Technical Support Document

Carbon Monoxide Maintenance Plan Revision For the Denver-Boulder Attainment Area

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Prepared by the Technical Services Program
Air Pollution Control Division
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Attainment Area Domain Emission Inventory Summary

The following table summarizes the emission inventories to support the Denver Maintenance plan transportation budget revision. All inventories have been apportioned to the geographical area bounded by the Denver-Boulder attainment area boundaries.

Table 1 – Emission Inventory Summaries

Source Category	**2001 tons/day**	**2004 ton/day**	**2005 tons/day**	**2006 tons/day**	**2013 tons/day**
Point Sources	31.6	25.6	25.6	25.6	25.6
Woodburning	46.5	32.5	32.5	29.0	22.4
Natural Gas	6.6	7.8	7.8	8.3	9.3
Structural Fires	3.6	4.5	4.5	4.7	5.2
Agriculture Equipment	0.0	0.0	0.0	0.0	0.0
Airport – Aircraft	15.3	20.3	20.3	21.6	23.7
Airport Service Equipment	7.6	7.3	7.3	7.2	7.7
Construction Equipment	9.4	7.8	7.8	7.4	7.7
Industrial Equipment	23.0	21.3	21.3	20.9	21.7
Light Commercial Equipment	129.0	120.9	120.9	118.9	123.9
Helicopters	.3	.3	.3	.3	.3
Railroads	.3	.3	.3	.3	.3
Point and Area Source Subtotal	273	249	249	244	248
Mobile6.2 On-Road Mobile	1638	1591	1562	1613	1125
Revised SIP Total	1911	1840	1811	1858	1373

This maintenance plan revision will become effective upon EPA approval, which is expected to occur after the 2003/2004 winter season and likely by mid-2004. In order to demonstrate that the Denver maintenance area will continue to stay in compliance with the carbon monoxide standard between the time EPA approves the plan in 2004 through 2006, emission inventories for mid-November 2004 and January 1, 2005 are included in the above table. The EPA Mobile6 user's guide was consulted for the correct methodology to estimate a November 15, 2004 mobile source emission inventory. The basis of this methodology, an interpolation between 1/1/2004 and 1/1/2005 Mobile6 runs, is fully documented with Mobile6 inputs, outputs and a spreadsheet showing all the calculations. This information is contained in Appendix C.

AM Peak	Running	Idle
CBD	15.04	84.46
Fringe	14.39	85.44
Urban	13.92	85.84
Suburban	13.98	86.04

Intersection Analysis / Allocation of Excess Emissions

The emission factors for the intersection analysis were calculated as described in the Modeling Protocol. The Modeling Protocol is included with this document as Appendix A. The Mobile6.2 and CAL3QHC inputs and outputs related to the intersection analysis are included in Appendix B (on CD).

Table 2 - 2013 Mobile6.2 Running and Idle Emission Factors

PM Peak	Running	Idle
CBD	14.18	82.42
Fringe	13.74	83.62
Urban	13.52	83.76
Suburban	13.64	83.92

Table 3 - 2000-2002 Ambient Carbon Monoxide Max and 2nd

Location	Area Type	2000	2001	2002
CAMP	CBD	8.5 / **5.4**	4.4 / 4.1	3.7 / 3.7
Speer & Auraria	CBD	5.0 / 4.6	4.6 / 4.0	3.9 / 3.6
Carriage	Fringe	4.1 / 3.4	3.8 / 3.7	3.7 / 2.7
National Jewish Hospital	Fringe	4.8 / **4.7**	4.0 / 3.9	3.5 / 3.1
Arvada	Urban/Suburban	3.9 / **3.8**	3.1 / 3.0	3.0 / 2.6
Boulder	Urban/Suburban	6.8 / **4.3**	4.5 / 3.4	3.5 / 3.0

2001 Background Concentrations Estimates:

CAMP: 5.4 ppm (CAMP monitor)
Foothills and Arapahoe: 4.3 ppm (Boulder monitor)
1st and University: 4.7 ppm (NJH monitor)
Hampden & University: 3.8 ppm (Arvada)
Parker & Iliff: 3.8 ppm (Arvada)
Arapahoe & University: 3.8 ppm (Arvada)

The rationale for the assignment of the background concentrations is described in the modeling protocol.

