest 24-hour PM_{10} impact at any Class II area occurs at Dinosaur NM and is 0.14% of the PSD increment. For SO_2, all CD-C Project impacts at Class I and sensitive Class II areas are many orders of magnitude lower than the relevant PSD Class I and Class II PSD increments.

Table 3-2. CD-C Project Class I Area Maximum PSD increments for the 2005-6 meteorological years for NO_2 and PM ($\mu g\ m^{-3}$).

Class I Areas	Annual Average NO_2/NOx		Annual Average PM_{10}		24-hr Average PM_{10}	
	Class I PSD	Max CD-C NOx	Class I PSD	Max CD-C	Class I PSD	Max CD-C
Bridger WA	2.5	2.96E-07	4	1.86E-04	8	7.99E-03
Fitzpatrick WA	2.5	6.41E-08	4	1.15E-04	8	5.99E-03
Mount Zirkel WA	2.5	3.74E-06	4	1.63E-03	8	3.82E-02
Rawah WA	2.5	1.84E-06	4	1.04E-03	8	1.20E-02
Savage Run WA	2.5	5.54E-06	4	2.00E-03	8	2.35E-02

Table 3-3. CD-C Project Class I Area Maximum PSD increments for the 2005-6 meteorological years for SO_2 ($\mu g\ m^{-3}$).

Class I Areas	Annual Average SO_2		24-hr Average SO_2		3-hr Average SO_2	
	Class I PSD	Max CD-C	Class I PSD	Max CD-C	Class I PSD	Max CD-C
Bridger WA	2	2.28E-08	5	7.58E-07	25	3.14E-06
Dinosaur NM*	2	2.44E-07	5	3.52E-06	25	1.07E-05
Fitzpatrick WA	2	8.88E-09	5	5.91E-07	25	1.85E-06
Mount Zirkel WA	2	2.10E-07	5	2.01E-06	25	9.33E-06
Rawah WA	2	1.06E-07	5	7.96E-07	25	2.88E-06
Savage Run WA	2	3.06E-07	5	2.17E-06	25	7.80E-06

*Dinosaur National Monument is a Federal Class II area and a Colorado Class I area for SO_2 only.

Table 3-4. CD-C Project Class II Area Maximum PSD increments for the 2005-6 meteorological years for NO_2 and PM ($\mu g\ m^{-3}$).

Sensitive Class II Areas	Annual Average NO_2/NOx		Annual Average PM_{10}		24-hr Average PM_{10}	
	Class II PSD	Max CD-C NOx	Class II PSD	Max CD-C	Class II PSD	Max CD-C
Dinosaur NM	25	4.19E-06	17	1.69E-03	30	4.17E-02
Popo Agie WA	25	3.11E-07	17	1.99E-04	30	8.58E-03
Wind River RA	25	8.24E-08	17	1.31E-04	30	5.11E-03

Table 3-5. CD-C Project Class II Area Maximum PSD increments for the 2005-6 meteorological years for SO_2 ($\mu g\ m^{-3}$).

Sensitive Class II Areas	Annual Average SO_2		24-hr Average SO_2		3-hr Average SO_2	
	Class II PSD	Max CD-C	Class II PSD	Max CD-C	Class II PSD	Max CD-C
Popo Agie WA	20	2.22E-08	91	6.46E-07	512	3.51E-06
Wind River RA	20	9.27E-09	91	5.71E-07	512	1.53E-06

Tables 3-2 through 3-5 show that the estimated potential air quality impacts due to existing 2008 development of CD-C Project emissions sources within the CD-C Project area would not exceed any PSD Class I increment at any Class I area or PSD Class II increment at any sensitive Class II area using 2005 or 2006 meteorology.

3.3. AIR QUALITY RELATED VALUES (AQRVS)

3.3.1. Visibility

3.3.1.1. Overview of Approach

The assessment of potential visibility impacts due to the existing CD-C Project area emission sources used incremental concentrations due to CD-C Project area emissions as quantified by the CAMx PSAT tool. Changes in light extinction from CAMx model concentration increments due to emissions from existing CD-C Project emissions sources were calculated for each day at all grid cells that intersect Class I and sensitive Class II areas within the 4 km modeling domain.

Change in atmospheric light extinction relative to background conditions is used to measure visibility impairment. The visual range (VR) in km is related to the atmospheric light extinction (b_{ext}) in Mm^{-1} by the following relationship:

$$VR = 3912 / b_{ext}.$$

Model results are post-processed so that they are reported in percent change in light extinction and change in deciview over background. The visibility evaluation metric is the change in extinction (Δb_{ext}) expressed as a percentage or as change in Deciview Haze Index (DHI) over a visibility background ($b_{ext(background)}$) as follows:

$$\Delta b_{ext} = 100 \text{ x } (b_{ext(source+background)} - b_{ext(background)} / b_{ext(background)})$$

$$\text{Deciview Haze Index} = 10 \ln (b_{ext}/10Mm^{-1})$$

$$\text{Change in DHI} = 10 \ln[(b_{ext(source + background)})/b_{ext(background)}]$$

Visibility impact assessments are typically based on the maximum predicted daily average visibility impacts across all receptors in a Class I or sensitive Class II area evaluated on an annual basis. The maximum number of days above threshold values and the maximum predicted impacts are reported. Following FLAG (2010) guidance for a first level (screening) analysis, the visibility impact assessment is reported in terms of the annual 98th percentile maximum predicted daily values (8th highest daily value in a year). The threshold value below which a source is presumed to have no adverse impact is a 5% change in light extinction over the reference background visibility [which is approximately equal to a 0.5 change in deciview (dv)] from project alone emissions. Note that there are no applicable local, state, tribal, or Federal regulatory visibility standards.

For visibility, the incremental daily average concentrations due to CD-C Project area emissions sources for grid cells containing the far-field Class I and sensitive Class II area receptors were processed using the new IMPROVE reconstructed mass extinction equation (FLAG 2010) to obtain maximum incremental daily visibility impacts at each far-field receptor area. The visibility results were then tabulated using the FLAG (2010) visibility screening method discussed below. The incremental contributions of existing CD-C Project emissions sources to changes in light extinction were compared to the 0.5 dv change threshold. When the BLM has completed development of required visibility analysis software, a refined visibility analysis will be conducted for project and cumulative sources using the method discussed in 3.3.1.4 and results will be compared to an analysis threshold of 1.0 dv.

3.3.1.2. New IMPROVE Equation for Evaluating Light Extinction

The FLAG procedures for evaluating visibility impacts at Class I areas use the new IMPROVE reconstructed mass extinction equation to convert PM species in μg m^{-3} to light extinction (b_{ext}) in Mm^{-1} as follows:

$$b_{ext} = b_{SO4} + b_{NO3} + b_{EC} + b_{OCM} + b_{Soil} + b_{PMC} + b_{SeaSalt} + b_{Rayleigh} + b_{NO2}$$

where

b_{SO4} = 2.2 × f_S(RH) × [Small Sulfate] + 4.8 × f_L(RH) × [Large Sulfate]
b_{NO3} = 2.4 × f_S(RH) × [Small Nitrate] + 5.1 × f_L(RH) × [Large Nitrate]
b_{OCM} = 2.8 × [Small Organic Mass] + 6.1 × [Large Organic Mass]
b_{EC} = 10 × [Elemental Carbon]
b_{Soil} = 1 × [Fine Soil]
b_{CM} = 0.6 × [Coarse Mass]
$b_{SeaSalt}$ = 1.7 × f_{SS}(RH) × [Sea Salt]
$b_{Rayleigh}$ = Rayleigh Scattering (Site Specific)
b_{NO2} = 0.33 × [NO_2 (ppb)] {or as: 0.1755 × [NO_2 (μg/m^3)]} .

Here, f(RH) are relative humidity adjustment factors that account for the fact that sulfate and nitrate aerosols are hygroscopic and are more effective at scattering radiation at higher relative humidities. For refined modeling calculations, FLAG (2010) recommends using monthly average f(RH) values rather than the hourly averages recommended in the previous FLAG (2000) guidance document in order to moderate the effects of extreme weather events on the visibility results.

The new IMPROVE equation treats "large sulfate" and "small sulfate" separately because large and small aerosols affect an incoming beam of light differently. However, the IMPROVE measurements do not separately measure large and small sulfate; they measure only the total $PM_{2.5}$ sulfate. Similarly, CAMx writes out a single concentration of particulate sulfate for each grid cell. Part of the definition of the new IMPROVE equation is a procedure for calculating the large and small sulfate contributions based on the magnitude of the model output sulfate concentrations; the procedure is documented in FLAG (2010). The sulfate concentration magnitude is used as a surrogate for distinguishing between large and small sulfate concentrations. For a given grid cell, the large and small sulfate contributions are calculated from the model output sulfate (which is the "Total Sulfate" referred to in the FLAG 2010 guidance) as:

For Total Sulfate < 20 µg/m3:

$$[\text{Large Sulfate}] = ([\text{Total Sulfate}] / 20\ \mu g/m3) \times [\text{Total Sulfate}]$$

For Total Sulfate ≥ 20 µg/m3:

$$[\text{Large Sulfate}] = [\text{Total Sulfate}]$$

For all values of Total Sulfate:

$$[\text{Small Sulfate}] = [\text{Total Sulfate}] - [\text{Large Sulfate}]$$

The procedure is identical for nitrate and organic mass. For the incremental visibility impact for an oil and gas development project in Wyoming, the sulfate and nitrate concentrations will be relatively small (<< 20 µg/m3), so we would expect most of the nitrate and sulfate to be found in the small sulfate size regime.

<u>3.3.1.3. FLAG Screening Method for Visibility Impact Analysis</u>

The FLAG Screening Method uses the new IMPROVE equation together with annual average natural conditions (Table 6; FLAG, 2010) and monthly relative humidity factors for each Class I area (Table 7-9; FLAG, 2010). Change in deciview haze index was calculated for each day of each annual CAMx run. The number of days in each annual run for CD-C Project sources alone with deciview haze values greater than 0.5 dv and 1.0 dv were counted, and the 98th percentile (8th highest day) values were compared to the 0.5 dv threshold for all grid cells that overlap a Class I area. If any impacts are greater than 0.5 dv, then a cumulative analysis would be performed that considers the impacts of CD-C Project emissions sources taken together with impacts of all other sources in the region.

3.3.1.4. Refined Method for Visibility Impact Analysis

The Refined Method uses the revised IMPROVE equation and area monitoring station data together with modeled concentration data to estimate changes in extinction values for each simulation day. Daily relative humidity factors based on relative humidity data from the nearest representative monitoring station and the revised IMPROVE relative humidity factors for small and large size distribution sulfate, nitrate, and sea salt are used along with 24-hour aerosol concentrations for the period of record at the nearest IMPROVE monitoring site. Because IMPROVE monitoring data are available for Federal Class I areas only, data from the nearest Federal Class I area must be used for the sensitive Class II areas. In this refined analysis, analysis results are compared to the 0.5 dv threshold as recommended in FLAG 2010 and to a 1.0 dv threshold which represents a just noticeable change in visibility when compared to background conditions.

The 98th percentile (8th highest day) for the CD-C Project sources alone would be compared to the 0.5 dv threshold and 1.0 dv threshold for all grid cells that overlap a Class I area. In order to assess cumulative impacts as required under NEPA for this project, a cumulative analysis would be performed that considers the impacts of CD-C Project emissions sources taken together with impacts of all other sources in the region. Cumulative visibility impacts from all sources would then be compared to the 1.0 dv threshold. The number of days exceeding the 1.0 dv threshold in the cumulative analysis would be reported.

As of the writing of this report, software for implementing the BLM Refined Method was under development by the BLM and not yet available (Melissa Hovey, personal communication, January, 2010), so the analysis was performed using only the FLAG (2010) method. However, in subsequent drafts of this report, the BLM Method results can be added once the software becomes available.

Table 3-6. Summary of visibility impact assessment methods used in the CD-C 2008 baseline modeling.

Method	Background Data	Relative Humidity Factor f(RH)	Calculation Method
Refined	Observed Daily	Hourly	Revised IMPROVE Equation
Screening	Annual Average	Monthly	Revised IMPROVE Equation

Data from Tables 6-10 of FLAG (2010) were used to calculate the light extinction under natural conditions ($b_{ext(background)}$) for each Class I area. For sensitive Class II areas, data from the nearest Class I area were used. FLAG (2010) annual average natural conditions visibility data from the Bridger Wilderness Area were used for the Popo Agie Wilderness Areas and the Wind River Roadless Area. Data from the Mount Zirkel Wilderness Area were also used for the Savage Run Wilderness Area and Dinosaur National Monument Monthly relative humidity factors are available for the Bridger, Fitzpatrick, Rawah, and Mount Zirkel Wilderness Areas. FLAG (2010) relative humidity data for the Bridger Wilderness Area were used for the Popo Agie Wilderness Area and for the Wind River Roadless Area analyses. Relative humidity data for the Mountain Zirkel Wilderness Area were also used for the Savage Run Wilderness and Dinosaur National Monument.

