State of Colorado

Technical Support Document

For Recommended 8-Hour Ozone Designations

Colorado Air Quality Control Commission
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Colorado Department of Public Health and Environment
Air Pollution Control Division
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SECTION 1

Denver Metro / North Front Range Region

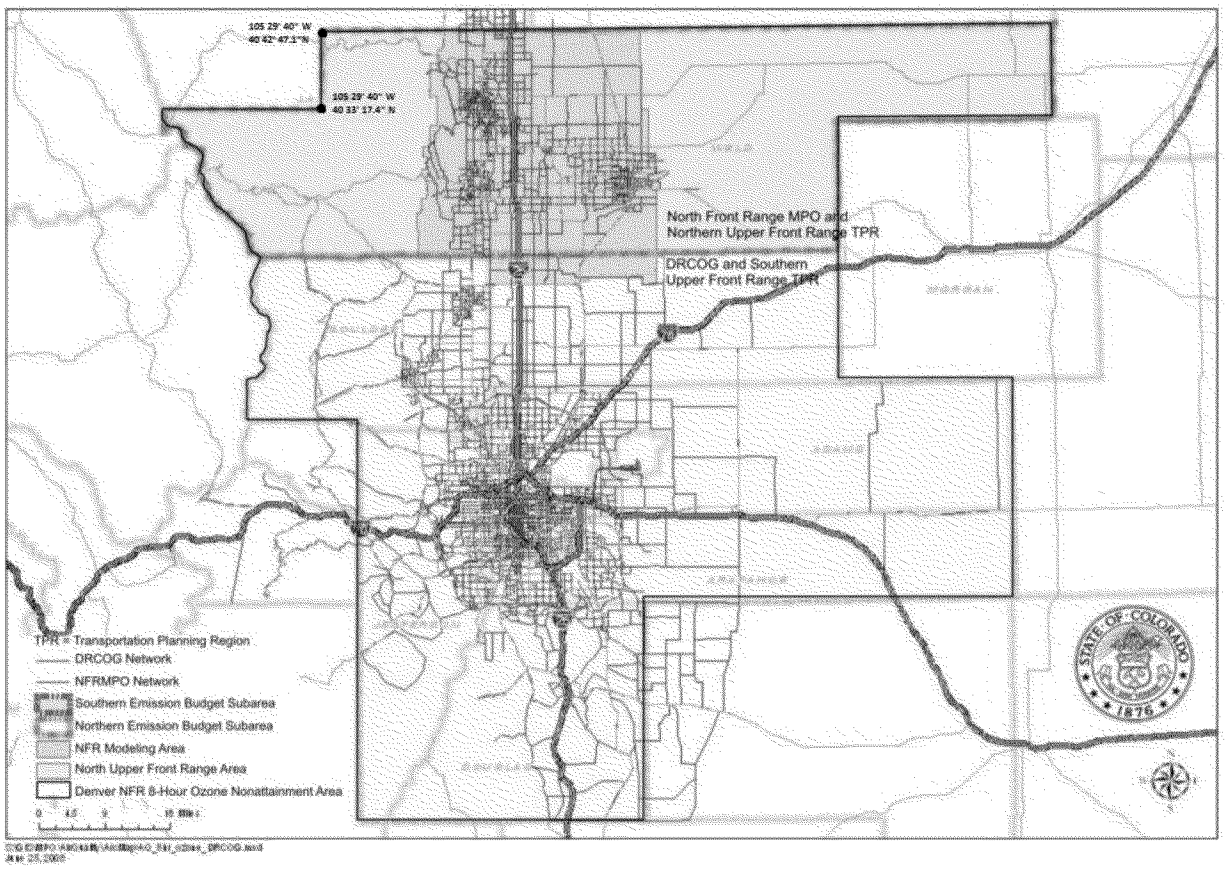
ED_002666_00009580-00006

SECTION 1: DM/NFR Area – Five Factor Analysis for Ozone Nonattainment

Designation Recommendation

The State recommends designating the current Denver Metro/North Front Range (DM/NFR) 8-hour nonattainment area (see Figure 1-1) as nonattainment for the 2015 revised 8-hour ozone standard (0.070 ppm). This recommendation is based on monitoring information that indicates the region is not in compliance with the 2015 8-hour ozone standard and the following five factor analysis that indicates the nonattainment boundary should remain unchanged:

Figure 1-1: DM/NFR Existing 8-hour Ozone Nonattainment Area



Nonattainment Boundary Recommendation

The State recommends that the proposed nonattainment area boundary for the revised 8-hour ozone standard should be identical to the current EPA-approved ozone nonattainment boundary for the 9-county area. This large area encompasses the region's 1) urbanized area, 2) traffic and commuting patterns, and 3) industrial and commercial activities. With the Rocky Mountains to the west, the Palmer Divide to the south, the Cheyenne Ridge to the north, and following the South Platte River valley to the northeast, the area is commonly referred to as the Denver Basin and serves as the topographic and climatological airshed for the region. The recommended boundary is as follows:

Adams County
Arapahoe County
Boulder County (including the portion of Rocky Mountain National Park therein)
Broomfield County
Denver County
Douglas County
Jefferson County
Larimer County (part) including the portion of Rocky Mountain National Park therein and that portion of the county that lies south of a line described as follows: Beginning at a point on Larimer County's eastern boundary and Weld County's western boundary intersected by 40 degrees, 42 minutes, and 47.1 seconds north latitude, proceed west to a point defined by the intersection of 40 degrees, 42 minutes, 47.1 seconds north latitude and 105 degrees, 29 minutes, and 40.0 seconds west longitude, thence proceed south on 105 degrees, 29 minutes, 40.0 seconds west longitude to the inter-section with 40 degrees, 33 minutes and 17.4 seconds north latitude, thence proceed west on 40 degrees, 33 minutes, 17.4 seconds north latitude until this line intersects Larimer County's western boundary and Grand County's eastern boundary.
Weld County (part): That portion of the county that lies south of a line described as follows: Beginning at a point on Weld County's eastern boundary and Logan County's western boundary intersected by 40 degrees, 42 minutes, 47.1 seconds north latitude, proceed west on 40 degrees, 42 minutes, 47.1 seconds north latitude until this line intersects Weld County's western boundary and Larimer County's eastern boundary.

DM/NFR Overview

The EPA recommends five criteria or "factors" to help with attainment/nonattainment determinations and, if necessary, to help determine the appropriate size of a nonattainment area. States must submit an analysis of these five factors, along with a proposed nonattainment boundary, for any areas that are not meeting the federal standard. The five factors to be addressed are:

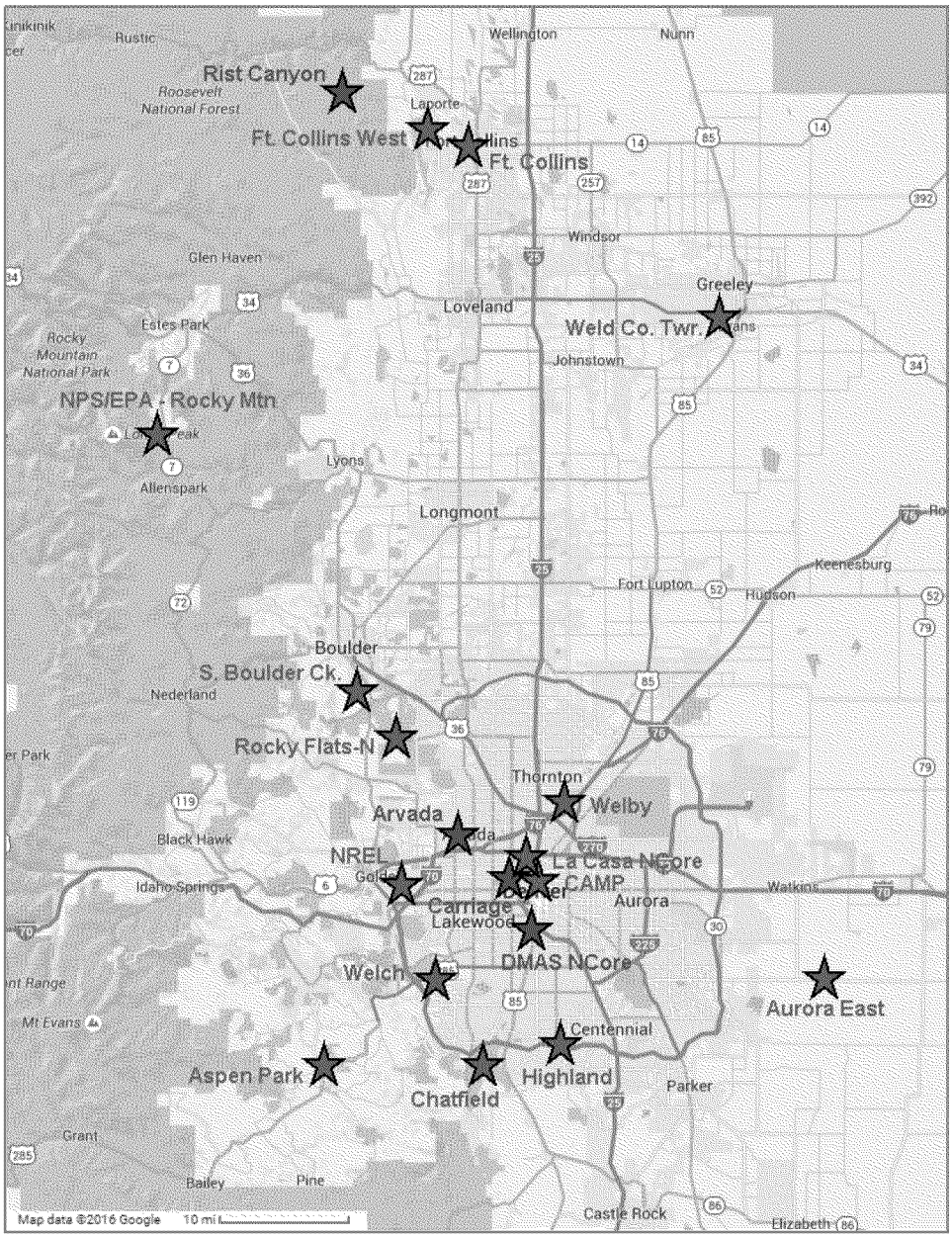
1. Air quality data
2. Emissions and emissions-related data
3. Meteorological data
4. Geography/topography
5. Jurisdictional boundaries

Since ozone monitoring data in the 9-county area indicates nonattainment of the 2015 National Ambient Air Quality Standard (NAAQS), the following five factor analysis is necessary to support the conclusion that the existing nonattainment boundary is appropriate for the revised ozone standard.

Factor # 1: Air Quality Data

There are 16 ozone monitors (see Figure 1-2 and Table 1-1) currently operating in the DM/NFR region (including monitors operated by other agencies). The Highland monitor was not operational from October 1, 2014 to September 1, 2015 due to a renovation of an underground water storage tank on the site, but is now currently operational. The Rist Canyon monitoring site was discontinued in June of 2013 after meeting its monitoring objectives.

Figure 1-2: Ozone Monitoring Sites for the DM/NFR Region



Red= Current sites in operation
Blue= Sites from past 10 years that are no longer in operation

The monitoring data from 2013 to 2015 at the monitoring locations is shown in the table below. The monitors currently in violation of the revised 2015 standard are highlighted in red.

Table 1-1: Ozone Monitoring Data for the DM/NFR Region

Denver Metro /North Front Range Region 4th Maximum 8-Hour Ozone Values and 3-Year Averages					
Site Name	AQS#	Year			3-Year Average
		2013	2014	2015	2013-2015 (ppm)
CDPHE-APCD Sites					
Welby	08-001-3001	0.077	0.067	0.069	0.071
Highland Reservoir	08-005-0002	0.079	-	-	-
Aurora - East	08-005-0006	0.073	0.067	0.068	0.069
South Boulder Creek	08-013-0011	0.079	0.070	0.074	0.074
CAMP	08-031-0002	0.067	0.061	0.067	0.065
La Casa	08-031-0027	0.071	0.066	0.071	0.069
Chatfield State Park	08-035-0004	0.083	0.074	0.081	0.079
Welch	05-059-0005	0.080	0.066	0.075	0.073
Rocky Flats - N	08-059-0006	0.085	0.077	0.077	0.079
NREL	08-059-0011	0.084	0.076	0.081	0.080
Aspen Park	08-059-0013	0.077	0.065	0.070	0.070
Ft. Collins - West	08-069-0011	0.082	0.074	0.075	0.077
Rist Canyon	08-069-0012	0.066	-	-	-
Ft. Collins - CSU	08-069-1004	0.074	0.072	0.069	0.071
Weld County Tower	08-123-0009	0.073	0.070	0.073	0.072
Other Agency Sites					
NPS- Rock Mtn. NP	08-069-0007	0.074	0.069	0.069	0.070
EPA Rocky Mountain NP	08-069-9991	0.075	0.073	0.070	0.072
Other Sites Near DM/NFR					
U.S. Air Force Academy, CO	08-041-0013	0.074	0.064	0.067	0.068
Manitou Springs, CO	08-041-0016	0.072	0.062	0.065	0.066
Cheyenne NCore, WY	56-021-0100	0.069	0.065	0.063	0.065
Centennial, WY	56-001-9991	0.069	0.066	0.065	0.066

The following figures provide historical trend data of the 8-hour ozone 4th maximum for the DM/NFR region monitors.

Figure 1-3: Western Denver Metro Area - 8-hour (4th Max) Ozone Values

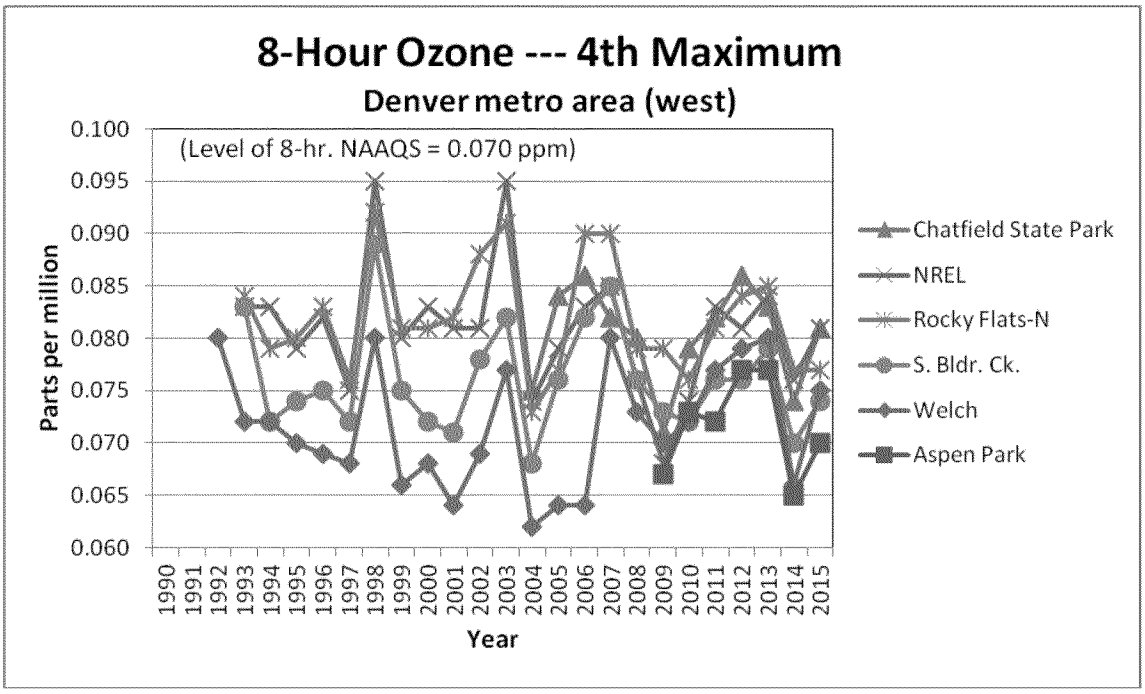


Figure 1-4: North, South and East Denver Metro Area - 8-hour (4th Max) Ozone Values

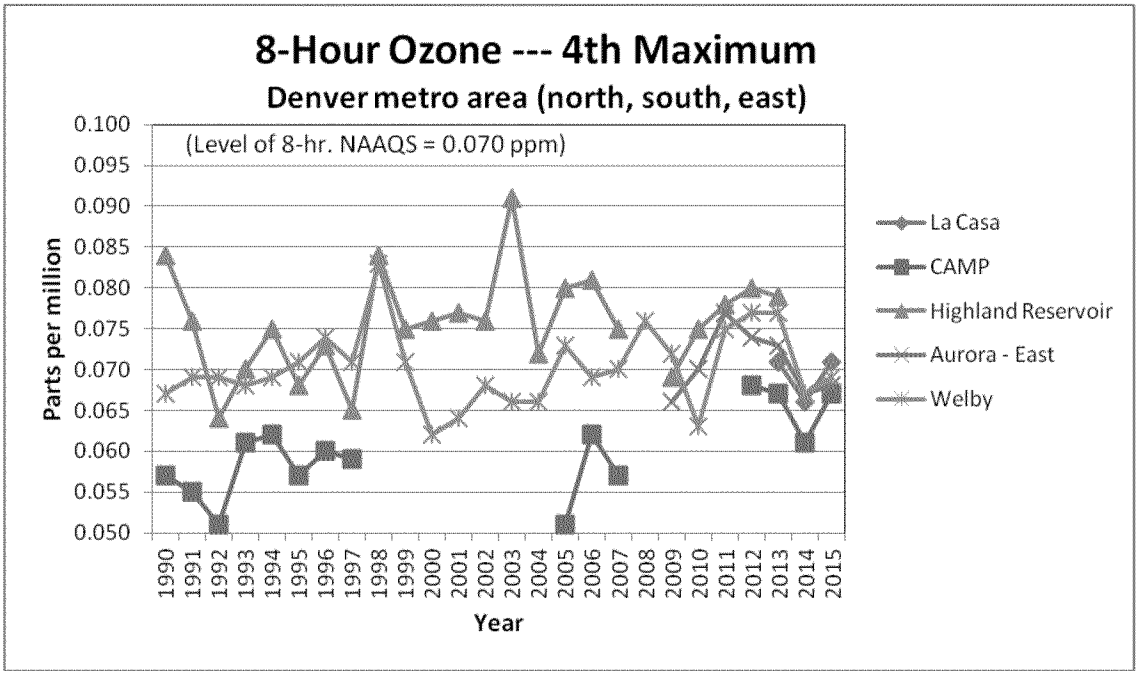
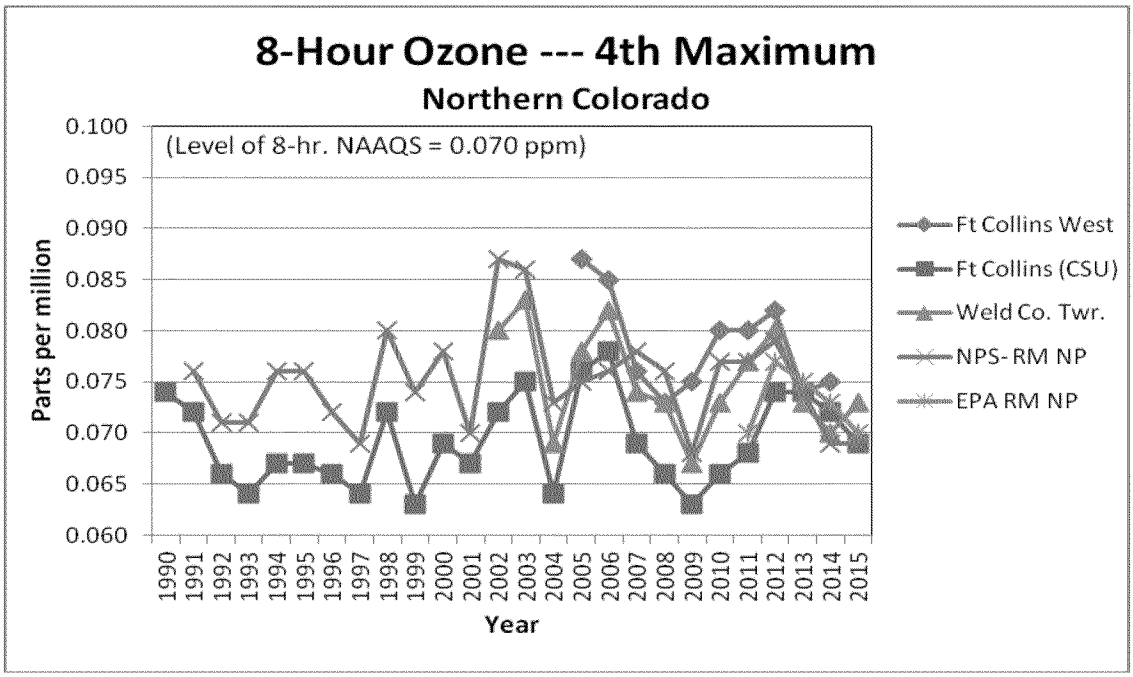


Figure 1-5: North Front Range Area - 8-hour (4th Max) Ozone Values



Air Quality Data Conclusions

The monitoring data supports the recommended nonattainment designation for the current 8-hour ozone nonattainment area. If future monitoring locations indicate that additional counties or regions are in violation of the revised ozone standard, the existing nonattainment boundary will be revaluated and expanded as necessary.