2013 CAL3QHC Modeling Results

The CAL3QHC inputs and outputs are included in Appendix A (on CD). The following table summarizes the results of the CAL3QHC modeling.

Table 3 – CAL3QHC Modeling Results Summary

Intersection	CAL3QHC	Background	Total
Broadway & Champa	1.47 ppm	5.4 ppm	6.87 ppm
Foothills & Arapahoe	4.97 ppm	4.3 ppm	**9.27 ppm**
1st & University	4.05 ppm	4.7 ppm	8.75 ppm
Hampden & University	4.83 ppm	3.8 ppm	8.63 ppm
Parker & Iliff	3.29 ppm	3.8 ppm	7.09 ppm
Arapahoe and University	4.62 ppm	3.8 ppm	8.42 ppm

The 9.27 ppm CAL3QHC modeling results at the Foothills and Arapahoe intersection is the highest intersection and it is above the carbon monoxide 8-hr NAAQS. This concentration is .28 ppm above a compliance level of 8.99 ppm. Consequently, to assure attainment in 2013, the attainment level inventory of 1911 tons needs to be reduced by an amount commensurate with .28 ppm:

2013 attainment emission inventory = 1911 ton/day *((4.3 ppm - .28 ppm) / 4.3 ppm) = 1911 ton/day * (4.02 ppm / 4.3 ppm) = 1787 tons/day

Therefore, 1787 tons will equate to a 4.02 ppm background at Foothills and Arapahoe. This is the attainment level inventory for 2013.

The amount of excess emissions that can be allocated to the transportation budget is the 2013 attainment inventory minus the estimated 2013 emission inventory:

Excess emissions = 1787 ton/day – 1373 ton/day = 414 ton/day.

2001-2003 Urban Business District Emission Inventory Comparisons

The Urban Business District has been defined as the grid cell containing the CAMP monitoring location and the adjacent eight cells (9 one-mile grid cells). The following table summarizes the emission inventory totals in the Urban Business District:

Table 4 – Urban Business District Emission Inventory Totals

	2001	2013
Vehicle Miles Traveled	1,905,071	2,176,651
Mobile Source Emissions	54.4 tons/day	33.5 tons/day
Non-road Emissions	7.7 tons/day	7.2 tons/day
Emissions Total	62.1 tons/day	40.7 tons/day

Since the Urban Business District carbon monoxide emissions loading in 2013 is about 66% of the 2001 attainment year level of emissions loading, it is reasonable to infer that the CO NAAQS will be met at this location in 2013.

Chapter 2 - Mobile Source Emission Inventory

Travel Demand Model based Mobile6.2 Inputs

The implementation of Mobile6.2 into the Air Pollution Control Divisions mobile emission modeling necessitated many changes to the processes used with Mobile5. The basis for mobile source activity level is the DRCOG the 2025 Regional Transportation Plan (RTP) travel demand modeling. The 2001, 2010 and 2020 networks from the 2025 RTP (RTP) will be used for VMT estimates. The 2004-2006 and 2013 VMT and network speed estimates were determined from interpolations between these three 2025 RTP networks.

The following Mobile6.2 inputs parameters for 2001, 2004-2006, 2010 and 2013 were derived from the 2025 RTP:

- Vehicle speeds (SPEED VMT command)
- Diurnal distribution of VMT (VMT BY HOUR command)
- Distribution of VMT by Facility class (VMT BY FACILITY)

A FORTRAN program was written to convert the speeds and VMT as a function of 10 peak periods, facility type and area type into the proper formats for the Mobile6.2 command files. This FORTRAN program, m6inputa.f, is included in Appendix C.

The temporal basis of the DRCOG 2025 RTP is 10 peak periods: 3 a.m. and p.m. peak periods and four off peak periods. Each link in the network has a traffic volume and speed associated with each of the 10 peak periods. The length of each peak period and where it occurs during the day is dependent on the level of congestion during the peak period. The FORTRAN processing program utilizes congestion level/peak period definition information from DRCOG to allocate the VMT and speed to the appropriate hour(s) in the day. Finally, the VMT for each area type is normalized to unity, resulting in the files referenced by the VMT BY HOUR command. The SPEED VMT files are processed similarly, although the speeds are weighted by the VMT across the 7 facility classes for each area type.

