Colorado State Implementation Plan for Ozone

Appendix C

Technical Support Document

Denver Metropolitan Area

Emission Inventories for the Ozone State Implementation Plan

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Technical Services Program
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Introduction

This document summarizes the emission inventory data provided to Environ by the Air Pollution Control Division of the Colorado Department of Public Health and Environment. The Division provided emission inventory data for 2002 base case, 2007 base and attainment cases, for the entire state of Colorado for mobile sources, point sources, non-road sources, and area sources.

Section 1.0 summarizes the emission inventories for the 2002 Base case, 2007 Base and Attainment cases and the 2012 Attainment case. The State Implementation Plan emission controls that affect ozone related inventories are described as well as the proposed control strategies for the Ozone Early Action Compact.

Section 2.0 through Section 4.0 describe the mobile source related emission inventories. Travel demand modeling link-based activity data (Section 2.0) was provided for the Denver Regional Council of Governments, the Pikes Peak Area Council of Governments and the North Front Range Transportation and Air Quality Planning Council planning areas. Highway Performance Management System (HPMS) data provided the VMTestimates for the remainder of the states (Section 3.0). These sources of VMT data provided the basis for the mobile source emission estimates. Environ used the link based data and the meteorological modeling parameters along with a MOBILE6-based tool to estimate the mobile source emissions factors to estimate the mobile source inventories utilized in the dispersion modeling. These methodologies are describe in more detail in Appendix E of this TSD (Air Quality Modeling Analysis for the Denver Early Action Ozone Compact: Development of the 2002 Base Case Emission Inventory, Environ, 2003) The mobile source inventories in this documents were prepared using a more simplistic approach that does not account for day to day variations in ambient temperatures nor account for many other factors that affect vehicle emissions on a day-to-day, or link by link basis. Consequently, the inventories in this TSD document will not necessarily match those prepared by Environ. The inventories are shown here for the purpose of describing the basic trends expected in mobile emissions.

Section 5.0 documents the point, area and non-road portions of the emission inventories. The 2002 point source emissions were extracted from the Colorado Air Inventory System which is based on the stationary source permit data. Point sources for 2007 and 2012 were estimates using the EPA Economic Growth Analysis System (EGAS) growth factors. Area source emissions for 2002 were based EPA National Emissions Inventory (NEI), and Non-road Emissions for 2002 were calculated using on the EPA Non-road model.

Section 6.0 describes the 2003 precursor monitoring project and compares this data with the emission inventories.

1.0 Emission Inventory Overview and Summaries for 2002, 2007, 2012.

1.1 Base Case 2002 and 2007 Emissions Inventories and Control Measures

This section presents emission inventories for Denver ozone action plan for the 2002 base year and the 2007 base year. Inventories for the 2007 attainment year will be presented later in this document and will include the additional control measures that are needed to show attainment of the 8-hour ozone NAAQS. All of the base inventories are for the Denver area (the seven county metro area of Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas and Jefferson) plus Weld County and provide emissions estimates for a typical summer weekday during the summer ozone season (May through September).

The emission estimates were developed based on the most recent demographics and vehicle miles traveled (VMT) estimates contained in 1) DRCOG's conformity analysis for the updated fiscally constrained element of the 2025 Regional Transportation Plan.

Table 1 - Demographic Data

DRCOG Demographics	2002	2007	2012
Population	2,492,627	2,718,479	2,944,330
Households	1,083,751	1,181,947	1,280,144
Employment	1,492,115	1,636,654	1,781,192
VMT	63,493,136	70,537,153	77,362,474

The 2002 and 2007 base inventories incorporate the control measures in place at that time. Control measures in place in 2002 and assumed for 2007 include:

1. Federal tailpipe standards and regulations, including those for small engines and non-road mobile sources. Credit is taken for these federal requirements but they are not part of the Colorado SIP. The credits change from 2002 to 2007 as EPA Tier II and low sulfur gasoline standards become effective.

2. Air Quality Control Commission Regulation No. 11 -- covering the Automobile Inspection and Readjustment (A.I.R.). For 2007, a maximum of 50% fleet coverage is assumed for the remote sensing clean screen program.

3. Air Quality Control Commission Regulations No. 3, No. 6, No. 7, and Common Provisions – covering gasoline station and industrial source control programs. The Common Provisions, Parts A and B of Regulation No. 3, and the VOC control requirements of Regulation No. 7 are already included in the approved SIP. Regulation No. 6 and Part C of Regulation No. 3 implement the federal standards of performance for new stationary sources and the federal operating permit program. This plan makes no changes to these regulations. This reference to Regulation No. 6 and Part C of Regulation No. 3 shall not be construed to mean that these regulations are included in the SIP.

4. Since 1991, gasoline sold in the Denver area during the summer ozone season (June 1 to September 15) has been subject to a national Reid Vapor Pressure (RVP) limit of 7.8 pounds per square inch (psi) in order to reduce fuel volatility. For ethanol-blended fuels, the RVP limit is 8.8 psi due to the federal 1.0 psi RVP waiver for ethanol. The EPA has granted waivers to allow a 9.0 psi RVP (10.0 psi for ethanol blends) gasoline in the Denver area instead of the more stringent 7.8 psi limit.

For 2002, because of voluntary efforts to reduce the gasoline RVP, the RVP of the base gasoline was measured at 8.1 psi; ethanol (10% blend) market share was measured at 20%. In other words, 80% of the gasoline was at 8.1% psi RVP, and 20% of the gasoline was at 9.1 psi RVP.

For 2007, the RVP of the base gasoline is assumed to be the regulatory level of 9.0 psi. The ethanol (10% blend) market share is assumed to be 25%. In other words, 75% of the gasoline is assumed to be 9.0% psi RVP, and 25% of the gasoline is assumed to be 10.0 psi RVP.

All of the inventories were developed using EPA-approved emissions modeling methods, including EPA's Mobile6 model and local VMT data for on-road mobile source emissions, EPA's non-road model and local demographic information for area and off-road sources, and reported actual emissions for point sources. Estimates for future emissions are based the above-mentioned tools and the EPA EGAS model for estimating future point sources activity, VMT growth for on-road mobile sources, and 2007 demographic data for off-road and area sources. This ozone maintenance plan technical support document contains detailed information on model assumptions and parameters for each source category.

Summaries of the VOC and NOx base inventories for 2002 and 2007 are presented in Table 2 through Table5 below (8-county summaries and 11-county summaries). Emissions of CO, NOx and VOCs are in tons per summer day.

Table 2 - 2002 8-County Base Case Emission Inventories
Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas, Jefferson and Weld Counties (tons/day)

	2002 VOC	2002 NOx	2002 CO
Flash	133.9	0	0
Gas Stations	22.3	0.1	0.2
Oil and Gas Production	4.13	0.2	0.2
Reciprocating Internal Combustion Engines	7.8	93.5	29.8
Other Stationary Sources	24.6	11.4	6.9
Total Point	192.8	105.2	37.1
Automotive After Market Products	27.2		
Architectural Coatings	19.5		
Household and Personal Products	17.0		
Adhesives and Sealants	14.7		
Pesticide Application	8.9		
Other Area Sources	9.6	25.60	18.28
Total Area	96.9	25.60	18.28
Lawn & Garden	47.3	9.31	815.4
Other Off-road	25.8	78.7	341.7
Total Off-road	73.1	87.99	1157.1
On-road Mobile	152.8	157.8	1672.7
Total Anthropogenic	515.6	377.6	2840.2
Total Biogenic	468.1	37.1	57.0
Total	983.7	414.7	2897.2

Table 3 – 2007 8-County Base Case Emission Inventories
Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas, Jefferson and Weld Counties (tons/day)

	2007 VOC tons/day	**2007 NOx** tons/day	**2007 CO** tons/day
Flash	146.1	0	0
Gas Stations	16.0	0.1	0.2
Oil and Gas Production	4.5	0.2	0.2
Reciprocating Internal Combustion Engines	8.7	94.7	32.6
Other Stationary Sources	28.8	12.2	7.2
Total Point	204.1	107.1	40.2
Automotive After Market Products	29.0		
Architectural Coatings	20.8		
Household and Personal Products	8.0		
Adhesives and Sealants	15.7		
Pesticide Application	10.0		
Other Area Sources	20.6	27.6	21.0
Total Area	104.1	27.6	21.0
Lawn & Garden	31.2	9.3	905.6
Other Off-road	22.5	73.2	373.0
Total Off-road	53.7	82.5	1278.5
On-road Mobile	117.5	119.3	1207.3
Total Anthropogenic	479.4	336.5	2547.0
Total Biogenic	468.1	37.1	57.0
Total	947.5	373.6	2604.0

Table 4 - 2002 11-County Base Case Emission Inventories

Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas, Jefferson, Weld, Elbert, Larimer and MorganCounties (tons/day)

2002 Base Case			
	2002 VOC	2002 nox	2002 CO
Flash	134.26		
RICE	9.03	125.76	34.72
Oil and Gas Production	4.21	0.19	0.2
Gas Stations	24.45	0.07	0.21
Other Points	28.04	14.07	7.62
Total Points	199.99	140.09	42.75
Automotive After Market Products	30.03		
Architectual Coatings	21.52		
Household and Personal Products	18.84		
Adhesives and Sealants	16.28		
Pesticide Application	11.74		
Other Area Sources	12.93	30.36	19.58
Total Area	111.34	30.36	19.58
Lawn & Garden Equipment	52.96	10.42	912.99
Other Off-road	31.93	94.2	388.46
Total Off-road	84.89	104.62	1301.45
Total On-road Mobile	172.6	177.6	1901.2
Total Anthropogenic	568.82	452.67	3264.98
Biogenic	799.46	52.34	108.44
Total	1368.28	505.01	3373.42

Table 5 - 2007 11-County Base Case Emission Inventories

Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas, Jefferson, Weld, Elbert, Larimer and MorganCounties (tons/day)

2007 Base			
	2007 VOC	2007 NOx	2007 CO
Flash	147.17	0	0
RICE	9.93	129.65	37.95
Oil and Gas Production	4.61	0.2	0.22
Gas Stations	17.51	0.08	0.22
Other Points	30.12	14.98	7.94
Total Points	209.33	144.91	46.33
Automotive After Market Products	32.06		
Architectual Coatings	22.97		
Household and Personal Products	20.11		
Adhesives and Sealants	17.37		
Pesticide Application	13.09		
Other Area Sources	14	32.65	22.37
Total Area	119.6	32.65	22.37
Lawn & Garden Equipment	34.95	10.35	1013.99
Other Off-road	27.74	82.81	418.81
Total Off-road	62.69	93.16	1432.8
Total On-road Mobile	135.1	136.6	1388.7
Total Anthropogenic	526.72	407.32	2890.2
Biogenic	799.46	52.34	108.44
Total	1326.18	459.66	2998.64

1.2 Attainment Case 2007 and 2012 Emissions Inventories and Control Measures

In addition to the Colorado SIP-based controls included in the 2007 Base case, the following control strategies were modeled in the inventories developed for the 2007 attainment photochemical modeling demonstration:

- 8.1 psi RVP, 25% ethanol market share, applied in 7-county Denver metro area only.
- The traditional 7-county area qualifies; the larger area does not.
- Uncontrolled engines controls, applied to all DMA and Weld Counties.
- Flash emissions controls at 37.5%, applied to the 7-county Denver Metro area and Weld Counties.
- Dehydrators control credits will be applied.

