DATA REQUEST #4
AIR QUALITY

BACKGROUND

Section 6.1.4 of the SPPE states that sulfur dioxide (SOx) emission reduction credits will be utilized to mitigate the project's PM10 emission increases. The applicant proposed to provide 2.5 lb of SOx emission reduction credits for every pound of new PM10 emissions. While we believe that SOx emission reduction credits can be used to mitigate new PM10 emissions, we are concerned that the proposed 2.5:1 trading ratio of SOx to PM10 may not be adequately justified without an analysis to support its use.

DATA REQUEST

4. Please provide an analysis demonstrating that using the proposed 2.5:1 SOx for PM10 trading ratio would mitigate the project's new PM10 emissions impacts in the existing ambient air quality setting.

DATA RESPONSE

An analysis was conducted to estimate the appropriate interpollutant ratio for the use of sulfur dioxide emission reduction credits to offset the ECGS Unit 3 Repower Project emissions of PM_{10}. This analysis utilized a calculation approach that was used by the Sacramento Metropolitan Air Quality Management District (SMAQMD) as part of its evaluation to determine the SO_2/PM_{10} ratio for the Consumnes Power Plant in Sacramento County. SMAQMD provided a portion of the technical report for that evaluation and a spreadsheet (they used) to develop the estimate for the Consumnes project. This same approach was used with emissions and air quality data specific to Imperial County to develop an equivalent estimate of the appropriate interpollutant ratio for the Project area. Although not all of the air chemistry data needed for a thorough resolution of this issue are currently available in the case of Imperial County, reasonable assumptions have been made in quantifying some of the relevant parameters.

The “ratio of monitor to emissions” methodology was used as the basis for the current evaluation. This method is designed to determine the reduction in sulfur oxides (SO_x) (in pounds) that would be required in the Project area to produce the same reduction in ambient PM_{10} concentrations as a one pound reduction of primary particulate emissions. The method inherently assumes that the principal chemical pathway for converting gaseous SO_x to particulate matter is by means of ammonium sulfate formation.

Docket Number 06-SPPE-2
First Round Data Requests
El Centro Unit 3 Repower Project
July 2006

DATA REQUEST #4
AIR QUALITY

Ammonium sulfate is formed in the atmosphere primarily through the gas phase oxidation of SO_2 by the hydroxyl radical, producing sulfuric acid, which condenses into the particulate phase. The oxidation of SO_2 can also occur in the condensed phase; through the reaction of dissolved SO_2 with ozone and hydrogen peroxide. Ammonia and nitric acid also can react in the atmosphere to form ammonium nitrate (NH_4NO_3). Ammonium nitrate is formed in areas characterized by high ammonia and nitric acid concentrations and low sulfate concentrations. If sufficient ammonia is available, ammonia will first react with sulfate to form ammonium sulfate and the remaining ammonia will react with existing nitric acid to form ammonium nitrate. (Seinfeld and Pandis 1998)

The basic steps of the ratio of monitor to emissions method are as follows:

1. Estimate the combustion component of measured ambient PM_{10} concentrations per unit combustion PM_{10} emissions in the project area.
2. Estimate the ambient particulate ammonium sulfate concentration per unit sulfur oxides emissions in the project area.
3. Calculate the ratio of the quantity resulting from Step 1 to that resulting from Step 2 to determine the interpollutant offset ration, i.e., the reduction in sulfur oxides emissions that would be equivalent to a unit reduction in primary PM_{10} emissions.

Two basic conditions must be satisfied for this method to provide a reasonable estimate of the appropriate SO_2/PM_{10} interpollutant offset ratio: (1) there must be a strong correlation between measured total PM_{10} concentrations and the sulfate and nitrate components of PM_{10}, since the method assumes that reductions in SO_x emissions have the effect of reducing the particulate sulfate component of PM_{10}; and (2), the area where the reductions in SO_x emissions occur must be "ammonia rich," i.e., there must be sufficient atmospheric ammonia available to drive the reactions that form ammonium sulfate from sulfuric acid (derived from nitrogen oxides emissions). When sulfur oxides emissions are reduced in an ammonia rich environment, there is insufficient nitrate available to form particulate ammonium nitrate. Therefore a reduction in SO_x emissions under these conditions will result in a reduction of airborne particulate matter without the complicating factor of additional nitrate production.

The available evidence regarding the fulfillment of these criteria in Imperial County is discussed below.

DATA REQUEST #4
AIR QUALITY

Correlations between PM_{10} and its sulfate and nitrate components

Limited data from three air monitoring stations are available from the California Air Resources Board website to test these correlations in Imperial County. These data consist of 24 hour PM_{10} concentrations along with the measured sulfate and nitrate PM_{10} fractions recorded every sixth day during 2000 at the Brawley, Calexico Ethel Street, and El Centro 9th Street stations and during 2004 at the Calexico Ethel Street Station. While the data for the El Centro station are probably the most geographically representative of conditions at the ECGS, the 2004 Ethel Street data are considerably more recent and are thus included in the analysis.