3.3.1.5. CAMx Species Used in Visibility Analysis

Table 3-7 gives the species mapping between the CAMx modeled species and those in the IMPROVE reconstructed mass extinction equation given above. The IMPROVE equation assumes that sufficient ammonium is present to completely neutralize sulfate and nitrate. This means that if a quantity of sulfate, SO_4, is present in a grid cell, we assume there is enough ammonium present to completely convert the sulfate to ammonium sulfate ($[NH_4]_2SO_4$). The ratio of the molecular weights of SO_4 to $[NH_4]_2SO_4$ is 1.375, so the sulfate concentration output of CAMx must be scaled by 1.375 to produce the sulfate input to the IMPROVE equation in the visibility impact assessment. A similar procedure is performed for nitrate, in which NO_3 is assumed to be neutralized to ammonium nitrate (NH_4NO_3), and the CAMx nitrate (NO_3) concentration is scaled by the factor 1.290 prior to use in the IMPROVE equation. Although CAMx explicitly models ammonium (NH_4), the NH_4 concentration is not considered in the visibility impact analysis. This may overstate the visibility degradation because sulfate and nitrate are not always completely neutralized by ammonium.

The NO_2 concentration is approximated by using the CAMx NOX species. This is a conservative assumption equivalent to saying that all NOx is composed entirely of NO_2 for the purposes of the visibility calculation. Although sodium and particulate chloride are treated in the CAMx core model, these species are not carried in the CAMx PSAT tool; neglecting sea salt in the visibility calculations in the 4 km domain does not compromise the accuracy of the analysis as IMPROVE measurements show that sea salt concentrations are extremely small in this inland area and there would be no sea salt associated with the CD-C project emissions.

Table 3-7. Mappings of species from the CAMx model to the IMPROVE visibility equation.

IMPROVE Component	Name	CAMx Species
$[SO_4]$ (as $[NH_4]_2SO_4$)	Sulfate (as $[NH_4]_2SO_4$)	PS4*1.375
$[NO_3]$ (as NH_4NO_3)	Nitrate (as NH_4NO_3)	PN3*1.290
[EC]	Elemental Carbon	PEC
[OCM]	Organic Mass	POA
[Soil]	Fine Soil	PFC+PFN
[CM]	Coarse Mass	PCC+PCS
$[NO_2]$	Nitrogen Dioxide	NOX
Sea Salt	Sea Salt	None

3.3.1.6. FLAG Screening Method Visibility Impact Results

Table 3-8 presents the visibility impacts for the incremental visibility changes due to the CD-C Project emissions scenarios using the FLAG (2010) screening method for the 2005 meteorological year. The largest 98th percentile impact occurs at Dinosaur NM (98th percentile dv = 0.165; 0 days > 0.5 dv), Savage Run WA (98th percentile dv = 0.087; 0 days > 0.5 dv), and Mount Zirkel WA (98th percentile dv = 0.086; 0 days > 0.5 dv). The size of the b_{NO3} extinction term relative to the sulfate (b_{SO4}) and other ($b_{other}= b_{EC} + b_{OCM} + b_{Soil} + b_{PMC}+ b_{SeaSalt}+ b_{NO2}$) terms indicates that nitrate makes the largest contribution toward visibility impairment from the CD-C project sources. For Non-CD-C emissions sources within the CD-C Project area, visibility impacts are far lower during 2005 (Table 3-9), with all 98th percentile impacts <0.03 dv. As for CD-C Project sources, nitrate is the largest contributor to the overall change in visibility.

Table 3-8. 2005 CDC project visibility impacts using FLAG (2010) screening method.

CDC Project Met 2005											
Class I or Class II Area	#days > 1.0	#days > 0.5	98th percentile dv	day	frh_l	frh_s	b_src	back_bext	b_so4	b_no3	b_other
Bridger WA	0	0	0.010	1/5/05	2.2	2.8	0.014	13.969	0.004	0.009	0.001
Fitzpatrick WA	0	0	0.006	5/15/05	1.9	2.4	0.008	13.787	0.003	0.003	0.002
Mount Zirkel WA	0	0	0.086	12/3/05	2.0	2.4	0.114	13.203	0.007	0.091	0.016
Rawah WA	0	0	0.043	12/3/05	1.9	2.3	0.057	13.163	0.002	0.049	0.005
Dinosaur NM	0	0	0.165	2/23/05	2.0	2.4	0.221	13.238	0.066	0.121	0.034
Popo Agie WA	0	0	0.010	3/24/05	2.0	2.6	0.014	13.847	0.002	0.012	0.000
Savage Run WA	0	0	0.087	3/22/05	1.9	2.3	0.115	13.173	0.011	0.092	0.012
Wind River RA	0	0	0.010	3/24/05	2.0	2.6	0.014	13.847	0.002	0.012	0.000

Table 3-9. 2005 Non-CDC project visibility impacts using FLAG (2010) screening method.

CDC non-Project Met 2005											
Class I or Class II Area	#days > 1.0	#days > 0.5	98th percentile dv	day	frh_l	frh_s	b_src	back_bext	b_so4	b_no3	b_other
Bridger WA	0	0	0.001	5/14/05	2.0	2.5	0.001	13.792	0.000	0.000	0.001
Fitzpatrick WA	0	0	0.001	1/5/05	2.2	2.8	0.001	13.969	0.000	0.001	0.000
Mount Zirkel WA	0	0	0.014	3/9/05	1.9	2.3	0.019	13.173	0.003	0.011	0.005
Rawah WA	0	0	0.006	2/8/05	2.0	2.4	0.007	13.213	0.001	0.004	0.002
Dinosaur NM	0	0	0.023	1/22/05	2.0	2.4	0.030	13.233	0.004	0.021	0.006
Popo Agie WA	0	0	0.001	5/14/05	2.0	2.5	0.001	13.792	0.000	0.000	0.001
Savage Run WA	0	0	0.011	11/12/05	2.0	2.4	0.014	13.223	0.003	0.006	0.005
Wind River RA	0	0	0.001	9/24/05	1.7	2.0	0.001	13.572	0.000	0.000	0.000

Table 3-10 compares the visibility impacts for the incremental visibility changes due to the CD-C Project emissions scenarios using the FLAG (2010) screening method for the 2006 meteorological year. The largest 98th percentile impacts occur at the Dinosaur NM (98th percentile dv = 0.105; 0 days > 0.5 dv), Savage Run WA (98th percentile dv = 0.091; 0 days > 0.5 dv) and Mount Zirkel (98th percentile dv = 0.093; 0 days > 0.5 dv). Nitrate makes the largest contribution to the overall 98th percentile change in extinction for all areas. For Non-CD-C emissions sources within the CD-C Project area, visibility impacts are far lower than for the CD-C Project sources during 2006 (Table 3-11), with all 98th percentile impacts <0.02 dv.

Table 3-10. 2006 CDC project visibility impacts using FLAG (2010) screening method.

CDC Project Met 2006											
Class I or Class II Area	#days > 1.0	#days > 0.5	98th percentile dv	day	frh_l	frh_s	b_src	back_bext	b_so4	b_no3	b_other
Bridger WA	0	0	0.013	3/12/06	2.0	2.6	0.017	13.847	0.006	0.009	0.002
Fitzpatrick WA	0	0	0.014	2/19/06	2.1	2.6	0.020	13.875	0.002	0.016	0.001
Mount Zirkel WA	0	0	0.093	2/19/06	2.0	2.4	0.123	13.238	0.007	0.108	0.008
Rawah WA	0	0	0.041	12/3/06	1.9	2.3	0.053	13.163	0.001	0.050	0.002
Dinosaur NM	0	0	0.105	12/17/06	2.0	2.4	0.139	13.203	0.009	0.103	0.028
Popo Agie WA	0	0	0.015	3/12/06	2.0	2.6	0.021	13.847	0.006	0.013	0.001
Savage Run WA	0	0	0.091	2/2/06	2.0	2.4	0.121	13.238	0.030	0.071	0.020
Wind River RA	0	0	0.016	3/12/06	2.0	2.6	0.022	13.847	0.006	0.014	0.001

Table 3-11. 2006 Non- CDC project visibility impacts using FLAG (2010) screening method.

CDC non-Project Met 2006												
Class I or Class II Area	#days > 1.0	#days > 0.5	98th percentile dv	day	frh_l	frh_s	b_src	back_bext	b_so4	b_no3	b_other
Bridger WA	0	0	0.001	9/8/06	1.7	2.0	0.002	13.572	0.001	0.000	0.001
Fitzpatrick WA	0	0	0.001	2/19/06	2.1	2.6	0.001	13.875	0.000	0.000	0.000
Mount Zirkel WA	0	0	0.016	4/30/06	1.9	2.4	0.021	13.203	0.004	0.009	0.008
Rawah WA	0	0	0.006	12/2/06	1.9	2.3	0.008	13.163	0.001	0.006	0.001
Dinosaur NM	0	0	0.015	8/19/06	1.7	2.0	0.019	13.026	0.006	0.001	0.012
Popo Agie WA	0	0	0.001	5/22/06	2.0	2.5	0.002	13.792	0.001	0.000	0.001
Savage Run WA	0	0	0.011	2/2/06	2.0	2.4	0.014	13.238	0.003	0.006	0.005
Wind River RA	0	0	0.001	3/19/06	2.0	2.6	0.002	13.847	0.000	0.001	0.000

In summary, there are no days for which the emissions from either CD-C Project or non-CD-C Project sources within the CD-C Project area cause visibility impairment greater than 0.5 dv at any Class I or sensitive Class II receptor. Nitrate impacts dominate the total visibility impairment in both years for CD-C Project sources.

The FLAG 2010 document states that a cumulative visibility analysis is not required if project along impacts are less than 0.5 dv. Given that the CD-C Project visibility impacts are all less than 0.5 dv, a cumulative analysis is not required following the FLAG guidance.

3.4. DEPOSITION

The effects of atmospheric deposition of nitrogen and sulfur compounds on terrestrial and aquatic ecosystems are well documented and have been shown to cause leaching of nutrients from soils, acidification of surface waters, injury to high elevation vegetation, and changes in nutrient cycling and species composition. FLAG (2010) recommends that applicable sources assess impacts of nitrogen and sulfur deposition at Class I areas. Although the CD-C Project is not an “applicable source” under New Source Review, BLM is analyzing nitrogen and sulfur deposition impacts attributable to this project at Class I areas and identified sensitive Class II areas within the Project study area.

3.4.1. Overview of Approach

CAMx-predicted wet and dry fluxes of sulfur- and nitrogen-containing species were processed to estimate total annual sulfur (S) and nitrogen (N) deposition values at each PSD Class I and sensitive PSD Class II area and at each acid sensitive lake. The maximum annual S and N deposition values from any grid cell that intersects a Class I or Class II receptor area were used to represent deposition for that area, in addition to the average annual deposition values of all grid cells that intersect a Class I or Class II receptor area. Maximum and average predicted S and N deposition impacts were estimated for existing emissions sources within the CD-C Project area.

Nitrogen deposition impacts were calculated by taking the sum of the nitrogen contained in the fluxes of all nitrogen species modeled by CAMx. CAMx species used in the nitrogen deposition flux calculation are: reactive gaseous nitrate species, RGN (NOX, NO3, HONO, N2O5), TPN (PAN, PANX, PNA), organic nitrates (NTR), particulate nitrate formed from primary emissions plus secondarily formed nitrate (PN3), gaseous nitric acid (HN3), gaseous ammonia (NH3) and particulate ammonium (PN4). CAMx species used in the sulfur deposition calculation are primary sulfur dioxide emissions (SO2) and particulate sulfate ion from primary emissions plus secondarily formed sulfate (PS4).

FLAG 2010 recommends that applicable sources assess impacts of nitrogen and sulfur deposition at Class I areas. This guidance recognizes the importance of establishing critical deposition loading values ("critical loads") for each specific Class I area as these critical loads are completely dependent on local atmospheric, aquatic and terrestrial conditions and chemistry. Critical load thresholds are essentially a level of atmospheric pollutant deposition below which negative ecosystem effects are not likely to occur. FLAG 2010 does not include any critical load levels for specific Class I areas and refers to site-specific critical load information on FLM websites for each area of concern. This guidance does, however recommend the use of deposition analysis thresholds (DATs) developed by the National Park Service and the Fish and Wildlife Service. The DATs represent screening level values for nitrogen and sulfur deposition from project alone emission sources below which estimated impacts are considered negligible. The DAT established for both nitrogen and sulfur in western Class I areas is 0.005 kilograms per hectare per year (kg/ha/yr).

BLM has compiled currently available research data on critical load values for Class I areas in the vicinity of this project. Critical load thresholds published by Fox et al. (Fox 1989) established pollutant loadings for total nitrogen of 3-5 kilograms per hectare per year (kg/ha/yr) and for total sulfur of 5 kg/ha/yr for Bob Marshall Wilderness Area in Montana and Bridger Wilderness Area in Wyoming. Research conducted by Jill Baron (Baron 2006) using hindcasting of diatom communities suggests 1.5 kg/ha/yr as a critical loading value for wet nitrogen deposition for high elevation lakes in Rocky Mountain National Park, Colorado. Recent research conducted by Saros et al. (2010) using fossil diatom assemblages suggests that a critical load value of 1.4 kg/ha/yr for wet nitrogen is applicable to the eastern Sierra Nevada and Greater Yellowstone ecosystems.