Each link in the DRCOG networks is also designated with a facility class (freeway, expressway, principal and minor arterial, collector, ramp and local) and area type (CBD, fringe, urban, suburban and rural). The file referenced by the VMT BY FACILITY command results from a summary of VMT by facility type for each area type.

Finally, the FORTRAN processing program writes a text file of five scenarios, one for each area type. The text for each scenario references the appropriate files through the SPEED VMT, VMT BY FACILITY and VMT BY HOUR commands. The scenarios text is then appended to the 'header' and 'run' sections to complete the Mobile6.2 input file.

Local Vehicle Mix and Vehicle Registration Distribution

Colorado data on VMT mix and vehicle registration distribution has been recently updated. These new local data sets were included in this budget revision. The VMT mix by area type is appended to each area type scenario as described in the previous section. The reference to the registration distribution is included in the 'RUN DATA' section of the Mobile6.2 input files. The

VMT mix information and registration distribution is included in Appendix C with the Mobile6.2 inputs and outputs.

Control Strategy Parameterization

Control strategies for this budget revision analysis are characterized as defined in the Denver Maintenance Plan (December 14, 2001). An I/M 240 inspection and maintenance program and an oxygenated fuel program are scheduled to continue through the 2001 to 2013 time period. In addition, a Clean Screen program is to be implemented for the 2004-2006 timeframe at penetration levels of 40% to 80%, respectively. Since the year-to-year description of these strategies is quite complex, it is not included here. However, the Mobile6.2 input files for each year contains all of the information regarding these strategies and how they are parameterized for the Mobile6.2 runs. These files are located in Appendix C.

The Clean Screen Utility provided by the EPA (May 22, 2003) was utilized to estimate the reduction of the I/M 240 benefit resulting from the implementation of Clean Screening during the 2004-2006 time period.

Mobile Source Emission Inventories

The mobile source emission factors were calculated using the Mobile6.22 executable. The effects of the Clean Screen program (a reduction in emission benefit due to the I/M 240 program for 2004, 2005 and 2006) was estimated using a Draft MOBILE6-Based Clean Screen Utility dated 5/21/2003.

The following tables summarize the VMT, emissions factors and resulting emissions inventories:

Table 5 - VMT, Emissions Factors and Resulting Emissions Inventories

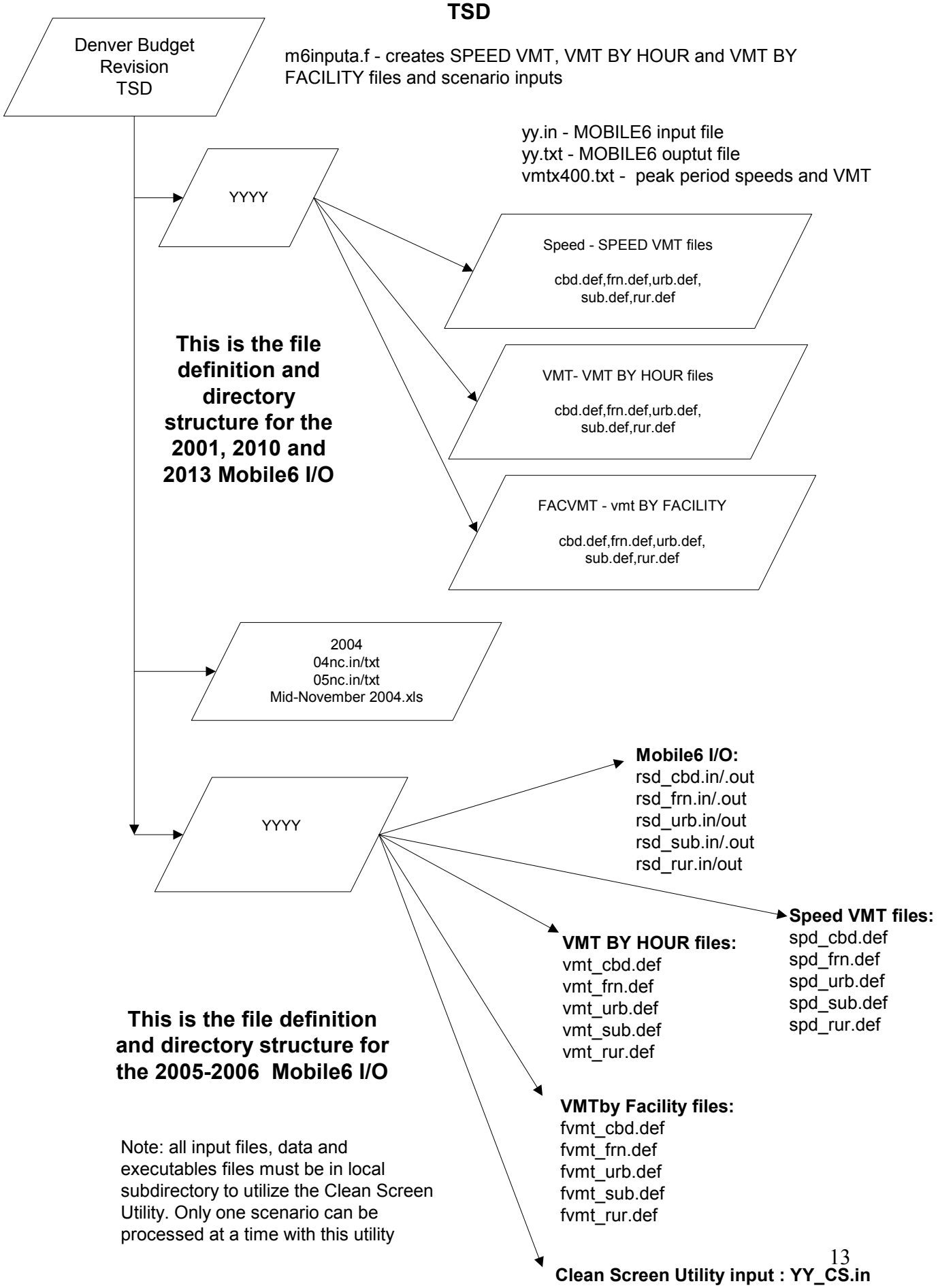
2001	**VMT**	**grams/mile**	**tons/day**
Central Business District	498,644	26.310	14.461
Fringe	5,097,315	25.812	145.031
Urban	18,474,354	25.493	519.143
Suburban	24,896,918	26.325	722.455
Rural	7,826,686	27.421	236.569
Totals	56,793,928	26.160	1637.660
2004	**VMT**	**grams/mile**	**tons/day**
Central Business District	536,764	23.021	13.621
Fringe	5,505,324	23.261	141.158
Urban	19,953,088	23.083	507.688
Suburban	26,889,829	23.631	700.436
Rural	8,453,155	24.468	227.989
Totals	61,338,159	23.530	1590.892
2005	**VMT**	**grams/mile**	**tons/day**

Central Business District	538,068	22.558	13.379
Fringe	5,518,701	22.790	138.637
Urban	20,001,572	22.615	498.606
Suburban	26,955,172	23.125	687.101
Rural	8,473,695	23.965	223.845
Totals	61,487,224	23.040	1561.568
2006	**VMT**	**grams/mile**	**tons/day**
Central Business District	561,274	22.683	14.038
Fringe	6,070,653	23.084	154.470
Urban	22,341,234	22.931	564.712
Suburban	27,834,858	23.381	717.380
Rural	6,114,905	24.157	162.828
Totals	62,922,904	23.262	1613.4
2010			
Central Business District	581,477	15.83	10.145
Fringe	6,321,896	15.80	110.083
Urban	22,666,738	15.74	393.170
Suburban	31,156,764	16.08	552.112
Rural	7,180,332	16.68	132.051
Totals	67,907,192	16.00	1197.561
2013	**VMT**	**grams/mile**	**tons/day**
Central Business District	608,309	13.90	9.318
Fringe	6,613,616	14.21	103.607
Urban	23,712,684	14.14	369.465
Suburban	32,594,488	14.44	518.846
Rural	7,511,661	14.95	123.812
Totals	71,040,744	14.37	1125.048

Mobile6.2 Input/Output File Documentation

Due to the volume and complexity of files utilized in the emission processing for this budget revision, the Mobile6.2 input and output files as well as all ancillary input files are included on a CD as Appendix C. The subdirectory structure of the files on this CD is described in the following diagram.