EPA guidance requires that areas under the EAC demonstrate long-term maintenance of the 8-hour ozone NAAQS through the year 2012. Although photochemical modeling is required for the 2007 attainment demonstration, a simple comparison of emission inventories is required to demonstrate maintenance. For this plan, the 2007 attainment emission inventory is compared with the 2012 inventory; if total emissions in 2012 are less than total emissions in 2007, maintenance is demonstrated. The 2012 inventories assume that the 2007 control measures remain in place throughout the maintenance period through 2012. The 2012 inventory also accounts for federal emission control measures taking effect from 2007 through 2012. The 2007 attainment and the 2012 maintenance inventories are presented in Table 4 and Table5 below. A comparison of the inventory totals in Table 4 and Table 5 indicates that the 2012 Attainment Case emissions are less than the 2007 Attainment case emission inventory totals.

Table 6 - 2007 Attainment Case Emission Inventories
Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas, Jefferson and Weld Counties (tons/day)

	2007 VOC	2007 NOx	2007 CO
Flash	91.3		
Gas Stations	14.8	0.1	<0.1
Oil and Gas Production	3.7	0.2	0.2
Reciprocating Internal Combustion Engines	4.77	75.8	20.5
Other Stationary Sources	28.7	12.2	7.2
Total Point	143.3	88.3	28.2
Automotive After Market Products	29.0		
Architectural Coatings	20.8		
Household and Personal Products	1 8.2		
Adhesives and Sealants	15.7		
Pesticide Application	10.0		
Other Area Sources	10.4	27.6	21.0
Total Area	104.1	27.6	21.0
Lawn & Garden	31.0	9.4	889.0
Other Off-road	22.6	73.2	358.3
Total Off-road	53.5	82.6	1247.3
Total On-road Mobile	108.4	119	1119.2
Total Anthropogenic	409.3	317.5	2415.7
Total Biogenic	468.1	37.1	57.0
Total	877.4	354.6	2472.7

Table 7 - 2012 8-County Attainment Case Emission Inventories
Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas, Jefferson and Weld Counties (tons/day)

	2012 VOC	2012 NOx	2012 CO
Flash	100.9		
Gas Stations	10.2	0.1	0.2
Production Oil and Gas Facilities	4.1	0.2	0.3
Reciprocating Internal Combustion Engines	5.4	82.8	22.9
Other Stationary Sources	32.3	13.4	7.9
Total Point	152.9	96.5	31.3
Automotive After Market Products	31.5		
Architectural Coatings	22.6		
Household and Personal Products	19.8		
Adhesives and Sealants	17.1		
Pesticide Application	11.5		
Other Area Sources	11.6	31.1	23.5
Total Area	114.0	31.1	23.5
Lawn & Garden	26.7	9.3	972.6
Other Off-road	21.00	65.5	397.6
Total Off-road	47.7	74.8	1370.2
Total On-road Mobile	76	77.7	857.5
Total Anthropogenic	390.6	280.1	2282.6
Total Biogenic	468.1	37.1	57.0
Total	858.7	317.2	2389.5

Table 8 - 2007 11-County Attainment Case Emission Inventories

Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas, Jefferson, Weld, Elbert, Larimer and MorganCounties (tons/day)

2007 Attainment			
	2007 VOC	2007 NOx	2007 CO
Flash	91.98		
RICE	5.96	110.85	25.91
Oil and Gas Production	3.73	0.2	0.22
Gas Stations	16.27	0.08	0.22
Other Points	30.12	14.98	7.94
Total Points	148.1	126.11	34.3
Automotive After Market Products	32.06		
Architectual Coatings	22.97		
Household and Personal Products	20.11		
Adhesives and Sealants	17.37		
Pesticide Application	13.09		
Other Area Sources	14	32.65	22.37
Total Area	119.6	32.65	22.37
Lawn & Garden Equipment	34.74	10.52	995.44
Other Off-road	27.92	82.77	403.41
Total Off-road	62.66	93.29	1398.85
Total On-road Mobile	126	136.3	1300.6
Total Anthropogenic	456.36	388.35	2756.12
Biogenic	799.46	52.34	108.44
Total	1255.82	440.69	2864.56

Table 9 - 2012 11-County Attainment Case Emission Inventories

Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas, Jefferson, Weld, Elbert, Larimer and MorganCounties (tons/day)

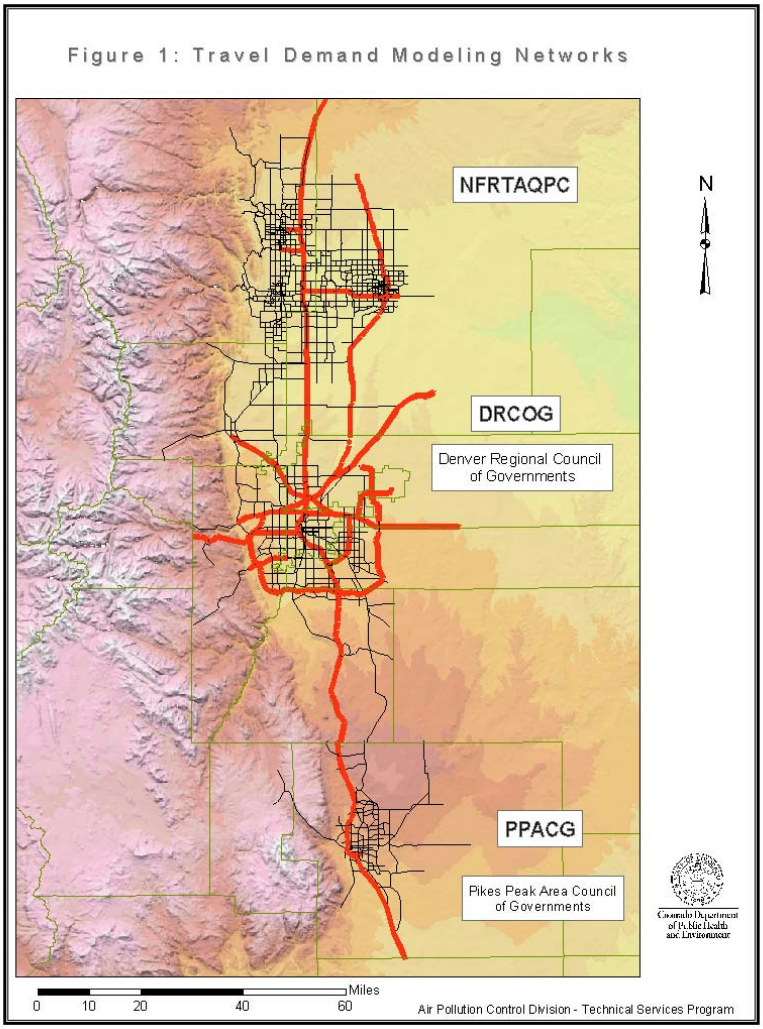
2012 Attainment			
	2012 VOC	2012 NOx	2012 CO
Flash	101.69		
RICE	6.69	121.28	28.8
Oil and Gas Production	4.16	0.22	0.25
Gas Stations	11.27	0.08	0.24
Other Points	35.42	16.52	8.76
Total Points	159.23	138.10	38.05
Automotive After Market Products	34.9		
Architectual Coatings	25.01		
Household and Personal Products	21.9		
Adhesives and Sealants	18.92		
Pesticide Application	15.01		
Other Area Sources	15.56	36.7	24.95
Total Area	131.3	36.7	24.95
Lawn & Garden Equipment	30	10.43	1089.03
Other Off-road	26.21	74.13	445.82
Total Off-road	56.21	84.56	1534.85
Total On-road Mobile	89	90.1	1004.4
Total Anthropogenic	435.74	349.46	2602.25
Biogenic	799.46	52.34	108.44
Total	1235.20	401.8	2710.69

2.0 Mobile Source Related Emissions Inventories

2.1 Travel Demand Modeling VMT-based Emission Inventories

Travel demand modeling networks from recent Transportation Improvement Plans and Regional Transportation Plans were readily available in mid-June 2003 to be utilized for vehicle miles traveled (VMT) estimates for the Pikes Peak Area Council of Governments (PPACG), Denver Regional Council of Governments (DRCOG) and the North Front Range Transportation and Air Quality Planning Council (NFRTAQPC) Municipal Planning Organizations (MPO's). **Figure 1** shows the geographical extent of the travel demand modeling for each MPO.

Figure 1 – Travel Demand Modeling for Each MPO



Environ International Corporation had the responsibility of computing the mobile source emissions inventories for input into the Ozone Early Action Compact dispersion modeling. The APCD transmitted the travel demand modeling (basis for VMT estimates) and the information concerning vehicle emission control strategies to Environ for use in

making the EPA Mobile6.2 emission factor model runs and subsequent emission inventory estimates.