As a screening analysis, N and S maximum deposition from CD-C project sources were compared to the DATs. As a refined analysis, project alone N and S deposition were compared to the following critical load values: 3.0 kg/ha/yr was used as for total N deposition and 5 kg/ha/yr was used for total S deposition for the Class I areas evaluated in this analysis. For N and S, we report both the average deposition as well as the maximum deposition, although only the maximum deposition is compared with the applicable level of concern.

3.4.2. Nitrogen Deposition Impacts:

Table 3-12 shows the incremental nitrogen deposition impacts of the CD-C Project sources within the CD-C Project area for the 2005 meteorological year. Nitrogen deposition impacts exceed the DAT at three Class I areas for project alone sources; therefore, a refined approach was used to compare impacts to more representative values. No Class I or sensitive Class II area exceeds the 3.0 kg/ha/yr critical load value. The largest impacts are at the Savage Run WA, Dinosaur NM, Mount Zirkel WA, and Rawah WA, all with maximum impacts that are less than 0.3% of the critical load. Impacts at the Bridger WA, Fitzpatrick WA, Popo Agie WA and Wind River Roadless Area are lower still, and are all less than 0.03% of the critical load; these sites are further from the CD-C Project area and are generally upwind.

Table 3-13 displays the total nitrogen deposition impacts for the 2005 meteorological year for the non-CDC Project emissions sources within the CD-C Project area. Impacts are smaller than for CD-C Project sources within the Project area and do not exceed the DAT. No Class I or Class

II areas exceed the 3.0 kg/ha/yr critical load. As with the CD-C Project sources, the largest impacts are at Savage Run, Mount Zirkel, Dinosaur and Rawah, with maximum impacts that are all 0.03% or less of the critical load.

Table 3-12. 2005 meteorological year nitrogen deposition impacts for the CD-C Project sources within the CD-C Project area.

CD-C Project Deposition 2008Met2005				
Class I or Class II Area	CAMx N Species Max (kgN/ha)	CAMx N Species % of Critical Load (3 kg N /ha)	CAMx N Species % of DAT (0.005 kg N /ha)	CAMx N Species Average (kgN/ha)
Bridger WA	*0.0006*	*0.0208%*	*12.46%*	*0.0003*
Fitzpatrick WA	*0.0003*	*0.0111%*	*6.69%*	*0.0002*
Mount Zirkel WA	*0.0057*	*0.1885%*	*113.08%*	*0.0039*
Rawah WA	*0.0040*	*0.1327%*	*79.63%*	*0.0029*
Dinosaur NM	*0.0058*	*0.1931%*	*115.86%*	*0.0031*
Popo Agie WA	*0.0008*	*0.0265%*	*15.89%*	*0.0004*
Savage Run WA	*0.0075*	*0.2486%*	*149.15%*	*0.0066*
Wind River RA	*0.0004*	*0.0129%*	*7.73%*	*0.0003*

Table 3-13. 2005 meteorological year nitrogen deposition impacts for the non-CD-C Project sources within the CD-C Project area.

CD-C Non-Project Deposition 2008Met2005				
Class I or Class II Area	CAMx N Species Max (kgN/ha)	CAMx N Species % of Critical Load (3 kg N /ha)	CAMx N Species % of DAT (0.005 kg N /ha)	CAMx N Species Average (kgN/ha)
Bridger WA	*0.0000*	*0.0011%*	*0.65%*	*0.0000*
Fitzpatrick WA	*0.0000*	*0.0007%*	*0.41%*	*0.0000*
Mount Zirkel WA	*0.0007*	*0.0230%*	*13.78%*	*0.0005*
Rawah WA	*0.0004*	*0.0148%*	*8.90%*	*0.0003*
Dinosaur NM	*0.0005*	*0.0178%*	*10.70%*	*0.0003*
Popo Agie WA	*0.0000*	*0.0013%*	*0.76%*	*0.0000*
Savage Run WA	*0.0009*	*0.0300%*	*18.03%*	*0.0008*
Wind River RA	*0.0000*	*0.0009%*	*0.51%*	*0.0000*

Table 3-14 shows the incremental nitrogen deposition impacts of the CD-C Project sources within the CD-C Project area for the 2006 meteorological year. Nitrogen deposition impacts exceed the DAT at four Class I areas for project alone sources; therefore, a refined approach was used to compare impacts to more representative values. No Class I or sensitive Class II area exceeds the 3.0 kg/ha/yr critical load. The largest impacts are at the Savage Run WA, Mount Zirkel WA, Rawah WA and Dinosaur NM, all with maximum impacts that are less than 0.4% of the critical load. As in the 2005 meteorological year, impacts at the Bridger WA, Fitzpatrick WA, Popo Agie WA and Wind River Roadless Area are lower, and are all less than 0.05% of the critical load.

Table 3-15 displays the total nitrogen deposition impacts for the 2006 meteorological year for the non-CDC Project emissions sources within the CD-C Project area. Impacts are smaller than for CD-C Project sources within the Project area and do not exceed the DAT. There are no Class I or Class II areas that exceed the 3.0 kg/ha/yr critical load. As with the CD-C Project sources, the largest impacts are at Savage Run, Mount Zirkel, Dinosaur and Rawah, with maximum impacts that are all 0.05% or less of the critical load.

Table 3-14. 2006 meteorological year nitrogen deposition impacts for the CD-C Project sources within the CD-C Project area.

CD-C Project Deposition 2008Met2006				
Class I or Class II Area	CAMx N Species Max (kgN/ha)	CAMx N Species % of Critical Load (3 kg N /ha)	CAMx N Species % of DAT (0.005 kg N /ha)	CAMx N Species Average (kgN/ha)
Bridger WA	*0.0011*	*0.0358%*	*21.5%*	*0.0006*
Fitzpatrick WA	*0.0007*	*0.0217%*	*13.0%*	*0.0005*
Mount Zirkel WA	*0.0074*	*0.2482%*	*148.9%*	*0.0054*
Rawah WA	*0.0066*	*0.2198%*	*131.9%*	*0.0045*
Dinosaur NM	*0.0064*	*0.2125%*	*127.5%*	*0.0036*
Popo Agie WA	*0.0015*	*0.0491%*	*29.4%*	*0.0009*
Savage Run WA	*0.0100*	*0.3340%*	*200.4%*	*0.0086*
Wind River RA	*0.0006*	*0.0207%*	*12.4%*	*0.0005*

Table 3-15. 2006 meteorological year nitrogen deposition impacts for the non-CD-C Project sources within the CD-C Project area.

CD-C Non-Project Deposition 2008Met2006				
Class I or Class II Area	CAMx N Species Max (kgN/ha)	CAMx N Species % of Critical Load (3 kg N /ha)	CAMx N Species % of DAT (0.005 kg N /ha)	CAMx N Species Average (kgN/ha)
Bridger WA	*0.0001*	*0.0022%*	*1.35%*	*0.0000*
Fitzpatrick WA	*0.0000*	*0.0013%*	*0.80%*	*0.0000*
Mount Zirkel WA	*0.0010*	*0.0327%*	*19.64%*	*0.0007*
Rawah WA	*0.0007*	*0.0248%*	*14.87%*	*0.0005*
Dinosaur NM	*0.0006*	*0.0190%*	*11.38%*	*0.0003*
Popo Agie WA	*0.0001*	*0.0030%*	*1.80%*	*0.0001*
Savage Run WA	*0.0012*	*0.0406%*	*24.35%*	*0.0010*
Wind River RA	*0.0000*	*0.0013%*	*0.76%*	*0.0000*

3.4.3. Sulfur Deposition Impacts

Table 3-16 shows the total sulfur deposition impacts of CD-C Project sources within the CD-C Project area for the 2005 and 2006 meteorological years. No Class I or Class II area exceeds the DAT. All areas have sulfur deposition less than 0.03% of the critical load of 5.0 kg/ha/yr. Areas with the highest deposition due to CD-C Project sources are Mount Zirkel (0.03% of the critical load in 2006) and Rawah (0.02% of the critical load in 2006). Impacts are higher overall in 2006 than in 2005. For non-CDC Project sources within the CD-C Project area (Table 3-17) impacts are even lower, with no area exceeding the DAT and all areas with impacts less than 0.003% of the critical load.

Table 3-16. 2005-2006 meteorological year sulfur deposition impacts for CD-C Project sources. CAMx species used in the sulfur deposition flux calculation are: SO2 and PS4.

	CDC Project 2008Met2005				CDC Project 2008Met2006			
	Sulfur- Max	% of Critical Load	% of DAT	Sulfur- Avg	Sulfur- Max	% of Critical Load	% of DAT	Sulfur- Avg
Class I or Class II Area	(kgS/ha)	(5 kg S /ha)	(0.005 kg S/ha)	(kgS/ha)	(kgS/ha)	(5 kg S /ha)	(0.005 kg S/ha)	(kgS/ha)
Bridger WA	*0.0001*	*0.0016%*	*1.56%*	*0.0000*	*0.0002*	*0.0031%*	*3.15%*	*0.0001*
Fitzpatrick WA	*0.0001*	*0.0016%*	*1.61%*	*0.0000*	*0.0001*	*0.0026%*	*2.61%*	*0.0001*
Mount Zirkel WA	*0.0005*	*0.0103%*	*10.27%*	*0.0003*	*0.0014*	*0.0272%*	*27.20%*	*0.0007*
Rawah WA	*0.0005*	*0.0092%*	*9.23%*	*0.0003*	*0.0012*	*0.0233%*	*23.26%*	*0.0006*
Dinosaur NM	*0.0006*	*0.0110%*	*11.02%*	*0.0002*	*0.0008*	*0.0162%*	*16.19%*	*0.0003*
Popo Agie WA	*0.0001*	*0.0019%*	*1.93%*	*0.0001*	*0.0002*	*0.0045%*	*4.51%*	*0.0002*
Savage Run WA	*0.0006*	*0.0113%*	*11.35%*	*0.0005*	*0.0007*	*0.0147%*	*14.70%*	*0.0005*
Wind River RA	*0.0001*	*0.0021%*	*2.13%*	*0.0001*	*0.0001*	*0.0025%*	*2.54%*	*0.0001*

Table 3-17. 2005-6 meteorological year sulfur deposition impacts for non-CDC sources within the CD-C Project area. CAMx species used in the sulfur deposition flux calculation are: SO2 and PS4.

	CDC Non-Project 2008Met2005				CDC Non-Project 2008Met2006			
	Sulfur- Max	% of Critical Load	% of DAT	Sulfur- Avg	Sulfur- Max	% of Critical Load	% of DAT	Sulfur- Avg
Class I or Class II Area	(kgS/ha)	(5 kg S /ha)	(0.005 kg S/ha)	(kgS/ha)	(kgS/ha)	(5 kg S /ha)	(0.005 kg S/ha)	(kgS/ha)
Bridger WA	*0.0000*	*0.0000%*	*0.04%*	*0.0000*	*0.0000*	*0.0001%*	*0.15%*	*0.0000*
Fitzpatrick WA	*0.0000*	*0.0001%*	*0.08%*	*0.0000*	*0.0000*	*0.0001%*	*0.13%*	*0.0000*
Mount Zirkel WA	*0.0000*	*0.0009%*	*0.94%*	*0.0000*	*0.0001*	*0.0027%*	*2.72%*	*0.0001*
Rawah WA	*0.0000*	*0.0010%*	*0.97%*	*0.0000*	*0.0001*	*0.0018%*	*1.79%*	*0.0000*
Dinosaur NM	*0.0000*	*0.0006%*	*0.60%*	*0.0000*	*0.0001*	*0.0012%*	*1.19%*	*0.0000*
Popo Agie WA	*0.0000*	*0.0001%*	*0.07%*	*0.0000*	*0.0000*	*0.0002%*	*0.21%*	*0.0000*
Savage Run WA	*0.0001*	*0.0012%*	*1.21%*	*0.0000*	*0.0001*	*0.0014%*	*1.36%*	*0.0001*
Wind River RA	*0.0000*	*0.0001%*	*0.11%*	*0.0000*	*0.0000*	*0.0001%*	*0.14%*	*0.0000*

3.4.3.1. Summary of Deposition Impacts

The deposition analysis indicates total nitrogen deposition impacts from CD-C Project emission sources are estimated to be above the DAT at four Class I areas. Total nitrogen and sulfur deposition impacts were estimated to be well below the critical load values as a result of existing 2008 CD-C Project emissions sources. Total N and S deposition impacts from non-CD-C sources were estimated to be even lower than for project sources.

3.4.4 Sensitive Lakes Analysis

3.4.4.1. Sensitive Lakes Acid Neutralizing Capacity (ANC)

The CAMx-predicted annual deposition fluxes of S and N at sensitive lake receptors listed in Section 3.1 were used to estimate the impact on the acid neutralizing capacity (ANC) of each lake due to the existing CD-C project emissions and regional emissions. The changes in ANC were calculated following the January 2000, USFS Rocky Mountain Region's *Screening Methodology for Calculating ANC Change to High Elevation Lakes, User's Guide* (USFS, 2000). The most recent lake chemistry background ANC data were obtained from the BLM for each sensitive lake to be analyzed. The 10th percentile lowest ANC values were calculated for each lake following procedures provided by the USFS. The ANC values used in this analysis and the number of samples used in the calculation of the 10th percentile lowest ANC values are provided in Tables 3-18 - 3-21. Two lakes listed in Tables 3-18 through 3-21 are considered by the USFS to be extremely sensitive to atmospheric deposition (background ANC values are less than 25 microequivalents per liter (µeq/l)); these are Lazy Boy Lake and Upper Frozen Lake in the Bridger Wilderness.