Factor # 2: Emissions and Emissions-Related Data

Table 1-2 contains the 2011 emissions data for NO_x and VOC emissions for 16 source categories for the 9-county DM/NFR region from version 2 of the 2011 National Emissions Inventory (NEI). The emission sources are categorized into controllable and uncontrollable emissions. Biogenic, agricultural livestock waste and wildfire emissions comprise the uncontrolled emission sources. The emissions data for Larimer and Weld Counties includes the whole county and does not apportion emissions originating from the proposed nonattainment area portion of these counties. Consequently, the Division analyzed the ozone nonattainment area NOx and VOC emissions with the total county emissions to determine the percentage of NOx and VOC emissions that are attributed to the northern portions of Larimer and Weld Counties. Based on this analysis, the northern portions of Larimer and Weld Counties (excluding nonattainment area) comprise about 26.4% and 13.9% of the 2011 NO_x and VOC emissions respectively. Accordingly, the controllable emissions from portions of Larimer and Weld Counties that are excluded from the proposed nonattainment area are estimated as follows:

Larimer County (northern portion excluding NAA): NOx = 2,879 tpy; VOC = 3,076 tpy
Weld County (northern portion excluding NAA): NOx = 8,042 tpy; VOC = 18,610 tpy

Table 1-2: 2011 Ozone Precursor Emissions Data for DM/NFR Nonattainment Area Counties

Category	Adams		Arapahoe		Boulder		Broomfield		Denver		Douglas		Jefferson		Larimer		Weld	
	NO_x (tpy)	VOC (tpy)	NO_x (tpy)	VOC (tpy)	NO_x (tpy)	VOC (tpy)	NO_x (tpy)	VOC (tpy)	NO_x (tpy)	VOC (tpy)	NO_x (tpy)	VOC (tpy)	NO_x (tpy)	VOC (tpy)	NO_x (tpy)	VOC (tpy)	NO_x (tpy)	VOC (tpy)
Agriculture Burning	14	24	2	4	3	5	0	0	0	1	0	0	0	0	18	28	199	307
Aircraft	2	4	23	40	4	9	0	0	2,824	540	0	0	5	10	8	9	6	14
Commercial Cooking	0	16	0	27	0	20	0	3	0	43	0	13	0	33	0	17	0	8
Electricity Generating Units	9,105	62	129	10	2,106	17	99	6	2,133	21	2	0	13	5	1,896	40	789	100
Prescribed Fire	16	171	0	0	31	660	0	0	0	0	0	0	10	203	571	12,130	37	601
Fuel Combustion	2,599	856	1,592	900	918	758	12	76	1,814	1,007	458	388	2,303	904	857	792	6,773	2,589
Highway Vehicles	8,763	4,522	8,397	5,643	3,972	2,671	1,111	579	9,618	5,543	5,082	2,478	8,825	5,607	5,914	3,375	6,668	3,239
Non-Road	1,974	1,512	2,016	2,336	1,375	1,337	201	134	2,723	2,009	1,506	1,246	2,226	2,160	1,326	1,756	1,632	1,235
Oil and Gas Production	448	2,480	63	387	161	1,145	68	667	20	106	0	0	0	4	79	691	12,478	104,473
Other Point Sources	762	4,200	52	2,416	780	1,216	1	230	55	2,297	62	1,073	641	2,886	87	1,418	730	18,620
Railroads	837	45	263	13	183	9	0	0	732	44	699	35	255	13	150	7	1,131	56
Solvent Utilization	0	2,567	0	3,149	0	1,623	0	302	0	3,387	0	1,579	0	2,990	0	1,678	0	1,901
Surface Coating	1	736	0	391	0	204	0	126	0	597	0	122	0	472	0	201	19	828
Total- Controllable	**24,521**	**17,195**	**12,538**	**15,317**	**9,533**	**9,674**	**1,492**	**2,125**	**19,920**	**15,593**	**7,809**	**6,933**	**14,279**	**15,287**	**10,905**	**22,142**	**30,463**	**133,972**
Biogenics	724	5,044	484	4,064	201	9,155	60	658	122	1,551	212	10,212	78	11,342	582	30,323	2,233	17,006
Agriculture- Livestock Waste	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wildfires	0	3	0	0	30	667	0	0	0	0	27	239	49	759	90	1,333	1	4
Total- Uncontrollable	**724**	**5,048**	**484**	**4,064**	**231**	**9,823**	**60**	**658**	**122**	**1,551**	**239**	**10,451**	**127**	**12,100**	**672**	**31,656**	**2,233**	**17,010**
Total- Controllable + Uncontrollable	**25,245**	**22,243**	**13,022**	**19,381**	**9,764**	**19,497**	**1,552**	**2,783**	**20,042**	**17,144**	**8,048**	**17,384**	**14,406**	**27,388**	**11,577**	**53,798**	**32,696**	**150,982**

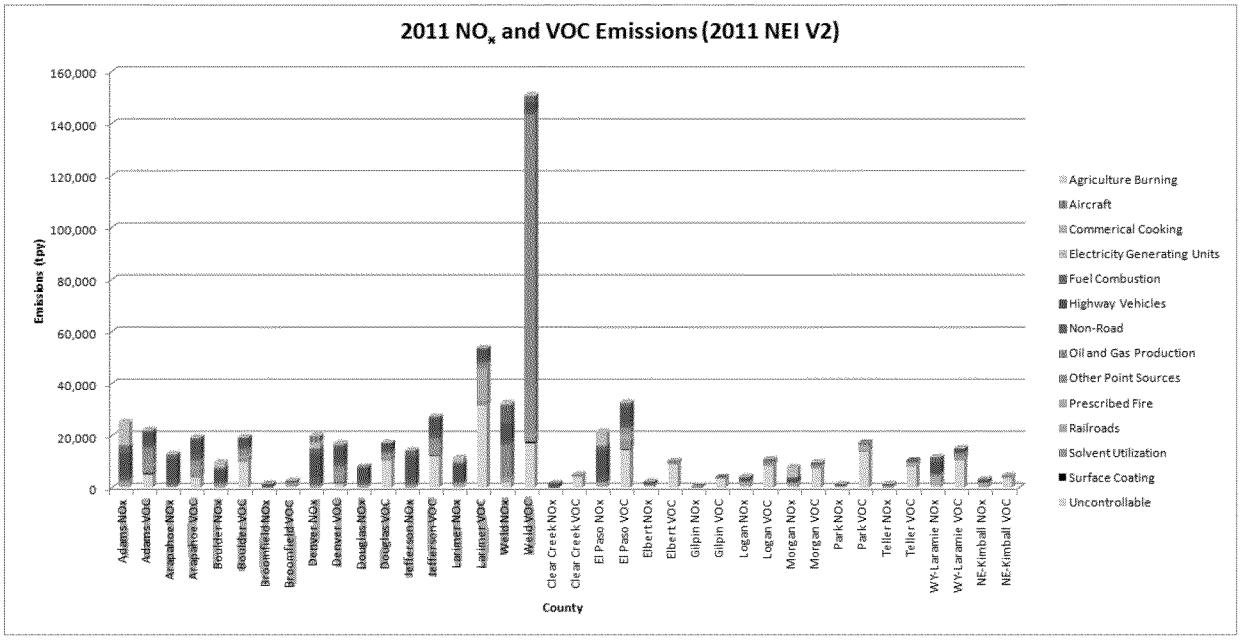
Table 1-3 includes the 2011 emissions data for NOx and VOC emissions for 16 source categories for the counties representing micropolitan and metropolitan statistical areas bordering the current DM/NFR region, including bordering Wyoming and Nebraska counties.

Table 1-3: 2011 Ozone Precursor Emissions Data for Counties nearby the DM/NFR region

Category	Clear Creek		El Paso		Elbert		Gilpin		Logan		Morgan		Park		Teller		WY-Laramie		NE-Kimball	
	NO_x (tpy)	VOC (tpy)	NO_x (tpy)	VOC (tpy)	NO_x (tpy)	VOC (tpy)	NO_x (tpy)	VOC (tpy)	NO_x (tpy)	VOC (tpy)	NO_x (tpy)	VOC (tpy)	NO_x (tpy)	VOC (tpy)	NO_x (tpy)	VOC (tpy)	NO_x (tpy)	VOC (tpy)	NO_x (tpy)	VOC (tpy)
Agriculture Burning	0	0	1	1	5	8	0	0	69	109	86	179	0	0	0	0	18	29	0	0
Aircraft	0	0	102	49	0	0	0	0	0	1	0	1	0	0	0	0	5	20	0	0
Commercial Cooking	0	1	0	27	0	0	0	0	0	1	0	1	0	1	0	2	0	4	0	0
Electricity Generating Units	5	0	5,435	107	0	0	0	0	8	1	3,799	62	0	0	0	0	1	0	0	0
Prescribed Fire	4	95	52	1,991	2	21	2	45	2	22	8	188	116	2,566	55	1,052	2	23	0	1
Fuel Combustion	31	19	1,573	1,515	103	37	21	11	711	172	768	127	41	30	85	65	1,916	215	15	6
Highway Vehicles	1,655	386	10,339	6,488	1,088	402	156	106	965	332	1,215	462	700	352	617	393	4,435	1,509	1,247	187
Non-Road	35	93	2,221	1,923	124	106	100	47	413	159	356	152	99	287	83	321	456	319	224	35
Oil and Gas Production	0	0	3	1	33	227	0	0	85	1,194	44	649	0	0	0	0	295	405	42	369
Other Point Sources	14	81	100	2,202	0	151	0	11	6	193	16	198	0	51	639	91	709	1,313	67	120
Railroads	1	0	926	46	135	7	178	9	1,009	52	784	39	0	0	0	0	2,834	151	1,086	56
Solvent Utilization	0	50	1	3,414	0	202	0	29	0	245	0	250	0	89	0	127	0	600	0	103
Surface Coating	0	3	0	472	0	7	0	2	0	14	0	54	0	5	0	7	0	75	0	9
Total- Controllable	**1,767**	**729**	**20,752**	**18,236**	**1,490**	**1,169**	**457**	**260**	**3,268**	**2,494**	**7,078**	**2,311**	**955**	**3,485**	**1,479**	**2,057**	**10,671**	**4,665**	**2,681**	**886**
Biogenics	62	4,409	852	14,582	921	9,194	33	3,664	1,105	8,559	920	7,475	462	13,574	120	8,381	1,250	10,638	596	3,922
Agriculture- Livestock Waste	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wildfires	0	0	2	15	0	0	0	0	1	13	0	0	21	339	1	16	0	2	0	2
Total- Uncontrollable	**62**	**4,409**	**853**	**14,597**	**921**	**9,194**	**33**	**3,664**	**1,106**	**8,572**	**920**	**7,475**	**483**	**13,913**	**121**	**8,397**	**1,250**	**10,640**	**596**	**3,924**
Total- Controllable + Uncontrollable	**1,829**	**5,139**	**21,605**	**32,833**	**2,411**	**10,363**	**490**	**3,924**	**4,374**	**11,066**	**7,997**	**9,786**	**1,438**	**17,398**	**1,600**	**10,454**	**11,922**	**15,305**	**3,277**	**4,810**

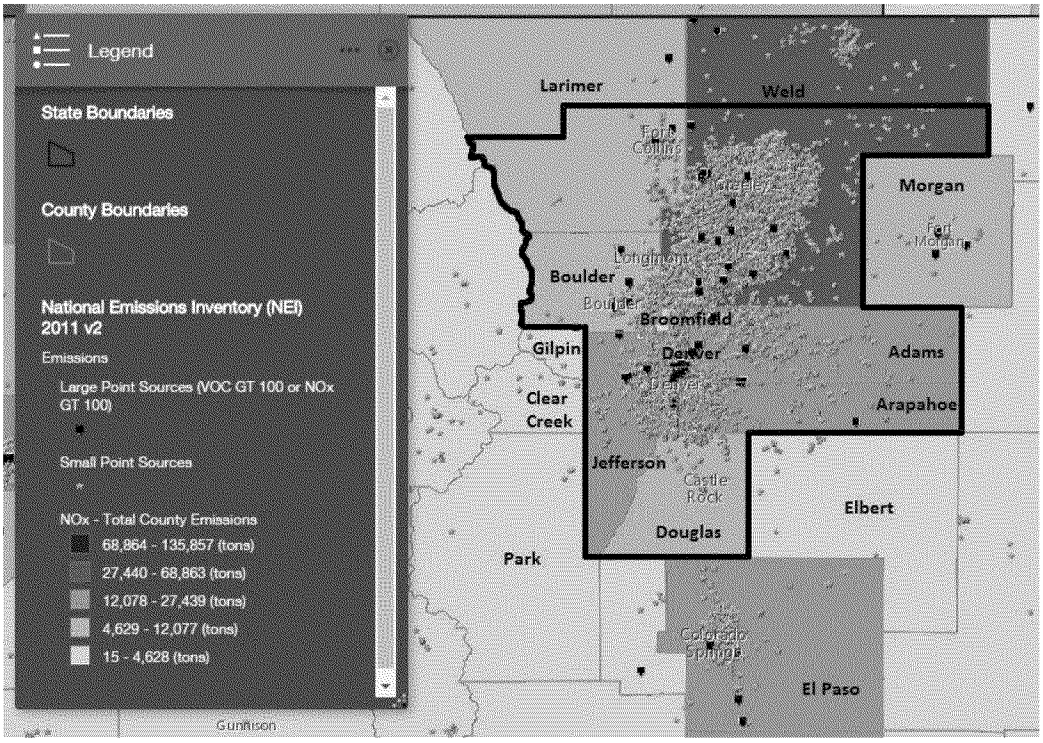
A summary of the above tabular data is provided in the following graph. The county names highlighted in yellow are the 9 counties in the existing nonattainment area.

Figure 1-6: 2011 Emissions In and Nearby the 9-County Nonattainment Area



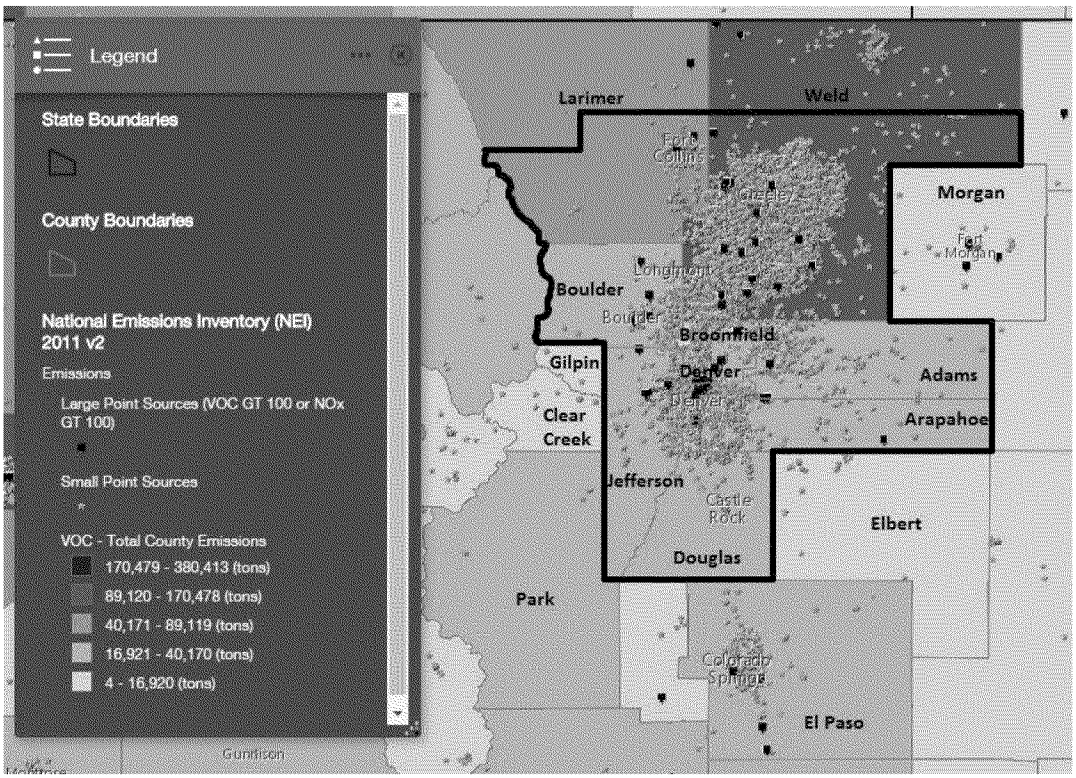
The NO_x and VOC emissions and the locations of small and large point stationary sources by county are shown in the two maps below (Figures 1-7 and 1-8). The current nonattainment boundary is shown with the thick, black line.

Figure 1-7: 2011 DM/NFR NO_x Emissions and Point Sources



ED_002666_00009580-00014

Figure 1-8: 2011 DM/NFR VOC Emissions and Point Sources



Emissions Data Conclusions

Precursor emissions outside of the current 8-hour ozone nonattainment area are substantially less than the emissions within the current nonattainment boundary. With the exception of El Paso County, controllable precursor emissions in nearby counties are either very small by comparison or at substantial distances from high concentration monitors. For El Paso County, the State determined that this region is in a separate airshed and emissions do not significantly contribute to ozone concentrations in the recommended nonattainment area. Also, ozone monitoring in El Paso County indicates attainment of the revised 8-hour ozone standard (see U.S. Air Force Academy, CO and Manitou Springs, CO air monitoring data in Table 1-1). Therefore, the emissions information supports the recommended nonattainment designation and boundary for the current 8-hour ozone nonattainment area. If future emissions growth indicates that additional counties or regions should be included in the nonattainment area, the existing nonattainment boundary will be revaluated and expanded as necessary.

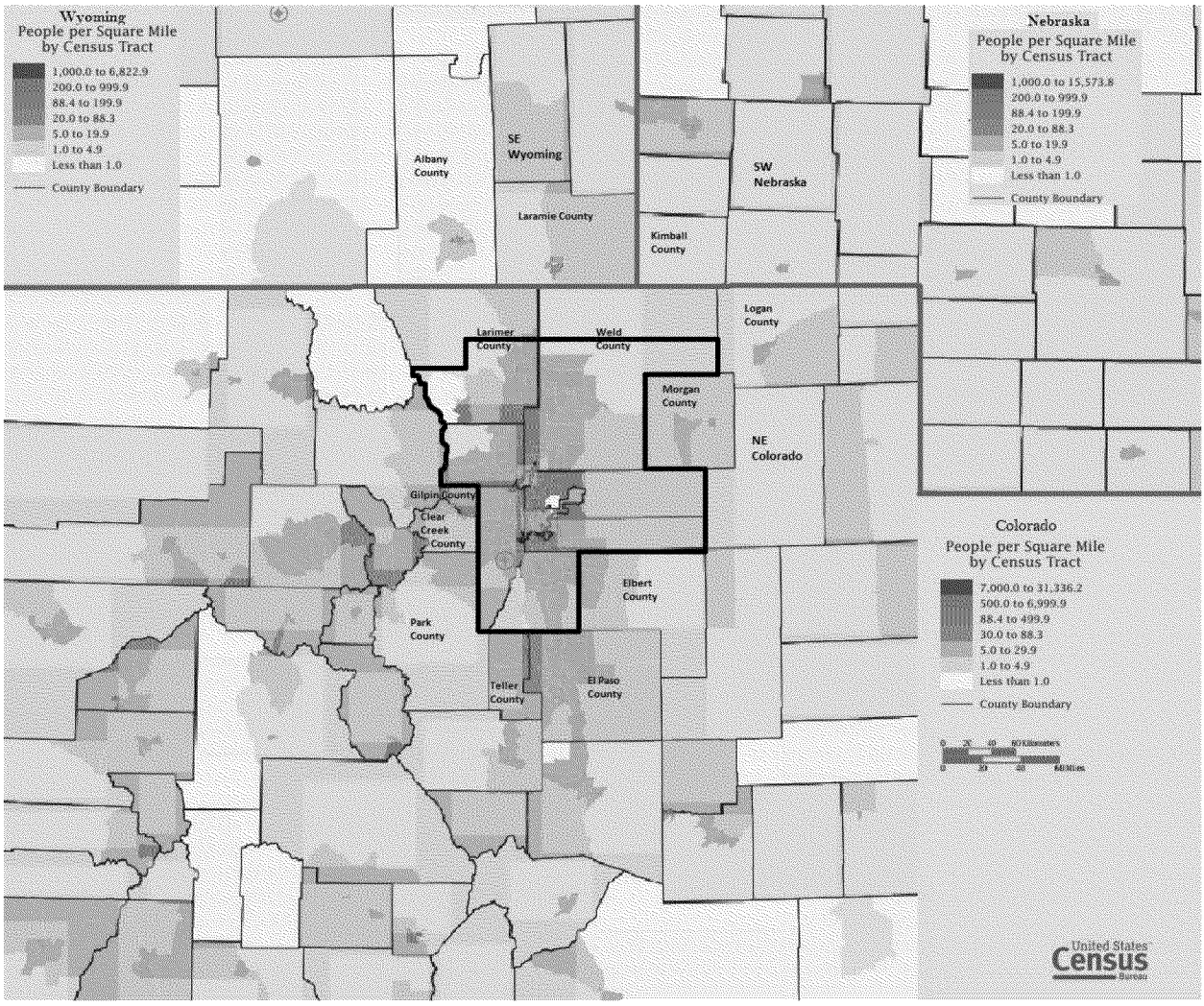
Population Density and Degree of Urbanization

Population Density

In Figure 1-9 below, the population density and the degree of urbanization for NE Colorado, SE Wyoming and SW Nebraska is depicted based on the 2010 US Census. The nonattainment area

is highlighted in black and some peripheral counties are labeled that were also evaluated in the above emissions data section.

Figure 1-9: Population Density & Degree of Urbanization of the NE Colorado Region (2010 Census)



In Figure 1-10 and Figure 1-11, below, the regional population density for the Denver Metro Area and North Front Range Region are shown.

Figure 1-10: 2010-2014 Regional Population Density for Denver Metro Area

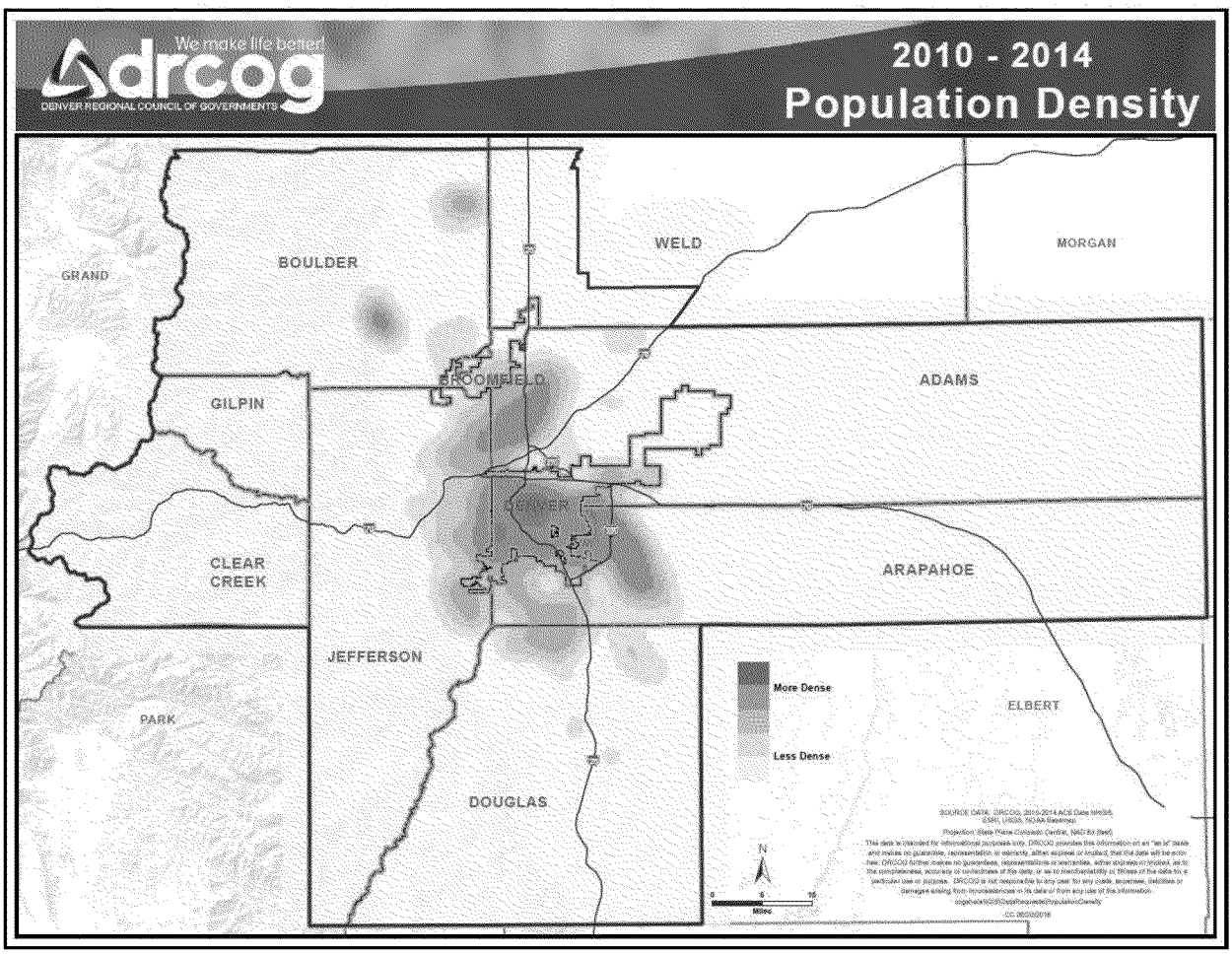


Figure 1-11: 2012 Household Density for North Front Range Area

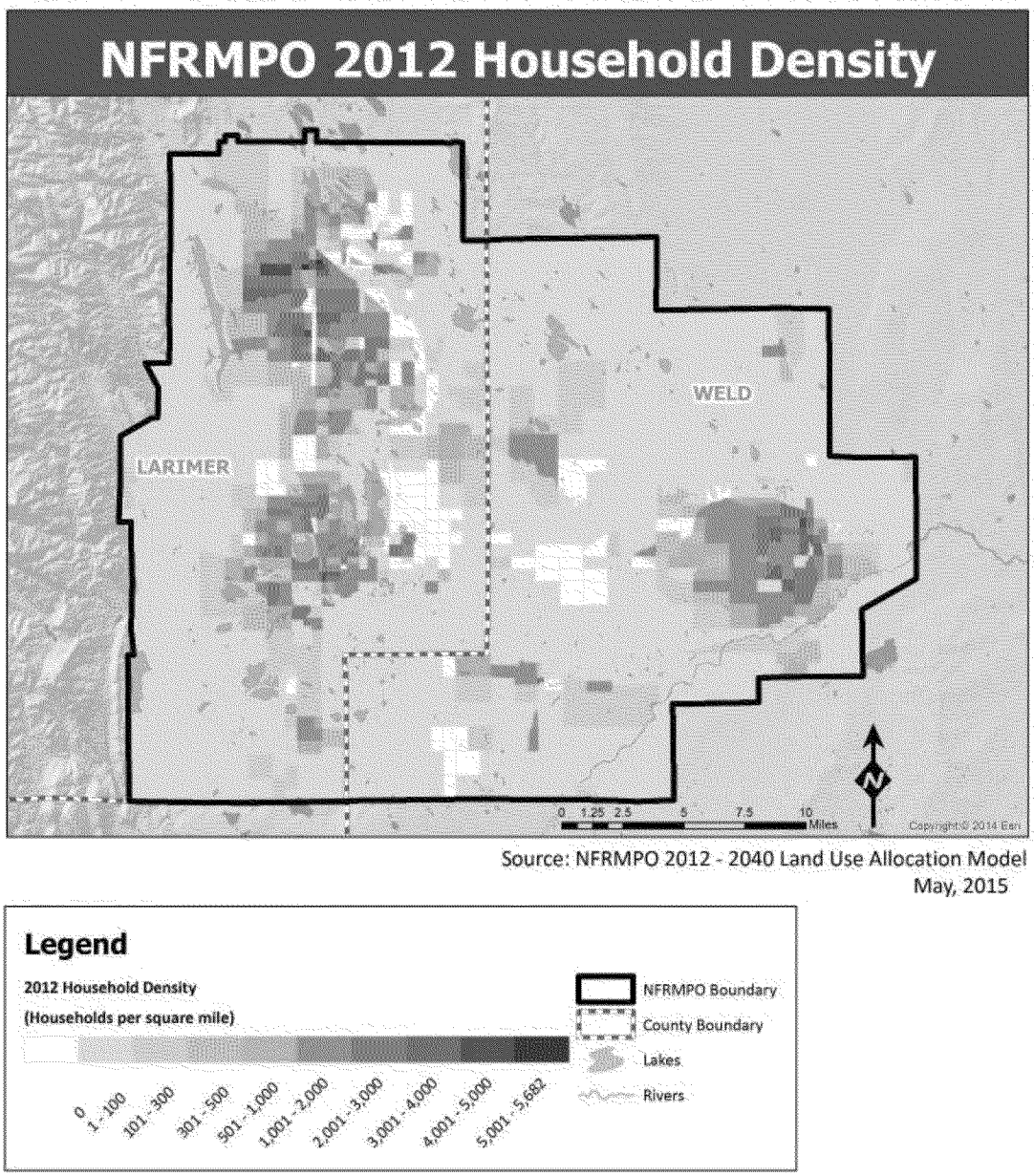


Table 1-4, below, shows the county level population, land area and calculated population density for the current nonattainment area, bordering counties and nearby micropolitan statistical areas.