2.2 EPA Mobile6.2 Mobile Source Emission Factor Assumptions

Mobile source related emission inventory estimates were also made by the APCD. This section outlines the base information that was transmitted to Environ for the mobile source related emissions estimates. The same set of information was used by APCD for the emissions estimates. The assumptions specific to the various areas of the state are described in detail in subsequent sections of this document. The following assumptions were made for the Mobile6.2 inputs:

2002 Base Case

- Minimum/Maximum ambient temperature: 58.0, 91.0 (average minimum and maximum temperature in Denver over the June 2002 and July 2002 ozone episodes)
- Reid Vapor Pressure: 8.4 (from field tests during 2002 summer)
- Oxygenated fuels: 20% ethanol penetration (from field tests during 2002 summer) Since ethanol penetration is market driven this level was assumed for the entire state of Colorado for the summer of 2002
- I/M programs: I/M 240 program for the Denver-Boulder attainment area; Idle I/M programs for Fort Collins, Greeley and Colorado Springs attainment areas.
- Vehicle Miles Traveled Fraction: VMT fractions for the Denver metro area were used for the entire state (from 2001 survey data).
- Registration Distribution: Registration distribution specific to Denver, Colorado Springs and North Front Range areas were used (from 2001 Department of Revenue registration record data).
- Evaluation Month: July
- Altitude: High

2007 Base Case

- Minimum/Maximum ambient temperature: 58.0, 91.0; the same as the 2002 Base Case
- Reid Vapor Pressure: 9.0 (regulatory default)
- Oxygenated fuels: 25% ethanol penetration, I/M programs: I/M 240 and 50% Clean screening programs as specified in the Denver-Boulder Carbon Monoxide SIP for the Denver-Boulder attainment area; No I/M program for the remainder of the state (Idle programs for North Front Range areas and Colorado Springs are terminated in 2004 and 2005, respectively).
- Vehicle Miles Traveled Fraction: the same as 2002 Base Case although the fractions are ‘aged’ to 2007 with the Mobile6.2 default VMT fraction distribution.
- Registration Distribution: same as 2002 Base Case
- Evaluation Month: July
- Altitude: High

2007 Base Case

- Minimum/Maximum ambient temperature: 58.0, 91.0; the same as the 2002 Base Case
- Reid Vapor Pressure: 8.1 (regulatory default)
- Oxygenated fuels: 25% ethanol, I/M programs: I/M 240 and 50% Clean screening programs as specified in the Denver-Boulder Carbon Monoxide SIP for the Denver-Boulder attainment area; No I/M program for the remainder of the state (Idle programs for North Front Range areas and Colorado Springs are terminated in 2004 and 2005, respectively).
- Vehicle Miles Traveled Fraction: the same as 2002 Base Case although the fractions are 'aged' to 2007 with the Mobile6.2 default VMT fraction distribution.
- Registration Distribution: same as 2002 Base Case
- Evaluation Month: July
- Altitude: High

2012 Attainment Case

- Minimum/Maximum ambient temperature: 58.0, 91.0; the same as the 2002 Base Case
- Reid Vapor Pressure: 8.1 (regulatory default)
- Oxygenated fuels: 25% ethanol penetration, I/M programs: I/M 240 program as specified in the Denver-Boulder Carbon Monoxide SIP for the Denver-Boulder attainment area; No I/M program for the PPACG and NFRTAQPC MPO areas VMT.
- Vehicle Miles Traveled Fraction: the same as 2002 Base Case although the fractions are 'aged' to 2012 with the Mobile6.2 default VMT fraction distribution.
- Registration Distribution: same as 2002 Base Case
- Evaluation Month: July
- Altitude: High

The effect of oxygenated fuels on emissions depends on whether the oxygenate is alcohol or ether, the amount of oxygenate in the fuel and the marketshare of oxygenated fuels. Mobile6 characterizes the effect of oxygenated fuels on vehicle emissions by using all three of these parameters. All Mobile6-based emissions factors used to generate the inventories for this Ozone Early Action Compact emissions inventories used the oxygenated fuels parameters as described above in the manner prescribed by the Mobile6 User's Guide.

2.3 Denver Regional Council of Governments Area Mobile Source Emissions

Travel demand modeling from the 2025 Regional Transportation Plan was used to estimate VMT in the MPO planning area. The 2001 FA, 2010QA and 2020 8A networks were used to estimate the VMT during the summer months of 2002, 2007 and 2012.

The emissions factors for the DRCOG planning area were calculated using Moble6.2 with inputs parameterized as described in the EPA Mobile6.2 Mobile Source Emission Factor Assumptions section. All control parameter assumptions used for emissions factor estimates are included in the Mobile6.2 input files. The Mobile6.2 input files and resultant output files are included in the Appendix (available upon request from CDPHE).

Table 10a. through Table 10d. summarize the VMT, Mobile6.2 emission factors and inventory estimates resulting from the 2025 Regional Transportation Plan.

Table 10a. - DRCOG VMT, Emission factors and inventory estimates for 2002

2002							
		Emission Factors(gram/mile)			Emission Inventories(ton/day)		
	VMT	VOC	CO	NOx	VOC	CO	NOx
CBD	514,703	2.012	21.566	2.152	1.14	12.24	1.22
Fringe	5,260,467	1.970	21.292	1.987	11.42	123.46	11.52
Urban	19,297,054	1.971	21.388	2.068	41.93	453.88	43.99
Suburban	26,239,990	1.981	21.614	2.051	57.30	625.17	59.32
Rural	12,180,922	1.997	21.562	2.083	26.81	289.51	27.97
Totals	63,493,136				138.60	1504.26	144.02

Table 10b. - DRCOG VMT, Emission factors and inventory estimates for 2007 Base Case

2007							
		Emission Factors(gram/mile)			Emission Inventories(ton/day)		
	VMT	VOC	CO	NOx	VOC	CO	NOx
CBD	551,628	1.386	13.838	1.518	.843	8.414	.923
Fringe	5,996,830	1.345	13.761	1.334	8.891	90.964	8.818
Urban	21,745,348	1.344	13.798	1.381	32.215	330.736	33.102
Suburban	30,568,082	1.340	18.889	1.371	45.151	467.990	45.196
Rural	11,675,175	1.361	18.931	1.388	17.515	179.284	17.863
Totals	70,573,153				104.620	1077.390	106.900

Table 10c. - DRCOG VMT, Emission factors and inventory estimates for 2007 Attainment Case

2007							
		Emission Factors(gram/mile)			Emission Inventories(ton/day)		
	VMT	VOC	CO	NOx	VOC	CO	NOx
CBD	551,628	1.268	12.720	1.514	.771	7.73	.92
Fringe	5,996,830	1.228	12.625	1.330	8.117	83.45	8.79
Urban	21,745,348	1.229	12.666	1.376	29.459	303.5	32.98
Suburban	30,568,082	1.226	12.756	1.367	41.310	429.81	46.06
Rural	11,675,175	1.245	12.799	1.383	16.022	164.72	17.80
Totals	70,573,153				95.45	989.32	106.55

Table 10d. - DRCOG VMT, Emission factors and inventory estimates for 2012 Attainment Case

2012							
		Emission Factors(gram/mile)			Emission Inventories(ton/day)		
	VMT	VOC	CO	NOx	VOC	CO	NOx
CBD	597,534	.798	8.620	.940	.553	5.678	.619
Fringe	6,531,749	.773	8.703	.783	5.875	62.661	5.638
Urban	24,000,614	.774	8.734	.804	21.641	231.064	21.270
Suburban	33,765,533	.773	8.788	.801	30.446	327.085	29.813
Rural	12,467,044	.794	8.859	.806	11.516	121.742	11.076
Totals	77,362,474				70.030	748.230	68.420

2.4 North Front Range Transportation and Air Quality Planning Council

The travel demand modeling for 2000, 2007 and 2015 from the NFRTAQPC 2004-2009 Transportation Improvement Plan was to estimate VMT in this MPO area during the summer months of 2002, 2007 and 2012.

The emissions factors for the NRFTAQPC planning area were calculated using Moble6.2 with inputs parameterized as described in the EPA Mobile6.2 Mobile Source Emission Factor Assumptions section. All control parameter assumptions used for emissions factor estimates are included in the Mobile6.2 input files. The Mobile6.2 input files and resultant output files are included in the Appendix (available upon request from CDPHE).

Tables 11a.-11c. summarize the VMT, emission factors and inventory estimates resulting from the 2003-2008 Transportation Improvement Plan.

Table 11a. - NRFTAQPC VMT, Emission factors and inventory estimates for 2002

2002							
		Emission Factors(gram/mile)			Emission Inventories(ton/day)		
	VMT	VOC	CO	NOx	VOC	CO	NOx
CBD	480,178	2.602	27.412	2.332	1.380	14.51	1.23
Urban	6,105,313	2.558	26.913	2.833	17.21	181.12	15.36
Rural	5,847,967	2.584	27.134	2.302	16.66	174.91	14.84
Totals	12,433,458				35.25	370.54	31.44

Table 11b. - NRFTAQPC VMT, Emission factors and inventory estimates for 2007 Base and Attainment Case

2007							
		Emission Factors(gram/mile)			Emission Inventories(ton/day)		
	VMT	VOC	CO	NOx	VOC	CO	NOx
CBD	575,580	1.803	17.895	1.804	1.14	11.35	1.15
Urban	7,318,306	1.768	17.893	1.701	14.26	144.34	13.72
Rural	7,009,831	1.788	18.045	1.715	14.69	139.43	13.25
Totals	14,903,717				29.22	295.13	28.12

Table 11c. - NRFTAQPC VMT, Emission factors and inventory estimates for 2012 Base and Attainment Case

2012							
		Emission Factors(gram/mile)			Emission Inventories(ton/day)		
	VMT	VOC	CO	NOx	VOC	CO	NOx
CBD	658,579	1.241	12.985	1.244	.86	9.43	.90
Urban	8,373,606	1.222	13.166	1.119	10.73	121.52	10.33
Suburban	8,020,649	1.245	13.291	1.124	10.47	117.51	9.94
Totals	17,052,833				22.05	248.46	21.17

2.5 Pike Peak Area Council of Governments

The travel demand modeling for 1998, 2005 and 2015 from the PPACG 2003-2008 Transportation Improvement Plan was to estimate VMT in this MPO area during the summer months of 2002, 2007 and 2012.