The predicted changes in ANC are compared below with the USFS's Level of Acceptable Change (LAC) thresholds of 10% of the 10^{th} percentile lowest ANC value for lakes with ANC values greater than 25 µeq/l. For lakes with background ANC values of 25 µeq/l and less the USFS LAC threshold is that no further decrease is acceptable. Lake impacts must be assessed with consideration of limited data points available for several analyzed lakes. ANC calculations are shown for CD-C Project and non-CD-C Project sources of emissions located within the CD-C Project area.

3.4.4.2. CD-C Project Area Source ANC Impacts

Tables 3-18 through 3-21 show that in 2005 and 2006, none of the Lakes undergoes a change in ANC that exceeds the LAC threshold of 10% due to the impacts of CD-C Project or non-CD-C Project sources within the CD-C Project area. The predicted change in ANC due to non-CD-C Project sources impacts or CD-C Project source impacts is very small.

Table 3-18. Modeled changes in ANC from CD-C Project sources for the 2005 meteorological year.

CDC Project 2008 Met 2005												
Wilderness Area	Lake	Latitude (Deg N, NAD27)	Longitude (Deg W, NAD27)	Elevation (m)	10th Percentile Lowest ANC Value (µeq/L)	Number of Samples	Period of Monitoring	Total S Dep (kg-S/ha-yr)	Total N Dep (kg-N/ha-yr)	PPT (m)	Delta ANC (%)	Delta ANC (ueq/l)
Bridger	Black Joe Lake	42º44'22"	109º10'16"	3126.6	69.7	78	1984-2009	0.00004	0.00040	0.91186	0.01	n/a
Bridger	Deep Lake	42º43'10"	109º10'15"	3201.0	60.4	75	1984-2009	0.00005	0.00043	0.91186	0.01	n/a
Bridger	Hobbs Lake	43º02'08"	109º40'20"	3066.3	70.1	85	1984-2009	0.00004	0.00030	0.91186	0.01	n/a
Bridger	Lazy Boy Lake	43º19'57"	109º43'47"	3535.7	12.4	5	1997-2009	0.00003	0.00024	0.91186	0.03	0.00
Bridger	Upper Frozen Lake	42º41'13"	109º09'39"	3486.9	7.4	12	1997-2009	0.00006	0.00053	0.91186	0.09	0.01
Fitzpatrick	Ross Lake	43º22'41"	109º39'30"	2948.9	54.1	60	1988-2009	0.00003	0.00022	0.91186	0.01	n/a
Mount Zirkel	Lake Elbert	40º38'03"	106º42'25"	3291.8	53.6	67	1985-2007	0.00037	0.00378	1.08966	0.07	n/a
Mount Zirkel	Seven Lakes (LG East)	40º53'45"	106º40'55"	3271.4	40.5	24	1985-2007	0.00041	0.00487	1.08966	0.13	n/a
Mount Zirkel	Summit Lake	40º32'43"	106º40'55"	3144.3	48.0	108	1985-2007	0.00039	0.00367	1.08966	0.08	n/a
Popo Agie	Lower Saddlebag Lake	42º37'24"	108º59'38"	3432.7	55.6	59	1989-2009	0.00008	0.00059	0.91186	0.01	n/a
Rawah	Island Lake	40º37'38"	105º56'28"	3391.8	71.4	21	1996-2009	0.00028	0.00274	0.84582	0.05	n/a
Rawah	Rawah Lake #4	40º40'16"	105º57'28"	3497.3	41.6	26	1996-2009	0.00029	0.00295	0.84582	0.10	n/a

Table 3-19. Modeled changes in ANC from non-CD-C Project sources for the 2005 meteorological year.

CDC Non-Project 2008 Met 2005												
Wilderness Area	Lake	Latitude (Deg N, NAD27)	Longitude (Deg W, NAD27)	Elevation (m)	10th Percentile Lowest ANC Value (µeq/L)	Number of Samples	Period of Monitoring	Total S Dep (kg-S/ha-yr)	Total N Dep (kg-N/ha-yr)	PPT (m)	Delta ANC (%)	Delta ANC (ueq/l)
Bridger	Black Joe Lake	42º44'22"	109º10'16"	3126.6	69.7	78	1984-2009	0.00000	0.00002	0.91186	0.00	n/a
Bridger	Deep Lake	42º43'10"	109º10'15"	3201.0	60.4	75	1984-2009	0.00000	0.00002	0.91186	0.00	n/a
Bridger	Hobbs Lake	43º02'08"	109º40'20"	3066.3	70.1	85	1984-2009	0.00000	0.00002	0.91186	0.00	n/a
Bridger	Lazy Boy Lake	43º19'57"	109º43'47"	3535.7	12.4	5	1997-2009	0.00000	0.00001	0.91186	0.00	0.00
Bridger	Upper Frozen Lake	42º41'13"	109º09'39"	3486.9	7.4	12	1997-2009	0.00000	0.00003	0.91186	0.00	0.00
Fitzpatrick	Ross Lake	43º22'41"	109º39'30"	2948.9	54.1	60	1988-2009	0.00000	0.00001	0.91186	0.00	n/a
Mount Zirkel	Lake Elbert	40º38'03"	106º42'25"	3291.8	53.6	67	1985-2007	0.00003	0.00042	1.08966	0.01	n/a
Mount Zirkel	Seven Lakes (LG East)	40º53'45"	106º40'55"	3271.4	40.5	24	1985-2007	0.00004	0.00058	1.08966	0.01	n/a
Mount Zirkel	Summit Lake	40º32'43"	106º40'55"	3144.3	48.0	108	1985-2007	0.00003	0.00040	1.08966	0.01	n/a
Popo Agie	Lower Saddlebag Lake	42º37'24"	108º59'38"	3432.7	55.6	59	1989-2009	0.00000	0.00003	0.91186	0.00	n/a
Rawah	Island Lake	40º37'38"	105º56'28"	3391.8	71.4	21	1996-2009	0.00002	0.00028	0.84582	0.01	n/a
Rawah	Rawah Lake #4	40º40'16"	105º57'28"	3497.3	41.6	26	1996-2009	0.00002	0.00031	0.84582	0.01	n/a

Table 3-20. Modeled changes in ANC from CD-C Project source for the 2006 meteorological year.

CDC Project 2008 Met 2006													
Wilderness Area	Lake	Latitude (Deg N, NAD27)	Longitude (Deg W, NAD27)	Elevation (m)	10th Percentile Lowest ANC Value (µeq/L)	Number of Samples	Period of Monitoring	Total S Dep (kg-S/ha-yr)	Total N Dep (kg-N/ha-yr)	PPT (m)	Delta ANC (%)	Delta ANC (ueq/l)
Bridger	Black Joe Lake	42º44'22"	109º10'16"	3126.6	69.7	78	1984-2009	0.00019	0.00085	0.91186	0.02	n/a
Bridger	Deep Lake	42º43'10"	109º10'15"	3201.0	60.4	75	1984-2009	0.00020	0.00097	0.91186	0.02	n/a
Bridger	Hobbs Lake	43º02'08"	109º40'20"	3066.3	70.1	85	1984-2009	0.00010	0.00067	0.91186	0.01	n/a
Bridger	Lazy Boy Lake	43º19'57"	109º43'47"	3535.7	12.4	5	1997-2009	0.00006	0.00040	0.91186	0.04	0.01
Bridger	Upper Frozen Lake	42º41'13"	109º09'39"	3486.9	7.4	12	1997-2009	0.00016	0.00104	0.91186	0.19	0.01
Fitzpatrick	Ross Lake	43º22'41"	109º39'30"	2948.9	54.1	60	1988-2009	0.00007	0.00038	0.91186	0.01	n/a
Mount Zirkel	Lake Elbert	40º38'03"	106º42'25"	3291.8	53.6	67	1985-2007	0.00095	0.00575	1.08966	0.12	n/a
Mount Zirkel	Seven Lakes (LG East)	40º53'45"	106º40'55"	3271.4	40.5	24	1985-2007	0.00108	0.00698	1.08966	0.19	n/a
Mount Zirkel	Summit Lake	40º32'43"	106º40'55"	3144.3	48.0	108	1985-2007	0.00052	0.00467	1.08966	0.10	n/a
Popo Agie	Lower Saddlebag Lake	42º37'24"	108º59'38"	3432.7	55.6	59	1989-2009	0.00018	0.00118	0.91186	0.03	n/a
Rawah	Island Lake	40º37'38"	105º56'28"	3391.8	71.4	21	1996-2009	0.00069	0.00427	0.84582	0.09	n/a
Rawah	Rawah Lake #4	40º40'16"	105º57'28"	3497.3	41.6	26	1996-2009	0.00075	0.00465	0.84582	0.16	n/a

Table 3-21. Modeled changes in ANC from non-CD-C Project sources for the 2006 meteorological year.

Non-CDC Project 2008 Met 2006												
Wilderness Area	Lake	Latitude (Deg N, NAD27)	Longitude (Deg W, NAD27)	Elevation (m)	10th Percentile Lowest ANC Value (µeq/L)	Number of Samples	Period of Monitoring	Total S Dep (kg-S/ha-yr)	Total N Dep (kg-N/ha-yr)	PPT (m)	Delta ANC (%)	Delta ANC (ueq/l)
Bridger	Black Joe Lake	42º44'22"	109º10'16"	3126.6	69.7	78	1984-2009	0.00001	0.00005	0.91186	0.00	n/a
Bridger	Deep Lake	42º43'10"	109º10'15"	3201.0	60.4	75	1984-2009	0.00001	0.00006	0.91186	0.00	n/a
Bridger	Hobbs Lake	43º02'08"	109º40'20"	3066.3	70.1	85	1984-2009	0.00000	0.00004	0.91186	0.00	n/a
Bridger	Lazy Boy Lake	43º19'57"	109º43'47"	3535.7	12.4	5	1997-2009	0.00000	0.00002	0.91186	0.00	0.00
Bridger	Upper Frozen Lake	42º41'13"	109º09'39"	3486.9	7.4	12	1997-2009	0.00001	0.00006	0.91186	0.01	0.00
Fitzpatrick	Ross Lake	43º22'41"	109º39'30"	2948.9	54.1	60	1988-2009	0.00000	0.00002	0.91186	0.00	n/a
Mount Zirkel	Lake Elbert	40º38'03"	106º42'25"	3291.8	53.6	67	1985-2007	0.00009	0.00066	1.08966	0.01	n/a
Mount Zirkel	Seven Lakes (LG East)	40º53'45"	106º40'55"	3271.4	40.5	24	1985-2007	0.00011	0.00089	1.08966	0.02	n/a
Mount Zirkel	Summit Lake	40º32'43"	106º40'55"	3144.3	48.0	108	1985-2007	0.00004	0.00052	1.08966	0.01	n/a
Popo Agie	Lower Saddlebag Lake	42º37'24"	108º59'38"	3432.7	55.6	59	1989-2009	0.00001	0.00007	0.91186	0.00	n/a
Rawah	Island Lake	40º37'38"	105º56'28"	3391.8	71.4	21	1996-2009	0.00005	0.00046	0.84582	0.01	n/a
Rawah	Rawah Lake #4	40º40'16"	105º57'28"	3497.3	41.6	26	1996-2009	0.00005	0.00050	0.84582	0.02	n/a

4.0. CRITERIA AIR POLLUTANT RESULTS

4.1. INTRODUCTION

During the fall of 2010, ENVIRON completed an initial 2008 baseline modeling run. Evaluation of the PSAT results indicated that a model error had been introduced when the new vertical velocity algorithm was added to the model in 2009. This error did not affect the CAMx host model results, only the APCA/PSAT source apportionment results. The error was identified and corrected, but insufficient time remained before the November 18, 2010 CD-C stakeholder meeting to rerun CAMx with PSAT, which is very computationally demanding. The model was rerun for ozone only with APCA to produce criteria pollutant and ozone results, and the criteria pollutant results were presented to the CD-C stakeholders at their November 18 meeting. A new 2008 baseline run with PSAT using the corrected version CAMx was then performed to calculate 2008 CD-C AQRV impacts. This run was completed in late December, 2010; in Section 4, we present results for criteria air pollutants from this run.

Criteria air pollutants (CAPs) are pollutants regulated under the Clean Air Act and for which National Ambient Air Quality Standards have been set. The CAPs are: ozone, NO_2, CO, PM_{10}, $PM_{2.5}$ and SO_2. ENVIRON processed the 2008 model output surface layer concentrations for the 4 km modeling domain for the two years of meteorology (2005 and 2006) for the required averaging periods so that the results for each of the CAPS could be compared to the relevant NAAQS. The purpose of this analysis was to determine whether the existing 2008 CD-C Project sources contribute to modeled exceedances of the NAAQS in the 4 km domain which will be the focus of the future year CD-C Project impact analysis.