Table1-4: County-Level Population and Calculated Population Density

County	Land Area (square mile)	Population July 2010 (Estimate)	Calculated Population Density (people/sqaure mile)	Population July 2015 (Estimate)	Caluclated Population Density (people/sqaure mile)	Population Density Rank
Adams	1,192	443,680	372.2	491,337	412.2	6
Araphoe	803	574,727	715.7	631,096	785.9	3
Boulder	746	295,986	396.8	319,372	428.1	5
Broomfield	28	56,271	2009.7	65,065	2323.8	2
Clear Creek	395	9,083	23.0	9,303	23.6	14
Denver	153	603,300	3943.1	682,545	4461.1	1
Douglas	840	286,964	341.6	322,387	383.8	7
Elbert	1,851	23,095	12.5	24,735	13.4	16
El Paso	2,126	626,916	294.9	674,471	317.2	8
Gilpin	150	5,461	36.4	5,828	38.9	13
Grand	1,847	14,783	8.0	14,615	7.9	18
Jackson	1,613	1,385	0.9	1,356	0.8	22
Jefferson	772	535,625	693.8	565,524	732.5	4
Larimer	2,601	300,524	115.5	333,577	128.2	9
Lincoln	2,586	5,469	2.1	5,557	2.1	20
Logan	1,839	22,130	12.0	22,036	12.0	17
Morgan	1,285	28,172	21.9	28,360	22.1	15
Park	2,201	16,262	7.4	16,510	7.5	19
Summit	608	28,065	46.2	30,257	49.8	11
Teller	557	23,450	42.1	23,385	42.0	12
Washington	2,521	4,801	1.9	4,864	1.9	21
Weld	3,992	254,166	63.7	285,174	71.4	10

Total for NAA	3,351,243	3,696,077
Sum for Other	809,072	861,277

Note: NAA total includes the total populations for Weld and Larimer counties

Counties in the current 8-hour ozone nonattainment area

Top 10- Population Density

CBSA and CSA Analysis

EPA suggests that because ground-level ozone and ozone precursor emissions are pervasive and readily transported, it is important to examine ozone-contributing emissions across a relatively broad geographic area. Accordingly, EPA states they will consider information associated with counties in Statistical Area (CBSA) or Combined Statistical Area (CSA) associated with a violating monitor(s).

The following tables (Table 1-5 and Table 1-6) contain the CBSAs and CSAs for Colorado. The CBSAs and CSAs with violating monitors are highlighted in blue.

Table 1-5: 2010 Colorado Metropolitan/Micropolitan Statistical Areas (CBSA)

Colorado Metropolitan/Metropolitan Statistical Areas-Core Based Statistical Areas (CBSA)			
Code	**Metropolitan/Micropolitan Statistical Areas**	**Principal Cities**	**Counties**
14500	Boulder, CO Metropolitan Statistical Area	Boulder	*Boulder*
14720	Breckenridge, CO Micropolitan Statistical Area	Breckenridge	*Summit*
15860	Cañon City, CO Micropolitan Statistical Area	Cañon City	*Fremont*
17820	Colorado Springs, CO Metropolitan Statistical Area	Colorado Springs	*El Paso* , Teller
18780	Craig, CO Micropolitan Statistical Area	Craig	Moffat
19740	Denver-Aurora-Lakewood, CO Metropolitan Statistical Area	Denver, Aurora, Lakewood	*Adams* , *Arapahoe* , *Broomfield* , Clear Creek, *Denver* , *Douglas* , Elbert, Gilpin, *Jefferson* , Park
20420	Durango, CO Micropolitan Statistical Area	Durango	*La Plata*
20780	Edwards, CO Micropolitan Statistical Area	Edwards	*Eagle*
22660	Fort Collins, CO Metropolitan Statistical Area	Fort Collins	*Larimer*
22820	Fort Morgan, CO Micropolitan Statistical Area	Fort Morgan	*Morgan*
24060	Glenwood Springs, CO Micropolitan Statistical Area	Glenwood Springs	*Garfield, Pitkin*
24300	Grand Junction, CO Metropolitan Statistical Area	Grand Junction	*Mesa*
24540	Greeley, CO Metropolitan Statistical Area	Greeley	*Weld*
33940	Montrose, CO Micropolitan Statistical Area	Montrose	*Montrose*
39380	Pueblo, CO Metropolitan Statistical Area	Pueblo	*Pueblo*
44460	Steamboat Springs, CO Micropolitan Statistical Area	Steamboat Springs	*Routt*
44540	Sterling, CO Micropolitan Statistical Area	Sterling	*Logan*

Italics= Central Counties

Areas with violating monitors

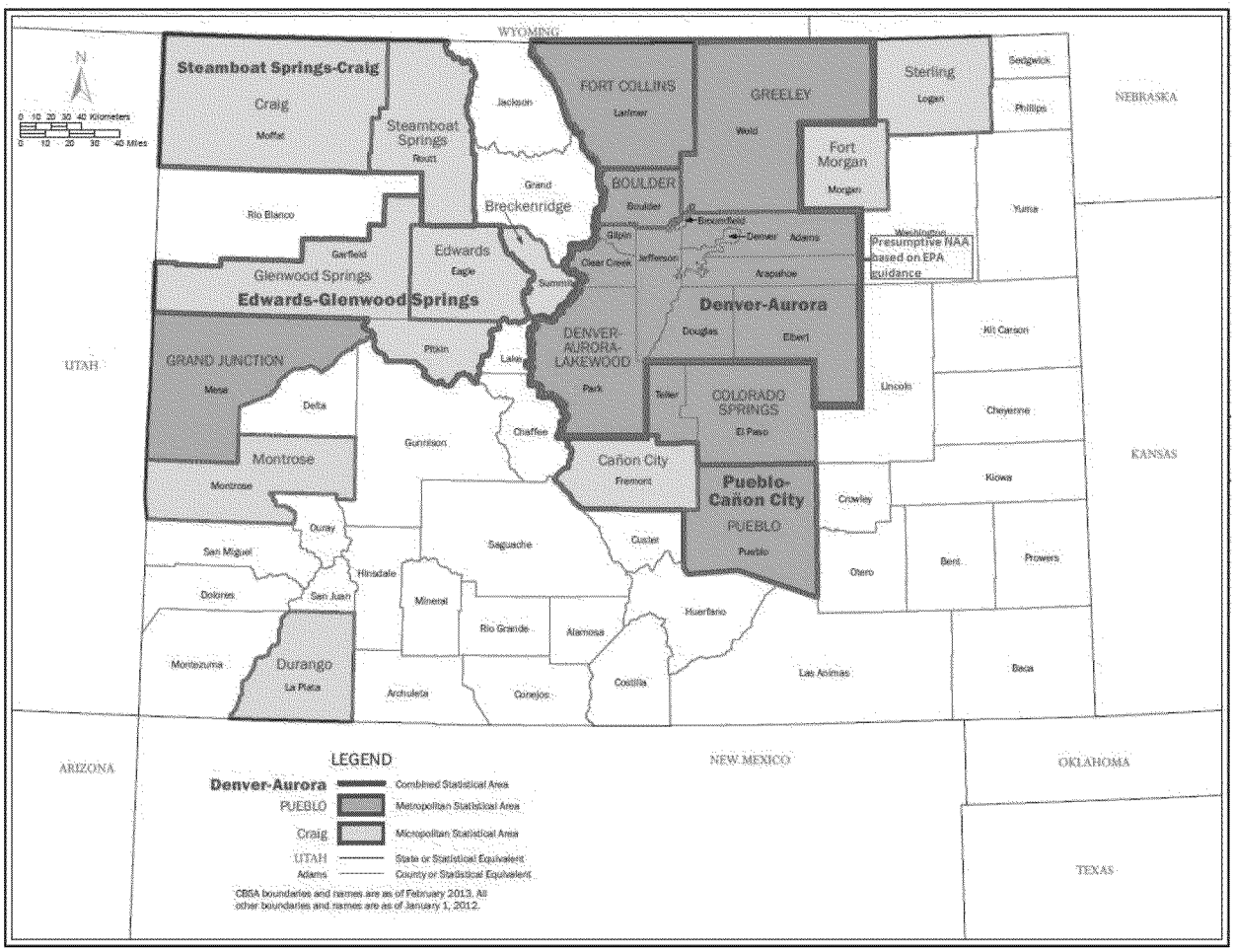
Table 1-6: 2010 Colorado Combined Statistical Areas

Colorado Combined Statistical Areas (CSA)			
Code	**Combined Statistical Area**	**CBSA's Included in CSA**	**Counties**
216	Denver-Aurora, CO	Boulder, CO Metropolitan Statistical Area, Denver-Aurora-Lakewood, CO Metropolitan Statistical Area, Greeley, CO Metropolitan Statistical Area	Adams, Arapahoe, Boulder, Broomfield, Clear Creek, Denver, Douglas, Elbert, Gilpin, Jefferson, Park, Weld
233	Edwards-Glenwood Springs, CO	Edwards, CO Micropolitan Statistical Area, Glenwood Springs, CO Micropolitan Statistical Area	Eagle, Garfield, Pitkin
444	Pueblo-Cañon City, CO	Cañon City, CO Micropolitan Statistical Area, Pueblo, CO Metropolitan Statistical Area	Fremont, Pueblo
525	Steamboat Springs-Craig, CO	Craig, CO Micropolitan Statistical Area, Steamboat Springs, CO Micropolitan Statistical Area	Moffat, Routt

Areas with violating monitors

As shown in the two tables above, CSAs and CBSAs with violating monitors (highlighted in red in Figure 1-12 below) includes one CSA (Denver-Aurora CSA, highlighted in blue in Figure 1-12) and one CBSA (Fort Collins, CO Metropolitan Statistical Area). The Denver-Aurora CSA includes Adams, Arapahoe, Boulder, Broomfield, Clear Creek, Denver, Douglas, Elbert, Gilpin, Jefferson, Park and Weld counties. The Fort Collins, CO Metropolitan Statistical Area CBSA comprises Larimer County.

Figure 1-12: 2013 CSAs and CBSAs and Counties in Colorado



Although, EPA recommends that any CSA or CBSA with a violating monitor should be examined, they also state that area-specific analyses should be used to support designations recommendations. The State recommends that although Clear Creek, Elbert, Gilpin, Park and the northern portions of Larimer and Weld counties are part of the violating CSA, they should not be included in the ozone nonattainment area. Additionally, in the past, EPA has requested further explanation from the State regarding the inclusion of Morgan County in the nonattainment area boundary, and the State recommends it not be included in the nonattainment area. The basis of recommendation for the exclusion of Clear Creek, Elbert, Gilpin, Park, northern portions of Larimer and Weld, and Morgan County is detailed below.

Clear Creek and Gilpin Counties

The counties of Clear Creek and Gilpin are lightly populated areas located in high elevation mountainous terrain outside of the existing ozone nonattainment area. Based on the information in Table 1-4, the estimated 2015 population density for Clear Creek and Gilpin Counties are 23.6 and 38.9 people per square mile respectively. The total estimated 2015 population residing in Clear Creek and Gilpin Counties is 9,303 and 5,828 people respectively. Compared to the 3.7

million (2015) people residing in the existing DM/NFR nonattainment area, these two counties represent less than 0.5 percent of the total population for the area.

The combined ozone precursor emissions (NO_x and VOC) for both counties are about 11,400 tons/year from all source categories with only 3,200 tons/year being attributed to controllable sources (excludes uncontrollable emissions: biogenic, agricultural livestock waste and wildfire emissions). There are no stationary point sources in Clear Creek or Gilpin Counties with ozone precursor emissions over 100 tons/year (see Figures 1-7 and 1-8).

The back trajectory analyses below (Figures 1-23 – 1-29) indicate that Clear Creek and Gilpin Counties are infrequent contributors to air quality in the DM/NFR nonattainment area. This is indicated by the low number of trajectory points in the grid cells over Clear Creek and Gilpin Counties.

In summary, the inclusion of Clear Creek and Gilpin Counties into the ozone nonattainment area is not warranted because of low population, low degree of urbanization, very low precursor emissions, and infrequent contributions to air quality in the DM/NFR.

Elbert and Park Counties

The counties of Elbert and Park are lightly populated areas outside of the existing ozone nonattainment area. Based on the information in Table 1-4, the estimated 2015 population density for Elbert and Park Counties are 13.4 and 7.5 people per square mile respectively. The total estimated 2015 population residing in Elbert and Park Counties is 24,735 and 16,510 people respectively. Compared to the 3.7 million (2015) people residing in the existing DM/NFR nonattainment area, these two counties represent less than 1.1 percent of the total population for the area.

Information from the State Demography Office indicates that the 2014 population estimates for the towns of Elizabeth and Kiowa are 1,395 and 739 persons respectively. Bailey is an unincorporated town that is not tracked as a municipality by the State Demography Office, although a Google search yielded population data for 2009 indicating that 8,859 people reside in the Bailey ZIP code (80421).

The combined ozone precursor emissions (NO_x and VOC) for Elbert and Park Counties are about 12,800 tons/year and 18,800 tons/year from all source categories respectively. Of the total emissions only 2,700 tons/year and 4,400 tons/year are due to controllable emission sources (excludes uncontrollable emissions: biogenic, agricultural livestock waste and wildfire emissions) for Elbert and Park Counties respectively. There are no stationary point sources in Elbert or Park Counties with ozone precursor emissions over 100 tons/year.

The back trajectory analyses below (Figures 1-23 – 1-29) indicate that Elbert and Park Counties are infrequent contributors to air quality in the DM/NFR nonattainment area. This is indicated by the very low number of trajectory points in the grid cells over Elbert and Park Counties, particularly over the urbanized areas of concern.

In summary, the inclusion of the urbanized areas of Elbert and Park Counties into the ozone nonattainment area is not warranted because of low population, low degree of urbanization, very low precursor emissions, and infrequent contributions to air quality in the DM/NFR.

Northern Portions of Larimer and Weld Counties

The northern portions of Larimer and Weld Counties are rural and sparsely populated with most areas having a population density fewer than five people per square mile, as indicated in the Figure 1-9. There are only three stationary point sources with ozone precursor air pollutant emissions above 100 tons/year located north of the existing nonattainment area boundary (see Figures 1-7 and 1-8). Expanding the nonattainment area to include these three point sources would not enhance the States regulatory authority, although any future major modifications to these facilities would be affected.

The estimated 2011 emissions (all source categories) for the northern portion of Larimer County are approximately 2,879 tons/year of NO_x and 3,076 tons/year of VOC (approximately 26.4% and 13.9% of total county emissions for NOx and VOC respectively). The estimated 2011 emissions (all source categories) for the northern portion of Weld County are approximately 8,042 tons/year of NO_x and 18,610 tons/year of VOC (approximately 26.4% and 13.9% of total county emissions for NOx and VOC respectively).

Depending on the future ozone nonattainment area classification, requirements associated with the existing ozone nonattainment area may increase in stringency, such as the need to expand the vehicle Inspection/Maintenance Program (I&M program). Accordingly, the potential expansion of the existing nonattainment area to include these rural areas could result in requiring residents with vehicles to be subject to mandatory vehicle inspections. The emission reduction benefit associated with a mandatory I/M program targeting rural residents often located far from an inspection station is negligible.

The back trajectory analyses below (Figures 1-23 – 1-29) indicate that the northern portions of Larimer and Weld Counties are infrequent contributors to air quality in the DM/NFR nonattainment area. This is indicated by the very low number of trajectory points in the grid cells over the northern portions of Larimer and Weld Counties.

In summary, the inclusion of the northern portions of Larimer and Weld Counties into the ozone nonattainment area is not warranted because of sparse population, low degree of urbanization, low precursor emissions, and infrequent contributions to air quality in the DM/NFR.

Morgan County

Morgan County is a rural area outside of the existing ozone nonattainment area. Based on the information in Table 1-4, the estimated 2015 population density for Morgan County is 22.1 people per square mile. The total estimated 2015 population residing in Morgan County is 28,360. Compared to the 3.7 million (2015) people residing in the existing DM/NFR nonattainment area, Morgan County represents less than 0.8 percent of the total population for the area.

The NO_x emissions for Morgan County are approximately 8,000 tons/year and the VOC emissions are approximately 9,800 tons/year from all source categories. The NO_x emissions from one electric generating unit (EGU) represent approximately half of the total NO_x emissions in the county. The NOx emissions from the EGU were reduced substantially when the operation of a selective catalytic reduction (SCR) system began in 2014. Also, of the 9,800 tons/year of VOC emissions, approximately 7,500 tons/year are from uncontrollable sources. There are three stationary point sources in Morgan County with ozone precursor emissions over 100 tons/year, see Figures 1-7 and 1-8.

The back trajectory analyses below (Figures 1-23 – 1-29) indicate that Morgan County is an infrequent contributor to air quality in the DM/NFR nonattainment area. This is indicated by the very low number of trajectory points in the grid cells over Morgan County.

In summary, the inclusion of Morgan County into the ozone nonattainment area is not warranted because of low population, low degree of urbanization, low precursor emissions, and infrequent contributions to air quality in the DM/NFR.

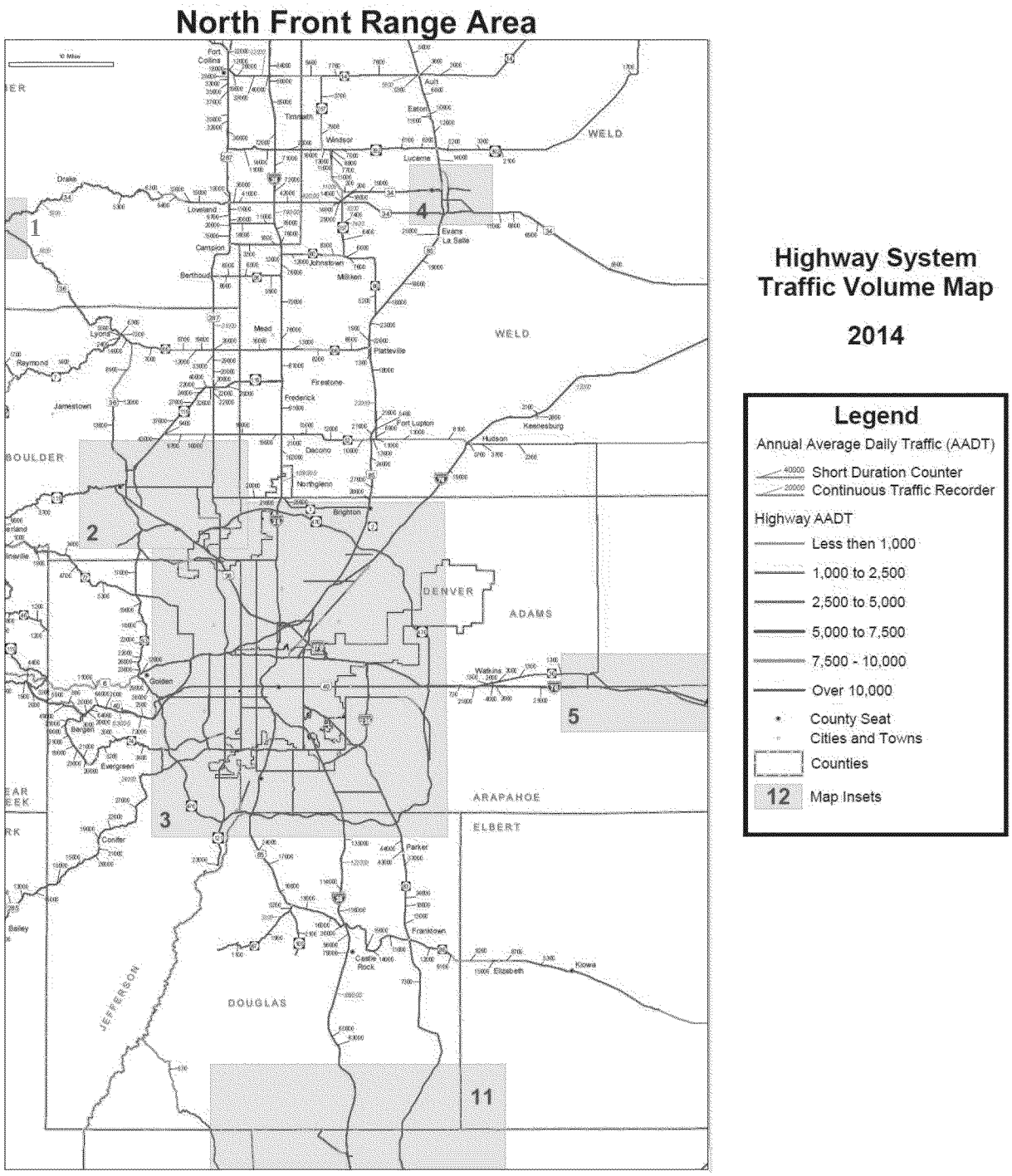
Population Density and Degree of Urbanization Conclusions

The region's population density/degree of urbanization information illustrates that the urbanization (and the associated activities that can result in emissions of ozone precursors) is concentrated within the current 8-hour ozone nonattainment area boundaries. As shown in Table 1-4, the current 8-hour ozone nonattainment area boundary contains 9 of the 10 most densely populated counties in the state. Urbanization rapidly diminishes beyond the central portion of the current nonattainment area. Because population in the surrounding counties is low by comparison, and the human landscape is rural with small pockets of development, the population/urbanization information supports the recommended nonattainment designation for the current 8-hour ozone nonattainment area. If future urbanization indicates that additional counties or regions should be included in the nonattainment area, the existing nonattainment boundary will be revaluated and expanded as necessary.