The emissions factors for the PPACG planning area were calculated using Moble6.2 with inputs parameterized as described in the EPA Mobile6.2 Mobile Source Emission Factor Assumptions section. All control parameter assumptions used for emissions factor estimates are included in the Mobile6.2 input files. The Mobile6.2 input files and resultant output files are included in the Appendix (available upon request from CDPHE).

Table 12a. through Table 3c. summarize the VMT, emission factors and inventory estimates resulting from the 2003-2008 Transportation Improvement Plan.

Table 12a. - PPACG VMT, Emission factors and inventory estimates for 2002

2002							
		Emission Factors(gram/mile)			Emission Inventories(ton/day)		
	VMT	VOC	CO	NOx	VOC	CO	NOx
CBD	48,510	2.412	25.380	2.285	.13	1.36	.12
Fringe	501,707	2.378	25.213	2.134	1.32	13.94	1.18
Urban	955,883	2.366	25.250	2.219	2.49	26.60	2.34
Suburban	7,272,284	2.382	25.495	2.200	19.09	204.37	17.64
Rural	2,605,261	2.397	25.445	2.235	6.88	73.07	6.42
Totals	11,383,645				29.92	319.35	27.69

Table 12b. - PPACG VMT, Emission factors and inventory estimates for 2007 Base and Attainment Case

2007							
		Emission Factors(gram/mile)			Emission Inventories(ton/day)		
	VMT	VOC	CO	NOx	VOC	CO	NOx
CBD	59,245	1.772	17.006	1.705	.109	1.111	.111
Fringe	612,637	1.745	17.014	1.524	1.108	11.490	1.029
Urban	1,167,263	1.744	17.041	1.575	2.109	21.926	2.026
Suburban	8,880,560	1.742	17.139	1.566	15.995	167.773	15.330
Rural	3,182,068	1.762	17.166	1.584	5.802	60.211	5.556
Totals	13,901,773				25.122	262.511	24.053

Table 12c. - PPACG VMT, Emission factors and inventory estimates for 2012 Base and Attainment Case

2007							
		Emission Factors(gram/mile)			Emission Inventories(ton/day)		
	VMT	VOC	CO	NOx	VOC	CO	NOx
CBD	66,100	1.158	12.328	1.119	.081	.903	.082
Fringe	683,519	1.137	12.533	.963	.814	9.443	.726
Urban	1,302,315	1.137	12.544	.988	1.552	18.007	1.418
Suburban	9,908,041	1.136	12.595	.983	11.773	137.557	10.736
Rural	3,550,233	1.156	12.681	.989	4.301	49.626	3.870
Totals	15,510,208				18.521	215.536	16.832

3.0 County-based VMT Emissions Inventories

The 2002 VMT for counties not covered by travel demand modeling were estimated by 2001 traffic count data from the Colorado Department of Transportation and adjusted by the United States Department of Transportation (DOT) Federal Highway Administration's (FHWA) Highway Performance Monitoring System (HPMS) data for 2001. The 2002 VMT estimates were projected to 2007 and 2012 using the percentage change in VMT for these years from the DRCOG network VMT for 2002, 2007 and 2012. Denver area VMT is estimated to increase by a factor of 1.111 between 2002 and 2007 and 1.097 between 2007 and 2012. Growth rates in the PPACG and NFRTAQPC

areas are higher than the Denver area VMT growth. It would be expected that the rural areas of Colorado would generally grow at a rate less than the rapidly urbanizing PPACG and NFRTAQPC areas.

3.1 EPA Mobile6.2 Mobile Source Emission Factor Assumptions

2002 Base Case

- Minimum/Maximum ambient temperature: 58.0, 91.0 (average minimum and maximum temperature in Denver over the June 2002 and July 2002 ozone episodes)
- Reid Vapor Pressure: 8.4 psi(from field tests during 2002 summer)
- Oxygenated fuels: 20% ethanol penetration. (from field tests during 2002 summer; since ethanol penetration is market driven this level was assumed for the entire state of Colorado)
- No I/M program related controls
- Vehicle Miles Traveled Fraction: VMT weighted fractions from the Denver metro area were used for the entire state (from 2001 survey data).
- Registration Distribution: The average for the state from Colorado Department of Revenue 2001 data.
- Evaluation Month: July
- Altitude: High

2007 Base Case and 2012 Base Case

All parameters are the same as the 2002 Base Case with the following exceptions:

- Oxygenated fuels: 25% ethanol penetration (average summer ethanol penetration over 1999-2003; assumed for the entire state of Colorado since this parameter is market driven)
- Vehicle Miles Traveled Fraction: the same as 2002 Base Case although the fractions are 'aged' to 2007 and 2012 with the Mobile6.2 default VMT fraction distribution.
- Reid Vapor Pressure: 9.0 psi

3.2 County-based Emissions Factors and Emissions Inventory Summary

Table 13 shows the county-based VMT for 2002, 2007 and 2012. Table 5 summarizes the VMT, emission factors and emission inventories.

Table 13 - County-based VMT for 2002, 2007 and 2012

County	2002 VMT	2007 VMT	2012 VMT
Alamosa	552,969	614,349	673,940
Archuleta	414,102	460,067	504,694
Baca	219,860	244,264	267,958
Bent	207,210	230,211	252,541
Chaffee	506,128	562,309	616,853
Cheyenne	183,092	203,415	223,146
Clear Creek	2,049,944	2,277,487	2,498,404
Conejos	246,268	273,603	300,143
Costilla	202,909	225,432	247,299
Crowley	108,594	120,648	132,351
Custer	119,104	132,325	145,160
Delta	815,695	906,237	994,142
Dolores	108,522	120,567	132,262
Eagle	2,555,234	2,838,865	3,114,235
Elbert	500,953	556,559	610,545
Fremont	1,325,531	1,472,665	1,615,514
Garfield	2,212,533	2,458,124	2,696,562
Gilpin	238,064	264,489	290,145
Grand	696,572	773,891	848,959
Gunnison	615,795	684,148	750,510
Hinsdale	40,414	44,900	49,255
Huerfano	634,027	704,404	772,731
Jackson	124,168	137,951	151,332
Kiowa	176,427	196,010	215,023
Kit Carson	1,306,500	1,451,522	1,592,320
Lake	325,970	362,152	397,281
La Plata	1,807,796	2,008,461	2,203,282
Las Animas	823,966	915,426	1,004,222
Lincoln	521,606	579,504	635,716
Logan	951,061	1,056,628	1,159,121
Mesa	3,186,688	3,540,410	3,883,830
Mineral	143,538	159,470	174,939
Moffat	693,126	770,063	844,759
Montezuma	1,244,552	1,382,697	1,516,818
Montrose	1,263,798	1,404,080	1,540,276
Morgan	1,164,778	1,294,068	1,419,592
Otero	703,504	781,593	857,408
Ouray	247,952	275,475	302,196
Park	497,253	552,448	606,035
Phillips	139,702	155,209	170,265
Pitkin	712,620	791,720	868,517

County	2002 VMT	2007 VMT	2012 VMT
Prowers	526,904	585,391	642,174
Pueblo	3,807,278	4,229,886	4,640,185
Rio Blanco	226,891	252,076	276,527
Rio Grande	361,198	401,291	440,216
Routt	753,437	837,068	918,264
Saguache	300,672	334,047	366,449
San Juan	187,049	207,812	227,970
San Miguel	309,414	343,759	377,104
Sedgwick	270,530	300,559	329,713
Summit	1,375,808	1,528,522	1,676,789
Teller	532,523	591,633	649,021
Washington	456,390	507,050	556,234
Yuma	304,609	338,421	371,247
Total	**40,001,227**	**44,441,363**	**48,752,175**

Table 5 shows the County-based VMT, Emission factors and inventory estimates for 2002, 2007 and 2012

4.0 Summary and Conclusions

Table 14 summarizes the mobile source emission inventories for the travel demand model based VMT and the county-based VMT areas of the state.

Table 14 - Statewide Summary of VMT and Mobile Source Emissions

		DRCOG	NFRTAQPC	PPACG	County based	Total
2002 Base						
	VMT	63,493,136	12,433,458	11,383,645	40,001,277	127,311,466
	VOC	138.60	35.25	29.92	125.91	294.43
	CO	1504.26	370.54	319.35	1341.19	3164.80
	NOx	144.02	31.44	27.69	101.40	273.12
2007 Base						
	VMT	70,753,153	14,903,717	13,901,733	44,441,363	143,784,006
	VOC	104.62	29.22	25.22	80.31	209.14
	CO	1077.39	295.13	262.511	839.20	2177.68
	NOx	106.9	28.12	24.05	76.89	206.91
2007 Attainment						
	VMT	70,753,153	14,903,717	13,901,733	44,441,363	143,784,006
	VOC	95.45	29.22	25.22	80.31	
	CO	989.32	295.13	262.511	839.20	
	NOx	106.55	28.12	24.05	76.89	

2012 Attainment						
	VMT	77,362,474	17,052,833	15,510,203	48,741,602	48,741,602
	VOC	70.03	22.05	18.52	58.20	151.25
	CO	748.23	248.46	215.54	677.31	1728.90
	NOx	68.42	21.17	16.83	52.89	138.40

The emission inventories presented in this TSD are estimates of the emission inventories calculated by Environ and used for the dispersion modeling. There are several reasons why the estimates in this TSD will not necessary match up with the Environ emission inventory estimates. The primary reasons are outlined below:

4.1 Temporal and spatial ambient temperature variations:

The inventories in this TSD are based on a minimum and maximum temperature of 58 and 91 degrees Fahrenheit, respectively. This is the average of the June and July episode days in downtown Denver during 2002. Mobile6 uses a generalized diurnal temperature variation based on the minimum and maximum temperatures for the emissions factor calculations. In addition, this maximum and minimum is representative of downtown Denver. Since ground level elevations vary from 2000 feet MSL to over 14,000 feet MSL over the state of Colorado, there is a wide variation in ambient temperature across the state. Consequently, the TSD inventories do not take into account the temporal and spatial variation of temperature across the state. Environ used the MM5 meteorological modeling temperature fields as input for the Mobile modeling to determine the mobile source emission factors. This methodology accounts for the spatial and temporal (diurnal as well as day to day) variations in ambient temperatures.