The ozone modeling results were processed for comparison with the 8-hour ozone NAAQS using two different methods. The first method was to use the absolute modeling concentrations to calculate the 4th high daily maximum 8-hour ozone concentration for each grid cell in the 4 km domain for each modeled year. Then, the results for 2005 and 2006 were averaged to approximate a design value for each grid cell; these values were then compared with the NAAQS. The second method was to use EPA's Modeled Attainment Software (MATS; Abt, 2009) to project the 2008 design values starting from observed 2008 ozone design values and using the modeling results via the calculation of relative reduction response factors (RRFs). The EPA projection procedures used in MATS are described further in the CD-C Modeling Protocol and in Abt (2009) and the results of the ozone analysis are presented in Section 2. Although MATS has the capability to project $PM_{2.5}$ values, the EPA MATS projection method for $PM_{2.5}$ could not be used due to insufficient ambient data in the CD-C 4 km domain.

For the CAPs other than ozone (NO_2, SO_2, $PM_{2.5}$, PM_{10}, and CO), the raw model results were processed for comparison with the relevant NAAQS for 2005 and 2006, and then the results for 2005 and 2006 were averaged together. Note that for these five pollutants, 2005 and 2006 results were similar enough that taking an average of the results for the two years was a reasonable strategy.

The CAPs analysis showed exceedances of the NAAQS for 1-hour SO_2, 24-hour and annual average PM_{10} and 8-hour average CO within the 4 km domain. Note that the 8-hour average

CO exceedance was caused by a fire that occurred in 2005. This fire is an exceptional event and will not affect the outcome of the CD-C impact analysis.

Air in the vicinity of large point sources may fall within the fenceline of the facility and so would not be considered ambient air regulated by the NAAQS. It is not clear how to define "ambient air" when the air quality model is running at 4 km grid resolution. Near-field air impacts within and in the vicinity of the fenceline of industrial facilities are typically evaluated with a plume model such as AERMOD. Near-field modeling of CAPs from the CD-C Project will be performed using AERMOD.

4.2. RESULTS FOR PM, NO_2, SO_2 AND CO

In this section, the 2008 baseline run results are displayed for each pollutant. Note that the CD-C Project-only contribution (lower panels of Figures 4-1 through 4-10) would not have been visible on the scale used to plot the absolute model results from all regional emissions sources (upper panel of Figures 4-1 through 4-10) so the CD-C Project contributions are plotted on different scales with much lower maxima. The NAAQS for each of the criteria pollutants is shown in Table 4-1. For species that show an exceedance of the NAAQS (1-hour SO_2, 24-hour and annual average PM_{10} and 8-hour average CO), the size and spatial scale of the CD-C Project contribution make it clear that the CD-C Project is not a significant contributor to the exceedance. For 8-hour CO, the exceedance is caused by a fire in Lincoln County and is not related to CD-C Project emissions.

Table 4-1. Ambient Air Quality Standards (μg/m³).

Pollutant/Averaging Time	NAAQS	WAAQS	
CO			
1-hour[1]	40,000	40,000	
8-hour[1]	10,000	10,000	
NO_2			
1-hour[5]	188	--	
Annual[2]	100	100	
PM_{10}			
24-hour[1]	150	150	
Annual[2]	--[3]	50	
$PM_{2.5}$			
24-hour[4]	35	35	
Annual[2]	15	15	
SO_2			
1-hour[6]	196		
3-hour[1]	1,300	1,300	
24-hour[1]	365	260	
Annual[2]	80	60	

1 No more than one exceedance per year.
2 Annual arithmetic mean.
3 The annual NAAQS for pollutant has been revoked by EPA.
4 An area is in compliance with the standard if the 98th percentile of 24-hour PM2.5 concentrations in a year, averaged over 3 years, is less than or equal to the level of the standard.
5 An area is in compliance with the standard if the 98th percentile of daily maximum 1-hour NO_2 concentrations in a year, averaged over 3 years, is less than or equal to the level of the standard.
6 An area is in compliance with the standard if the 99th percentile of daily maximum 1-hour SO_2 concentrations in a year, averaged over 3 years, is less than or equal to the level of the standard.

Tables 4-2 and 4-3 summarize the maximum CD-C Project impacts for NO_2, PM (Table 4-2) and SO_2, (Table 4-3) respectively within the Class I and sensitive Class II areas. 2005 and 2006 results were calculated for each CAP and averaging time and the higher of the 2005 and 2006 results is presented in Tables 4-2 and 4-3. Note that although PSAT does not track NO_2, it does track NOx (NO_2+NO).

Tables 4-2 and 4-3 show that the areas with largest impacts across all pollutants are: Dinosaur NM, Rawah WA, Savage Run WA, and Mount Zirkel WA. Bridger WA, Fitzpatrick WA and the Wind River Roadless Area tended to have lower impacts as they are further from the Project and are located generally upwind.

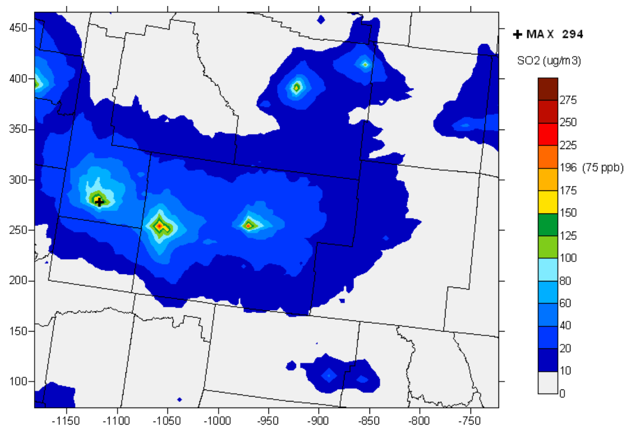
Table 4-2. Maximum CD-C Project contribution during 2005 and 2006 meteorological years across all Class I and sensitive Class II Areas.

Class I and Sensitive Class II Areas	Annual Average NO_2/NOx	Annual Average PM_{10}	24-hr Average PM_{10}	Annual Average $PM_{2.5}$	24-hr Average $PM_{2.5}$
Bridger WA	2.96E-07	1.86E-04	7.99E-03	1.86E-04	2.64E-03
Dinosaur NM	4.19E-06	1.69E-03	4.17E-02	1.69E-03	1.78E-02
Fitzpatrick WA	6.41E-08	1.15E-04	5.99E-03	1.15E-04	2.47E-03
Mount Zirkel WA	3.74E-06	1.63E-03	3.82E-02	1.63E-03	1.09E-02
Popo Agie WA	3.11E-07	1.99E-04	8.58E-03	1.99E-04	2.28E-03
Rawah WA	1.84E-06	1.04E-03	1.20E-02	1.04E-03	7.46E-03
Savage Run WA	5.54E-06	2.00E-03	2.35E-02	2.00E-03	1.34E-02
Wind River RA	8.24E-08	1.31E-04	5.11E-03	1.31E-04	2.51E-03

Table 4-3. Maximum CD-C Project contribution during 2005 and 2006 meteorological years across all Class I and sensitive Class II Areas.

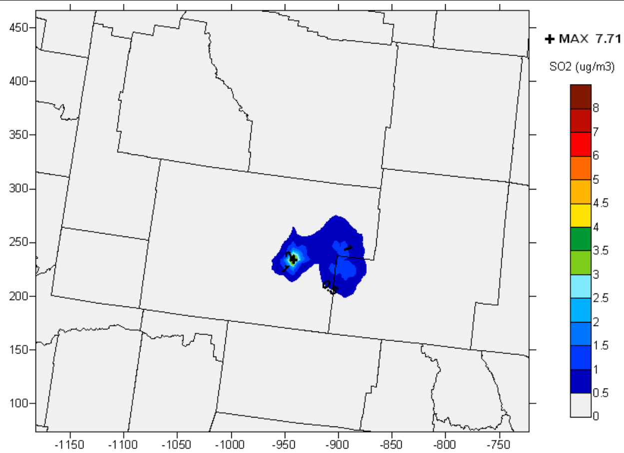
Class I and Sensitive Class II Areas	Annual Average SO_2	24-hr Average SO_2	3-hr Average SO_2
Bridger WA	2.28E-08	7.58E-07	3.14E-06
Dinosaur NM	2.44E-07	3.52E-06	1.07E-05
Fitzpatrick WA	8.88E-09	5.91E-07	1.85E-06
Mount Zirkel WA	2.10E-07	2.01E-06	9.33E-06
Popo Agie WA	2.22E-08	6.46E-07	3.51E-06
Rawah WA	1.06E-07	7.96E-07	2.88E-06
Savage Run WA	3.06E-07	2.17E-06	7.80E-06
Wind River RA	9.27E-09	5.71E-07	1.53E-06

1-hour SO_2: Contribution from All Regional Sources Including CD-C Project



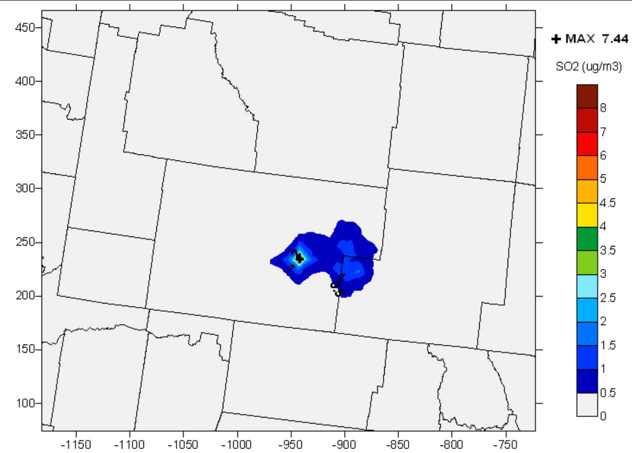
CDC CAMx r12 4km (Average of 2005 and 2006)
4th Highest Daily Max 1-hr SO2 Concentration

CD-C Project 1-hour SO_2 Contribution: 2008met2005



CDC CAMx r12 4km 2008met2005
4th Highest Daily Max 1-hr SO2 Concentration
CDC Contribution

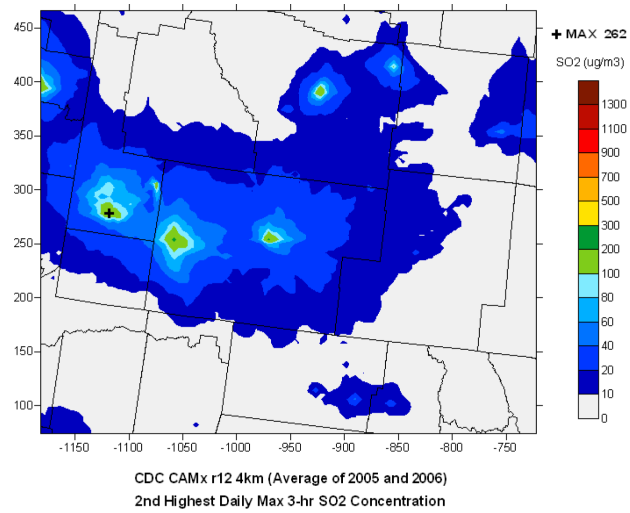
CD-C Project 1-hour SO_2 Contribution: 2008met2006



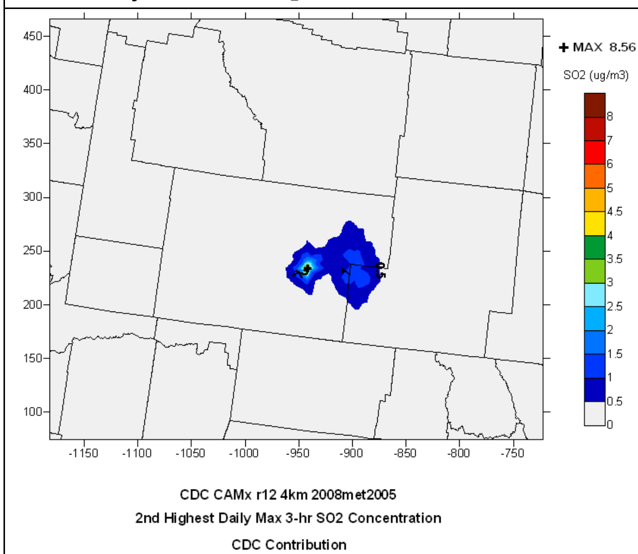
CDC CAMx r12 4km 2008met2006
4th Highest Daily Max 1-hr SO2 Concentration
CDC Contribution

Figure 4-1. CAMx 2008 baseline model results for 1-hour SO_2. Upper panel: Absolute model results for 1-hour SO_2 from all regional emissions sources, including CD-C Project and non-Project sources within the CD-C Project area. 1-hour SO_2 results from the 2005 and 2006 meteorological years using 2008 emissions were averaged together to produce this figure. Lower panels: 1-hour SO_2 contribution from the CD-C Project sources only for the 2005 (left panel) and 2006 (right panel) meteorological years, respectively. Note difference in scales between upper and lower panels.