Traffic and Commuting Patterns

The following figures (Figure 1-13 – Figure 1-18) show the traffic volume in various areas within and around the DM/NFR area based on information from the Colorado Department of Transportation (CDOT).

Figure 1-13: CDOT Traffic Volume in North Front Range Area



The above shaded areas in Figure 1-13 denoted by numbers (1-5) are expanded below to provide more detail on localized annual average daily traffic volumes.

Figure 1-14: CDOT Traffic Volume in Estes Park Area

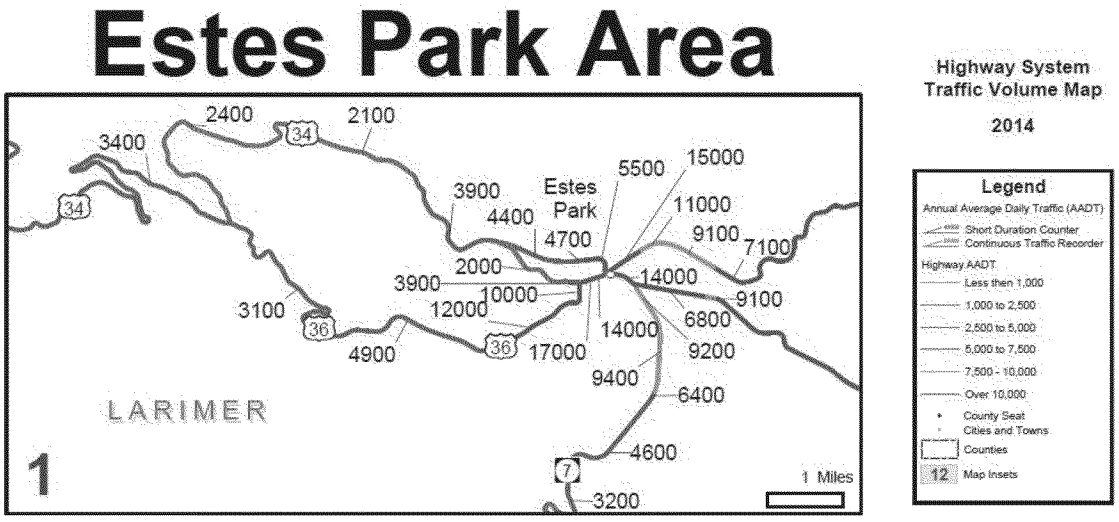


Figure 1-15: CDOT Traffic Volume in Boulder Area

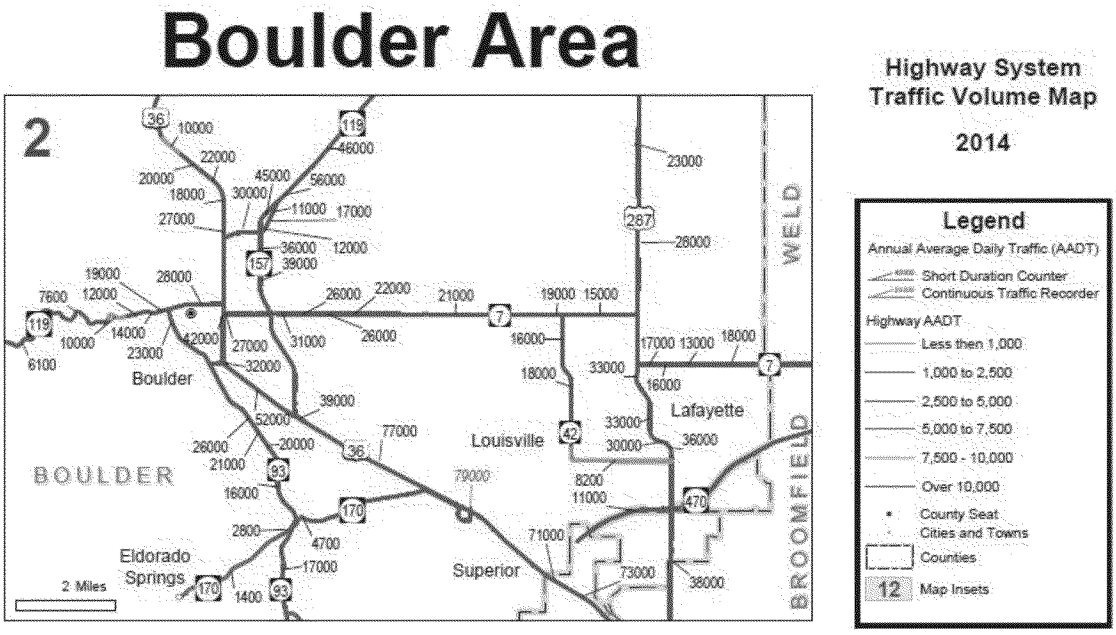


Figure 1-16: CDOT Traffic Volume in Denver Metro Area

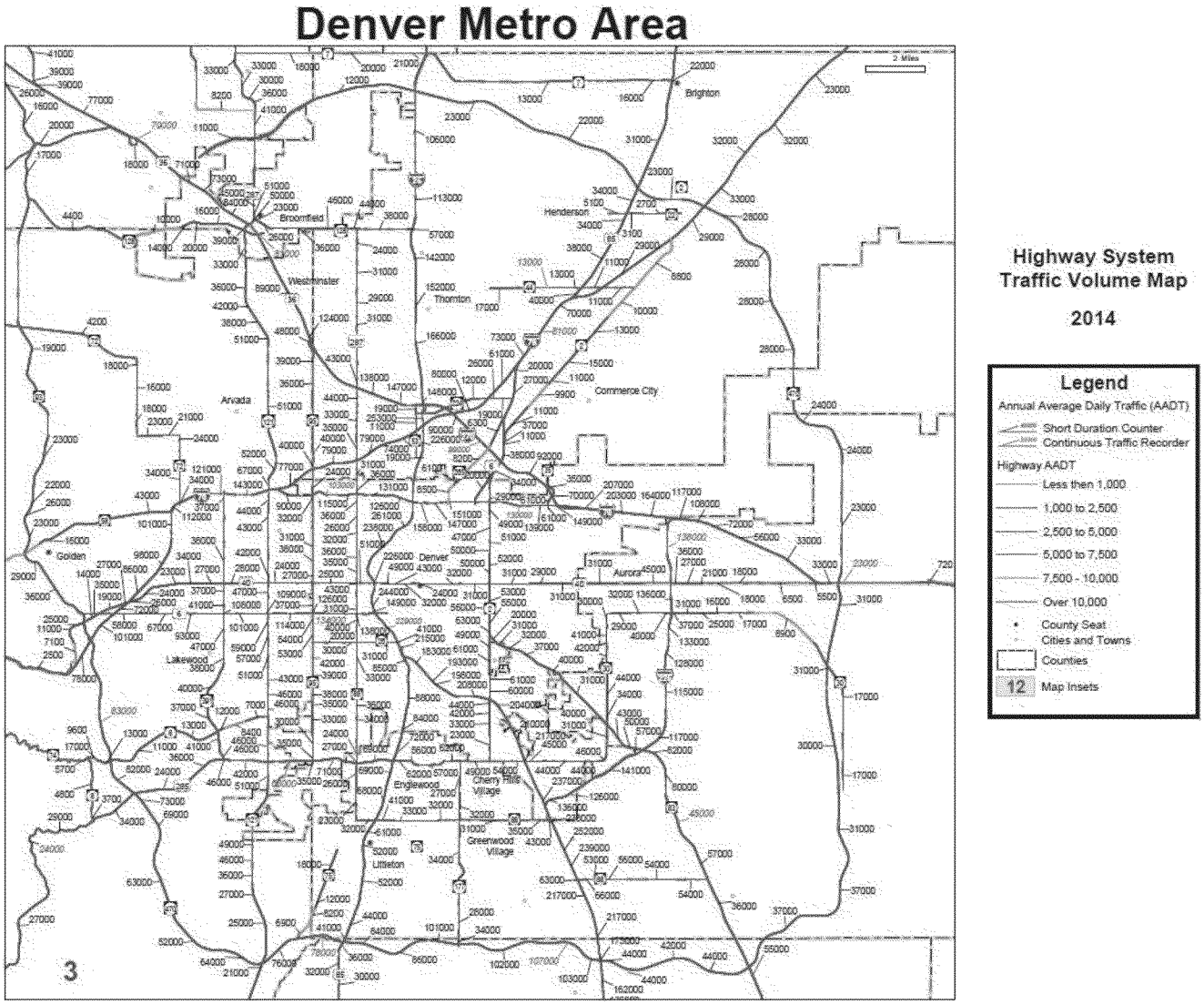


Figure 1-17: CDOT Traffic Volume in Greeley Area

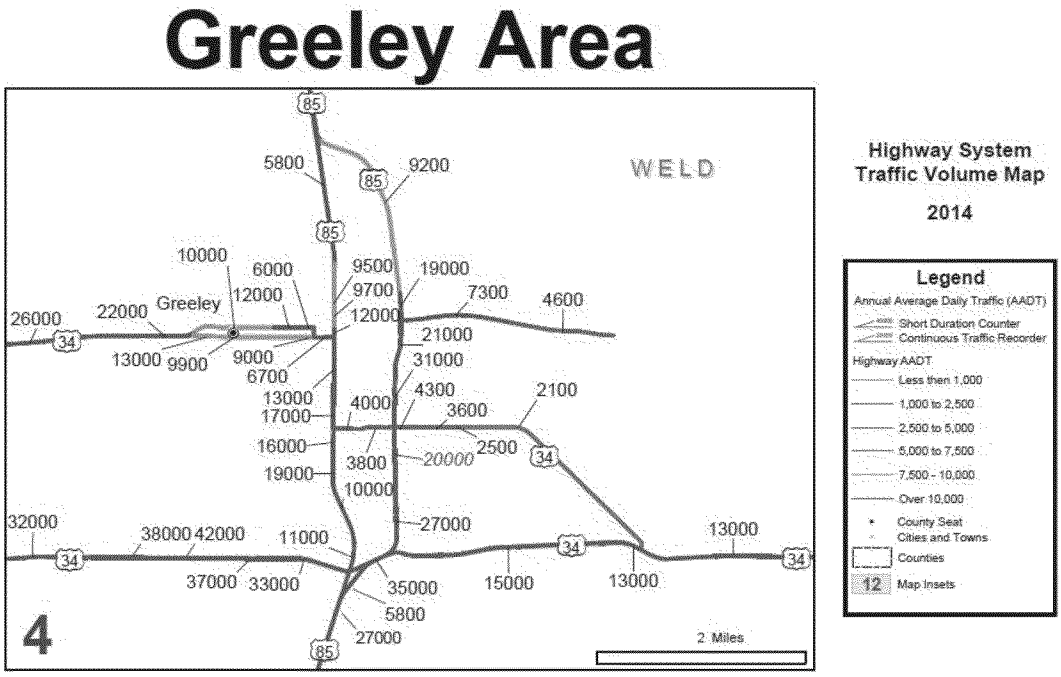


Figure 1-18: CDOT Traffic Volume in Bennett Area

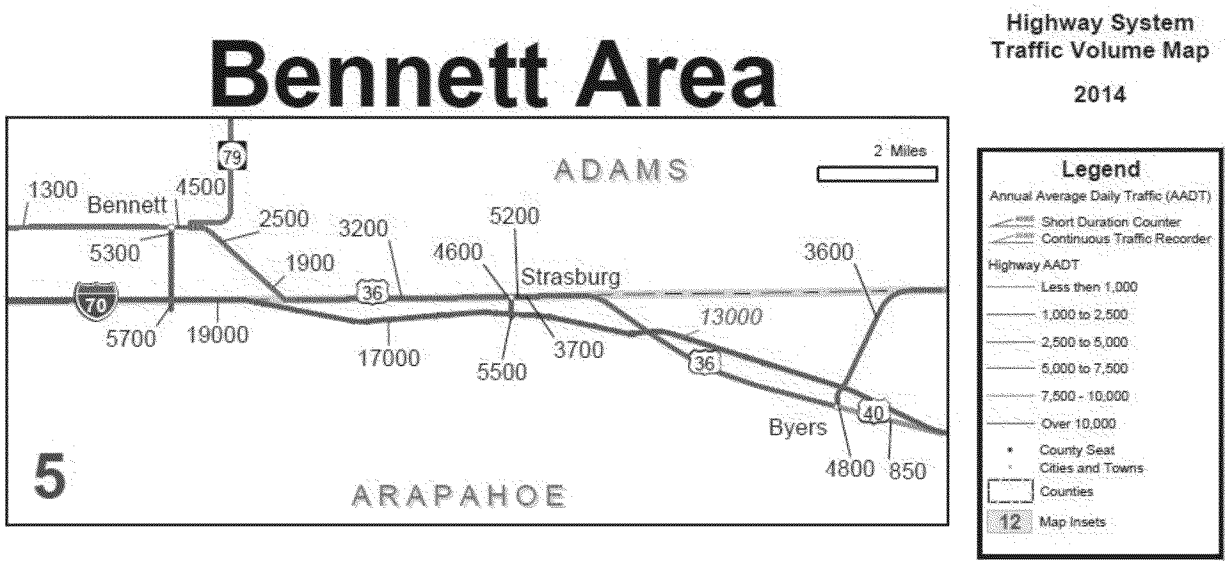
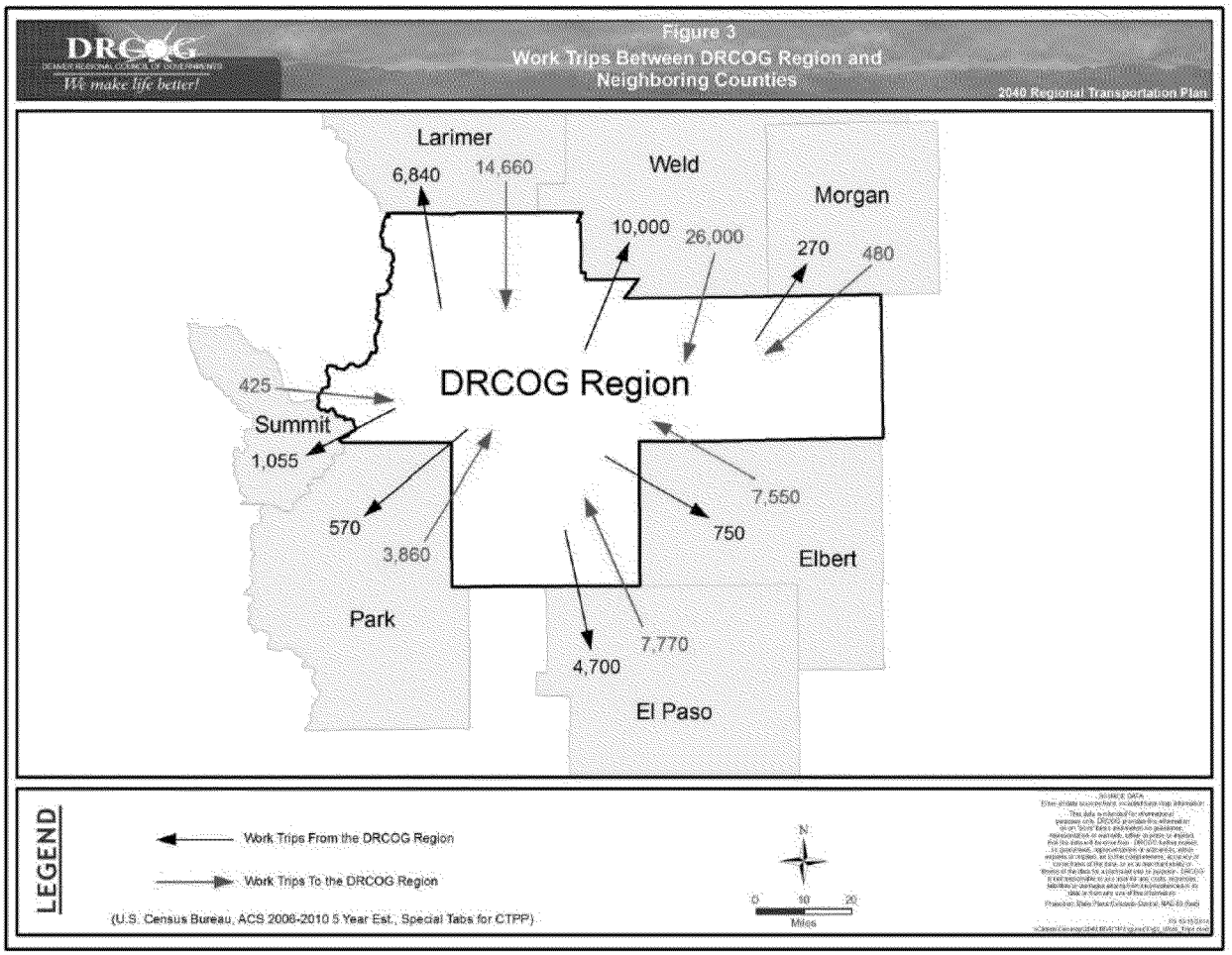


Figure 1-19, below, indicates the number of workers commuting into the Denver Region over a 5-year period 2006-2010. For the purposes of the figure, the Denver Region is composed of Adams, Arapahoe, Boulder, Broomfield, Clear Creek, Denver, Douglas, Gilpin, Jefferson counties.

Figure 1-19: Number of Workers Commuting between Denver Region and Neighboring Counties



The values shown in Figure 1-19 represent all workers commuting between the Denver Region and nearby counties. Since not everyone works every day of the week, the actual number of workers commuting on any given day would be somewhat lower.

In Table 1-7, below, the average vehicle miles traveled by county are shown. The values for Weld County in the table represent the vehicle miles traveled only for the southwest portion of the county. Table 1-8 shows the number of trips between residence and workplace for counties within Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas and Jefferson County.

Table 1-7: County-Level Annual Average Vehicle Miles Travelled

	YR2015		YR2025		YR2035		YR2040	
CountyName	VMT	%VMT	VMT	%VMT	VMT	%VMT	VMT	%VMT
Adams	14,483,101	17.3%	17,225,848	17.8%	20,111,484	18.8%	21,021,001	19.1%
Arapahoe	14,802,244	17.7%	17,384,553	18.0%	18,525,385	17.4%	19,073,286	17.3%
Boulder	7,432,845	8.9%	8,409,822	8.7%	9,204,069	8.6%	9,274,273	8.4%
Broomfield	2,297,786	2.8%	2,648,504	2.7%	3,121,476	2.9%	3,239,347	2.9%
Clear Creek	1,446,242	1.7%	1,676,227	1.7%	1,809,196	1.7%	1,977,498	1.8%
Denver	16,514,702	19.8%	18,699,769	19.4%	20,087,551	18.8%	20,641,570	18.7%
Douglas	9,545,751	11.4%	11,366,540	11.8%	12,920,780	12.1%	13,441,573	12.2%
Gilpin	182,830	0.2%	189,933	0.2%	207,552	0.2%	219,387	0.2%
Jefferson	13,729,808	16.4%	15,456,362	16.0%	16,666,397	15.6%	17,177,702	15.6%
Weld (SW)	3,051,510	3.7%	3,578,051	3.7%	4,053,377	3.8%	4,183,718	3.8%

Counties in the current 8-hour ozone nonattainment area

Table 1-8: Number of Trips Between Residence and Workplace for Counties within the Denver Region

Journey to Work Data by County (Avg. 2006-2010)

	WORKPLACE																			
RESIDENCE	Adams	Arapahoe	Boulder	Broomfield	Clear Creek	Denver	Douglas	Gilpin	Jefferson	SW Weld*	DRCOG Region Total	Weld (Non-DRCOG)	Elbert	El Paso	Larimer	Morgan	Park	Summit	Neighboring County Total	Grand Total
Adams	80,200	14,405	12,385	7,030	95	57,815	2,360	580	22,010	778	197,658	3,112	120	260	795	55	4	120	4,466	202,124
Arapahoe	17,145	136,010	1,925	870	10	88,130	18,695	315	12,465	122	275,687	488	135	1,015	395	45	215	205	2,498	278,185
Boulder	3,860	1,440	118,305	5,570	0	7,555	415	30	5,325	612	143,712	2,448	0	40	1,825	10	35	110	4,468	148,180
Broomfield	4,345	805	6,595	7,780	0	3,745	205	50	2,985	118	26,628	472	10	25	100	0	0	15	622	27,250
Clear Creek	115	125	20	4	2,345	535	0	320	1,370	3	4,837	12	0	0	4	0	0	165	181	5,018
Denver	19,210	43,930	5,300	2,150	40	183,050	8,590	700	26,150	151	289,271	604	10	680	410	50	25	90	1,869	291,140
Douglas	3,610	39,230	590	370	25	25,430	56,625	110	8,835	29	134,854	116	415	2,215	115	10	0	45	2,916	137,770
Gilpin	120	25	535	50	120	215	0	1,340	595	4	3,004	16	0	0	10	0	0	0	26	3,030
Jefferson	18,475	25,265	9,020	4,425	555	65,010	7,085	1,870	136,625	189	268,519	756	55	435	660	45	295	305	2,551	271,070
SW Weld*	1,333	212	2,388	222	0	1,238	54	2	456		5,905	2,000	2	33	2,521	56	0	0	4,612	10,517
DRCOG Region Total	148,413	261,447	157,663	28,471	3,190	432,723	94,029	5,317	216,816	2,006	1,350,075	10,024	747	4,703	6,835	271	574	1,055	24,209	1,374,284
Weld (Non-DRCOG)	5,332	848	9,552	888	0	4,952	216	8	1,824	2,500	26,120		8	132	10,084	224	0	0	10,448	36,568
Elbert	350	2,320	100	0	0	1,605	2,665	0	505	2	7,547	8	3,125	545	0	0	0	15	3,693	11,240
El Paso	495	2,345	190	35	0	2,620	1,510	0	555	15	7,765	60	215	277,090	120	0	25	25	277,535	285,300
Larimer	975	500	7,865	430	10	2,165	90	15	790	1815	14,655	7,260	0	125	123,155	95	0	0	130,635	145,290
Morgan	105	60	4	45	0	125	4	0	45	91	479	364	0	0	15	11,215	0	4	11,598	12,077
Park	225	550	120	25	0	1,030	45	0	1,860	0	3,855	0	0	100	0	0	3,170	745	4,015	7,870
Summit	30	40	15	0	165	115	0	0	60	0	425	0	0	0	0	0	4	15,935	15,939	16,364
Neighboring Counties Total	7,512	6,663	17,846	1,423	175	12,612	4,530	23	5,639	4,423	60,846	7,692	3,348	277,992	133,374	11,534	3,199	16,724	435,723	496,569
Grand Total	155,925	268,110	175,509	29,894	3,365	445,335	98,559	5,340	222,455	6,429	1,410,921	17,716	4,095	282,695	140,209	11,805	3,773	17,779	459,932	1,870,853

Source: US Census Bureau, ACS 2006-2010 5yr est., Special Tabs for CTPP

*Note - 2010 Census population used to determine number of commuters within SW Weld and number of commuters in remaining Weld County. (52,246 out of 252,825 - Approx. 20% SW Weld and 80% Non-DRCOG Weld)

Traffic and Commuting Patterns Conclusion

The region's traffic and commuting patterns illustrate that the vast majority of vehicle trips occur within the current 8-hour ozone nonattainment boundary. Average daily traffic rapidly diminishes beyond the core area of the current nonattainment area. Commuting information also

indicates that work trips into the region are minimal when compared to traffic volumes that exist in the recommended nonattainment area. Because vehicular traffic in the surrounding counties is low by comparison, and the human landscape is rural with small pockets of development, the traffic and commuting information supports the recommended nonattainment designation for the current 8-hour ozone nonattainment area. If future traffic and commuting information indicates that additional counties or regions should be included in the nonattainment area, the existing nonattainment boundary will be revaluated and expanded as necessary.