Vehicle speeds:

The emissions inventories in the TSD use Mobile6 default speeds. Environ used the link-based speed in the Mobile6 emission factor modeling for the dispersion modeling mobile source emission factors.

4.2 Stage II Refueling Emissions

Stage II refueling emissions are included in the point source emissions since gas station throughput is reported into the APEN system. These emissions are estimated using an emission rate of 11 lbs per thousand of gasoline dispensed at gas stations. Mobile6 was used to estimate the expected decrease in Stage II refueling emissions in 2007 and 2012 in due to the penetration of on-board vapor recovery systems. Mobile6-based Stage II refueling emissions estimates for the 2002, 2007 and 2012 are 11.1 tons/day, 7.4 tons/day and 4.2 tons/day, respectively.

Mobile6-based Stage II refueling emissions estimates for the 2007 and 2012 attainment case are, 6.8 tons/day and 3.8 tons/day, respectively.

5.0 Point, Area and Non-Road Inventories

The 2002 point source emissions were extracted from the Colorado Air Inventory System which is based on the stationary source permit data. Area source emissions for 2002 were based on Version 1.5 of the 1999 EPA National Emissions Inventory (NEI), grown to 2002 by county population based on data from the State Demographer's Office. Non-road Emissions for 2002 were calculated using on the EPA Non-road model.

Point source emissions were grown from 2002 to 2007 and 2012 using the EPA Economic Growth Analysis System (EGAS), using the EGAS growth factors. The output from the EGAS model was by source classification code (SCC) and Standard Industrial Classification Code (SIC) output was used for cases when EGAS did not provide a growth factor for a particular SCC.

The following text excerpted from the EGAS User's Guide (page 1-2) describes the Scope of EGAS:

SCOPE OF EGAS

EGAS 4.0 growth factors can be used to project emission inventories for multiple pollutants. These growth factors, which represent the ratio of a projection year's activity level to the 1996 activity level, are available for more than 2,600 SCCs not included in EGAS 3.0. Many of these new SCCs are related to maximum achievable control technology (MACT)-related source categories. Because the EGAS 3.0 geographic structure was maintained in the updated version, EGAS 4.0 includes separate growth factor modeling for each serious and above and multi-State moderate ozone nonattainment areas as identified in the November 6, 1991, *Federal Register*.[1] A list of these areas, their designations, and the counties included in these areas is presented in Table 1-1. (It should be noted that 3 additional North Carolina modeling areas were incorporated into EGAS 4.0 – Raleigh-Durham, Charlotte, and Greensboro-Winston Salem and that the EGAS 4.0 ozone nonattainment areas may not coincide with current or future ozone nonattainment area boundaries.) In addition, EGAS 4.0 develops growth factors for the attainment portions of the States associated with these nonattainment areas, and for States that did not contain any ozone nonattainment areas. As with EGAS 3.0, Alaska and Hawaii are not included within EGAS 4.0. Appendix A presents a list of the constituent counties included in each of the 75 modeling areas included in the program.

The following text excerpted from the EGAS User's Guide (page 4-15) describes the EGAS Crosswalk Module:

CROSSWALK MODULE

A number of significant changes were made for the EGAS 4.0 Crosswalk module. First, a new comprehensive list of SCCs was used to identify SCCs that had not been included in EGAS 3.0. Based on this list, approximately 2,600 new SCCs were incorporated into the Version 4.0 Crosswalk. These SCCs are either maximum achievable control technology (MACT) source categories (e.g., SCC 62540001–MACT Source Categories, Food and Agricultural Processes, Cellulose Food Casing Manufacture, Cellulose Food Casing), SCCs that are more detailed than the general SCCs that are currently included in EGAS Version 3.0 (e.g., SCC 2801500111–Miscellaneous Area Sources, Agriculture Production, Crops, Agricultural Field Burning, Field Crop is Alfalfa: Headfire Burning); or SCCs that represent completely new source categories (e.g., SCC 31401503–Industrial Processes, Transportation Equipment, Boat Manufacturing, Resin Storage). For this effort, the Crosswalk was updated so that these new SCCs are matched to growth indicators developed by one of the other EGAS modules.

Emissions from Public Service Company Arapahoe Units One and Two were zero in 2007 and 2012 because these units have been shutdown permanently.

Refueling emissions for 2002 are from the point source inventory. Adjustment factors were developed using the Mobile6 emission factor model and the projected VMT increase from the network models to account for the effects of Federal on-board refueling controls and increases in VMT respectively.

Area source emissions were grown from 2002 to 2007 and 2012 by county population based on data from the State Demographer's Office. Non-road Emissions for 2007 and 2012 were calculated using on the EPA Non-road model.

The Table below summarizes the calculation and projection of point, area and non-road sources.

Category	2002 inventory Calculation Method	Projection to 2007 and 2012
Point Sources	Colorado Air Inventory System	EPA EGAS Model
Distillate Oil	Grown From 1999 NEI	Population
Natural Gas	"	"
Adhesives and Sealants	"	"
Architectural Coatings	"	"
Automotive Aftermarket Products	"	"
Cutback Asphalt	"	"
Household Products	"	"
Industrial Maintenance Coatings	"	"
Personal Care Products	"	"
Pesticide Application: All Processes	"	"
Traffic Markings	"	"
Structure Fires	"	"
Air Taxi	Based on 1999 NEI Emission Factors and FAA Terminal Area Forecast	FAA Terminal Area Forecast
Commercial Aircraft	"	"
General Aviation	"	"
Yard Locomotives	Grown From 1999 NEI	EPA Non-road Model
Railroad	"	"
Agricultural Equipment	EPA Non-road Model	EPA Non-road Model
Airport Equipment	"	"
Commercial Equipment	"	"
Construction and Mining Equipment	"	"
Industrial Equipment	"	"
Lawn and Garden Equipment	"	"
Pleasure Craft	"	"
Railroad Equipment	"	"
Recreational Equipment	"	"

Non-road Model Input File For 2002

The "Non-road Model Input File for 2002" was produced automatically by the NonRoad Model. Note that there is no high altitude option in the Non-Road Model (selecting "HIGH" for "Altitude of region" has no effect). The inputs to the model that are reflected in this file are those within the /NAME/.../END/ delimiters such as:

/PERIOD/
Period type : Seasonal
Summation type : Typical day
Year of episode : 2002
Season of year : Summer
Month of year :
Weekday or weekend : Weekday
/END/

```
Written by Nonroad interface at 6/2/2003 12:25:32 PM
This is the options file for the NONROAD program.
The data is sperated into "packets" bases on common
information.  Each packet is specified by an
identifier and a terminator. Any notes or descriptions
can be placed between the data packets.

10/8/1999 changed default RVP from 9.0 to 8.0

-----------------------------------------------------

                  PERIOD PACKET

This is the packet that defines the period for
which emissions are to be estimated.  The order of the
records matter.  The selection of certain parameters
will cause some of the record that follow to be ignored.
The order of the records is as follows:

1  - Char 10  - Period type for this simulation.
                Valid responses are: ANNUAL, SEASONAL, and MONTHLY
2  - Char 10  - Type of inventory produced.
                Valid responses are: TYPICAL DAY and PERIOD TOTAL
3  - Integer  - year of episode (4 digit year)
4  - Char 10  - Month of episode (use complete name of month)
5  - Char 10  - Type of day
                Valid responses are: WEEKDAY and WEEKEND
-----------------------------------------------------
/PERIOD/
Period type        : Seasonal
Summation type     : Typical day
Year of episode    : 2002
Season of year     : Summer
```

```
Month of year      :
Weekday or weekend : Weekday
/END/

-----------------------------------------------------

                  OPTIONS PACKET

This is the packet that defines some of the user
options that drive the model.  Most parameters are
used to make episode specific emission factor
adjustments. The order of the records is fixed.
The order is as follows.

1  -  Char 80  - First title on reports
2  -  Char 80  - Second title on reports
3  -  Real 10  - Fuel RVP of gasoline for this simulation
4  -  Real 10  - Oxygen weight percent of gasoline for simulation
5  -  Real 10  - Percent sulfur for gasoline
6  -  Real 10  - Percent sulfur for diesel
7  -  Real 10  - Percent sulfur for LPG/CNG
8  -  Real 10  - Minimum daily temperature (deg. F)
9  -  Real 10  - maximum daily temperature (deg. F)
10 -  Real 10  - Representative average daily temperature (deg. F)
11 -  Char 10  - Flag to determine if region is high altitude
                      Valid responses are: HIGH and LOW
12 -  Char 10  - Flag to determine if RFG adjustments are made
                      Valid responses are: YES and NO
-----------------------------------------------------
/OPTIONS/
Title 1            : State Wide 2002
Title 2            : Ozone
Fuel RVP for gas   : 8.4
Oxygen Weight %    : 0.6
Gas sulfur %       : 0.034
Diesel sulfur %    : 0.0500
CNG/LPG sulfur %   : 0.003
Minimum temper. (F): 60.1
Maximum temper. (F): 93.7
Average temper. (F): 77.3
Altitude of region : LOW
/END/

-----------------------------------------------------

                  REGION PACKET

This is the packet that defines the region for which
emissions are to be estimated.

The first record tells the type of region and
allocation to perform.

Valid responses are:
US TOTAL   -  emissions are for entire USA without state
              breakout.
```

```
50STATE    -  emissions are for all 50 states
              and Washington D.C., by state.

STATE      -  emissions are for a select group of states
              and are state-level estimates

COUNTY     -  emissions are for a select group of counties
              and are county level estimates.  If necessary,
              allocation from state to county will be performed.

SUBCOUNTY  -  emissions are for the specified sub counties
              and are subcounty level estimates.  If necessary,
              county to subcounty allocation will be performed.

The remaining records define the regions to be included.
The type of data which must be specified depends on the
region level.

US TOTAL   -  Nothing needs to be specified.  The FIPS
              code 00000 is used automatically.

50STATE    -  Nothing needs to be specified.  The FIPS
              code 00000 is used automatically.

STATE      -  state FIPS codes

COUNTY     -  state or county FIPS codes.  State FIPS
              code means include all counties in the
              state.

SUBCOUNTY  -  county FIPS code and subregion code.
-----------------------------------------------------
/REGION/
Region Level       : COUNTY
The State of Col CO: 08000
/END/

or use -
Region Level       : STATE
Michigan           : 26000
-----------------------------------------------------

                  SOURCE CATEGORY PACKET

This packet is used to tell the model which source
categories are to be processed.  It is optional.
If used, only those source categories list will
appear in the output data file.  If the packet is
not found, the model will process all source
categories in the population files.
-----------------------------------------------------

All Equipment - just put semicolon at start of packet name line
or use the following SCC list -
                  :2260000000
                  :2265000000
                  :2267000000
```

```
                    :2268000000
                    :2270000000
                    :2282000000
                    :2285000000
Diesel Only -
                    :2270000000
                    :2282020000
                    :2285002015
Spark Ignition Only -
                    :2260000000
                    :2265000000
                    :2267000000
                    :2268000000
                    :2282005010
                    :2282005015
                    :2282010005
                    :2285004015
                    :2285006015

-----------------------------------------------------
 This is the packet that lists the names of output files
 and some of the input data files read by the model.  If
 a drive:\path\ is not given, the location of the
 NONROAD.EXE file itself is assumed.  You will probably
 want to change the names of the Output and Message files
 to match that of the OPTion file, e.g., MICH-97.OPT,
 MICH-97.OUT, MICH-97.MSG, and if used MICH-97.AMS.
-----------------------------------------------------
/RUNFILES/
ALLOC XREF          : c:\nonroad\data\allocate\allocate.xrf
ACTIVITY            : c:\nonroad\data\activity\activity.dat
TECHNOLOGY          : c:\nonroad\data\tech\tech.dat
SEASONALITY         : c:\nonroad\data\season\season.dat
REGIONS             : c:\nonroad\data\season\season.dat
MESSAGE             : c:\nonroad\outputs\stoz02.msg
OUTPUT DATA         : c:\nonroad\outputs\stoz02.out
EPS2 AMS            :
/END/

-----------------------------------------------------
This is the packet that defines the equipment population
files read by the model.
-----------------------------------------------------
/POP FILES/
Population File     : c:\nonroad\data\pop\co.pop
/END/

POPULATION FILE     : c:\nonroad\data\POP\MI.POP


-----------------------------------------------------
This is the packet that defines the growth files
files read by the model.
-----------------------------------------------------
/GROWTH FILES/
National defaults  :C:\nonroad\data\growth\nation.grw
/END/
```

```
-----------------------------------------------------
This is the packet that defines the spatial
allocation files read by the model.
-----------------------------------------------------
/ALLOC FILES/
Air Transportation :c:\nonroad\data\allocate\co_airtr.alo
Contruction empl.  :c:\nonroad\data\allocate\co_const.alo
Havested Cropland  :c:\nonroad\data\allocate\co_farms.alo
Golf Course estab. :c:\nonroad\data\allocate\co_golf.alo
Wholesale establis.:c:\nonroad\data\allocate\co_holsl.alo
Family housing     :c:\nonroad\data\allocate\co_house.alo
Logging empl.      :c:\nonroad\data\allocate\co_loggn.alo
Landscape empl.    :c:\nonroad\data\allocate\co_lscap.alo
Metal mining empl. :c:\nonroad\data\allocate\co_metal.alo
Manufacturing empl.:c:\nonroad\data\allocate\co_mnfg.alo
Oil & Gas employees:c:\nonroad\data\allocate\co_oil.alo
Census population  :c:\nonroad\data\allocate\co_pop.alo
RV Park employees  :c:\nonroad\data\allocate\co_rvprk.alo
Surface water area :c:\nonroad\data\allocate\co_water.alo
Allocation File    :c:\nonroad\data\allocate\co_sbr.alo
Allocation File    :c:\nonroad\data\allocate\co_sbc.alo
Allocation File    :c:\nonroad\data\allocate\co_snowm.alo
Allocation File    :c:\nonroad\data\allocate\co_wob.alo
Allocation File    :c:\nonroad\data\allocate\co_wib.alo
Allocation File    :c:\nonroad\data\allocate\co_coal.alo
/END/

-----------------------------------------------------
This is the packet that defines the emssions factors
files read by the model.
-----------------------------------------------------
/EMFAC FILES/
THC exhaust        : c:\nonroad\data\emsfac\exhthc.emf
CO exhaust         : c:\nonroad\data\emsfac\exhco.emf
NOX exhaust        : c:\nonroad\data\emsfac\exhnox.emf
PM exhaust         : c:\nonroad\data\emsfac\exhpm.emf
BSFC               : c:\nonroad\data\emsfac\bsfc.emf
Crankcase          : c:\nonroad\data\emsfac\crank.emf
Spillage           : c:\nonroad\data\emsfac\spillage.emf
Diurnal            : c:\nonroad\data\emsfac\diurnal.emf
/END/

-----------------------------------------------------
This is the packet that defines the deterioration factors
files read by the model.
-----------------------------------------------------
/DETERIORATE FILES/
THC exhaust        : c:\nonroad\data\detfac\exhthc.det
CO exhaust         : c:\nonroad\data\detfac\exhco.det
NOX exhaust        : c:\nonroad\data\detfac\exhnox.det
PM exhaust         : c:\nonroad\data\detfac\exhpm.det
/END/

Optional Packets - Add initial slash "/" to activate

/STAGE II/
```

```
Control Factor     : 0
/END/
Enter percent control: 95 = 95% control = 0.05 x uncontrolled
Default should be zero control.

MODELYEAR OUT/
by-model-year out  : C:\nonroad\outputs\template.bmy
/END/

SI REPORT/
SI report file-CSV :C:\NONROAD\OUTPUTS\NRPOLLUT.CSV
/END/
```

6.0 Ozone Precursor Monitoring and Emission Inventory Comparison

The Colorado APCD conducted a precursor field study in to 2003 to get a better understanding of precursors and their roles in the Denver ozone domain (Pierce, 2003). This field study presented an opportunity to compare emission inventory precursors with those species found though the ambient field study. A draft of the results from this precursor monitoring effort follows this monitoring/inventory discussion.

Since there are hundreds of VOCs and thousands of reactions in the atmosphere, the ambient measured species and the emission inventory data need to condensed and speciated for modeling. For the Denver EAC, the Carbon Bond-IV (CB-IV) chemical mechanism is being used within CAMx. The CB-IV mechanism decomposes VOC compounds based on reactive carbon bonds. A direct comparison of emission inventories to ambient data is not entirely correlated since emission inventories by themselves do not take into account atmospheric transport, photochemistry, background concentrations, etc.

However, it would be reasonable to compare ambient and emissions data in situations where the local ozone precursor concentrations are dominated by local ozone precursor emissions.

The following criteria can be used for this analysis:

- Use only monitoring data from sites located in areas with high local emission levels;

- Use only data from times of days when the ambient concentrations are least influenced by meteorology and chemical reactions (i.e., early morning - 0600 - 0900);

- Use only samples with "high" precursor concentrations (i.e., NMHC concentrations of at least 50 ppbC and NOx concentrations of at least 5 ppb).

- Consider only emissions "nearby" a monitor (i.e. 9 x 9 grid cell area centered on the monitoring site). For a particular hour, consider only those grid cells in the upwind quadrant (i.e., grid cells either totally and partially in 45 degree sector centered on hourly wind direction, with no weighting by distance or direction).

- Consider only those NMHC species that were identified in the ambient data. The identifiable species comprise about xx% of the total NMOC concentrations and about xx% of the total emissions inventory, on a molar basis.

- Convert emissions from mass to molar basis (ppbC equivalent)

- Emissions need to be adjusted "back" two hours to match ambient data (i.e., emissions are end-hour, ambient data are start hour)

- Emissions matched to day/hours meeting ambient threshold based on the following hierarchy:

    - Same day;
    - Same day of week and closest temperature (motor vehicles);
    - Same day of week (point and area sources).

- The analysis can be done both with and without elevated NOx and VOC emissions. It is not clear how much, if any, nearby elevated NOx and VOC sources contribute to local ground-level ambient concentrations during the early morning hours.

- Low-level inversions in the early morning hours during the summer in Denver are estimated at between 150 and 300 m. Some elevated sources may have effective stack heights below 150 - 300 m, but larger sources can have effective stack heights greater than 150 - 300 m.

- Either emissions data would need to be converted to actual NMHC species, or, ambient data would need to be converted to CB-IV species (which I think Dale did).

Figure2 through figure 5 present comparisons of the 2003 ambient measured data with 2002 emission inventories using Carbon Bond-IV as a common subset of VOC's. VOC emissions from the emission inventory were speciated to CB-IV using each SCC chemical profile. The emissions on a countywide basis were compared to the ambient monitored data that contained the monitored data.

For the most part, the CB-IV speciation show that the ambient data and the monitored data compare fairly well. Most all emissions and monitored data fall in the paraffin species.