Diagram 1: Directory structure of digital files for Denver Budget Revision TSD



Chapter 3 - Non-Mobile Source Emission Inventory

Non-Mobile Source Emission Inventory

All area, non-road and point source emission inventories are for the Denver metropolitan area carbon monoxide attainment maintenance area and provide emission estimates for a weekday during the winter carbon monoxide season.

All area, non-road and point source emission inventories were developed using EPA-approved emissions modeling methods and the demographics data from the Maintenance Plan previously approved on December 14, 2001. A comparison with the DRCOG's latest demographics data based on the 2000 census have been included to show that the growth assumptions in the previously approved Maintenance Plan continue to be valid for use in this budget revision effort.

Table 6 - Demographic Data Used to Develop Emission Inventories for the Maintenance Plan

Year	Population	Households	Employment
2001	2,364,000	970,000	1,415,500
2006	2,616,000	1,097,000	1,568,000
2013	2,889,000	1,244,000	1,718,000

Table 7 - Demographic Data Used to Develop the DRCOG 2025 Regional Transportation Plan

Year	Population	Households	Employment
2001	2,414,804	957,780	1,360,814
2006	2,616,000	1,097,000	1,495,791
2013	2,902,913	1,172,902	1,678,079

Household and employment estimates are slightly less for the more recent 2025 RTP demographic data and populations is slightly higher (approximately 0.5%). Population as a surrogate directly affects on the structural fire category. In combination with employment, population also affects the natural gas and helicopter source categories. Since these categories comprise only about .5% of the total carbon monoxide inventory, this slight increase in population is of little consequence. Since the growth and demographic data used in the previously approved maintenance plan are consistent with updated estimates, the non-mobile source categories emissions estimates from the previously approved maintenance plan remain valid as the basis for a budget revision.

Point Sources

As described in the TSD for the previously approved Maintenance plan, the maximum potential to emit for elevated point sources and the actual ground level point source emissions were used in the dispersion modeling to demonstrate maintenance in 2006 and 2013. In addition, there is a regulatory mechanism for new sources greater than 50 tons/year in an attainment area, requiring a modeling demonstration of compliance with ambient air quality standards before issuance of a

permit. The dispersion modeling done for the approved Maintenance plan also indicated that point sources because of their location, elevation and direction of plumes on the design days have little or no impact on the maintenance demonstration.

Since the geographical basis of the carbon monoxide budget revision is the attainment/maintenance area, the area and point sources were screened by location for whether they were located within or outside the attainment/maintenance area. Elevated point sources in 2006 and 2013 are comprised of 25.6 tons/day (79.2% of modeling domain elevated point sources) and area sources in the attainment area are comprised of 5.3 tons/day (25.3% of modeling domain area sources for 2006 and 2013. The attainment area totals for elevated and area area 20.3 tons/day and 11.3 tons/day, respectively.

Non-Road and Area Sources

The calculation methodologies used in the approved plan remains unchanged. Federal regulations are the only controls assumed for non-road categories (construction equipment, industrial equipment and light commercial equipment). There have been no changes in residential wood burning controls. Since households are projected to be somewhat less in future years than the household population used as the basis for the Maintenance plan wood burning inventories, the Maintenance plan wood burning emissions are conservative. Consequently, the non-road and area source category estimates from the Maintenance plan are valid for this budget revision analysis.

Appendix A - Denver-Boulder Carbon Monoxide Attainment Area Carbon Monoxide Budget Revision

Modeling Protocol

Modeling Protocol Overview

The previously approved maintenance demonstration was made through the use of area-wide dispersion modeling using the 2006 and 2013 emission inventories (including MOBILE5 motor vehicle emissions estimates) along with meteorological data from December 5, 1988 which was the design day for the 1994 Carbon Monoxide SIP, and selected intersection hot-spot modeling. The combined results of the dispersion and intersection modeling showed no 8-hour maximum carbon monoxide concentration greater than or equal to 9.0 ppm anywhere in the modeling domain with the implementation of the proposed control measures. The technical support document for the previously approved maintenance plan describes in detail the assumptions and methodologies used for all modeling work.