3-hour SO_2: Contribution from All Regional Sources Including CD-C Project



CD-C Project 3-hour SO_2 Contribution: 2008met2005



CD-C Project 3-hour SO_2 Contribution: 2008met2006

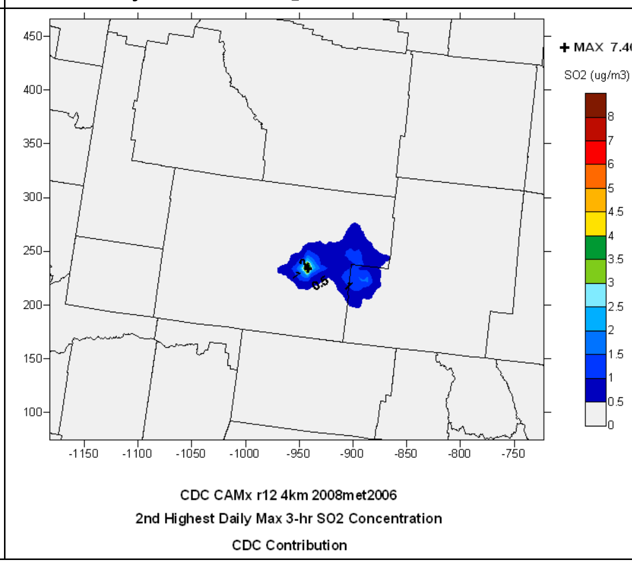
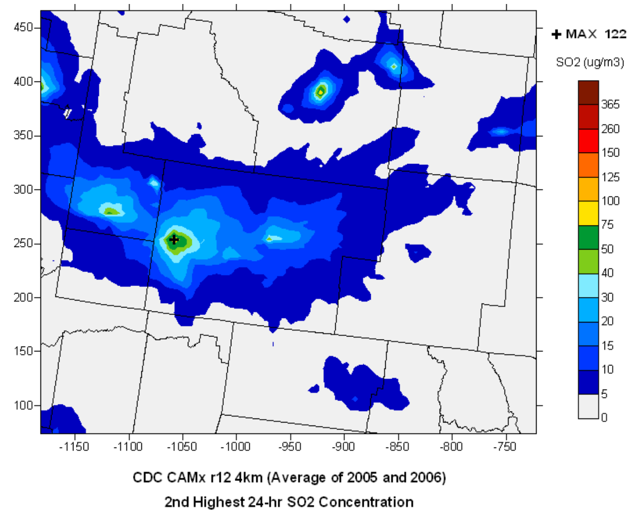
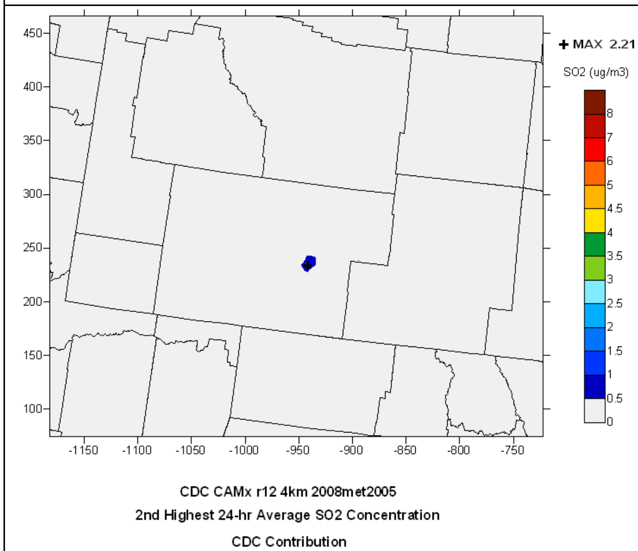


Figure 4-2. CAMx 2008 baseline model results for 3-hour SO_2. Upper panel: Absolute model results for 3-hour SO_2 from all regional emissions sources, including CD-C Project and non-Project sources within the CD-C Project area. 3-hour SO_2 results from the 2005 and 2006 meteorological years using 2008 emissions were averaged together to produce this figure. Lower panels: 3-hour SO_2 contribution from the CD-C Project sources only for the 2005 (left panel) and 2006 (right panel) meteorological years, respectively. Note difference in scales between upper and lower panels.

24-hour SO_2: Contribution from All Regional Sources Including CD-C Project



CD-C Project 24-hour SO_2 Contribution: 2008met2005



CD-C Project 24-hour SO_2 Contribution: 2008met2006

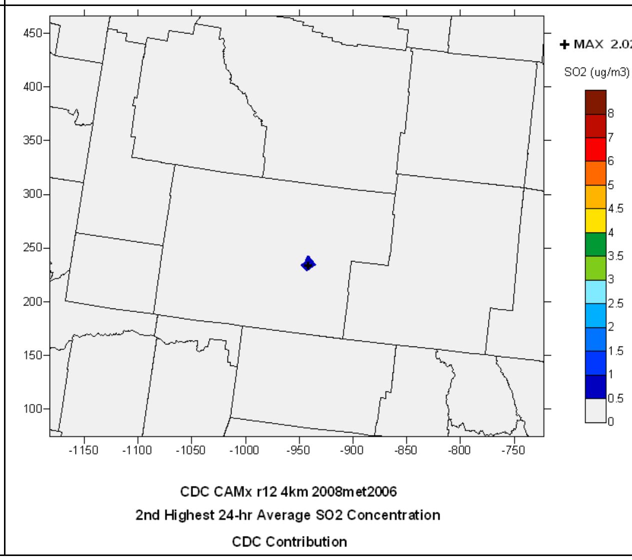


Figure 4-3. CAMx 2008 baseline model results for 24-hour SO_2. Upper panel: Absolute model results for 24-hour SO_2 from all regional emissions sources, including CD-C Project and non-Project sources within the CD-C Project area. 24-hour SO_2 results from the 2005 and 2006 meteorological years using 2008 emissions were averaged together to produce this figure. Lower panels: 24-hour SO_2 contribution from the CD-C Project sources only for the 2005 (left panel) and 2006 (right panel) meteorological years, respectively. Note difference in scales between upper and lower panels.

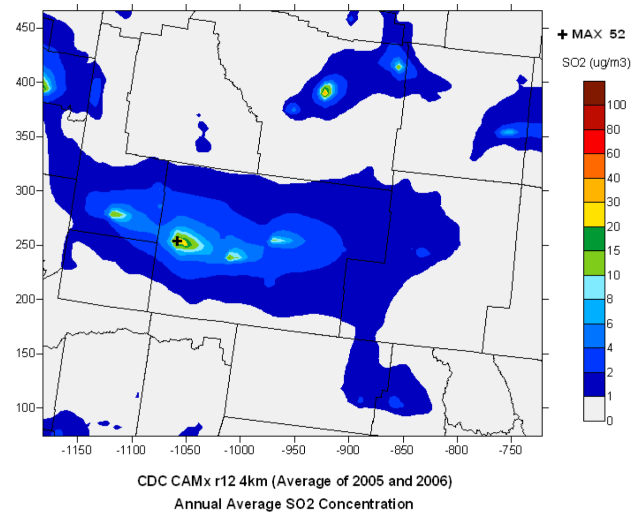
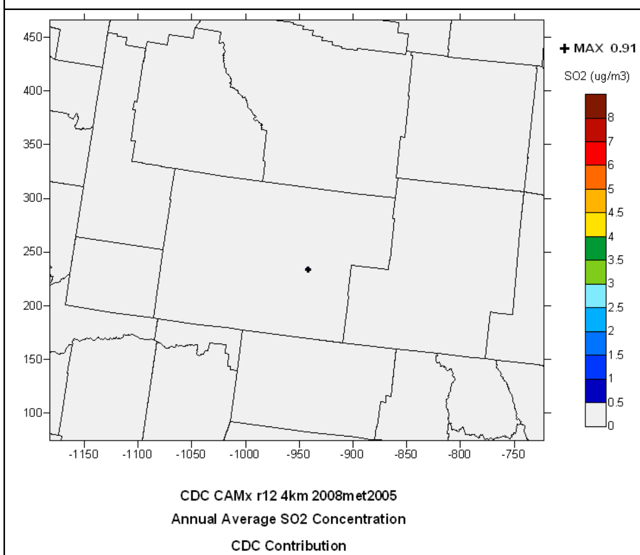
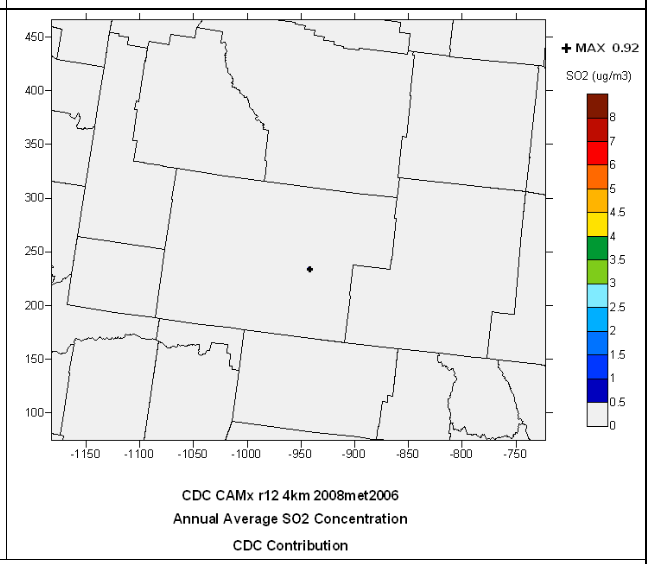
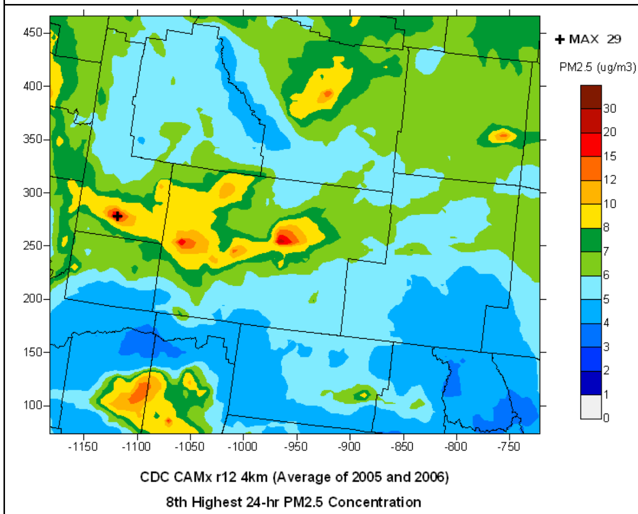
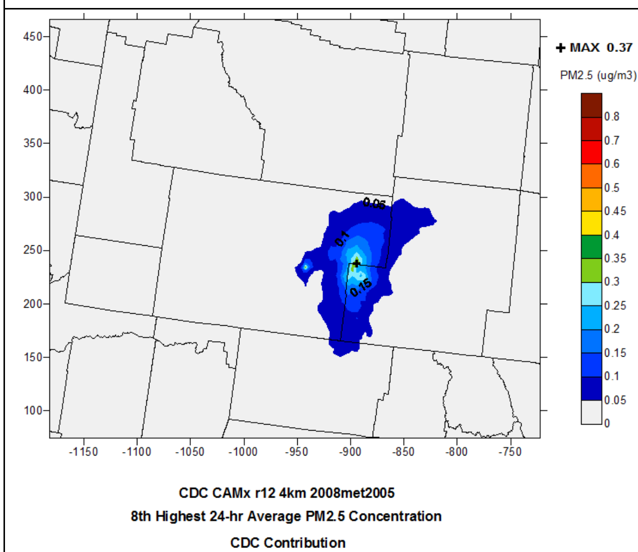
Annual Average SO_2: Contribution from All Regional Sources Including CD-C Project	
	
CD-C Project Annual Average SO_2 Contribution: 2008met2005	**CD-C Project Annual Average SO_2 Contribution: 2008met2006**
	

Figure 4-4. CAMx 2008 baseline model results for annual average SO_2. Upper panel: Absolute model results for annual average SO_2 from all regional emissions sources, including CD-C Project and non-Project sources within the CD-C Project area. Annual average SO_2 results from the 2005 and 2006 meteorological years using 2008 emissions were averaged together to produce this figure. Lower panels: annual average SO_2 contribution from the CD-C Project sources only for the 2005 (left panel) and 2006 (right panel) meteorological years, respectively. Note difference in scales between upper and lower panels.