Attachment A, Figures, contains Figures 1 through 4 that are plots showing the sequence of measured PM_{10}, and particulate sulfate and particulate nitrate concentrations for each station during the respective years when monitoring for these parameters occurred. These figures indicate a clear relationship between total PM_{10} and the sulfate and nitrate components, i.e., all three concentrations tend to rise and fall together. However, there is a generally stronger correlation for the sulfate fraction. When correlations coefficients between the measured total PM_{10} concentrations with the concentrations of particulate sulfate and particulate nitrate components were calculated, the results were as follows:

2000 Brawley	PM_{10} correlation with sulfate: 0.587
	PM_{10} correlation with nitrate: 0.322
2000 El Centro	PM_{10} correlation with sulfate: 0.759
	PM_{10} correlation with nitrate: 0.397
2000 Calexico	PM_{10} correlation with sulfate: 0.746
	PM_{10} correlation with nitrate: 0.258
2004 Calexico	PM_{10} correlation with sulfate: 0.498
	PM_{10} correlation with nitrate: 0.350

The correlations between total PM_{10} and particulate sulfate concentration are considerably stronger than between total PM_{10} and particulate nitrate levels for all stations and all available years of data. In addition, the 2000 and 2004 data for the Calexico monitoring station show a fairly high level of temporal variability in the correlations with both sulfate and nitrate concentrations at the same station. The El Centro data exhibits slightly higher correlations than the other stations for nitrates and considerably higher correlations for sulfates. This may reflect the

DATA REQUEST #4
AIR QUALITY

greater concentration of fuel combustion sources around El Centro than the other monitoring locations. In any case, the statistics developed from available data strongly support the existence of a positive relationship between sulfate and total particulates, and a somewhat weaker but consistent relationship between nitrates and total particulates ─ especially in El Centro.

Existence of ammonia-rich conditions

An area is generally considered to have ammonia-rich conditions when the total ammonia concentration (gaseous plus aqueous plus solid) is greater than twice the sulfate concentration (gaseous plus aqueous plus solid). It is important to examine the evidence for the existence or non-existence of ammonia-rich conditions in the context of the present analysis, because without the availability of excess ammonia, the reduction in sulfate particles resulting from reduced SO_x emissions could lead to an increase in particulate matter in the form of ammonium nitrate.

At present, there is insufficient information on the atmospheric chemistry of the Imperial Valley to demonstrate definitively that the area is in fact ammonia rich. Specific components for which data are completely unavailable include the gaseous and aqueous phase components of both sulfate and ammonia. The only data that are available are daily average concentrations of particulate ammonium and particulate sulfate.

Human activities and land characteristics that are usually associated with elevated ammonia production include:

- Mobile source catalytic converters that are designed to reduce NO_x emissions from gasoline-powered vehicles produce ammonia emissions as a by-product of NOx conversion. For this reason, late-model gasoline powered vehicles result in higher ammonia emissions than older vehicles.
- Municipal sewage treatment plants.
- Livestock and poultry husbandry.
- Fertilizer usage.
- Biogenics (exposed soils).

All of these ammonia source categories are present to some degree in Imperial County, with fertilizer application as well as livestock being particularly prominent in this intensely agricultural area.

DATA REQUEST #4
AIR QUALITY

A 2002 ammonia emissions inventory for the entire U.S. was developed using the Carnegie Mellon University (CMU) ammonia model (Version 3.6, 2004), as reported by Pavlovic (2005). The CMU model uses ammonia (NH_3) emission factors with information on the number of livestock animals; usage quantities for fertilizers of various types and the biological characteristics of lands (scrubland, grassland, oak forest, etc.); with input data resolved at the county level. The 2002 national inventory is presented on Figure 5 in Attachment A, Figures. Note that Imperial County in the southeastern corner of California was assigned the highest category of ammonia emissions in the entire Continental U.S. (between 17.3 and 39.6 million pounds per year), as were parts of the Inland Empire further north and the San Joaquin Valley. Thus, while atmospheric chemistry data are generally lacking in this county, there is strong evidence to support the contention that an ammonia-rich condition is in fact present.