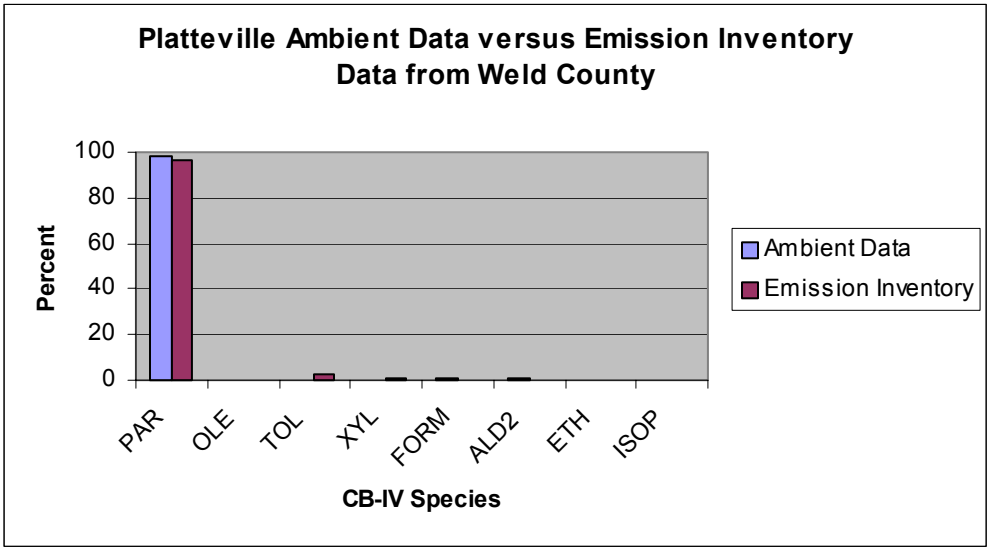


Figure 2 – Plattteville Ambient Data

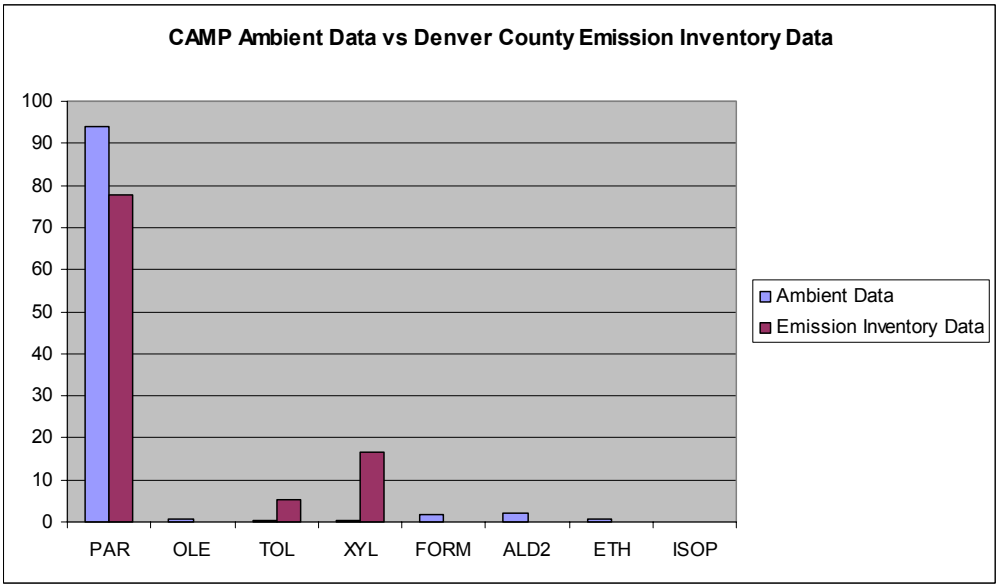


Figure 3 – CAMP Ambient Data

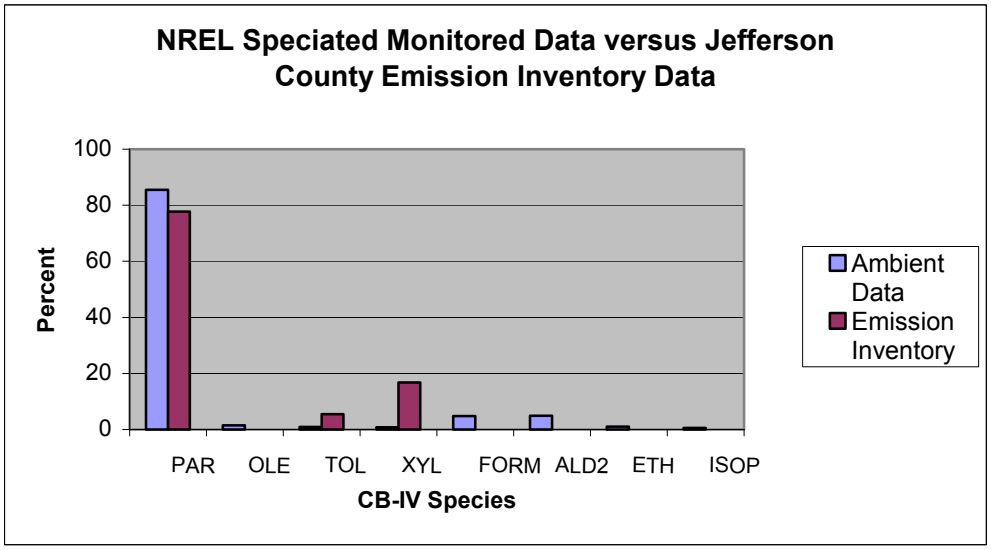


Figure 4 – NREL Speciated Monitored Data

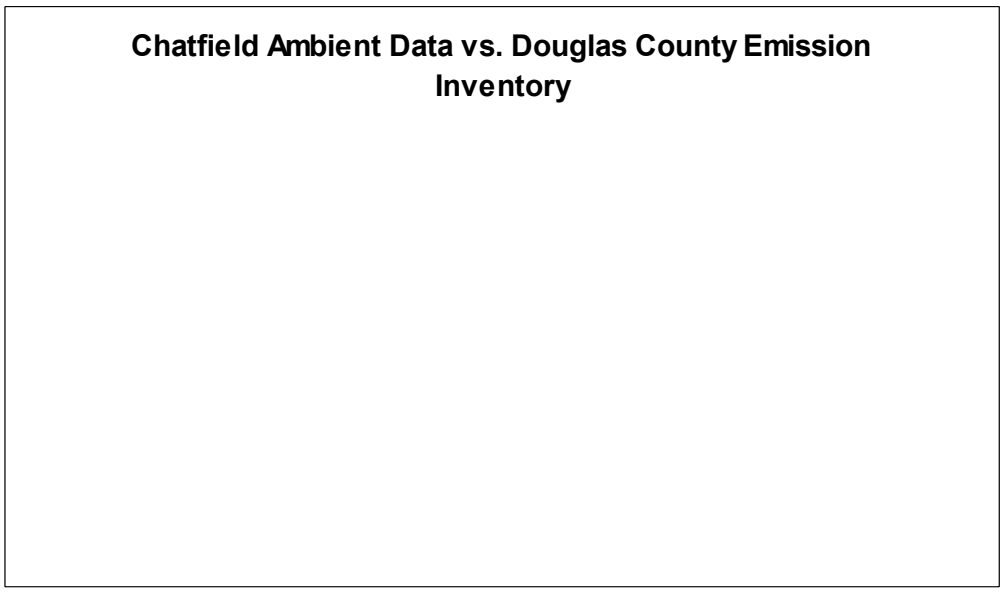


Figure 5 – Chatfield Ambient Data

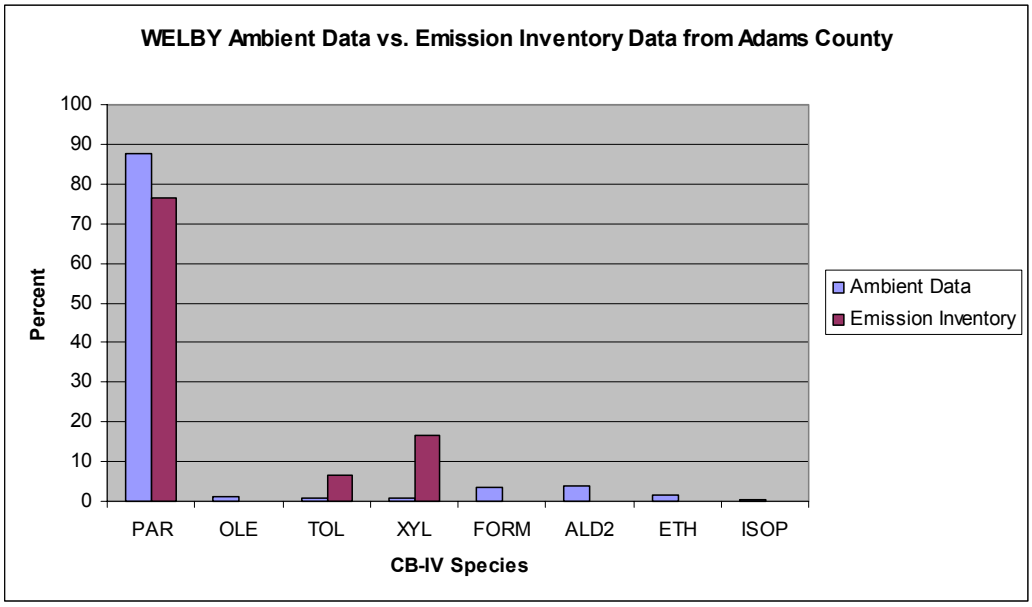


Figure 6 – WELBY Ambient Data

Comparison of the Flash Source Profile with Ambient Measurement

"Flash" emissions represent a large portion of the nonattainmentn area anthropogenic VOC emission inventory as well as the statewide inventory. Figure 7 presents a comparison of the non-methane hydrocarbon (NMHC) ambient measurements at Platteville made during August and September 2003 and the relative amounts of NMHC in the condensate/flash emission source profile. About 93% of the total molar C mass is accounted for in the emission profile for flash emissions when compared to the ambient data for Platteville. Morning samples (0600-0900) were used for the comparison when the ambient concentrations were least influenced by meteorology and chemical reactions, and, whose emission precursors are most influential on the afternoon ozone levels in Jefferson and Douglas Counties.

Emissions for individual organic compounds were converted from mass/rate to molar basis (ppbC equivalent) by dividing by the molecular weight and multiplying by the number of carbon atoms for each species.