24-hour $PM_{2.5}$: Contribution from All Regional Sources Including CD-C Project



CD-C Project 24-hour $PM_{2.5}$ Contribution: 2008met2005



CD-C Project 24-hour $PM_{2.5}$ Contribution: 2008met2006

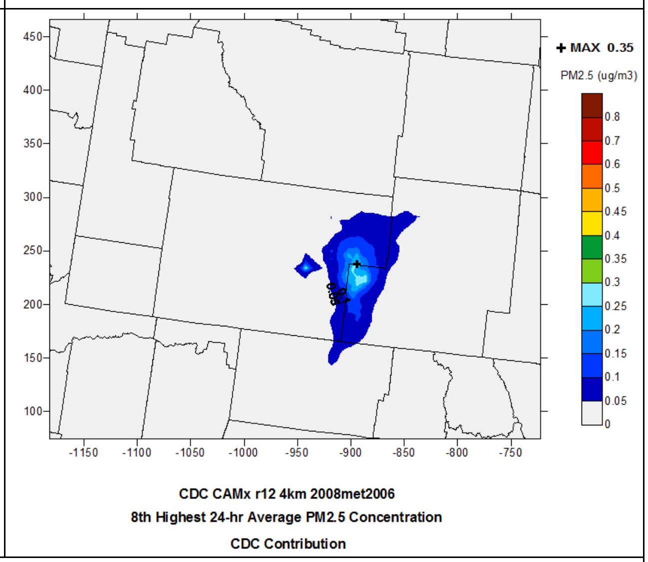
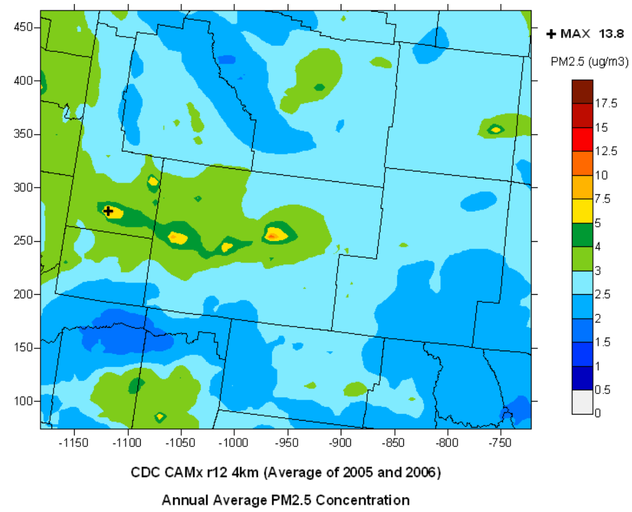
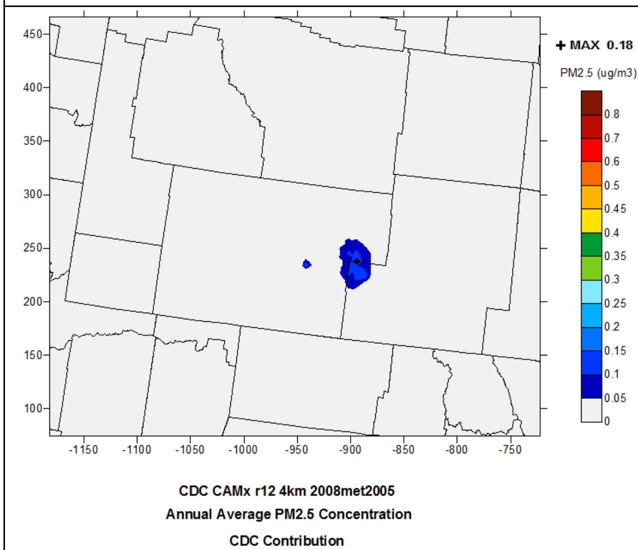


Figure 4-5. CAMx 2008 baseline model results for 24-hour $PM_{2.5}$. Upper panel: Absolute model results for 24-hour $PM_{2.5}$ from all regional emissions sources, including CD-C Project and non-Project sources within the CD-C Project area. 24-hour $PM_{2.5}$ results from the 2005 and 2006 meteorological years using 2008 emissions were averaged together to produce this figure. Lower panels: 24-hour $PM_{2.5}$ contribution from the CD-C Project sources only for the 2005 (left panel) and 2006 (right panel) meteorological years, respectively. Note difference in scales between upper and lower panels.

Annual Average $PM_{2.5}$: Contribution from All Regional Sources Including CD-C Project



CD-C Project Annual Average $PM_{2.5}$ Contribution: 2008met2005



CD-C Project Annual Average $PM_{2.5}$ Contribution: 2008met2006

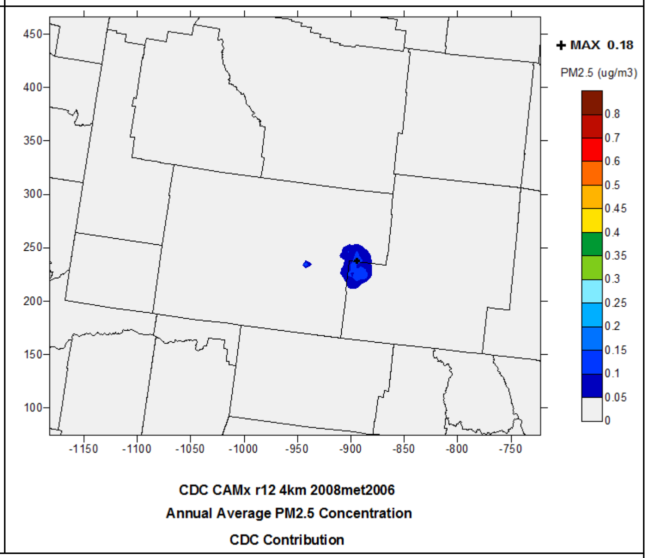
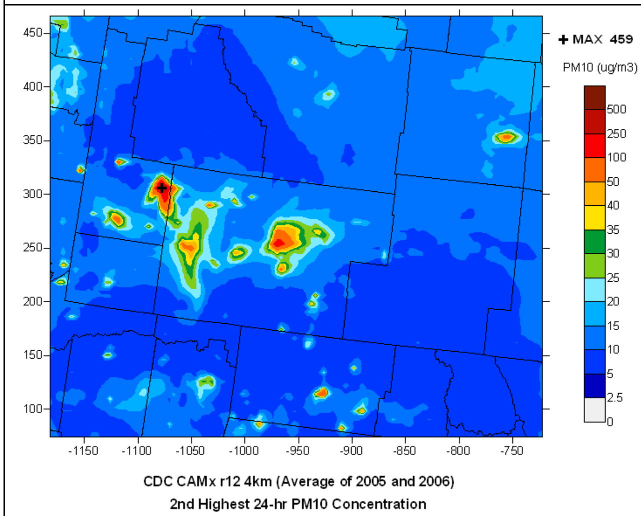
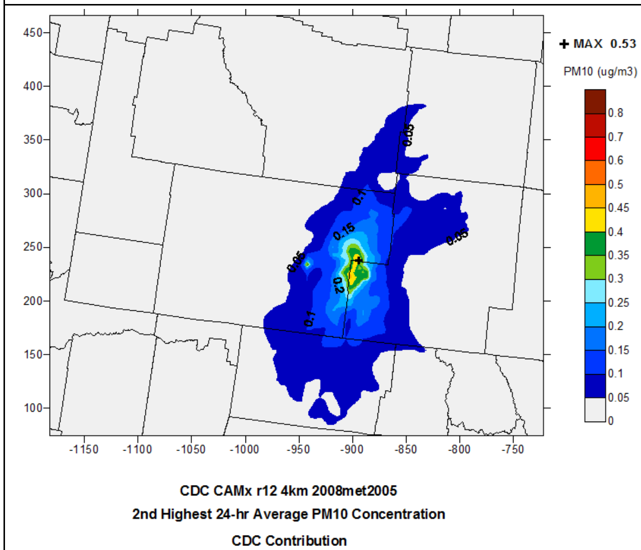


Figure 4-6. CAMx 2008 baseline model results for annual average $PM_{2.5}$. Upper panel: Absolute model results for annual average $PM_{2.5}$ from all regional emissions sources, including CD-C Project and non-Project sources within the CD-C Project area. Annual average $PM_{2.5}$ results from the 2005 and 2006 meteorological years using 2008 emissions were averaged together to produce this figure. Lower panels: annual average $PM_{2.5}$ contribution from the CD-C Project sources only for the 2005 (left panel) and 2006 (right panel) meteorological years, respectively. Note difference in scales between upper and lower panels.

24-hour PM_{10}: Contribution from All Regional Sources Including CD-C Project



CD-C Project 24-hour PM_{10} Contribution: 2008met2005



CD-C Project 24-hour PM_{10} Contribution: 2008met2006

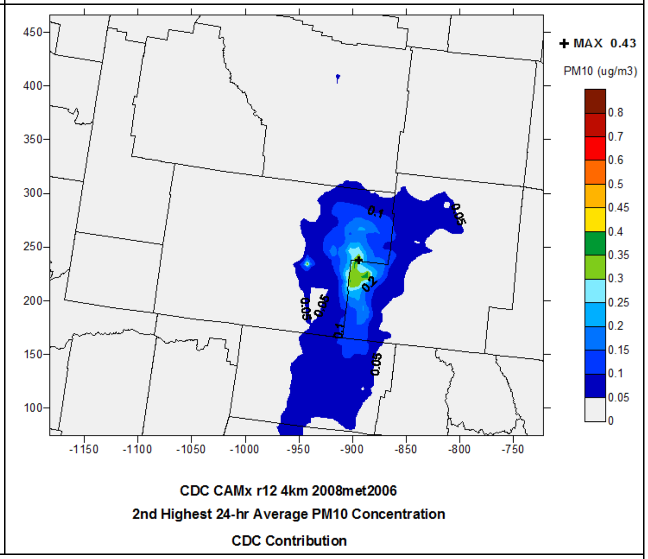
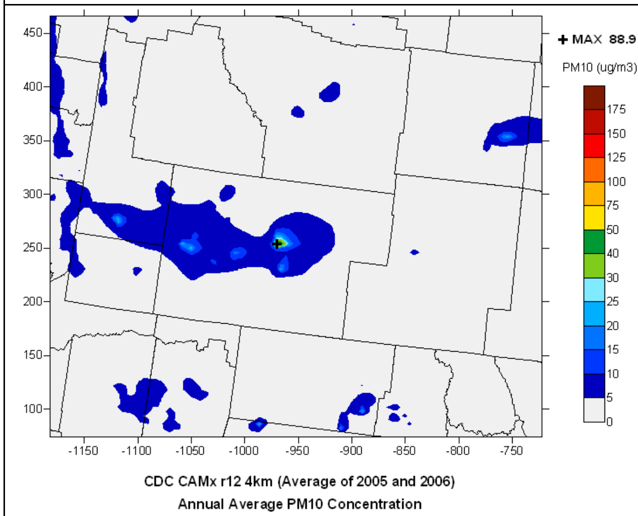
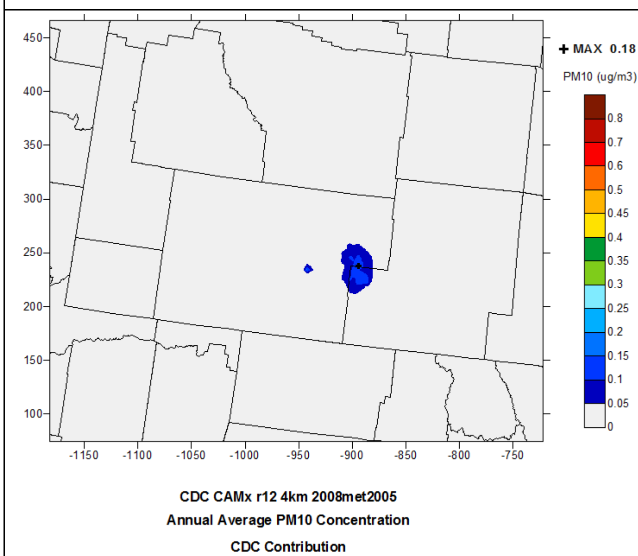


Figure 4-7. CAMx 2008 baseline model results for 24-hour PM_{10}. Upper panel: Absolute model results for 24-hour PM_{10} from all regional emissions sources, including CD-C Project and non-Project sources within the CD-C Project area. 24-hour PM_{10} results from the 2005 and 2006 meteorological years using 2008 emissions were averaged together to produce this figure. . Lower panels: 24-hour PM_{10} contribution from the CD-C Project sources only for the 2005 (left panel) and 2006 (right panel) meteorological years, respectively. Note difference in scales between upper and lower panels.