Calculation of Interpollutant Offset Ratio (SO_x for PM_{10})

The previous subsections established that the conditions required for applicability of the ratio of monitor to emissions methodology are very likely to exist in Imperial County. Accordingly, calculations were conducted using this method to estimate the appropriate interpollutant ratio for offsetting PM_{10} emissions from the ECGS Unit 3 Repower Project by means of emission reductions in sulfur oxides. This was accomplished using an adaptation of an Excel spreadsheet that was originally used by SMAQMD to conduct a similar interpollutant offsets analysis for the Consumnes Power Plant Project in Sacramento County, which was licensed by CEC in 2003. The following Imperial County data were used in four separate spreadsheets corresponding to the monitoring data sets covered in Figures 1 through 4:

1 Daily average total PM_{10} concentrations recorded every sixth day
2 Daily average sulfate portion of PM_{10}
3 Daily average nitrate portion of PM_{10}
4 Annual total PM_{10} emissions in Imperial County
5 Fraction of PM_{10} emissions in Imperial County that are due to direct fuel combustion sources
6 Estimated average regional background ammonium sulfate concentration

Data on the first three items were obtained from the historical ambient air quality database maintained on the CARB webpage:

http://www.arb.ca.gov/adam/welcome.html

DATA REQUEST #4
AIR QUALITY

Separate data records of the daily average values of these parameters throughout the year 2000 were compiled for the Brawley, El Centro, and Calexico Ethel Street stations and during 2004 for Calexico Ethel Street only. Total county emissions of SO_2, PM_{10} and the fraction of PM_{10} due to direct combustion sources were obtained from the 2000 and 2004 emissions inventories for Imperial County, also provided on the CARB website. The average regional background value for ammonium sulfate was assumed to be well represented by the minimum concentration calculated for that compound during each year of monitoring.

Using this approach, the following calculation steps were performed for each 24 hour monitoring period at the Imperial County monitoring sites:

1 Enter the total PM_{10} concentration.
2 Estimate the fraction of the total PM_{10} concentration due to fuel combustion sources (based on the emissions fraction in the County's inventory for the year in question).
3 Calculate the concentration per unit emissions of PM_{10} from combustion sources.
4 Enter the particulate sulfate concentration for the same day.
5 Calculate the corresponding ammonium sulfate concentration assuming all sulfate appears in that form.
6 Subtract the regional background ammonium sulfate concentration (assumed to be well represented by the lowest value during the year).
7 Calculate the concentration of adjusted ammonium sulfate per unit emissions of SO_x from the County's inventory.
8 Divide the ratio derived in Step 3 by the ratio derived in Step 7 to obtain the estimated SO_2 to PM_{10} interpollutant ratio for offsets.

Attachment B, Interpollutant Ratio Chart, compares Ammonium, Sulfate, and Nitrate levels each month in 2000. Attachment C, Interpollutant Ratio Data, is a CD that shows the application of these steps to each year of monitoring data discussed previously, as well as the Imperial County emissions inventories for 2000 and 2004. This procedure yielded the following interpollutant ratios (based on the arithmetic mean of the daily ratios throughout a given year):

Brawley Station 2000	2.22 to 1
El Centro Station 2000	1.23 to 1
Calexico Ethel Street 2000	1.29 to 1
Calexico Ethel Street 2004	2.08 to 1

DATA REQUEST #4
AIR QUALITY

All of these ratios are below the 2.5 value that was used to calculate emissions offsets for PM_{10} in the application submitted to CEC for the ECGS Unit 3 Repower Project SPPE. Given the uncertainty created by the lack of complete atmospheric chemistry data to support a more precise evaluation, the use of this conservative 2.5 to 1 ratio is considered to be appropriate. Note that the ratio calculated based on data from the closest monitoring station (El Centro) is just 1.23. The submitted ratio of 2.5 to 1 offers a 50% margin above the arithmetic average of the four results and a 12% margin over the highest results at the Brawley Sation in 2000. In addition, the ratio has been agreed to by ICAPCD as an appropriate mitigation for the Project's emissions of PM_{10}. As described above, there is good reason to believe that the conditions existing in Imperial County are favorable for the effective use of SO_2 credits to offset an increase in PM_{10} emissions.

R*eferences*

Pavlovic, Radovan Thomas. 2005 *The Impact of Ammonia Emissions on Atmospheric Particulate Matter Formation in Texas*. Thesis presented to the Faculty of the Graduate School of The University of Texas at Austin in partial fulfillment of the Requirements for the Degree of Master of Science in Engineering.

Seinfeld, J.H., Pandis, S.N. 1998 Atmospheric chemistry and physics. From air pollution to climate change. Wiley, New York.