Growth Rates and Patterns

The following three tables present population growth rates and patterns for the current nonattainment area, bordering counties and nearby micropolitan statistical areas. In Tables 1-9, 1-10 and 1-11, the population data for Larimer and Weld Counties includes the whole county and does not apportion persons residing in the nonattainment area portion of these counties. The 2015 population for the northern portion of Larimer County (nonattainment area excluded) is estimated at 16,679 persons (~5% of County total). The 2015 population for the northern portion of Weld County (nonattainment area excluded) is estimated at 2,852persons (~1% of County total).

Table 1-9: Recent Population Estimates for Denver Metro Area, North Front Range and Neighboring Counties

County	July 2010 (Estimate)	July 2015 (Estimate)	2010 to 2015 Total % Change	2010 to 2015 Annual % Change	2010 to 2015 Annual % Change Rank
Adams	443,680	491,337	10.7%	2.1%	6
Araphoe	574,727	631,096	9.8%	2.0%	7
Boulder	295,986	319,372	7.9%	1.6%	8
Broomfield	56,271	65,065	15.6%	3.1%	1
Clear Creek	9,083	9,303	2.4%	0.5%	14
Denver	603,300	682,545	13.1%	2.6%	2
Douglas	286,964	322,387	12.3%	2.5%	3
Elbert	23,095	24,735	7.1%	1.4%	11
El Paso	626,916	674,471	7.6%	1.5%	10
Gilpin	5,461	5,828	6.7%	1.3%	12
Grand	14,783	14,615	-1.1%	-0.2%	21
Jackson	1,385	1,356	-2.1%	-0.4%	22
Jefferson	535,625	565,524	5.6%	1.1%	13
Larimer	300,524	333,577	11.0%	2.2%	5
Lincoln	5,469	5,557	1.6%	0.3%	15
Logan	22,130	22,036	-0.4%	-0.1%	20
Morgan	28,172	28,360	0.7%	0.1%	18
Park	16,262	16,510	1.5%	0.3%	16
Summit	28,065	30,257	7.8%	1.6%	9
Teller	23,450	23,385	-0.3%	-0.1%	19
Washington	4,801	4,864	1.3%	0.3%	17
Weld	254,166	285,174	12.2%	2.4%	4
Total for NAA	3,351,243	3,696,077	10.3%	2.1%	
Sum for Other	809,072	861,277	6.5%	1.3%	

Note: NAA total includes the total populations for Weld and Larimer counties

	Counties in the current 8-hour ozone nonattainment area
	Top 10- 2010 to 2015 Annual % Change

Table 1-10: Population Projections for Denver Metro Area, North Front Range and Neighboring Counties

County	July 2020 (State Estimate)	July 2025 (State Estimate)	July 2030 (State Estimate)	July 2035 (State Estimate)	July 2040 (State Estimate)	July 2045 (State Estimate)	July 2050 (State Estimate)
Adams	545,237	603,716	665,364	726,331	787,411	841,102	893,563
Araphoe	687,520	748,470	810,672	875,381	935,138	981,660	1,016,184
Boulder	337,897	359,908	379,714	398,988	416,942	427,993	436,166
Broomfield	72,388	82,081	92,051	94,178	95,453	95,870	95,658
Clear Creek	9,627	10,873	12,088	13,210	14,344	15,427	16,419
Denver	734,079	770,900	804,797	836,961	867,545	896,110	922,512
Douglas	352,955	389,462	425,395	455,617	482,079	491,393	494,181
Elbert	33,896	42,326	49,029	54,671	59,873	64,743	69,333
El Paso	727,807	786,295	845,985	905,014	964,290	1,017,813	1,070,833
Gilpin	6,054	6,194	6,286	6,542	6,699	6,822	6,944
Grand	16,544	18,699	20,809	22,835	24,731	26,505	28,249
Jackson	1,483	1,535	1,579	1,630	1,673	1,682	1,692
Jefferson	595,849	625,516	652,326	674,241	686,319	693,880	700,173
Larimer	360,434	393,517	424,882	454,593	483,322	513,003	542,039
Lincoln	5,869	6,266	6,699	7,148	7,604	8,030	8,445
Logan	23,247	24,663	26,213	27,807	29,350	30,823	32,271
Morgan	30,232	32,336	34,436	36,619	39,017	41,391	43,710
Park	20,339	24,788	28,101	30,710	32,176	32,693	32,928
Summit	33,366	37,987	42,197	46,066	49,704	53,184	56,606
Teller	25,447	27,449	28,618	29,638	30,524	31,385	32,310
Washington	4,723	4,859	5,005	5,053	5,028	5,001	4,980
Weld	340,265	401,866	466,717	535,889	605,605	671,753	738,396
Total for NAA	4,026,624	4,375,436	4,721,918	5,052,179	5,359,814	5,612,764	5,838,872
Sum for Other	938,634	1,024,270	1,107,045	1,186,943	1,265,013	1,335,499	1,404,720

Note: NAA total includes the total populations for Weld and Larimer counties

Table 1-11: Population Percent Change Projections for Denver Metro Area, North Front Range and Neighboring Counties

County	2015 to 2020 (State Estimate)	2020 to 2025 (State Estimate)	2025 to 2030 (State Estimate)	2030 to 2035 (State Estimate)	2035 to 2040 (State Estimate)	2040 to 2045 (State Estimate)	2045 to 2050 (State Estimate)
Adams	2.2%	2.1%	2.0%	1.8%	1.6%	1.3%	1.2%
Araphoe	1.8%	1.7%	1.6%	1.5%	1.3%	1.0%	0.7%
Boulder	1.2%	1.3%	1.1%	1.0%	0.9%	0.5%	0.4%
Broomfield	2.7%	2.5%	2.3%	0.5%	0.3%	0.1%	0.0%
Clear Creek	1.1%	2.5%	2.1%	1.8%	1.7%	1.5%	1.3%
Denver	1.6%	1.0%	0.9%	0.8%	0.7%	0.7%	0.6%
Douglas	2.0%	2.0%	1.8%	1.4%	1.1%	0.4%	0.1%
Elbert	6.1%	4.5%	3.0%	2.2%	1.8%	1.6%	1.4%
El Paso	1.5%	1.6%	1.5%	1.4%	1.3%	1.1%	1.0%
Gilpin	0.6%	0.5%	0.3%	0.8%	0.5%	0.4%	0.4%
Grand	2.2%	2.5%	2.2%	1.9%	1.6%	1.4%	1.3%
Jackson	1.1%	0.7%	0.6%	0.6%	0.5%	0.1%	0.1%
Jefferson	1.1%	1.0%	0.8%	0.7%	0.4%	0.2%	0.2%
Larimer	1.8%	1.8%	1.5%	1.4%	1.2%	1.2%	1.1%
Lincoln	1.2%	1.3%	1.3%	1.3%	1.2%	1.1%	1.0%
Logan	0.9%	1.2%	1.2%	1.2%	1.1%	1.0%	0.9%
Morgan	1.2%	1.4%	1.3%	1.2%	1.3%	1.2%	1.1%
Park	3.8%	4.0%	2.5%	1.8%	0.9%	0.3%	0.1%
Summit	2.3%	2.6%	2.1%	1.8%	1.5%	1.4%	1.3%
Teller	1.5%	1.5%	0.8%	0.7%	0.6%	0.6%	0.6%
Washington	0.0%	0.6%	0.6%	0.2%	-0.1%	-0.1%	-0.1%
Weld	3.5%	3.4%	3.0%	2.8%	2.5%	2.1%	1.9%

Note: NAA total includes the total populations for Weld and Larimer counties

Growth Rates and Patterns Conclusions

The region's growth rates and patterns illustrate that vast majority of increased population and urbanization will occur within the current 8-hour ozone nonattainment boundary. As shown in Table 1-9, nine of the ten counties with the largest population increase from 2010 to 2015 are contained within the current 8-hour ozone nonattainment area. Population density and developed areas are projected to rapidly diminish beyond the core area of the current nonattainment area. Because projected population and activity in the surrounding counties is low by comparison, and the human landscape is projected to be rural with small pockets of development, the growth information supports the recommended nonattainment designation for the current 8-hour ozone nonattainment area. If future growth information indicates that additional counties or regions should be included in the nonattainment area, the existing nonattainment boundary will be revaluated and expanded as necessary.

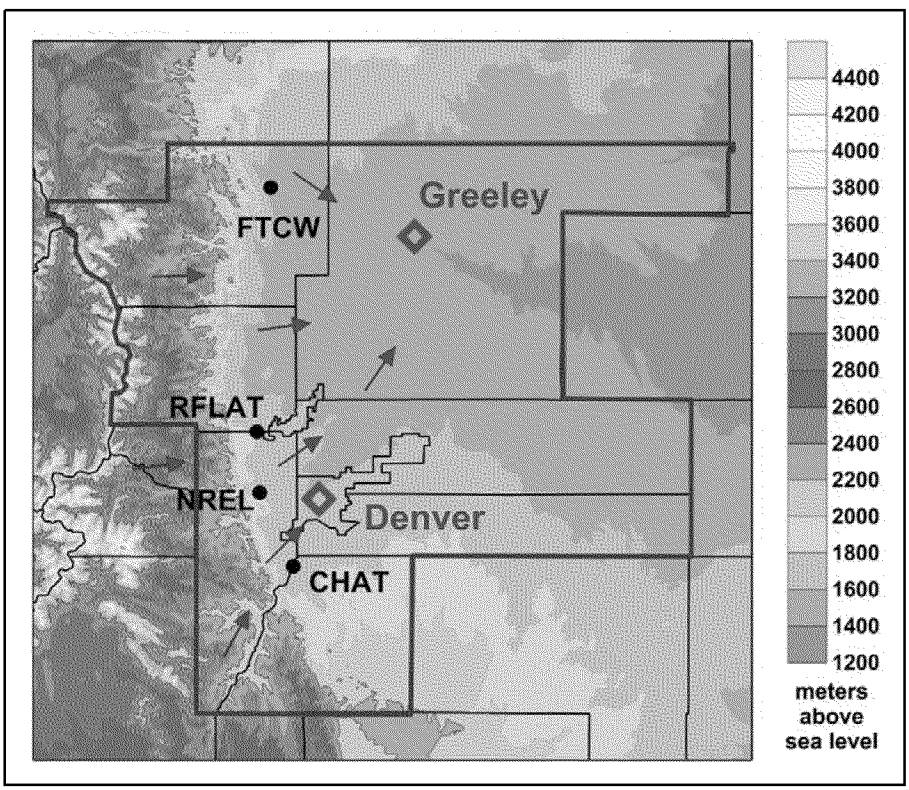
Factor #3: Meteorology

Meteorology is the single most important factor affecting mid-summer ozone in the DM/NFR area, and the Front Range and Platte Valley meteorology are significantly affected by terrain. As reported in a number of papers on the mesoscale meteorology of the area[2,3,4,5,7,8,10,11,12], the South Platte Valley and surrounding plains, the east-west Cheyenne Ridge along Colorado's border with Wyoming to the north of the South Platte Valley, the east-west Palmer Divide to the south of the Denver metro area, and the Continental Divide to the west of the South Platte Valley create local circulations that tend to magnify and constrain the influence of local emissions on air

quality. Although the terrain and these circulations do not prevent transport into or away from the basin, these factors tend to define a natural airshed. This airshed's boundaries provide a geographical focus for air quality control strategies.

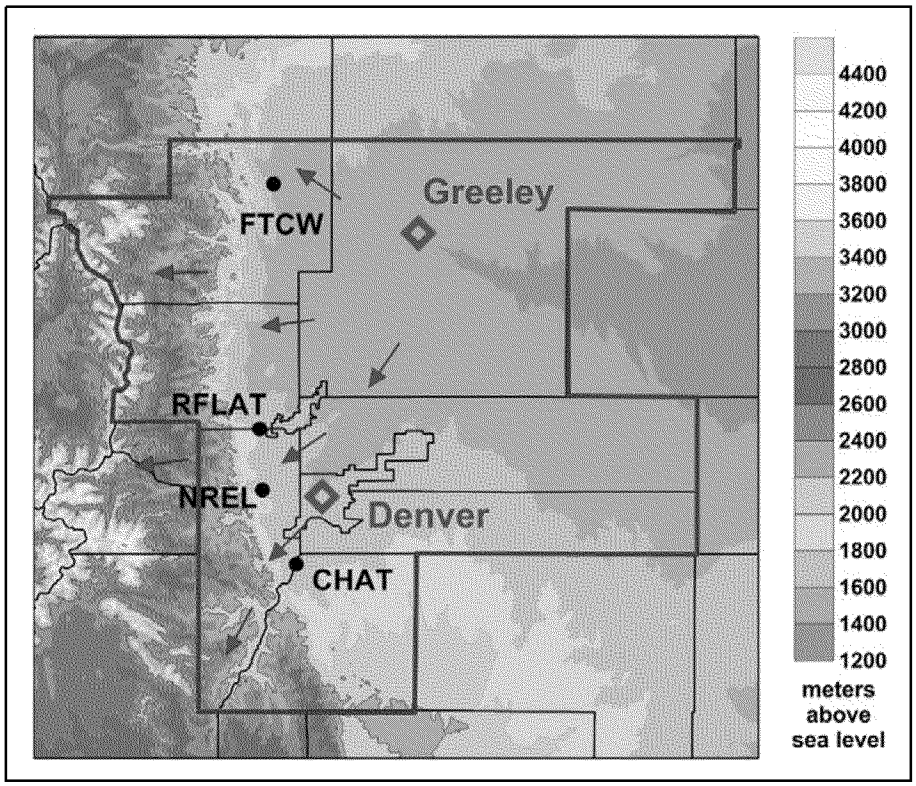
In general, three key circulations affect summer air quality within this basin or airshed. The first of these is nighttime and early-morning down-valley drainage flow. At night, infrared radiation from the surface disproportionately cools the ground and the air next to it. This chilled air is denser than surrounding air and flows downhill. These downhill flows converge to form drainage winds that move surface air down the canyons and valleys toward a widening of the Platte Valley in Weld County (see Figure 1-20). There the wider valley and a constriction further downstream, cause pooling of cooler air. Both the drainage winds and the cold pooling trap nighttime and early morning emissions. This phase contributes to the accumulation of emissions that are later processed by the sun and the daytime mountain-valley circulation during the afternoon.

Figure 1-20: Nighttime Drainage Flows (Red Arrows) into the Platte Valley or Basin



The second key circulation is thermally-driven upslope flow which is a component of a mountain-valley circulation. Daytime solar heating of higher terrain and sun-facing slopes creates areas of low pressure over these surfaces that cause a reversal of the nighttime drainage pattern. Winds tend to blow uphill or up-slope (see Figure 1-21).

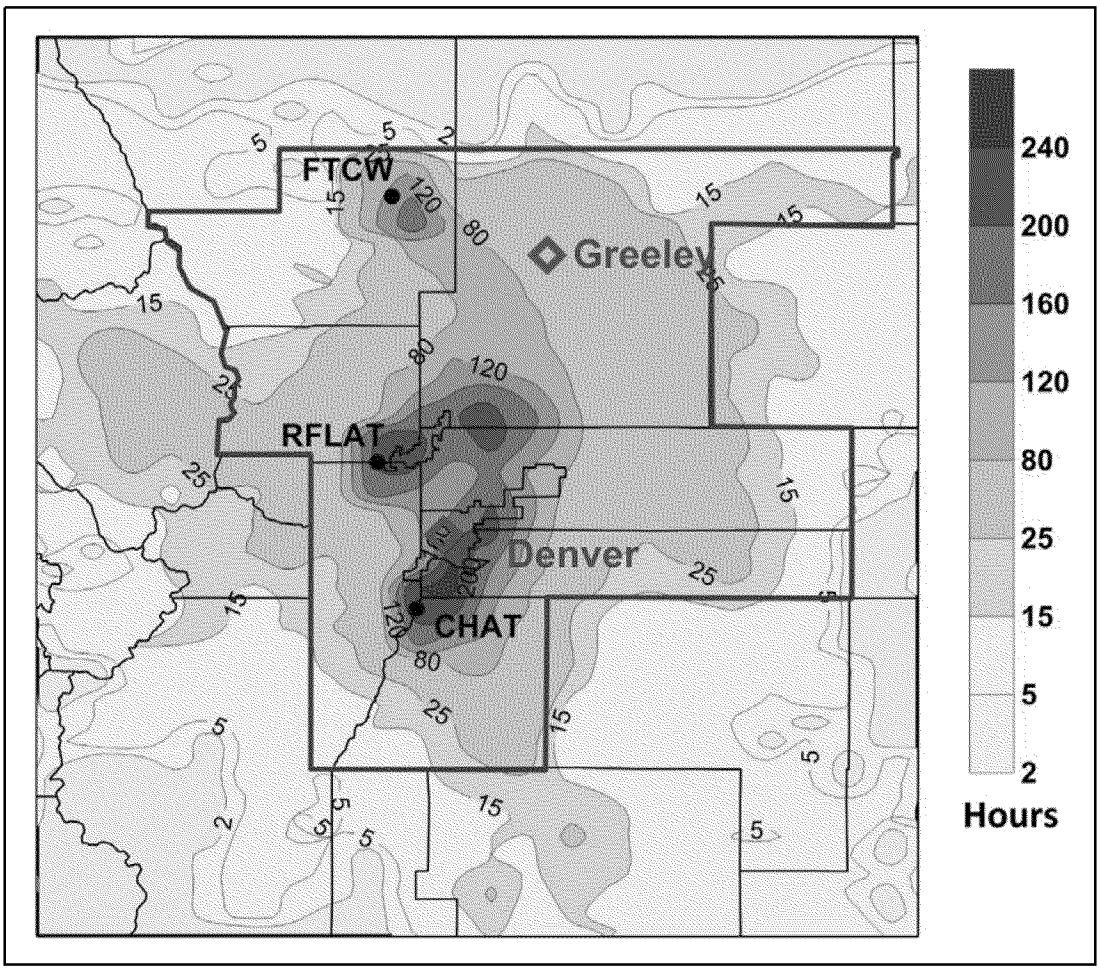
Figure 1-21: Daytime Thermally-Driven Upslope Flows (Red Arrows) Toward Higher Terrain



The third key circulation is the mountain plains solenoid circulation. Its relevance to ozone is described by Reddy and Pfister (2016) and Sullivan et al. (2016). The solenoid circulation consists of thermally-driven surface upslope flow (toward the southwest, west, and northwest) to mountain top level during the afternoon, mixing and transporting vertically, and weak transport to the east at higher altitudes. Vertical mixing and subsidence over plains near Denver closes this loop, tending to keep ozone in the area. Light winds, a deep layer of thermally-driven upslope flow, local vertical recirculation, cloud-free skies, and warm temperatures are key ingredients for high ozone at the surface.

A HYSPLIT (Rolph, 2016, and Stein et al., 2015) back-trajectory analysis on the four highest days for each year in 2006 to 2008 for Fort Collins West, Rocky Flats, and Chatfield was completed for analysis of the existing nonattainment area and the 2008 8-hour standard. Figure 1-22 shows the results of that analysis. The contouring is based on approximately 7,200 points or hours aggregated by 0.1 by 0.1 degree grids representing 24 hours of back trajectories for each of the eight hours contributing to the 4 highest values for each year and each site. Hours represent the aggregate back trajectory points or hours for these events in each grid cell. This analysis confirmed that the highest densities of the back-trajectory points for the prior 24-hours were within the airshed, overlapped with the highest emissions source areas, and were in the nonattainment area.

Figure 1-22: HYSPLIT Back-Trajectory for the Four Highest Days for Each Year in 2006 to 2008 for Fort Collins West, Rocky Flats, and Chatfield



This HYSPLIT analysis was repeated for the nonattainment area for the new 70 ppb standard. In the previous analysis (Figure 1-22), the meteorology used to drive HYSPLIT was the 40 km EDAS40 data assimilation/model product. For the current analysis, the NAM12 12 km pseudo analysis product was used, which provides a reasonable reconciliation of observations and model physics. The EDAS40, because of its coarser resolution and reduced ability to simulate thermally-driven upslope flows, likely attributed more of the elevated ozone to source areas in and near the foothills. Figures 1-23 through 1-26 show the results for Fort Collins West, Rocky Flats, NREL, and Chatfield, respectively, for the four highest ozone events at each site each year from 2013-2015 (data flagged as exceptional events have been excluded). Each site shows the highest areas of influence toward the typical afternoon upslope flow at each location. In other words, these plots point to source areas upwind. The contouring is based on 2,400 points or hours aggregated by 0.1 by 0.1 degree grids representing 24 hours of back trajectories for each of the eight hours contributing to the 4 highest values for each year. Hours represent the aggregate back trajectory points or hours for these events in each grid cell.