Annual Average PM_{10}: Contribution from All Regional Sources Including CD-C Project



CD-C Project Annual Average PM_{10} Contribution: 2008met2005



CD-C Project Annual Average PM_{10} Contribution: 2008met2006

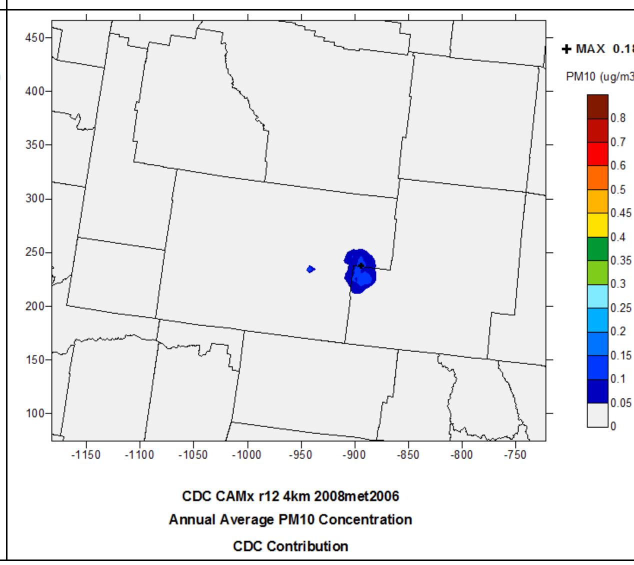
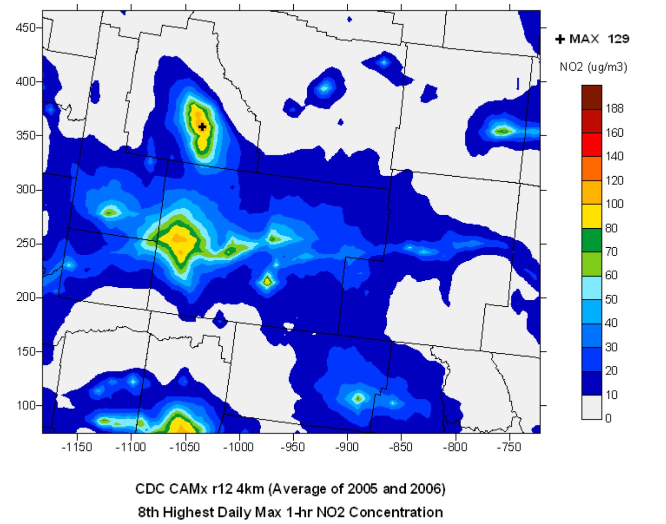


Figure 4-8. CAMx 2008 baseline model results for annual average PM_{10}. Upper panel: Absolute model results for annual average PM_{10} from all regional emissions sources, including CD-C Project and non-Project sources within the CD-C Project area. Annual average PM_{10} results from the 2005 and 2006 meteorological years using 2008 emissions were averaged together to produce this figure. Lower panels: annual average PM_{10} contribution from the CD-C Project sources only for the 2005 (left panel) and 2006 (right panel) meteorological years, respectively. Note difference in scales between upper and lower panels.

1-hour Average NO_2: Contribution from All Regional Sources Including CD-C Project



Annual Average NO_2: Contribution from All Regional Sources Including CD-C Project

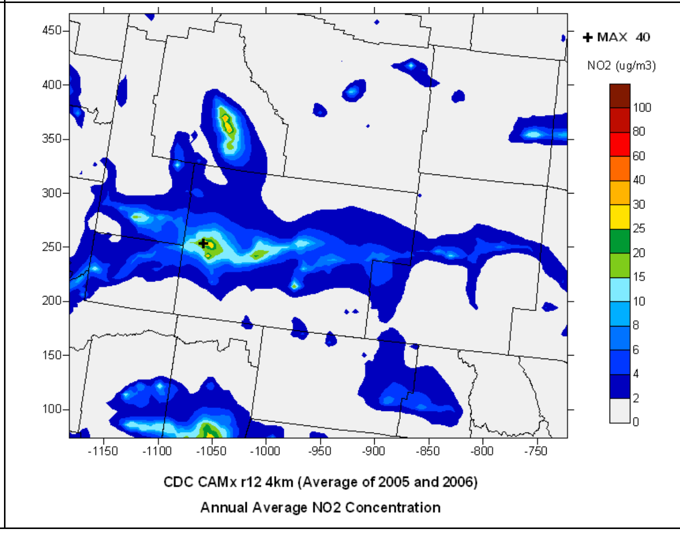


Figure 4-9. CAMx 2008 baseline model results for NO_2. Left panel: Absolute model results for 1-hour average NO_2 from all regional emissions sources, including CD-C Project and non-Project sources within the CD-C Project area. 1-hour average NO_2 results from the 2005 and 2006 meteorological years using 2008 emissions were averaged together to produce this figure. Right panel: as in left panel, but for annual average NO_2.

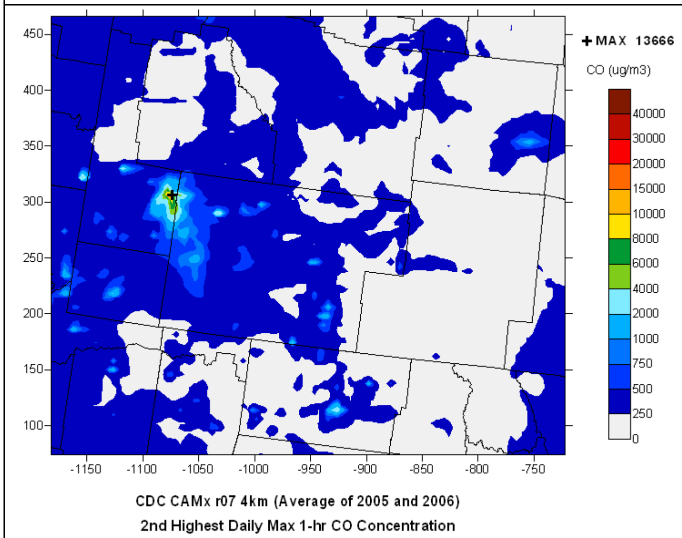
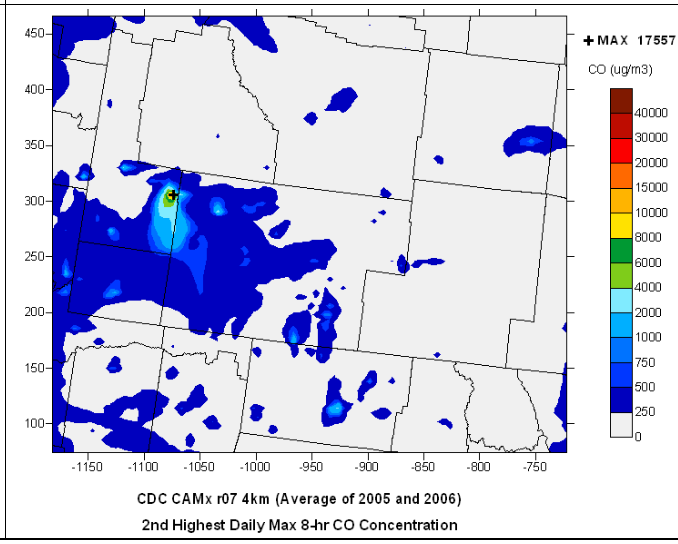
1-hour Average CO: Contribution from All Regional Sources Including CD-C Project	**8-hour Average CO: Contribution from All Regional Sources Including CD-C Project**
	

Figure 4-10. CAMx 2008 baseline model results for CO. Right panel: Absolute model results for 1-hour average CO from all regional emissions sources, including CD-C Project and non-Project sources within the CD-C Project area. 1-hour average CO results from the 2005 and 2006 meteorological years using 2008 emissions were averaged together to produce this figure. Left panel: as in right panel, but for 8-hour average CO.

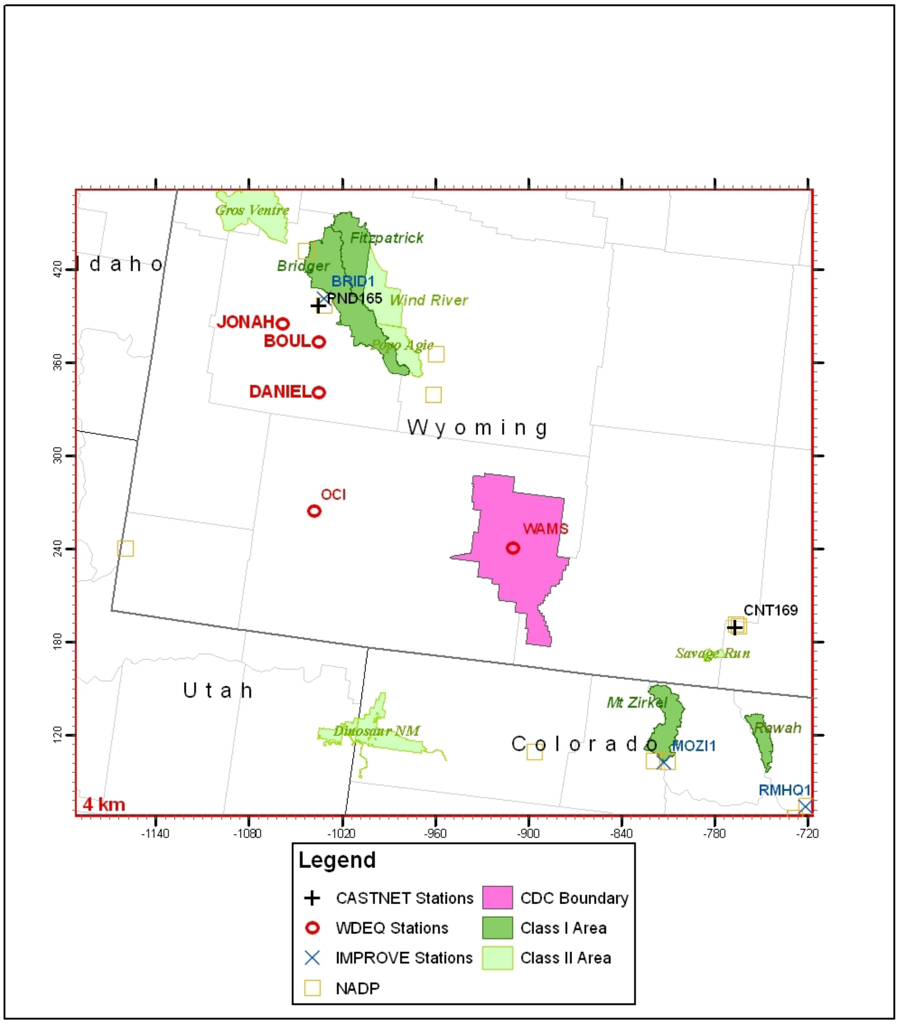


Figure 4-11. CAMx 4 km modeling domain, showing location of Class I and sensitive Class II areas and the CD-C Project area.

4.3. SUMMARY

Examination of the spatial scale and magnitude of the CD-C Project contribution to criteria pollutant concentrations within the 4 km grid show that exceedances of the NAAQS in the 2008 baseline modeling are not related to emissions from the existing CD-C Project.

5.0. CONCLUSIONS

Baseline year CAMx modeling was carried out for the CD-C EIS. A 2008 typical emissions scenario was modeled using 2005 and 2006 meteorology. This model run was performed to establish a baseline against which future year runs containing CD-C Project emissions will be evaluated. A second purpose of the baseline modeling was to assess 2008 AQ and AQRV impacts from existing CD-C Project area emissions sources.

Criteria pollutant levels within the 4 km domain were evaluated and the contributions of the CD-C Project emissions sources were quantified using the CAMx APCA and PSAT probing tools. Modeled ozone levels and CD-C Project area ozone impacts are reported in this document, and results for criteria pollutants other than ozone (NO_2, SO_2, PM_{10}, $PM_{2.5}$ and CO) have been reported to the CD-C stakeholders in a separate memorandum (ENVIRON and Carter Lake, 2011).

The regional ozone modeling results were analyzed using the EPA MATS tool as well as through examination of the absolute modeling results. Both methods showed exceedances of the 2008 ozone NAAQS (75 ppb) in the 4 km domain as well as exceedances of the full range of NAAQS proposed by the EPA in January 2010 (60 ppb-70 ppb). However, none of the exceedances of the 75 ppb NAAQS occurs in the vicinity of the CD-C Project area, which is distant from and has much lower ozone than the high ozone regions that include the Salt Lake City and Fort Collins/Denver metropolitan areas and Sublette County, WY.

The ozone source apportionment results from the CAMx APCA tool showed that CD-C Project emissions sources contributed 0.4 ppb or less to 8-hour ozone Design Values across the 4 km domain. The CD-C contribution to 8-hour ozone at monitors on observed and modeled DM8>75 ppb days and DM8>70 ppb days was 1.1 ppb or less and 1.4% or less of the DM8 value. The CD-C contribution to 8-hour ozone at monitors on observed and modeled DM8>60 ppb days was 2.3 ppb or less and 3.2% or less of the DM8 value. The largest CD-C ozone impacts occurred at monitors near and generally downwind of the CD-C Project area; these are Wamsutter, Atlantic Rim, Sun Dog, and Centennial. In 2006 only, there is a comparable impact at the Spring Creek monitor due to an episode of southerly winds on April 22, 2006 that brought ozone and precursors northward from the CD-C Project area to Fremont and Natrona Counties.

The non-CD-C project contribution to high observed and modeled 8-hour ozone at Sublette County monitors was 0.2 ppb or less and less than 0.3% of the DM8. The contribution of CD-C Project sources was larger than that of non-CD-C Project sources within the CD-C Project area.

The AQRV impact analysis evaluated CD-C project impacts on visibility, deposition and acidification of sensitive lakes. The visibility impact assessment showed that there were no days during the 2005 or 2006 meteorological years when the 0.5 dv visibility impact threshold was exceeded at any Class I or sensitive Class II area within the 4 km domain. The deposition analysis showed that there were no nitrogen or sulfur deposition impacts from CD-C Project area emissions sources that exceeded the BLM levels of concern at any Class I or Class II sensitive area; impacts on ANC from CD-C Project area sources at sensitive lakes were less than the levels of acceptable change.

Finally, examination of the spatial scale and magnitude of the CD-C Project contribution to criteria pollutant concentrations within the 4 km grid showed that exceedances of the NAAQS in the 2008 baseline modeling are not related to emissions from the existing CD-C Project.

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