ATTACHMENT A
AIR QUALITY
FIGURES

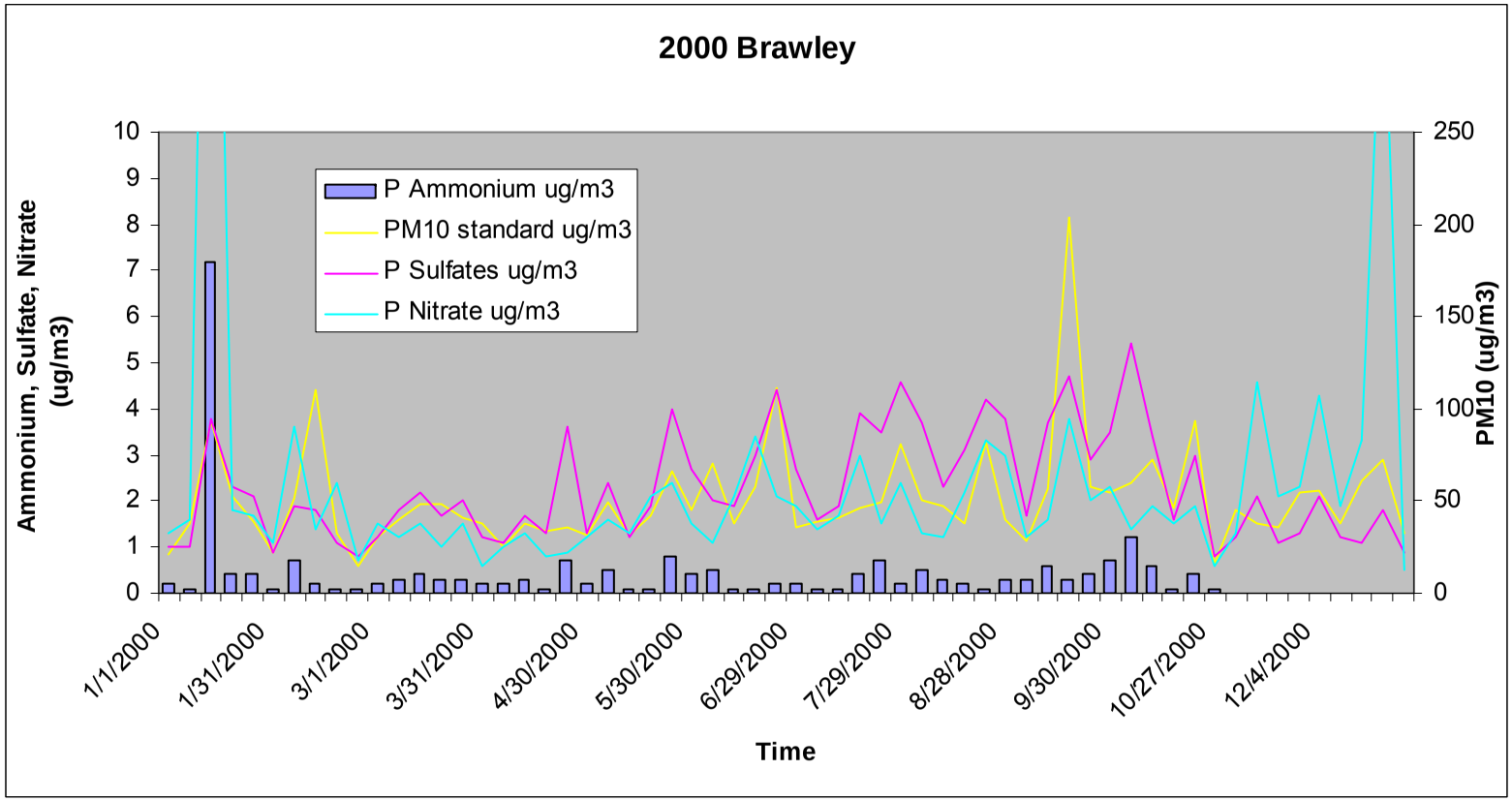


Figure 1
Measured ambient PM_{10} and particulate sulfate and nitrate concentrations at the Brawley monitoring station during 2000