EPA's "Policy Guidance on the Use of MOBILE6 for SIP Development and Transportation Conformity," (dated January 18, 2002), indicates that SIP revisions based on MOBILE6 must continue to demonstrate maintenance of the standard when MOBILE5-based motor vehicle emission inventories are replaced with MOBILE6 inventories. The guidance indicates that areas can revise their motor vehicle emissions inventories and budgets using MOBILE6 without revising the entire SIP or completing additional modeling if:

1) the SIP continues to demonstrate attainment or maintenance when the MOBILE5-based motor vehicle emission inventories are replaced with MOBILE6 base year and attainment/maintenance year inventories; and,

2) the State can document that the growth and control strategy assumptions for non-motor vehicle sources continue to be valid and any minor updates do not change the overall conclusion of the SIP.

If both of the above criteria are met, the guidance indicates the State can simply re-submit the original SIP with the revised MOBILE6 motor vehicle emission inventories.

The guidance goes on to indicate that "if a carbon monoxide (CO) maintenance plan relied on either a relative or absolute demonstration [in the original maintenance plan], the first criterion could be satisfied by documenting that the relative emissions reductions between the base year and the maintenance year are the same or greater using MOBILE6 as compared to MOBILE5."

This revised maintenance plan replaces MOBILE5 estimates with MOBILE6.2 estimates, and bases the maintenance demonstration on showing that the interim years and maintenance (2013) year emissions are lower than the attainment (2001) year with MOBILE6.2. The protocol for establishing the inventories is described below.

Since this plan allocates available excess emissions reductions to the motor vehicle emissions budget, the EPA recommended a "more rigorous assessment" to ensure allocation of excess emissions will still demonstrate maintenance in 2013 throughout the region, which follows EPA's "Policy Guidance on the Use of MOBILE6 for SIP Development and Transportation Conformity," (dated January 18, 2002), noting "that regardless of the technique used for

attainment or maintenance demonstrations, a more rigorous assessment of the SIP's demonstration may be necessary if a State decides to reallocate possible excess emission reductions to the motor vehicle emissions budget as a safety factor".

This conservative, simplified approach includes an intersection modeling analysis similar to that performed in the original attainment SIP and previously approved maintenance plan. The analysis utilizes the maximum second high reading from 2000-2002 monitor data to establish 2013 background concentrations plus CAL3QHC intersection (hot spot) modeling of selected intersections using 2013 Mobile6.2 emissions factors and DRCOG traffic data. The combination of 2013 background and modeled intersection concentrations determines the amount of excess emissions that can be allocated and still demonstrate maintenance of the standard throughout the region. Details of the analysis are described below.

Additionally, an analysis of the emissions loading is provided to demonstrate that 2013 emissions in the urban core are less than 2001 emissions in the urban core, which was the area of maximum concentration in 2001 based on UAM modeling in the original attainment SIP and previously approved maintenance demonstration.

Emission Inventory Modeling

A key component of this modeling analysis will be the estimation of mobile source emissions inventory using Mobile6.2. The non-mobile component of the inventories will not be revised. The non-mobile component will not change since the growth surrogates have been shown to be less at this time than in the previously approved SIP. Each category however, will be addressed in the TSD. Emission inventories will be estimated for 2001, 2004, 2005, 2006 and 2013. The years November 15, 2004 and 2005 will be included to assure that phase-in of strategy reductions planned in the Redesignation Request do not cause the emission inventory totals for these years to exceed the 2001 attainment year levels.

2001 Base-year Inventory in Attainment/Maintenance

- The 2001 DRCOG travel demand modeling network from the 2025 Regional Transportation Plan will be used for VMT estimates
- The 2001 mobile source emission estimates will be revised using Mobile6.2
- Since this analysis supports a Maintenance Plan revision (emission inventory levels constrained and supported by regulation), the 2001 I/M and oxygenated fuels program will be parameterized as described in the Colorado State Implementation Plan for Carbon Monoxide, July 1994: Denver Metropolitan Nonattainment Area Element.
- Non-mobile emission inventory estimates for each category will be addressed in the TSD through a comparison of growth surrogates used.