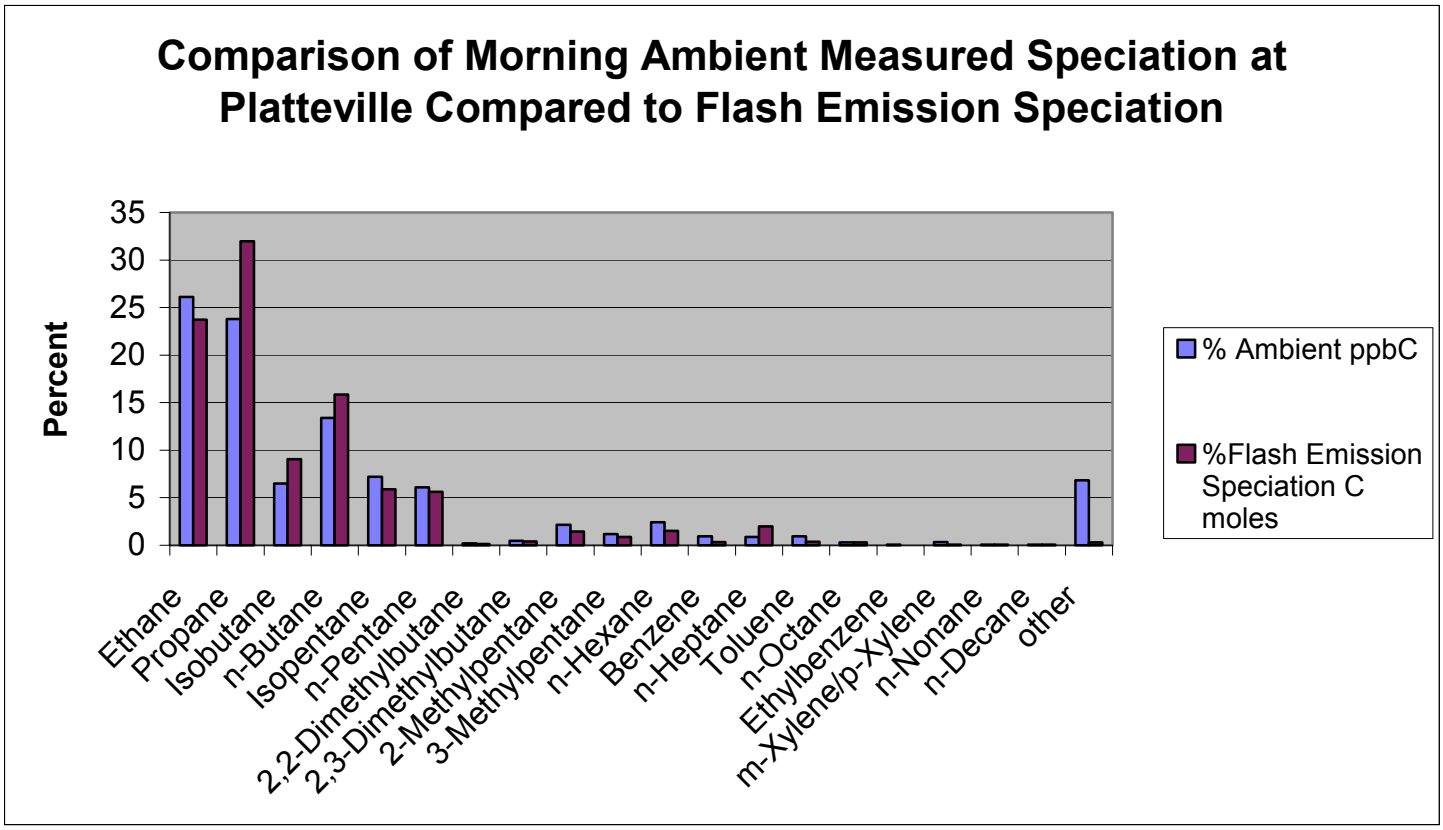


Figure 7 – Ambient Measured Speciation compared to Flash Emission Speciation

An initial review of the monitoring data has been completed, comparing a few selected compounds among sampling locations and to data collected in 2000 through 2003 at the CAMP monitoring site and in 2002 at the Welby monitoring site. Some ratios of pollutants have also been compared as described above, and the ratios were also compared to emission factor ratios from the Mobile6 emission factor model.

Table 15 - Data averages for 1,3-Butadiene and Benzene

			Concentration ppbv	
Location	YEAR	Time	1,3-Butadiene	Benzene
CAMP	2003	13:00-16:00	0.097	2.037
		6:00-9:00	0.201	2.406
	2003	average	0.149	2.222
	2002		0.141	0.959
	2001		0.129	0.859
	2000		0.170	0.989
Welby	2003	13:00-16:00	0.0425	2.475
		6:00-9:00	0.235	3.895
	2003	average	0.118	3.185
	2002		0.095	0.642
chatfield	2003	13:00-16:00		0.267
		6:00-9:00		0.295
		average		0.281
nrel	2003	13:00-16:00		1.419
		6:00-9:00	0.06	1.315
		average	0.06	1.367
plattville	2003	13:00-16:00		1.141
		6:00-9:00	0.10	3.977
		average	0.10	2.559

Benzene concentrations were higher at Plattville than at any other site except for Welby. 1,3-Butadiene concentrations were highest at CAMP. Benzene concentrations were much higher at CAMP and WELBY in 2003 than in the previous years.

Table 16 - Data averages for Formaldehyde, Acetaldehyde and Acetone

			Concentration ppbv		
Location	YEAR	Time	Formaldehyde	Acetaldehyde	Acetone
CAMP	2003	13:00-16:00	8.41	5.94	6.52
		6:00-9:00	10.61	8.70	9.62
	2003	ave	9.51	7.32	8.07
	2002		8.22	2.85	2.58
	2001		8.77	3.12	3.22
	2000		7.39	3.11	4.44
Welby	2003	13:00-16:00	5.51	2.81	4.42
		6:00-9:00	5.64	3.80	5.70
	2003	ave	5.58	3.30	5.06
	2002		3.27	1.50	1.66
chatfield	2003	13:00-16:00	4.53	2.03	3.82
		6:00-9:00	2.88	1.72	2.98
		ave	3.71		3.40
nrel	2003	13:00-16:00	6.02	3.28	5.40
		6:00-9:00	4.49	2.95	4.92
		ave	5.26		5.16
plattville	2003	13:00-16:00	5.14	3.29	5.20
		6:00-9:00	4.73	3.52	5.62
		ave	4.93	3.41	5.41

Concentrations for these pollutants were highest at CAMP. Concentrations of Acetaldehyde and Acetone were much higher at CAMP and Welby in 2003 than in previous years

Table 17 - Ratios of selected pollutants in mass units (micrograms per cubic meter and grams per mile for mobile source emissions.

			Mass Ratio				
Location		2003 Ratio	2002 ra	2001 ratio	2000 ratio	Mobil 2 exhaus emission ratio	
CAMP	1-3/CO	0.00033	0.00040	0.00040	0.00035	1-3/CO	0.00036
	benz/CO	0.00800	0.00388	0.00363	0.00297	benz/CO	0.00264
	benz/1-3B	26.85973	10.21209	10.53225	8.62104	benz/1-3B	7.25142
	Time	1-3/C					
	6:00-9:00	0.00038					
	13:00-1	0.00028					
	ave	0.00 3					
		benz/					
	6:00-9:00	0.00639					
	13:00-16:00	0.00961					
	ave	0.0					
		be z/1-3B					
	6:00-9:00	17.33536					
	13:00-16:00	.38410					
	ave	26.8					
	1-3/CO	0.00038	0.00040				
	be /CO	0.02035	0.00433				
	benz	38.98306	11.43477				
Welby	Time	1-3/CO					
	6:00-9:00	0.00043					
	13:00-16:00	0.00033					
	ave	0.00038					
	6:00-	0.01275					
	13:00-16:00	0.02794					
	ave	0.02035					
		benz/1-3B					
	6:00-9:00	31.94026					
	13:00-16:00	46.02587					
	ave	38.98306					
		benz/1-3B					
nrel	6:00-9:00	40.27007					
plattville	6:00-9:00	57.45657					

The ratio of 1,3-Butadiene to carbon monoxide (CO) is only slightly lower at CAMP and Welby in 2003 than in previous years, and is nearly the same as the Mobile6 emission ratio for these pollutants. This is not surprising, since 1,3-Butadiene is almost exclusively emitted by internal combustion engine exhaust. The ratio of Benzene to carbon monoxide is much higher in 2003 at CAMP and Welby than in previous years, and much higher than the Mobile6 emission ratio for these pollutants. This would

indicate that there is something unusual occurring with non-engine exhaust emissions in 2003.

The ratio of Benzene to 1,3-Butadiene is also much higher at CAMP and Welby than in previous years, and much higher than the Mobile6 emission ratio for these pollutants.

The ratios of Benzene to carbon monoxide and Benzene to 1,3-Butadiene are much closer to the Mobile6 emission ratios for these pollutants for the years previous to 2003 at CAMP and Welby.

The ratio of Benzene to 1,3-Butadiene is lowest at CAMP and highest at Plattville in 2003.

Table 18 - Concentrations of1,3-Butadiene and Benzene at Plattville

Table 4. Platteville Concentration ppbv			
Sampling Date:	Sampling Time:	1,3-Butadiene	Benzene
28-Aug-03	06:00-09:00	ND	1.69533333
26-Aug-03	06:00-09:00	0.11325	4.83
22-Aug-03	06:00-09:00	0.11275	5.19916667
20-Aug-03	06:00-09:00	0.13675	4.184
28-Aug-03	13:00-16:00	ND	0.3295
26-Aug-03	13:00-16:00	ND	0.868
22-Aug-03	13:00-16:00	ND	2.0485
20-Aug-03	13:00-16:00	ND	2.04466667

There seem to be at least three regimes at work here. In the morning, when 1,3-Butadiene is not detected, Benzene concentrations are lower, indicating that there is a motor vehicle component to the high Benzene concentrations (perhaps transported from Denver). In the afternoon, no 1,3-Butadiene is detected, and Benzene concentrations can be high or low.