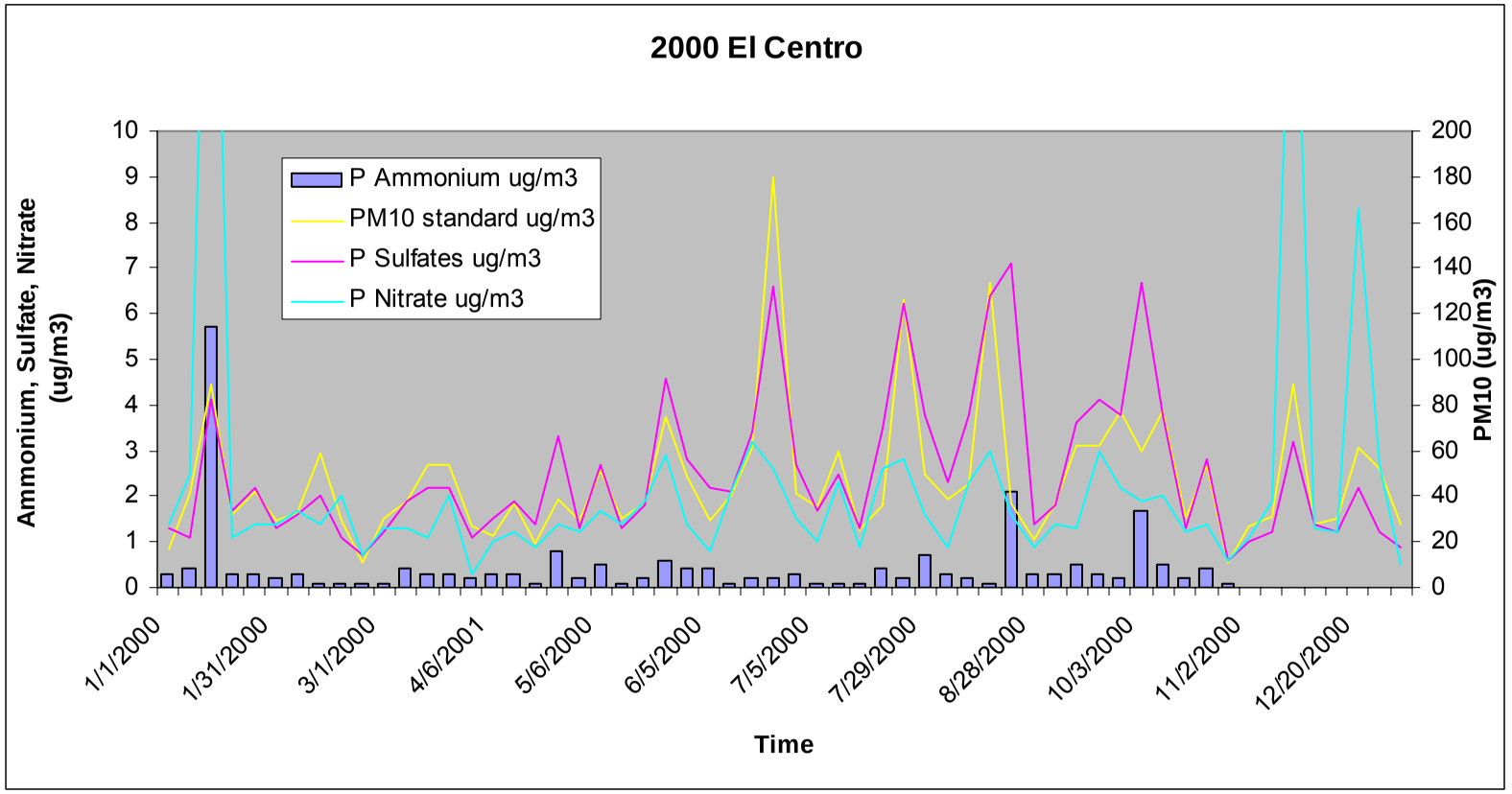


Figure 2
Measured ambient PM_{10} and particulate sulfate and nitrate concentrations at the El Centro 9th Street monitoring station during 2000