2004-2006 and 2013 Future Year Inventories

- The 2001, 2010 and 2020 DRCOG travel demand modeling network from the 2025 Regional Transportation Plan will be used for VMT estimates. The 2004-2006 and 2013 VMT estimates we be determined from interpolations between these networks.
- The mobile source emission estimates will be revised using Mobile6.2
- 2004-2006 and 2013 I/M and oxygenated fuels programs will be parameterized as described in the Carbon Monoxide Redesignation Request and Maintenance Plan for the Denver Metropolitan Area, January 2000.
- Non-mobile emission inventory estimates for each category will addressed in the TSD through a comparison of growth surrogates used.
- The Clean Screen program dis-benefit to the I/M 240 inspection and maintenance program will be estimated for the 2004-2006 inventories using the Clean Screen Utility supplied by the EPA.

MOBILE6.2 Input Parameters

- Analysis years: 2001, 2004, 2005, 2006, 2013
- Vehicle miles traveled (VMT) by area type from DRCOG 2025 RTP travel demand modeling will be used to estimate the VMT for the analysis years.
- Speeds: The ten peak period speed definitions will be used to define the 24-hour speed distribution for each discrete the five area types in the DRCOG 2025 RTP travel demand modeling (CBD, fringe, urban, suburban and rural). The speeds will be VMT weighted for the facility classes.
- The 2004-2006 and 2013 speeds will be determined from interpolations between the appropriate 2025 RTP networks. Local and ramp facility classes will use Mobile6.2 default speeds.
- Facility type dependence is accommodated through the use of the Mobile6.2 VMT BY FACILITY command. The VMT BY FACILITY vectors were with the distribution of VMT by facility class that from the transportation modeling.
- Vehicle Registration: Recently updated registration distribution will be incorporated as describe in the Mobile6.2 User's Guide.
- Vehicle miles traveled mix: Recently updated VMT mix will be incorporated in the Mobile6.2 inputs.
- Temperatures: The diurnal temperature distribution for the UAM modeling demonstration design day will be used.

Urban Business District Emission Inventory Comparison

The 2001 and 2013 emission inventories in a nine-cell subset of Urban Business District grid cells (one mile square) will be compared to assure that emission loading in 2013 does not exceed the 2001 emissions load.

Modeling Demonstration for Allocation of Excess Emissions

It is anticipated that the Mobile6.2 emission factors for 2013 will result in a mobile source emission inventory that is substantially lower than the 2001 attainment year mobile source inventory. Consequently, the 2013 total inventory will be substantially lower than the 2001 attainment year inventory. It is desirable to allocate all or some portion of the difference between the 2013 and 2001 total emissions inventory to the transportation budget. An intersection modeling analysis similar to that performed for the SIP and the Redesignation Request will be performed to provide technical justification for allocation of excess emissions. The two primary components of this analysis are the estimation of background concentrations and evaluation of the intersection contribution to the ambient concentration at five intersections.

Intersection Modeling

CAL3QHC modeling will be performed for the following intersections:

- Broadway & Champa
- Foothills & Arapahoe (Boulder)
- 1st Avenue and University
- Hampden Avenue and University
- Parker Road and Iliff
- Arapahoe and University

The intersection modeling will be performed, in general, as described in the Technical Support Document (TSD) for the Carbon Monoxide Redesignation Request and Maintenance Plan for the Denver Metropolitan Area (see Section 3.9). The CAL3QHC input data will be derived as described in Section 3.9.2 of this document. The 1999-2013 traffic growth between 1999 and 2013 will be estimated from DRCOG's 2025 RTP. The mobile source emission factors for the intersection modeling will be adapted to the Mobile6.2 paradigm as follows:

- Idle emission factors will be estimated using the with the vehicle speed set to 2.5 miles per hour. The resulting gram per mile carbon monoxide emission factor will be multiplied by 2.5 miles to convert the rate to grams per hour for CAL3QHC input.
- Running emissions factors will be estimated with 'arterial' Mobile6.2 emission factors.
- Mobile6.2 Emission factor estimates for arterials include an estimate of the mix of operating modes. Consequently, an emission factor with the facility type set to 'arterial' will adequately estimate emissions from vehicles in the various modes of operation. No additional adjustments will be made to account for operating modes.