Figure 1-23: HYSPLIT Back-Trajectory for the Four Highest Days for Each Year in 2013 to 2015 for Fort Collins West

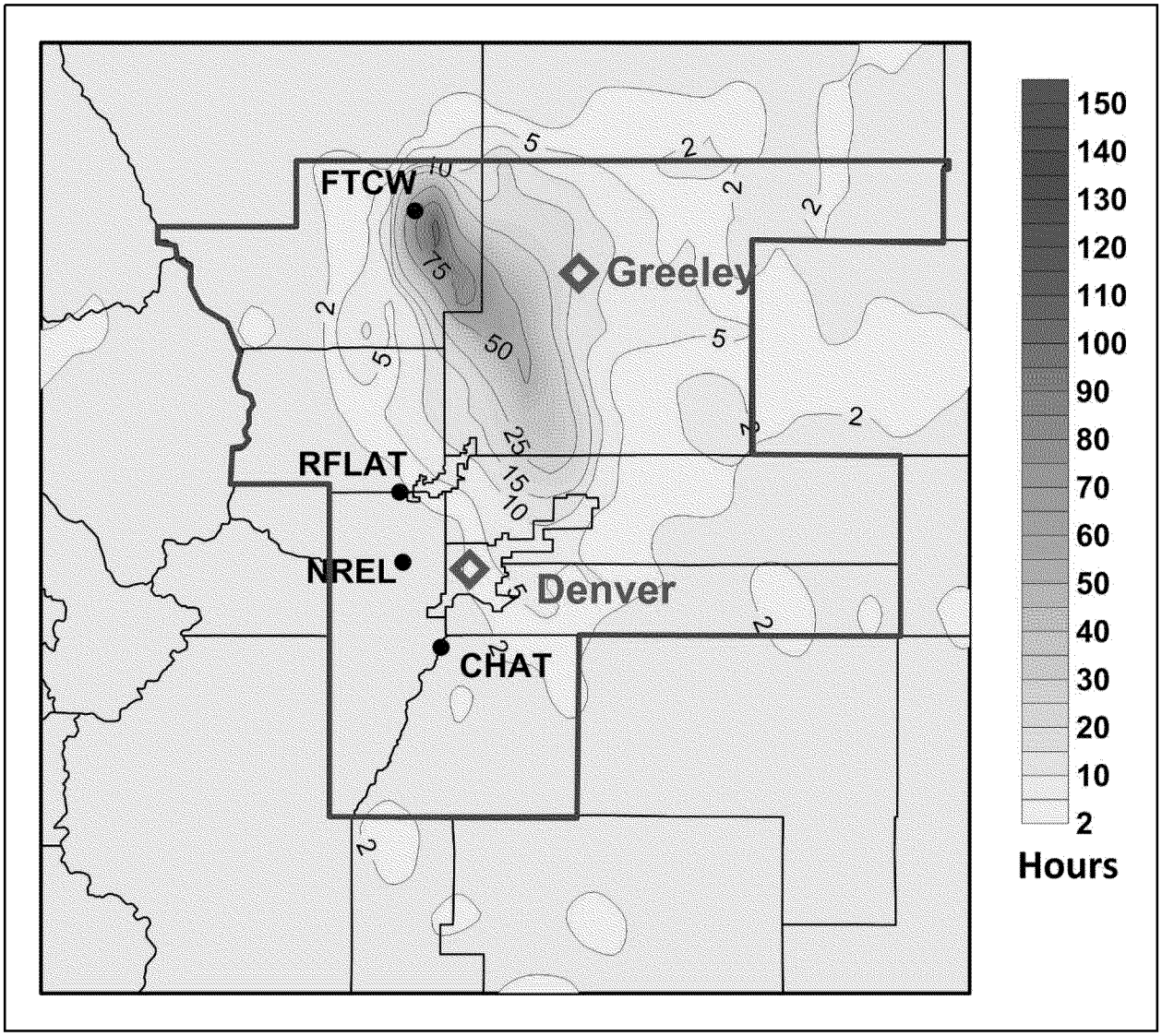


Figure 1-24: HYSPLIT Back-Trajectory for the Four Highest Days for Each Year in 2013 to 2015 for Rocky Flats

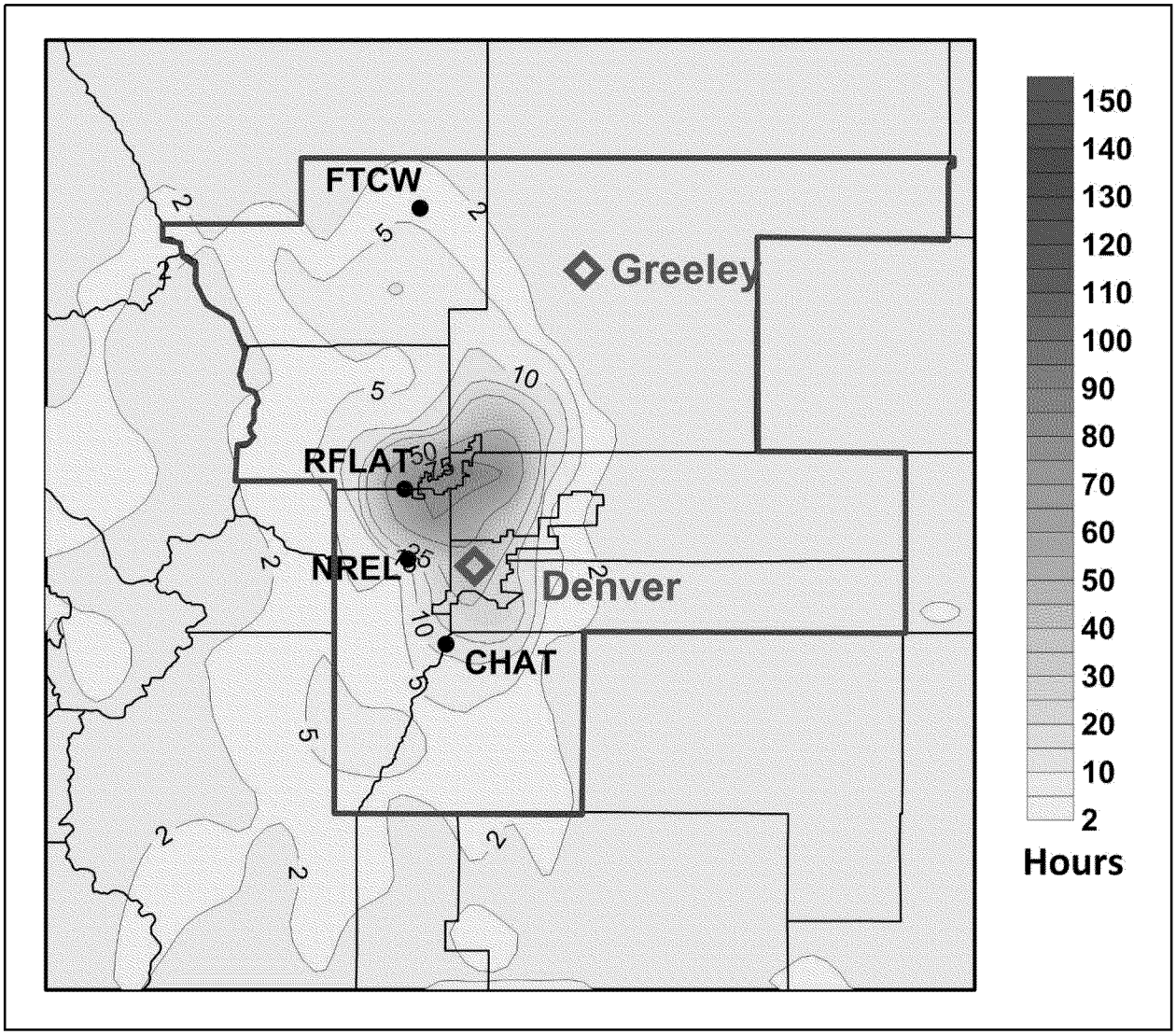


Figure 1-25: HYSPLIT Back-Trajectory for the Four Highest Days for Each Year in 2013 to 2015 for NREL

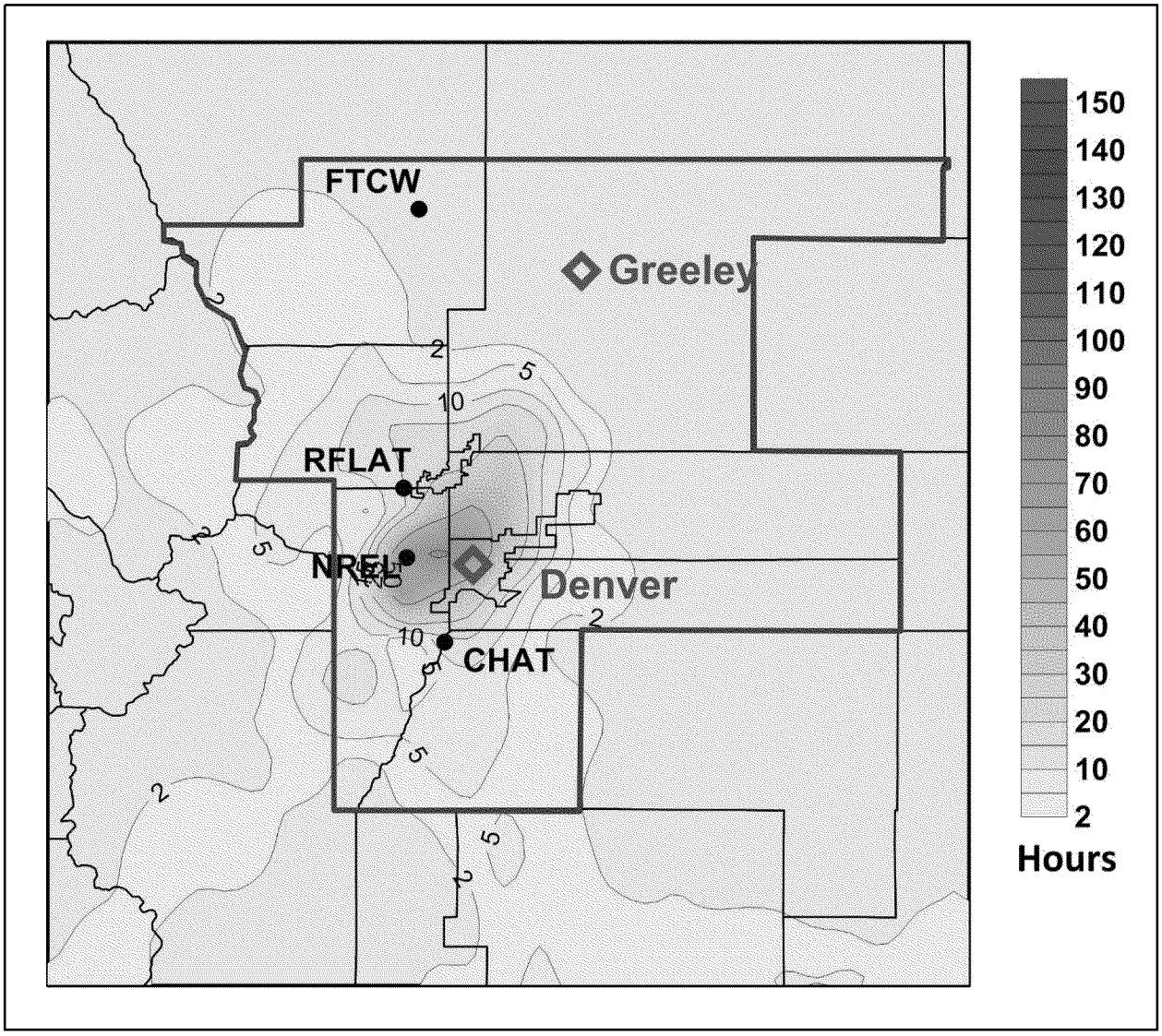
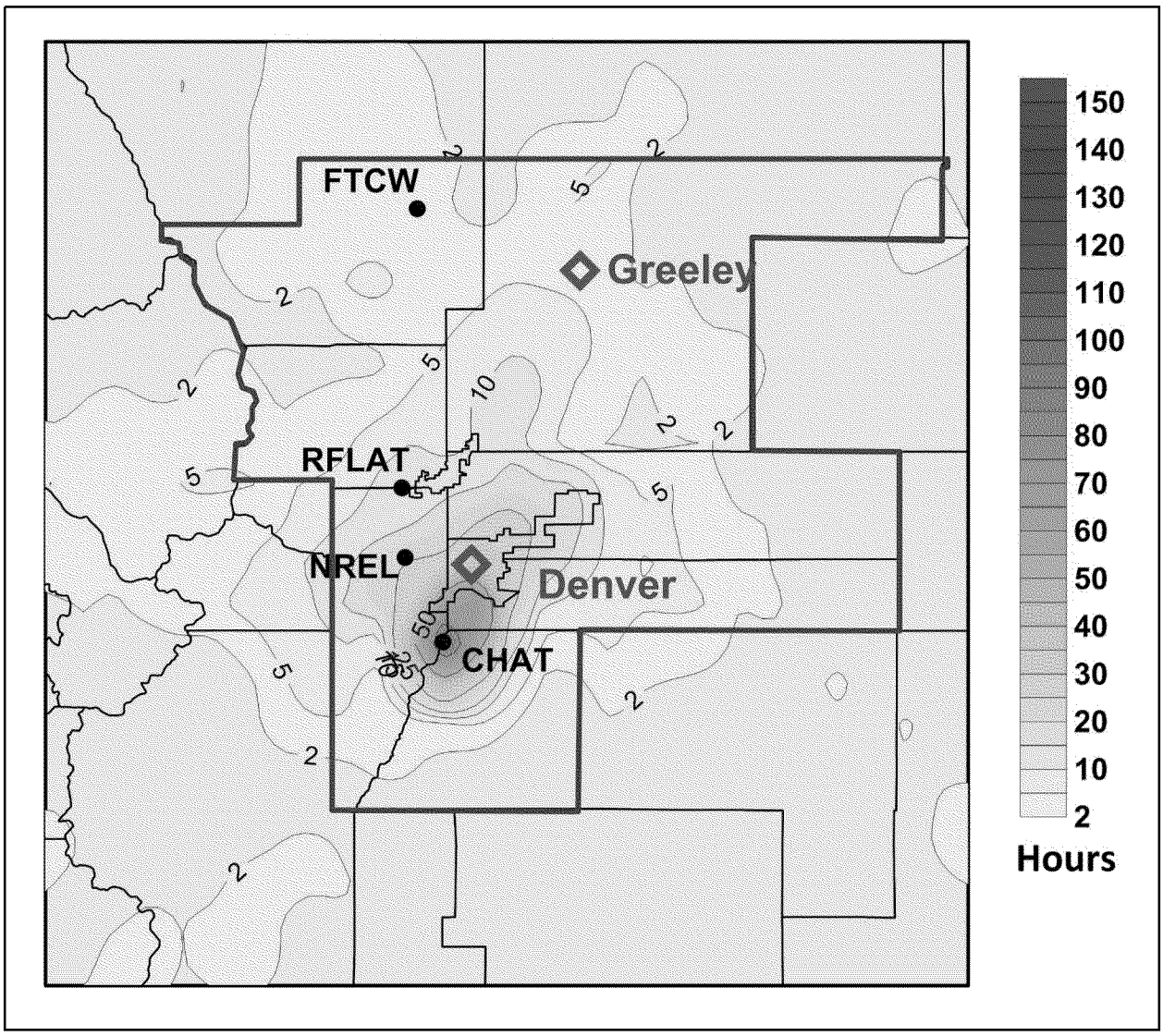


Figure 1-26: HYSPLIT Back-Trajectory for the Four Highest Days for Each Year in 2013 to 2015 for Chatfield



In Figure 1-27, below, the results of Figures 1-23 – 1-26 have been combined in a composite contour plot for the four sites. The contouring is based on 9,600 points or hours aggregated by 0.1 by 0.1 degree grids representing 24 hours of back trajectories for each of the eight hours contributing to the 4 highest values for each year and each site. Hours represent the aggregate back trajectory points or hours for these events in each grid cell.

Figure 1-27: Composite HYSPLIT Back-Trajectory for the Four Highest Days for Each Year in 2013 to 2015 for Fort Collins West, Rocky Flats, NREL, and Chatfield

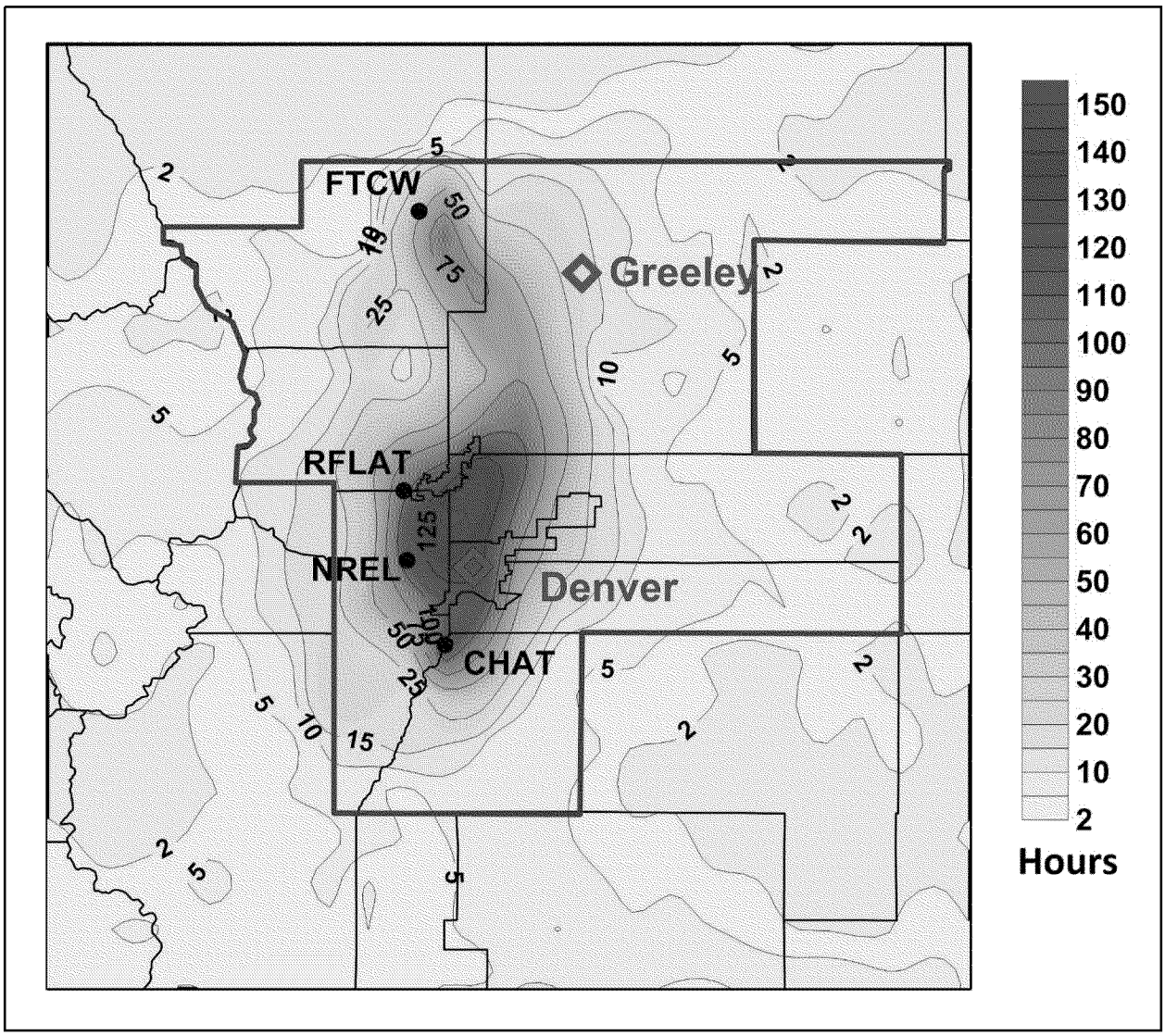


Figure 1-28, below, shows the total hour counts for each 0.1 by 0.1 grid cell, and Figure 1-29 shows the percentage of the total 9,600 back trajectory point hours for all four sites that occurred in each grid cell. These maps show that the areas of greatest influence continue to be within the existing nonattainment area boundary. It is worth noting that some unknown portion of the points/hours from areas to the west of the nonattainment area are likely the result of mountain plains solenoid circulations simulated in the NAM12 data set. These represent ozone and precursors that would be attributable to sources within the nonattainment area boundaries. In these cases, ozone and or its precursors would have completed a loop flow and returned to the nonattainment area.

The plot in Figure 1-28 is based on 9,600 points or hours aggregated by 0.1 by 0.1 degree grids representing 24 hours of back trajectories for each of the eight hours contributing to the 4 highest

values for each year and each site. Hours represent the aggregate back trajectory points or hours for these events in each grid cell.

In Figure 1-29, the percentage of total hours in each grid cell is based on 9,600 points or hours aggregated by 0.1 by 0.1 degree grids representing 24 hours of back trajectories for each of the eight hours contributing to the 4 highest values for each year and each site.

Figure 1-28: HYSPLIT Back-Trajectory for the Four Highest Days for Each year in 2013 to 2015 for Fort Collins West, Rocky Flats, NREL, and Chatfield.

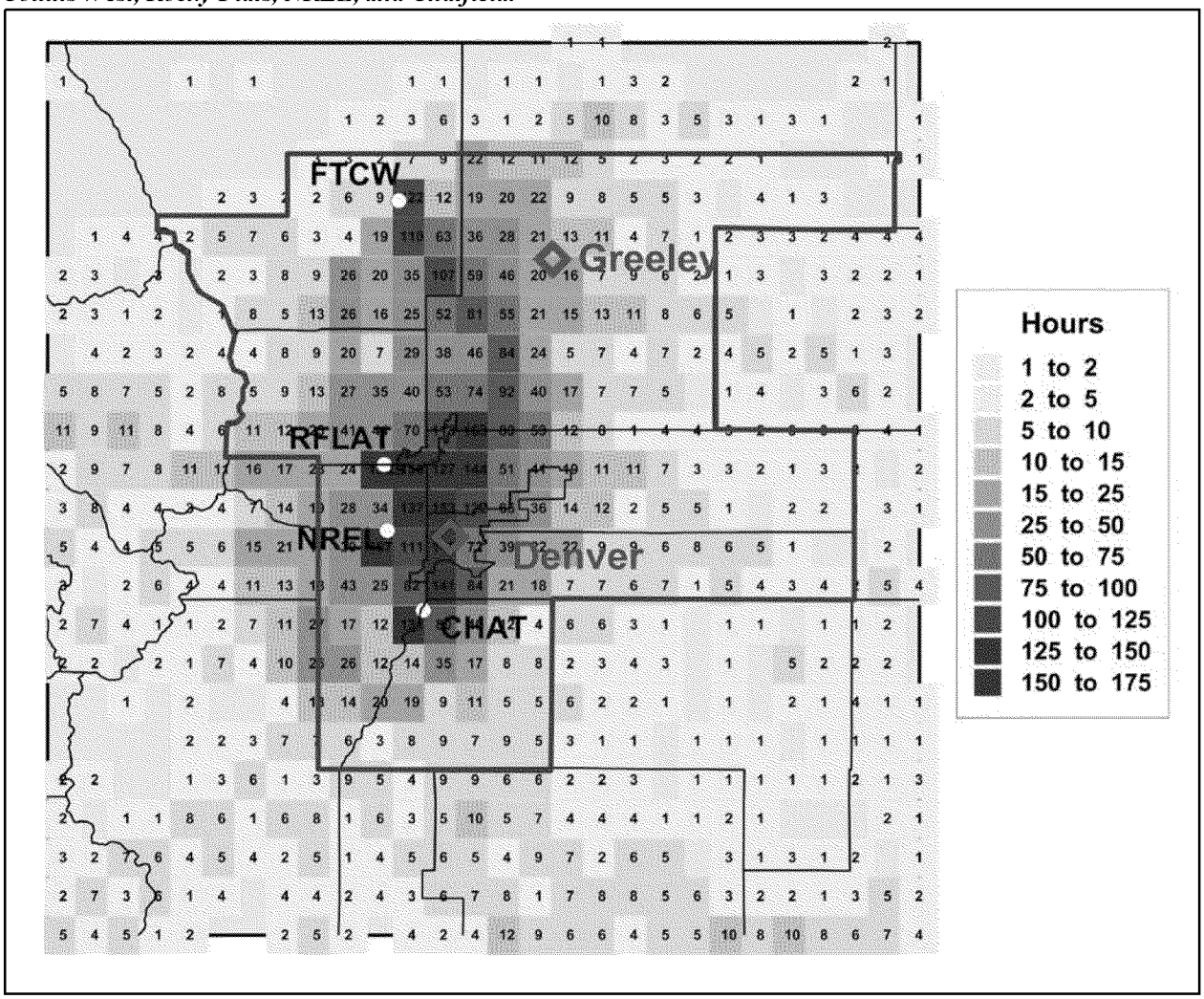
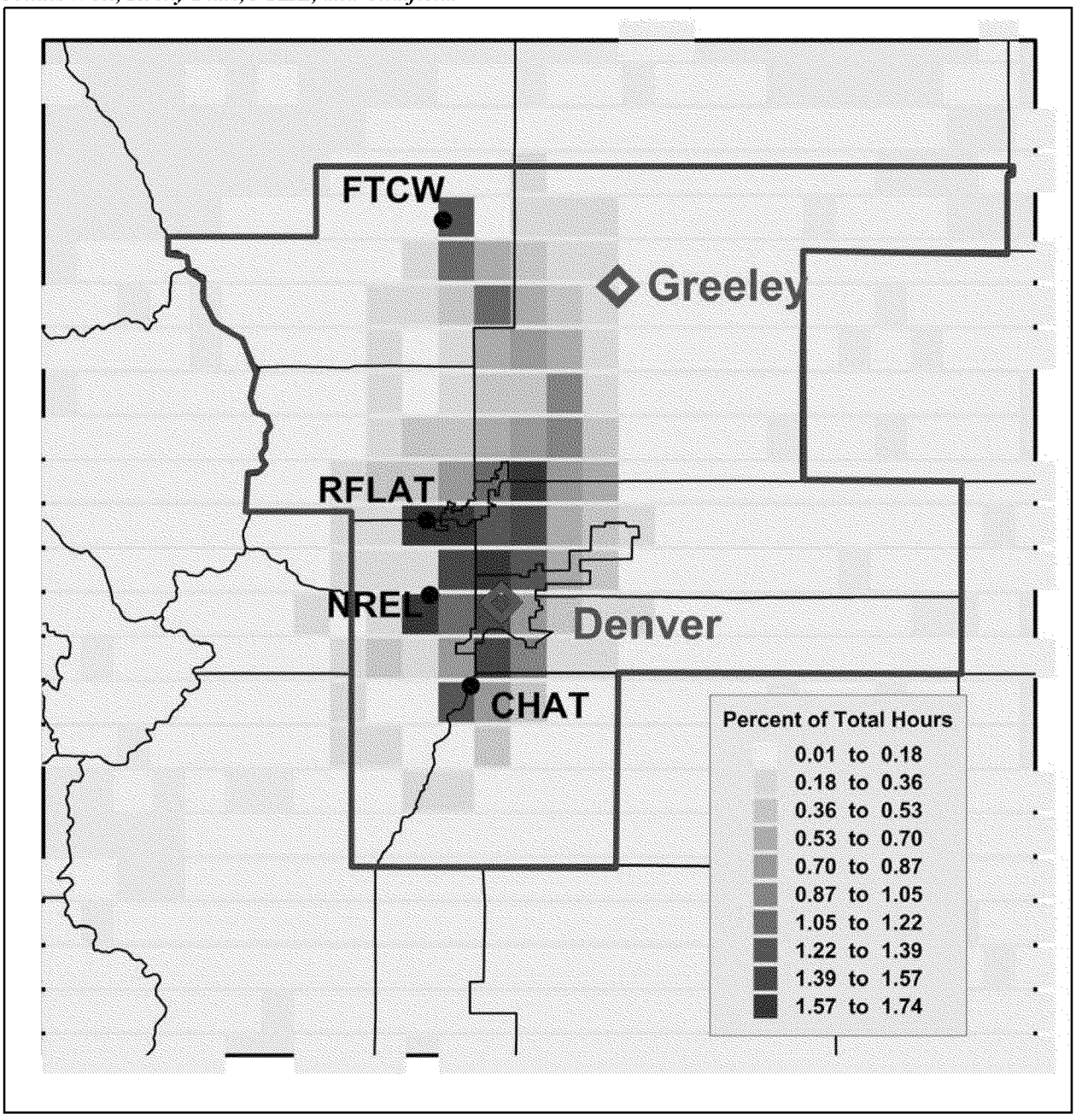