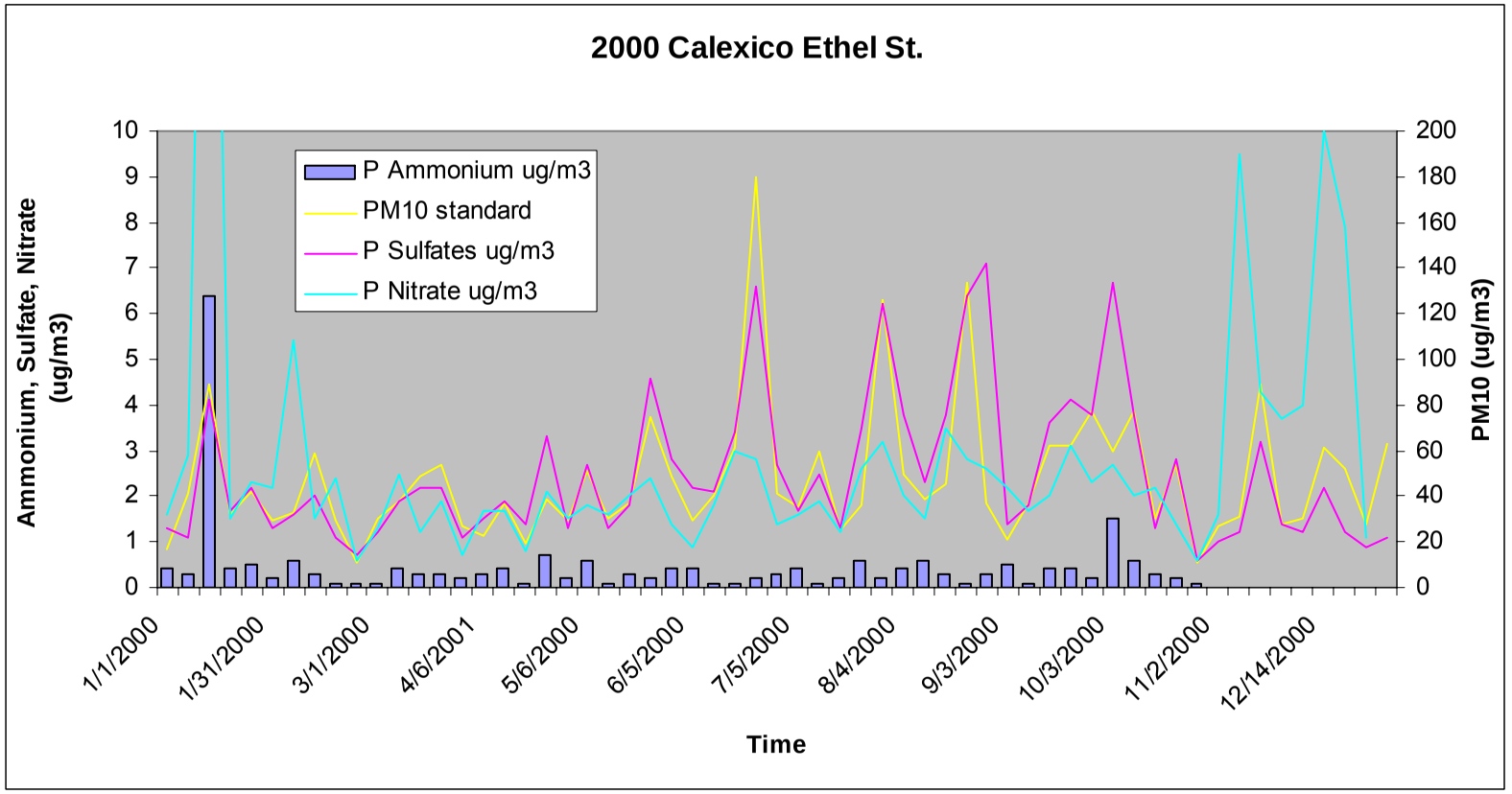


Figure 3
Measured ambient PM_{10} and particulate sulfate and nitrate concentrations at the Calexico Ethel Street monitoring station during 2000