Background Concentrations

The 2013 background concentrations for the intersection modeling demonstration will be estimated using the Denver metro ambient monitoring for 2000 through 2002. For this roll-back analysis, the maximum second-maximum over the three year period of monitoring will be used. The 2000-2002 time period bounds the attainment year for the Denver-Boulder Carbon Monoxide attainment area. Consequently, the highest-second-maximum concentration from the area monitoring network can be considered to be representative of ambient concentrations that result from an "attainment" level of emissions (i.e., 1911 tons in 2001 from Table 1). The following table shows the maximum and second maximum values for each monitoring location.

Table 1 - 2000-2002 Ambient Carbon Monoxide Max and 2nd

Location	Area Type	2000	2001	2002
CAMP	CBD	8.5 / **5.4**	4.4 / 4.1	3.7 / 3.7
Speer & Auraria	CBD	5.0 / 4.6	4.6 / 4.0	3.9 / 3.6
Carriage	Fringe	4.1 / 3.4	3.8 / 3.7	3.7 / 2.7
National Jewish Hospital	Fringe	4.8 / **4.7**	4.0 / 3.9	3.5 / 3.1
Arvada	Urban/Suburban	3.9 / **3.8**	3.1 / 3.0	3.0 / 2.6
Boulder	Urban/Suburban	6.8 / **4.3**	4.5 / 3.4	3.5 / 3.0

Since ambient monitoring is conducted at the Broadway and Champa intersection location, highest-second-maximum 8-hour average concentration of 5.4 ppm from the 2000 will be used as the basis for the 2013 background estimate at this intersection location. Ambient monitoring in Boulder will be used to characterize the background concentrations at the Foothills & Arapahoe intersection in Boulder (4.3 ppm). The 1st and University intersection was characterized by the National Jewish Hospital location (Colfax and Colorado Boulevards) background concentration in the SIP. The 4.7 ppm maximum second-maximum will be used for this modeling demonstration. Background concentrations for the remaining three intersections, Parker & Iliff, Hampden and University and University and Arapahoe will be estimated with the Arvada monitoring site highest second-maximum of 3.8. This is reasonable estimate of background locations since all three intersections are urban/suburban area type.

Allocation of Excess Emissions

Step 1: Calculate the CAL3QHC concentration using Mobile6.2 emission factors
Step 2: Calculate the total concentration estimate at each intersection (background concentration + CAL3QHC concentration)
Step 3: Identify the maximum concentration location.
Step 4: If the maximum concentration exceeds 8.99, calculate the amount that it exceeds 8.99.
Step 5: Calculate the tons per ppm basis for attainment based on the ambient concentration at the controlling intersection (i.e., the attainment year tons per day divided by the background concentration).
Step 6 Multiply the results of Step 4 and Step 5 to estimate how much of the excess emissions needs to be removed from the attainment level to assure attainment in 2013.

Example Calculation

2001 Mobile6.2 Based inventory total: 1911 tons/day
2013 Mobile6.2 based inventory total: 1373 tons/day
2013 UAM-based background concentration at Foothills and Arapahoe: 4.3 ppm
2013 CAL3QHC Mobile6.2-based concentration: 4.97 ppm

Step 1: 2013 CAL3QHC Mobile6.2-based concentration: 4.97 ppm
Step 2: Total concentration = 4.97 ppm + 4.3 ppm = 9.27 ppm
Step 3: This intersection at 9.27 ppm is the maximum.
Step 4: 9.27 – 8.99 = .28 ppm
Step5: 1911tons / 4.3 ppm = 444 tons / day – ppm.
Step 6: .28 ppm x 444 tons / day – ppm = 124 tons / day.

Therefore, the revised attainment inventory level for 2013 is 1787 tons per day (1911 tpd – 124 tpd).

The excess emissions available for allocation to the transportation budget is the revised attainment inventory level minus the 2013 inventory total: 1787 tons/day – 1373 tons/day = 414 tons/day.

Appendix B - CAL3QHC Documentation

(This Appendix is available upon request in CD format.)

Appendix C - Mobile6.2 I/O

(This Appendix is available upon request in CD format.)