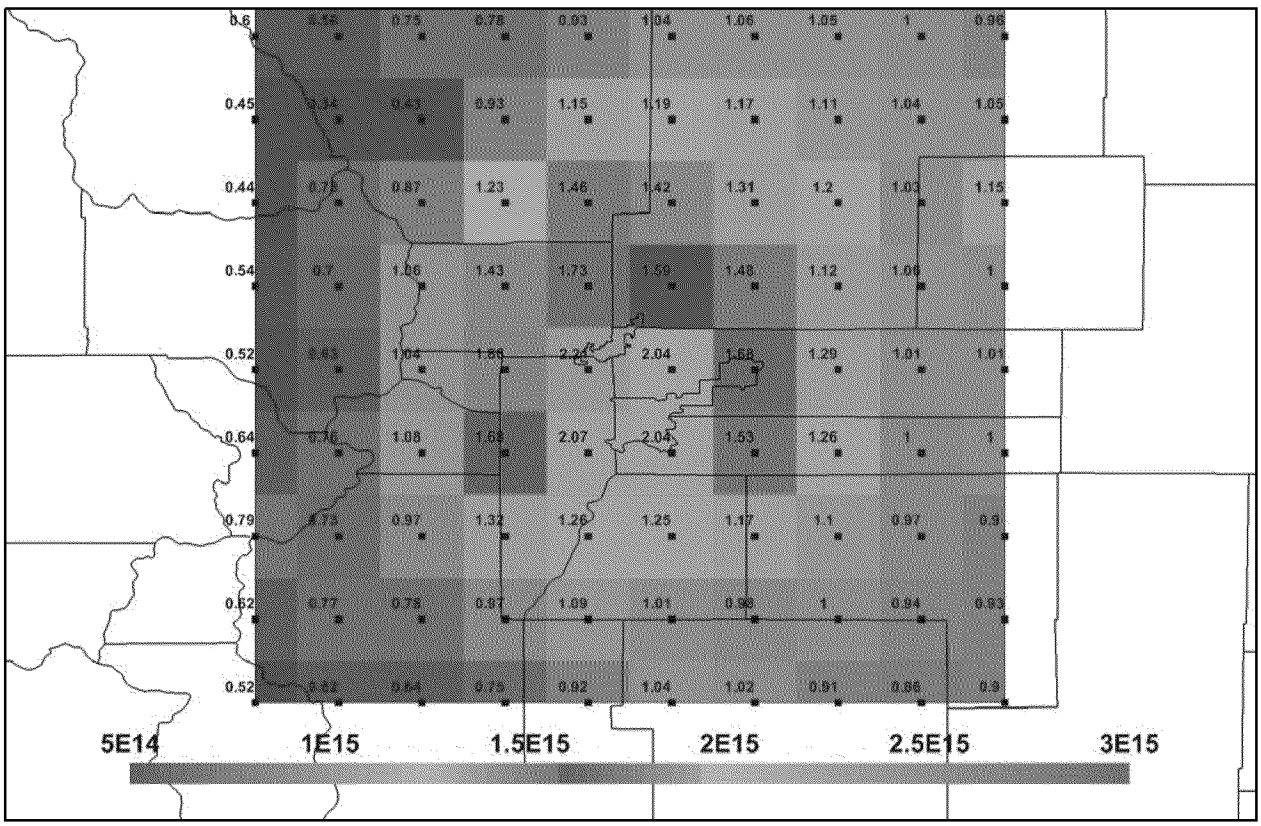
Figure 1-29: HYSPLIT Back-Trajectory for the Four Highest Days for Each Year in 2013 to 2015 for Fort Collins West, Rocky Flats, NREL, and Chatfield.



Tropospheric column NO_2 amounts were acquired from measurements made by the Ozone Monitoring Instrument (OMI) aboard NASA's Aura satellite - Version 003 Level 3 NO_2 data cloud-screened at 30% with a grid resolution of 0.25° by 0.25° based on the NASA algorithm (Bucsela et al., 2013) obtained from the NASA Giovanni website http://giovanni.sci.gsfc.nasa.gov/giovanni/. The mean tropospheric column NO_2 in 10^{15} molecules per square centimeter for June 1 through August 31, 2015, is shown in Figure 1-30. This plot represents conditions at about 13:30 MST each day, and by this time thermally-driven upslope would have shifted NO_2 to the west of the principal urban sources and towards the

foothills. Nevertheless, this data set shows that most of the higher levels of NO_x in the area continue to be within the existing nonattainment area boundaries.

Figure 1-30: Mean OMI Tropospheric Column NO_2 in 10^{15} Molecules per Square Centimeter for Approximately 13:30 MST for June 1 through August 31, 2015.



Meteorology Conclusions

The region's meteorological information indicates that the current 8-hour ozone NAA boundary is appropriate for the recommended ozone NAA. The Division has thoroughly evaluated the region's meteorology over the years and has concluded that the airshed for the region is encompassed by the current 8-hour NAA. Upslope flow from the lower elevation regions through the urbanized and industrialized regions of the air shed dominates on high ozone days. If meteorological information indicates that additional counties or regions should be included in the nonattainment area, the existing nonattainment boundary will be revaluated and expanded as necessary.

Meteorology References

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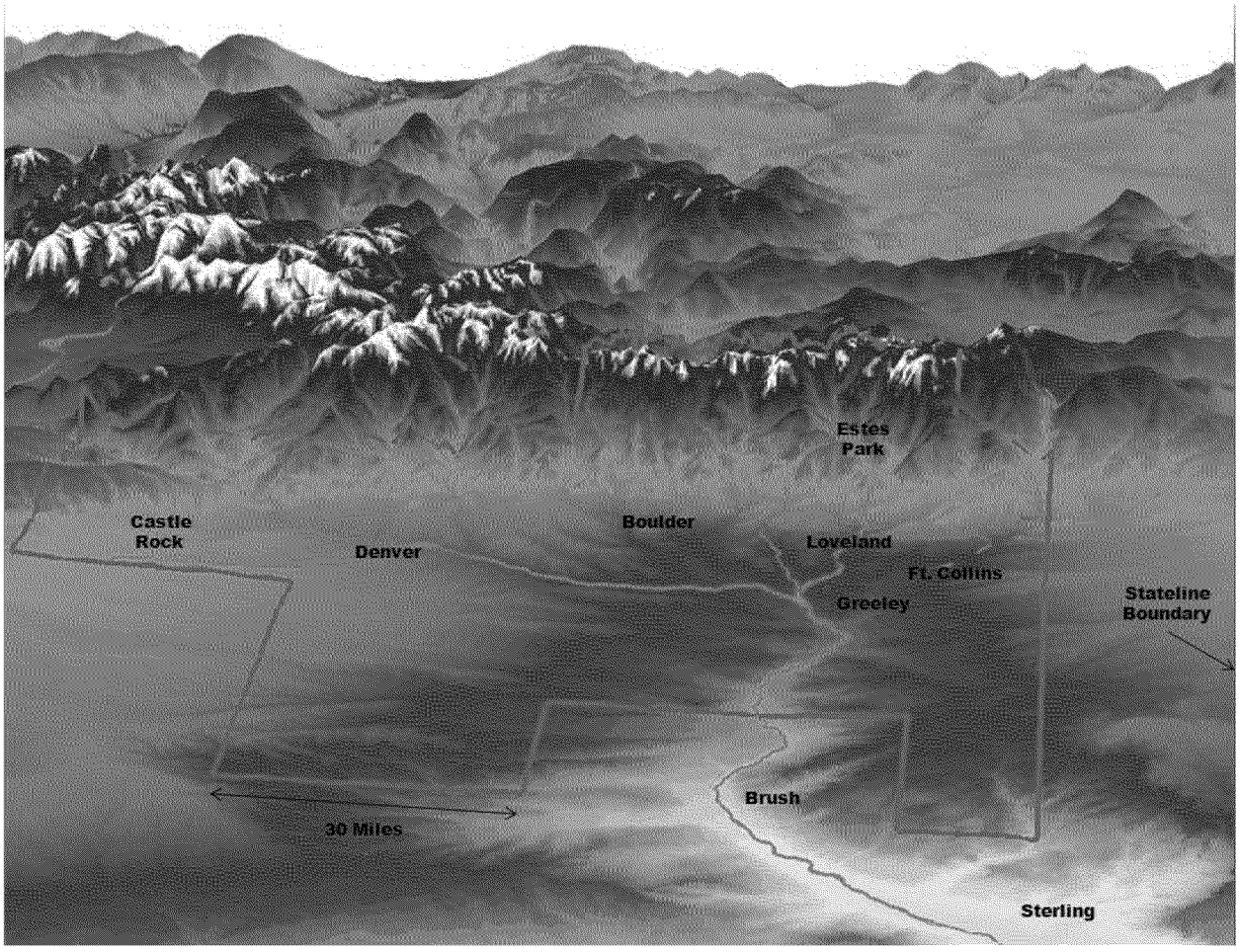
Factor #4: Geography/Topography

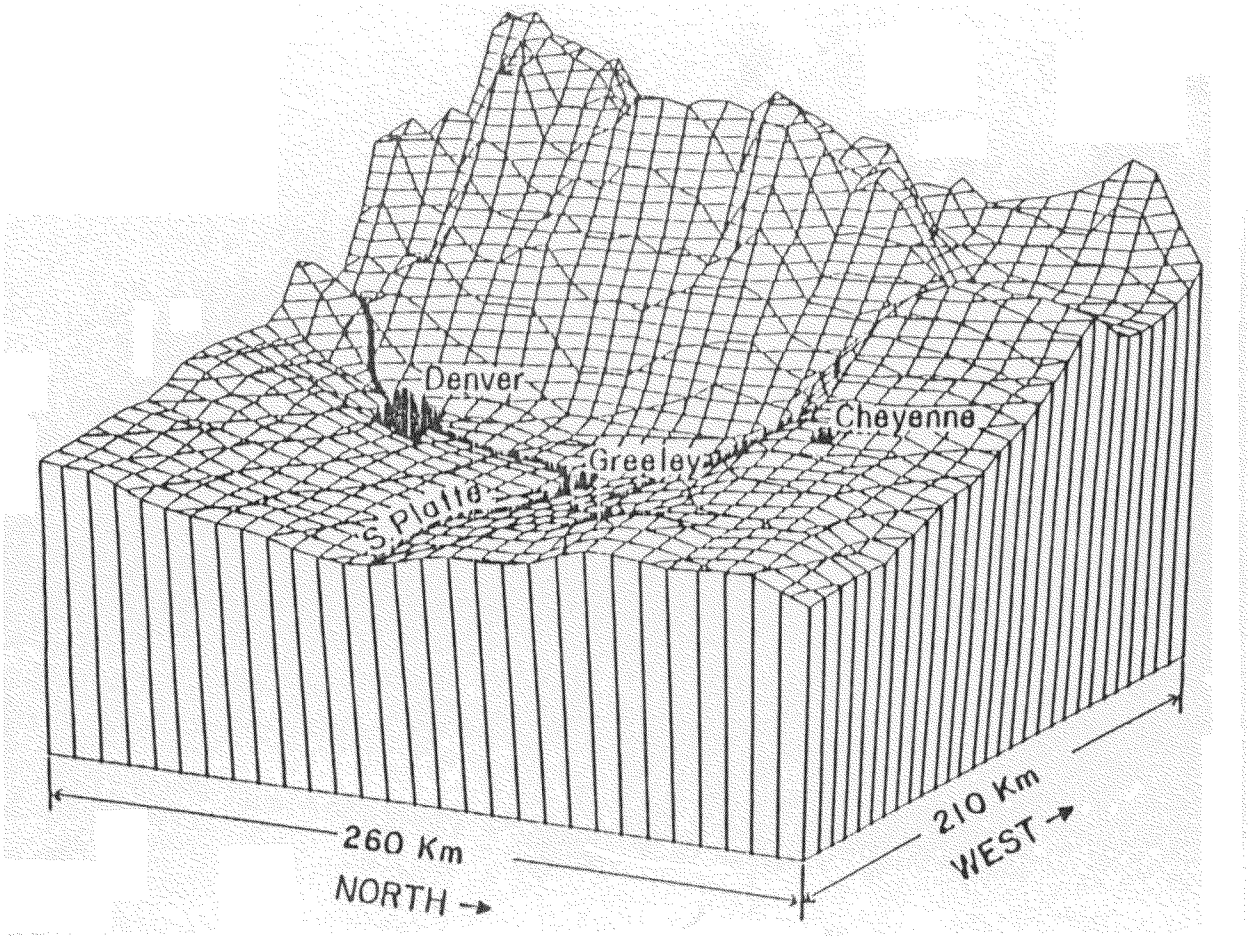
An illustration of the topography of the Denver basin is shown below.

Figure 1-31: Topographic Illustration of Physical Barriers that define the Denver Basin



With the Rocky Mountains to the west, the Palmer Divide to the south, the Cheyenne Ridge to the north, and following the S. Platte River valley to the northeast, the area is commonly referred to as the Denver Basin and serves as the topographic and climatological airshed for the region. The region's geography and topographic features supports the recommended nonattainment designation for the current 8-hour ozone nonattainment area. The following topographic map illustrates the physical barriers that define the Denver Basin.

Figure 1-32: Topographic illustration of physical barriers that define the Denver Basin



Elevation and Ozone Concentrations

Decades of weekly ozonesondes in Boulder, recent aircraft profiles of ozone over the Front Range, and research in other places in the United States -show that ozone concentrations in the boundary layer often increase with altitude above ground. One of the main reasons is that ozone near the ground is diminished by reactions with nitric oxide emitted near the surface by mobile and point sources. Ozone at ground level is also reduced to some extent by oxidation reactions with vegetation and other materials on the surface. Ozone near the top of the boundary layer may also be elevated because of complex re-circulation effects, residual layer processes, and prolonged residence times that allow for an accumulation of ozone aloft.

High ozone concentrations are possible in the higher terrain of the Front Range. It is known that individual concentrations in excess of the new standard have been measured at NOAA's Niwot Ridge Tundra monitor at 11,500 feet in Boulder County (located in the existing 8-hour ozone non-attainment area) and a short-term exploratory monitor operated by the United States Forest Service (USFS) for several seasons at Kenosha Pass in Park County. The Niwot Ridge Tundra site uses an "equivalent" analyzer, but to our knowledge the NOAA air monitoring does not meet the QA/QA requirements as set forth in 40CFR58, Appendix A. At Kenosha Pass, the USFS used the 2B-Tech analyzer. This monitor is not designated as a "reference" or "equivalent"

analyzer as set forth in 40CFR53, and the monitoring effort did not meet the QA/QA requirements as set forth in 40CFR58, Appendix A. Presently, there is no federal reference method data that show that ozone concentrations are in violation of the standard in Clear Creek, Gilpin, or Park Counties

In response to the possibility of elevated ozone in the higher elevations or the Front Range foothills, where public exposure to elevated ozone is of particular concern, the Division added two ozone monitors, one located at Aspen Park (elevation 8,095 feet - near Conifer) and the other in Rist Canyon (elevation 6,750 feet - west of Fort Collins). Both monitors began operation in 2009 and the Rist Canyon monitor ceased operation in 2013 when it fulfilled its monitoring objectives. The Aspen Park monitor is currently showing attainment with the revised standard.

In addition to the long-term federal reference method ozone monitor located near Longs Peak at an elevation of about 9,000 feet in Rocky Mountain National Park, the Division began operation of a non-federal reference monitor at Mines Peak in 2014. The Mines Peak ozone monitor is located above Berthoud Pass at an elevation over 12,400 feet, which has an average 4th maximum ozone concentration around 69 ppb.

While it is certainly possible that high concentrations may occur at high altitudes in these Clear Creek, Gilpin, or Park Counties, it is important to note that the primary source for this ozone is most likely the urbanized area of the plains to the east. Anthropogenic emissions from these mountain areas are expected to have an insignificant contribution to ozone in the nonattainment area.

Geography/Topography Conclusion

The region's east-facing open bowl topography indicates that the current 8-hour ozone nonattainment boundary is appropriate for the recommended ozone nonattainment area. If future refined modeling indicates that additional counties or regions should be included in the nonattainment area, the existing nonattainment boundary will be revaluated and expanded as necessary.

Factor #5: Jurisdictional Boundaries

Regional Air Quality Council

The Regional Air Quality Council (RAQC) is designated as the lead air quality planning agency for the Denver metropolitan area and the DM/NFR ozone nonattainment area. In this capacity, the mission of the RAQC is to develop effective and cost efficient air quality initiatives with input from state and local government, the private sector, stakeholder groups, and private citizens. The RAQC's primary task is to prepare state implementation plans (SIPs) for compliance with federal air quality standards. The RAQC consists of a 24 member board appointed by the Governor. Since July 2007, the RAQC has been directed by the Governor to develop effective plans (SIPs) to reduce ozone in the DM/NFR Area as well as to propose measures to further reduce ozone concentrations.

North Front Range Transportation and Air Quality Planning Council

The North Front Range Transportation and Air Quality Planning Council is designated by the Governor as the lead air quality planning organization for the North Front Range region. It is a nonprofit, public organization of 15 local and county governments in Larimer and Weld counties and is funded through federal and state grants, and local funds. The goal of the council is to enhance air quality and mobility among northern Colorado communities and between the North Front Range and the Denver Metro area by developing cooperative working relationships and financial partnerships among its member governments, the Colorado Department of Transportation (CDOT), Federal Highway Administration (FHA), the Federal Transit Administration (FTA), and the private sector. The council is responsible for proposing air quality measures affecting the North Front Range and performing conformity determinations to ensure its transportation plans and programs comply with the state implementation plan.

Colorado Air Quality Control Commission

The Colorado Air Quality Control Commission (AQCC) is the regulatory body with responsibility for adopting air quality regulations consistent with state statute including the responsibility and the authority to adopt state implementation plans (SIPs) and implementing regulations. The AQCC takes action on SIPs and regulations through a public rulemaking process. The AQCC has nine members who are appointed by the Governor and confirmed by the State Senate.

Level of Control of Emission Sources

The current recommended nonattainment area has been subject to numerous and aggressive emission control programs. Some of these programs are listed below:

Stationary Source Emission Controls:

- Oil and gas controls
  - 90% emission reduction from existing condensate tanks
  - 95% control efficiency for new and modified condensate tanks
  - Low-bleed pneumatics only
  - 95% control efficiency for air pollution control equipment
  - Leak detection and repair program
  - Flash separator or flash tank on glycol natural gas dehydrator reduce VOC's by 90%
  - Auto-igniters required on combustion devices for VOC control
- Stationary source controls for VOCs and NOx in Regulations 3, 6, 7 and 8
- Paint shops, solvent usage, industrial process changes
- Colorado Clean Air Clean Jobs Act
- Regional Haze SIP provisions – contained in regulation No. 3

Mobile Source Emission Controls:

- Federal diesel fuel standards
- 7.8 reid vapor pressure with 1 PSI Ethanol Waiver (8.8 RVP)
- Stage I vapor recovery
- Tier II Low Sulfur Gasoline
    - 30ppm average/80ppm max
        - Statewide/Year Round
        - Phased-in from 2004
- Enhanced I/M throughout the region
- Federal tailpipe standards – TIER II
- Ozone transportation conformity
- Diesel school bus retrofits
- Federal alternative fuels programs
- Federal/state tax credits for hybrids/alternative fuels use
- Federal on-road and non-road mobile source standards and regulations
- Non-Road Engines, Vehicles, Equipment
    - Large Non–Road Diesel Engine Rule – Tier 4 (Phased–In Model Years (MY) 2008–2015)
    - Locomotive Engine Rule (MY 2015+)
    - Federal Non–Road Spark–Ignition Engines and Equipment (Phased–In MY 2008–2016)
    - Recreational Spark–Ignition (SI) Engine Standards (Phased–In MY 2008+)
- On-Road Engines and Vehicles
    - Tier 2 Standards for Light–Duty and some Medium–Duty Vehicles (Phased–In MY 2004– 2009)
    - Tier 3 Standards for Light–Duty and some Medium–Duty Vehicles (Phased–In MY 2017– 2025)
    - Heavy–Duty Engine and Vehicle Standards (Phased–In MY 2007+)
    - Light–Duty Vehicle Greenhouse Gas Rule (Phase 1 (Phased–In MY 2012–2016); Phase 2 – (Phased–In MY 2017–2025))
    - Medium and Heavy–Duty Vehicle Greenhouse Gas Rules (Phase 1 (Phased–In MY 2014– 2018))
- Fuels
    - Tier 3 Fuel Standards (Effective 2017 for large refineries, 2020 for small refineries)
    - Renewable Fuel Standard Program (RFS2) (Effective 2015)
    - Control of Hazardous Air Pollutants From Mobile Sources (Effective 2007)
    - Ultra–Low–Sulfur Diesel (ULSD) (Effective 2006)

<u>Area Source Emission Controls:</u>

- Architectural/traffic/industrial and consumer products standards
- Prescribed burning limits
- Low emission gasoline cans

Education/Outreach:

An extensive media-advertising program to raise public awareness about ozone solutions has been implemented - emphasis on motor vehicle solutions

- High ozone forecasting
- Paid advertising
- Media and education outreach
- Lawn mower exchange
- Gas can exchange
- Car care clinics
- Gas cap checks for municipal fleets
- Pre- and post-study surveys to determine effectiveness of the outreach and education efforts in affecting behavior change
- Outreach, awareness and education
- Rideshare/transit programs
- Local voluntary programs to reduce VMT
- Repair your air program - local high emitter identification/repair program
- Repair Your Air Campaign aggressively utilizes available "cash-for-clunkers" monies

Summary Conclusions for DM/NR 8-hour Nonattainment Area

The data and analysis presented in the five factors provide documentation and compelling evidence supporting a finding of nonattainment and for maintaining the current nonattainment area for the revised 8-hour ozone area.