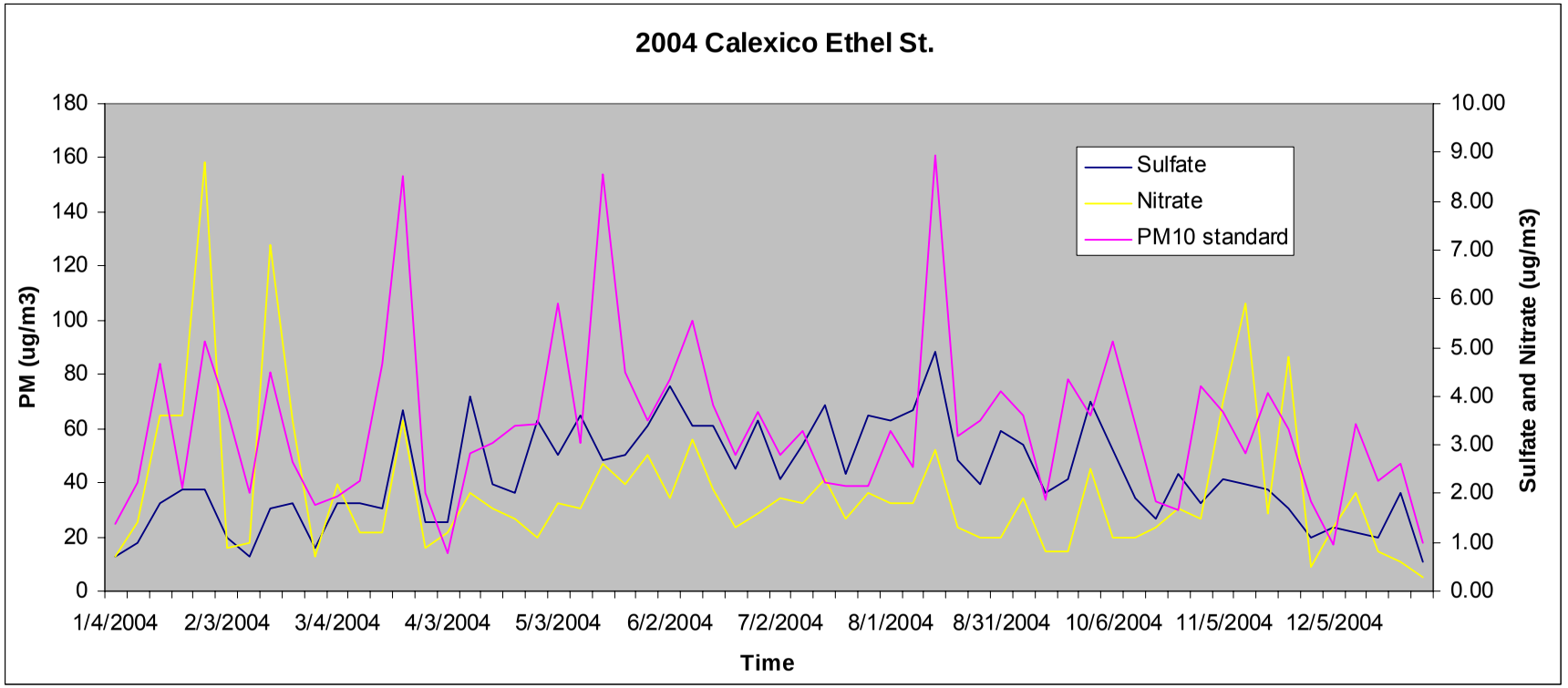


Figure 4
Measured ambient PM_{10} and particulate sulfate and nitrate concentrations at the Calexico Ethel Street monitoring station during 2004

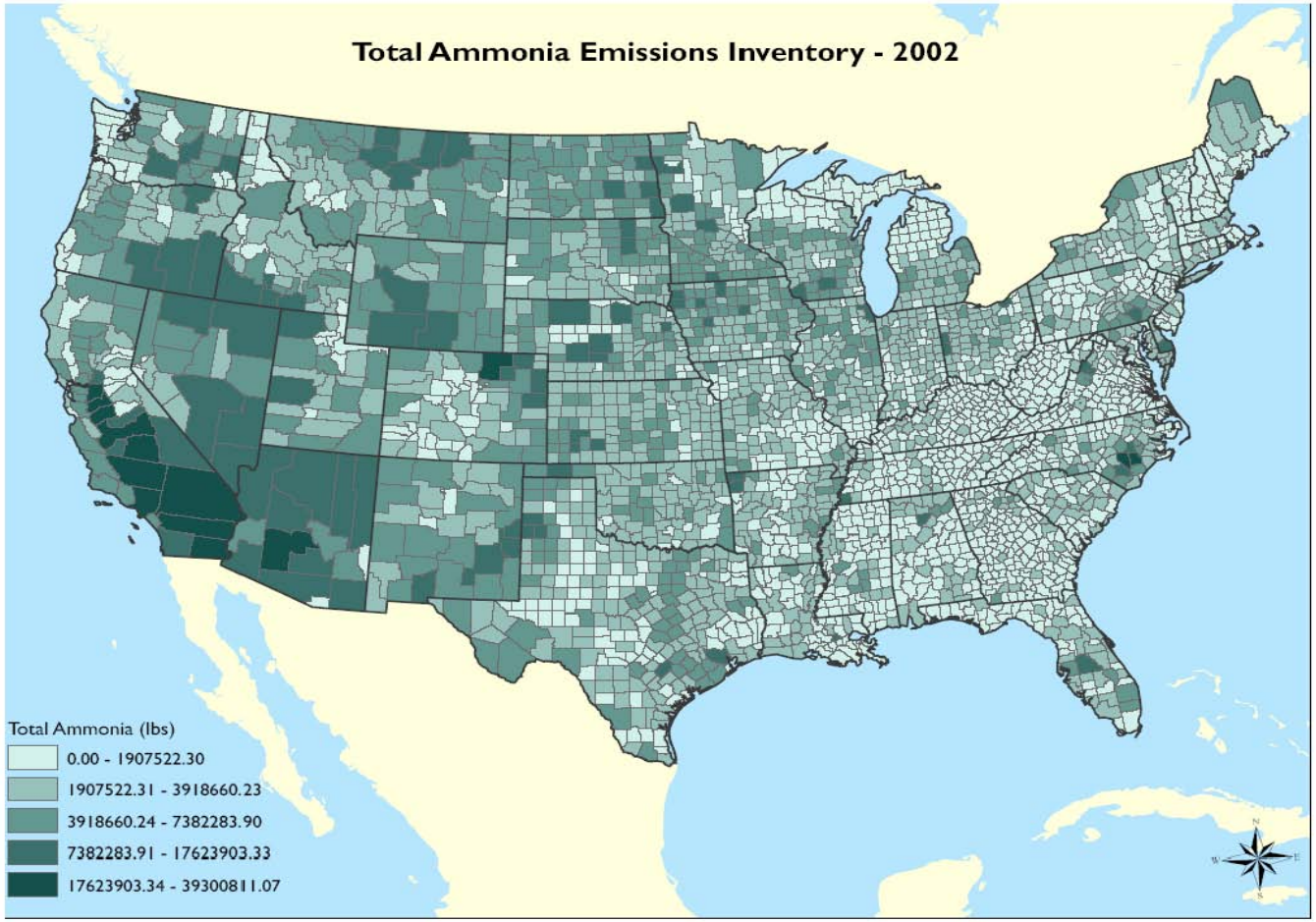
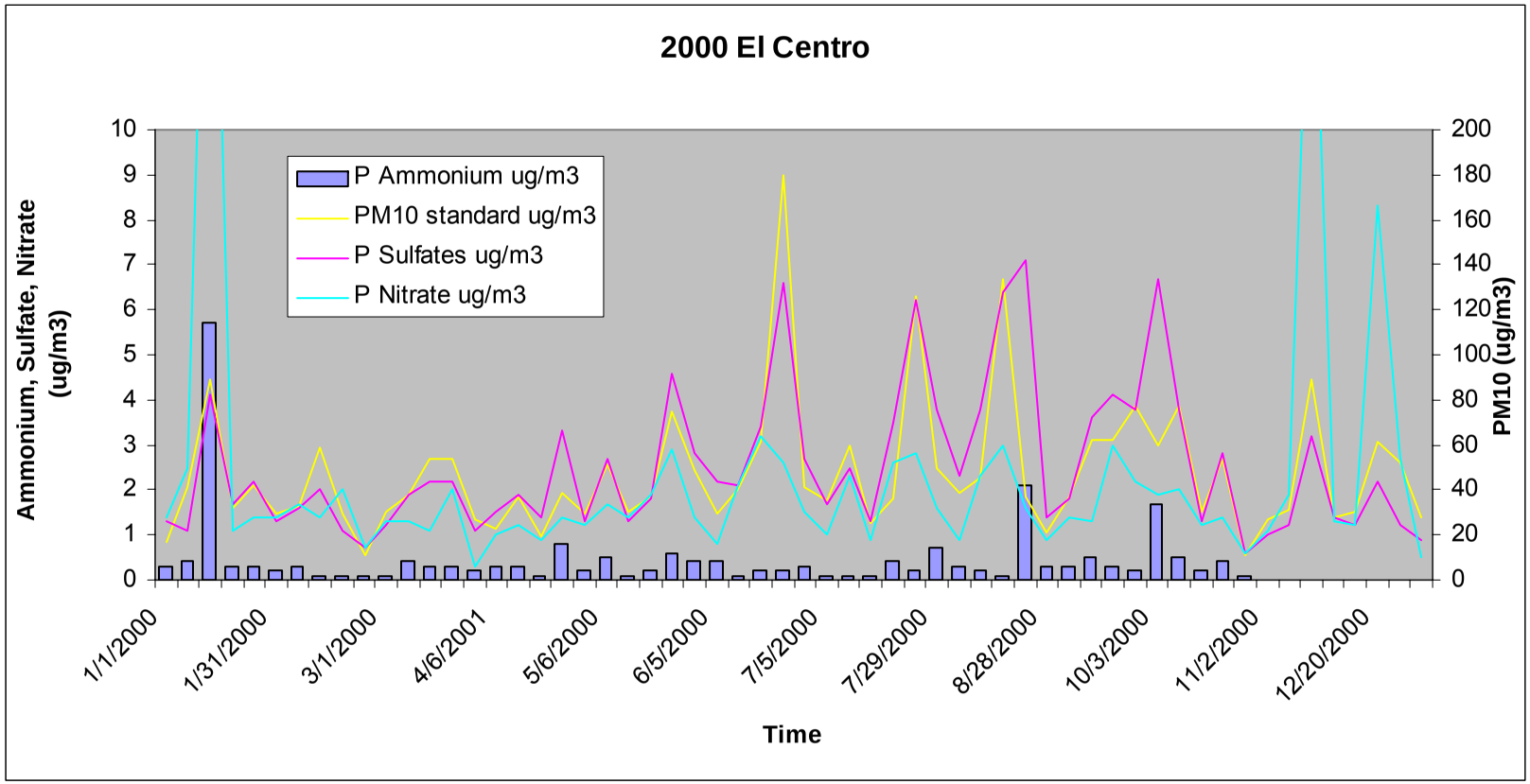


Figure 5
2002 National Ammonia Emissions Inventory Prepared Using the Carnegie Mellon University Ammonia Model

ATTACHMENT B
AIR QUALITY
INTERPOLLUTANT RATIO CHART


2000 El Centro
P Ammonium ug/m3
PM10 standard ug/m3
P Sulfates ug/m3
P Nitrate ug/m3
Ammonium, Sulfate, Nitrate (ug/m3)
PM10 (ug/m3)
Time
0
1
2
3
4
5
6
7
8
9
10
0
20
40
60
80
100
120
140
160
180
200
1/1/2000
1/31/2000
3/1/2000
4/6/2001
5/6/2000
6/5/2000
7/5/2000
7/29/2000
8/28/2000
10/3/2000
11/2/2000
12/20/2000

ATTACHMENT C
AIR QUALITY
INTERPOLLUTANT RATIO DATA

(See CD on Following Page)