SECTION 2

Rangely Area of Rio Blanco County

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SECTION 2: Rangely Area of Rio Blanco County – Five Factor Analysis for Ozone Attainment

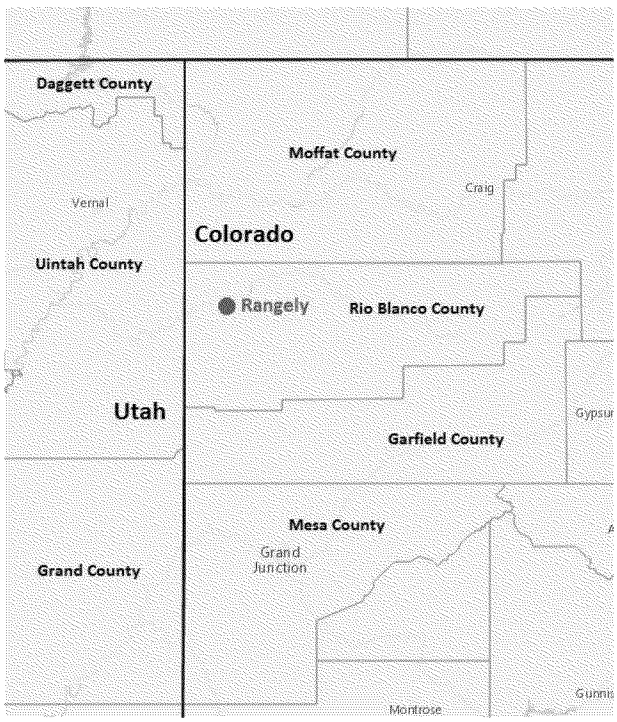
Designation Recommendation

The State recommends designating the Rangely area of Rio Blanco County as attainment/unclassifiable for the 2015 revised 8-hour ozone standard (0.070 ppm). The three-year average of the 4th maximum 8-hour ozone concentration over the period of 2013 - 2015 at the Rangely monitor (operated by the Bureau of Land Management) is in violation of the revised 8-hour ozone standard; however, the State is recommending an attainment/unclassifiable designation based on the following technical review using a five-factor analysis.

Rangely Area Overview

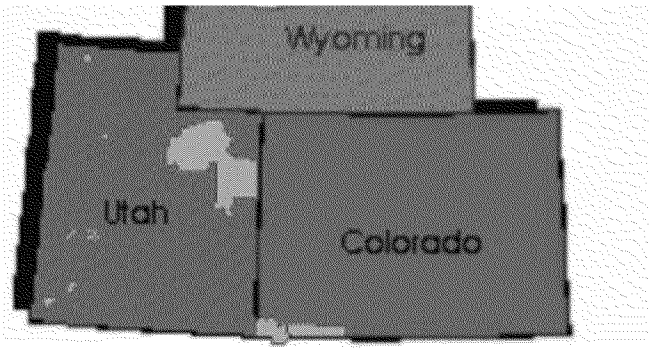
The town of Rangely is located in northwest Colorado in western Rio Blanco County, see Figure 2-1. Rangely is approximately 13 miles from the Utah border and Uintah County. Rio Blanco County is rural and sparsely populated.

Figure 2-1: Rangely Location



The Ute Indian Tribe of the Uintah and Ouray Reservation is located to the west in Uintah County on the border with Rio Blanco County, as shown in Figure 2-2. EPA Region 8 has full air quality management authority over the tribal lands in this area.

Figure 2-2: Utah/Colorado Tribal Lands Map



The Piceance and Uinta geologic basins lie beneath southwest Colorado, including the Rangely area, and northeast Utah as shown in Figure 2-3. These basins are the source of commercial oil and gas production.

Figure 2-3: Uinta/Piceance Basin Map

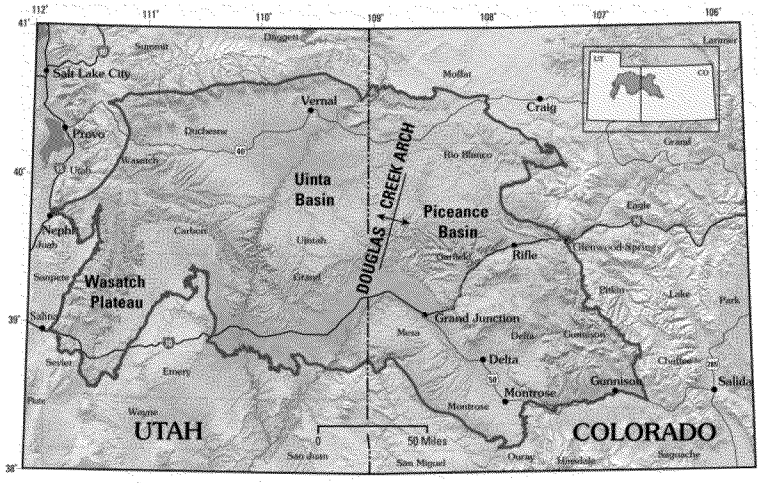


Figure 1. Digital elevation model showing the location and topography of the Uinta-Piceance Province (red line).

Current maps of the oil and gas wells in the Piceance and Uinta Basins are shown below in Figures 2-4 and 2-5. A 2012/2013 map showing both the Uinta and Piceance oil and gas well locations is shown in Figure 2-6. The Utah Department of Environmental Quality (DEQ) estimates that about 70% of the oil and gas production in the Uinta Basin takes place in tribal lands.

Figure 2-4: Colorado Piceance Basin Well Location Map

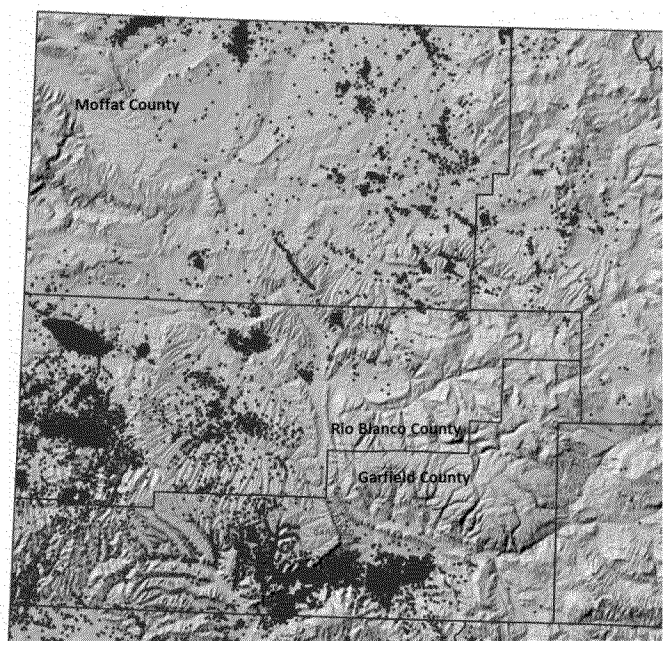


Figure 2-5: Utah Uinta Basin Well Location Map

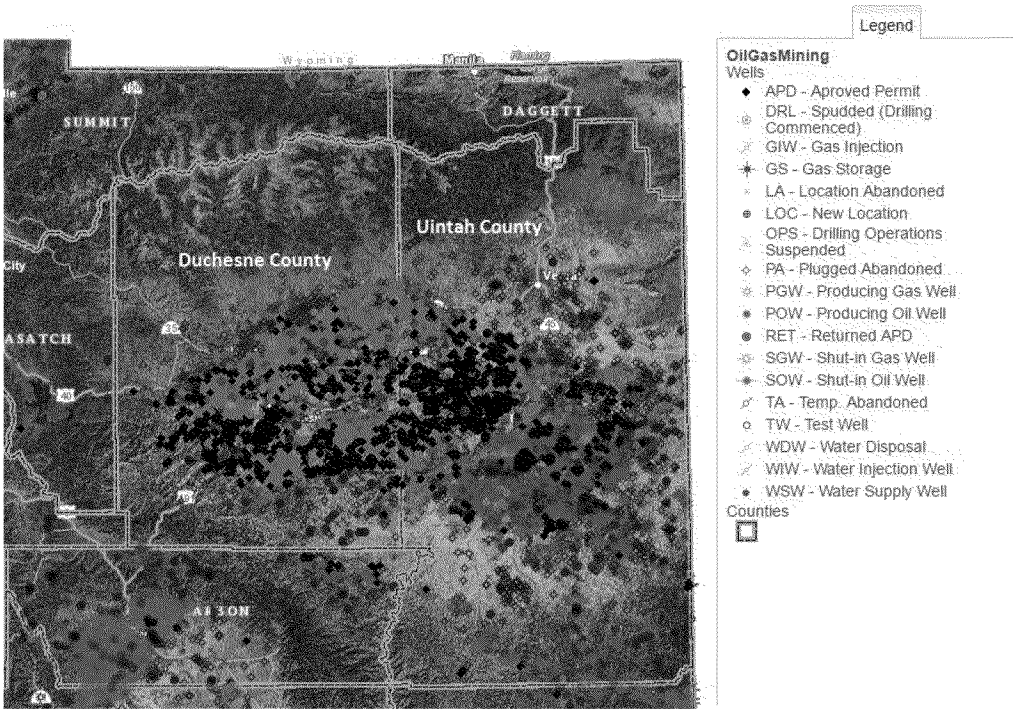
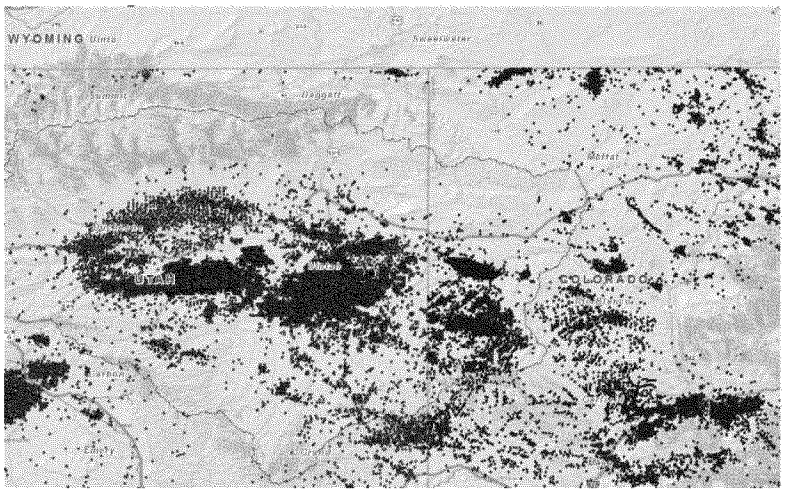


Figure 2-6: Piceance/Uinta Basins Well Location Map



Factor #1: Air Quality Data

The Rangely area of Rio Blanco County is part of Air Quality Control Region (AQCR) 11. AQCR 11 is made up of Garfield, Mesa, Moffat and Rio Blanco counties. There are currently 8 ozone monitors operating in AQCR 11 (Lay Peak was discontinued at the end of 2014 due to the site meeting its monitoring objectives). There are also numerous ozone monitors in the Uinta Basin that were examined in this technical analysis. A map of the monitoring stations in this area is shown in Figure 2-7. For the monitoring locations shown in Figure 2-7, 2013-2015 monitoring data is summarized in Table 2-1 (the monitors currently in violation of the revised 2015 standard are highlighted in red) and historic monitoring data is shown in Figures 2-8 and 2-9.

Figure 2-7: Ozone Monitoring Sites for AQCR 11 and Utah

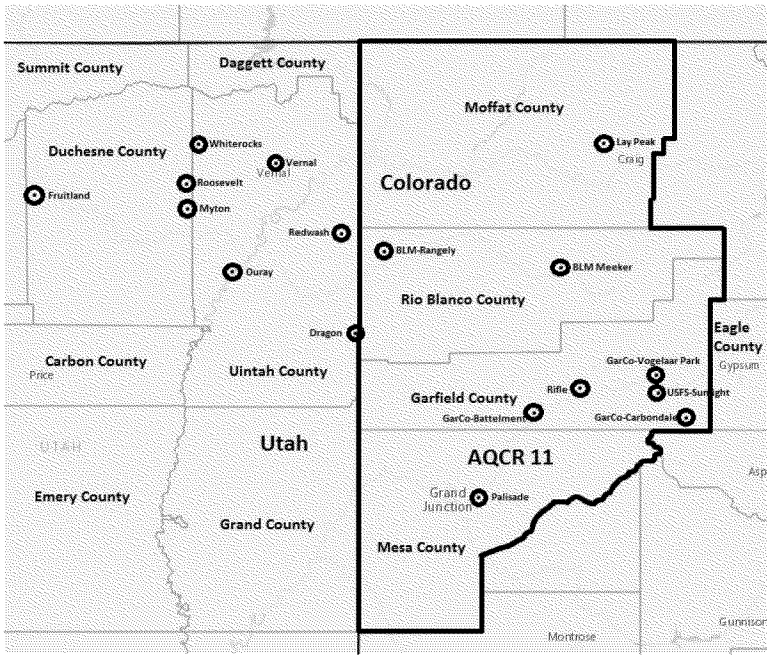


Table 2-1: Ozone Monitoring Data for AQCR 11

AQCR 11 Sites 4th Maximum 8-Hour Ozone Values and 3-Year Averages					
Site Name	AQS#	Year			3-Year Average
		2013	2014	2015	
CDPHE-APCD Sites					
Rifle	08-045-0012	0.062	0.061	0.068	0.063
Palisade	08-077-0020	0.066	0.062	0.065	0.064
Lay Peak	08-081-0002	0.065	0.062	-	-
Other Agency Sites					
USFS-Sunlight Mtn	08-045-0016	-	0.055	-	-
GarCo-Battlement	08-045-0019	0.069	0.061	-	-
GarCo-Vogelaar Park	08-045-0020	-	-	0.064	0.000
GarCo-Carbondale	08-045-0021	0.058	0.059	0.066	0.061
BLM-Meeker	08-103-0005	0.064	0.062	0.064	0.063
BLM-Rangely	08-103-0006	0.091	0.062	0.066	0.073
Uinta Basin					
Roosevelt, Utah	49-013-0002	0.104	0.062	0.060	0.075
Fruitland, Utah	49-013-1001	0.069	-	-	-
U&O Myton, Utah	49-013-7011	0.108	0.067	0.066	0.080
Vernal, Utah	49-047-1003	0.102	0.062	0.064	0.076
Redwash, Utah	49-047-2002	0.112	0.064	0.067	0.081
Ouray, Utah	49-047-2003	0.133	0.079	0.068	0.093
Dragon, Utah	49-047-5632	0.082	-	-	-
U&O Whiterocks, Utah	49-047-7022	0.095	0.064	0.068	0.075

Figure 2-8: AQCR 11- 8-hour (4th Max) Ozone Values

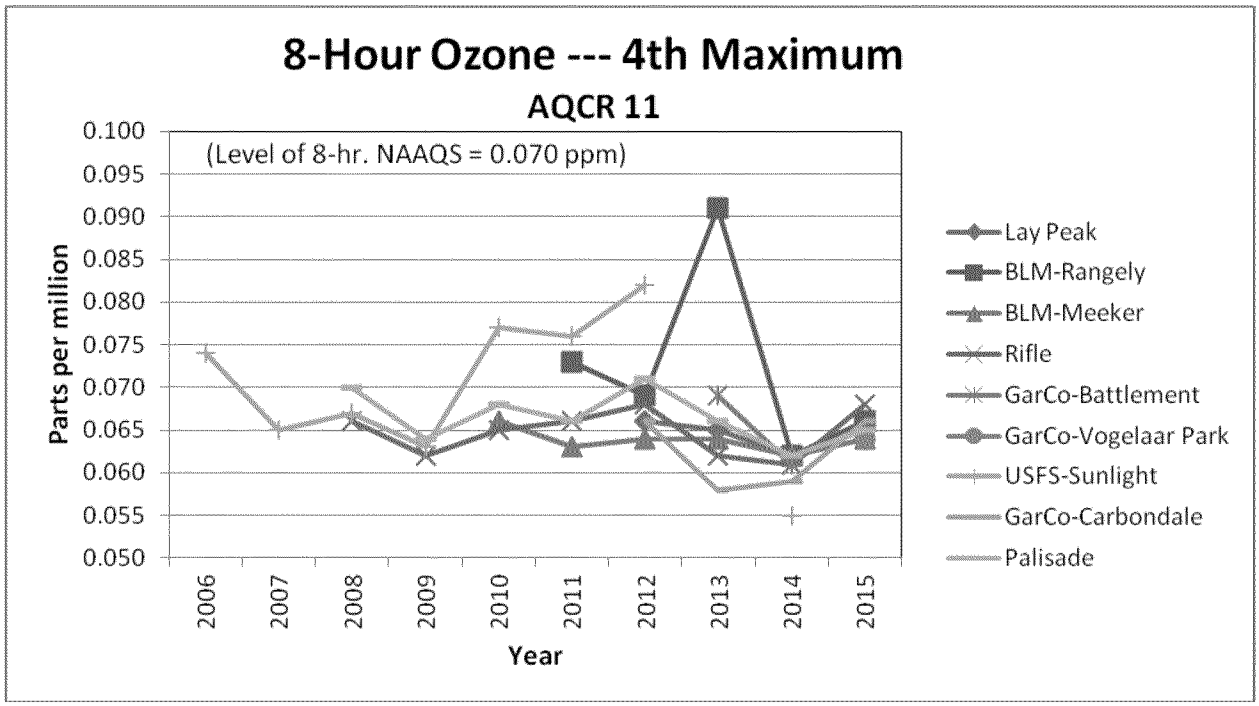
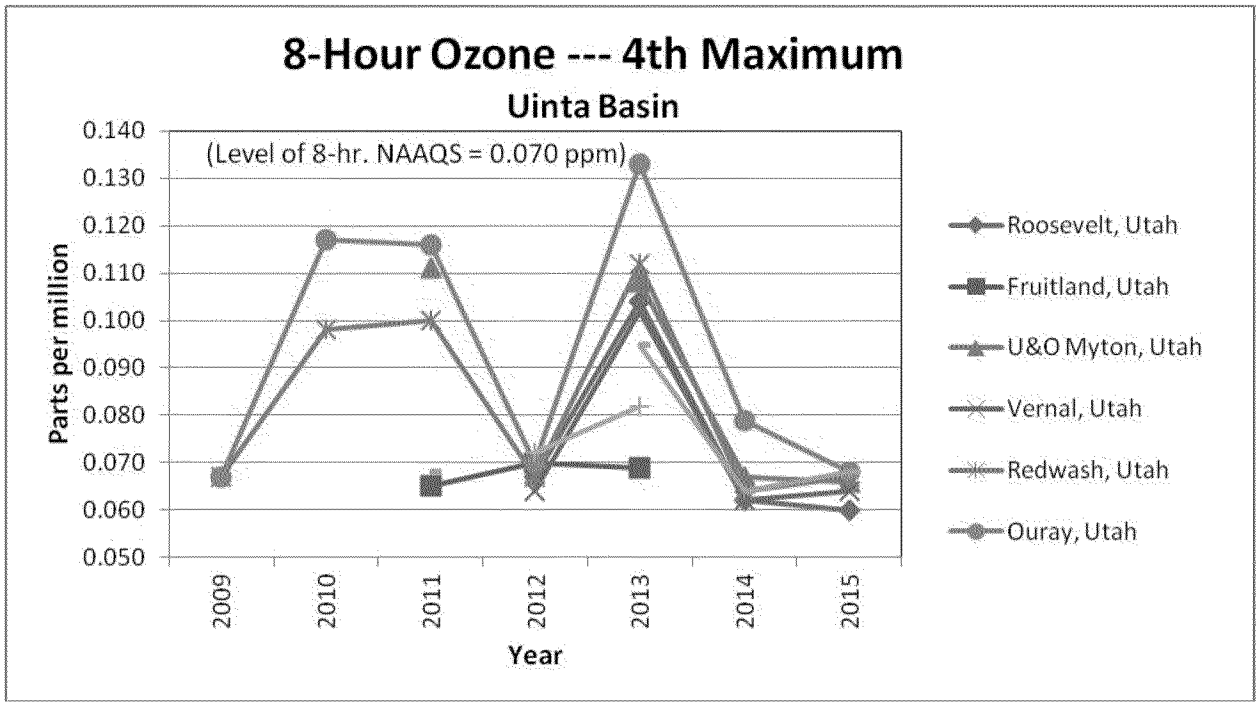


Figure 2-9: Uinta Basin- 8-hour (4th Max) Ozone Values



Air Quality Data Conclusions

As shown in Table 2-1 the three-year average of the 4th maximum 8-hour concentration from 2013-2015 at the BLM Rangely monitor is 0.073 ppm, which is in violation of the revised 8-hour ozone standard. However, the violation of the standard is due to an unusually high value in 2013

(0.091 ppm) that is associated with wintertime ozone formation. This unusually high year is also seen for all monitors in the Uinta Basin, as shown in Figure 2-9. Since 2013 ozone levels were very uncharacteristic, and that 2013 data will not be used by the EPA in determining compliance with the standard, the State recommends the area be designated as attainment/unclassifiable.

Factor #2: Emissions and Emissions-Related Data

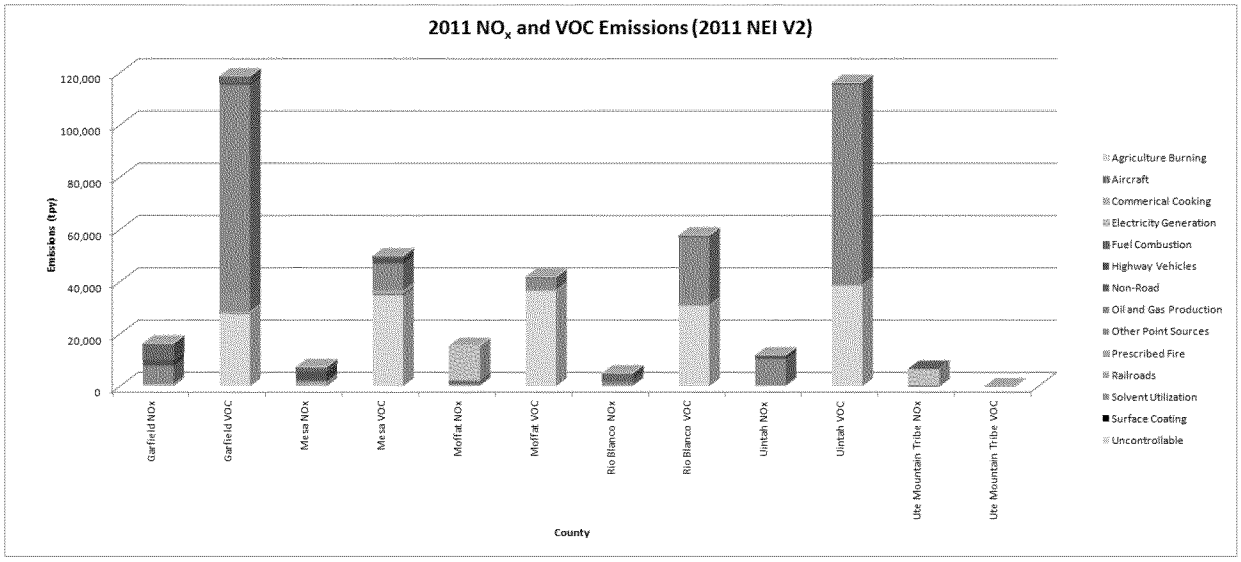
Table 2-2 includes the 2011 emissions for NO_x and VOC emissions for 16 source categories for AQCR 11 and Uintah County along with emissions from the Ute Mountain Ute Tribe of the Ute Mountain Reservation (includes Ute Indian Tribe of the Uintah and Ouray Reservation, Southern Ute Tribe and Ute Mountain Ute Tribe). The emission sources are categorized into controllable and uncontrollable emissions. Biogenic, agricultural livestock waste and wildfire emissions comprise the uncontrolled emission sources.

Table 2-2: 2011 Ozone Precursor Emissions Data for AQCR 11 and Surrounding Areas

Category	Garfield		Mesa		Moffat		Rio Blanco		Uintah		Ute Mountain Tribe	
	NO_x (tpy)	VOC (tpy)	NO_x (tpy)	VOC (tpy)	NO_x (tpy)	VOC (tpy)	NO_x (tpy)	VOC (tpy)	NO_x (tpy)	VOC (tpy)	NO_x (tpy)	VOC (tpy)
Agriculture Burning	0	0	1	2	4	9	1	3	7	17	0	0
Aircraft	1	2	33	14	0	0	2	4	1	4	0	0
Commercial Cooking	0	4	0	6	0	1	0	0	0	1	0	0
Electricity Generating Units	47	18	62	1	13,557	65	1	2	0	0	6,590	46
Prescribed Fire	23	393	32	585	3	26	4	66	0	3	0	0
Fuel Combustion	6,081	2,283	1,479	707	687	155	2,987	488	67	46	0	0
Highway Vehicles	2,258	847	3,241	1,724	338	203	174	103	1,275	463	0	0
Non-Road	327	322	561	670	135	183	170	318	191	286	0	0
Oil and Gas Production	6,762	79,607	639	9,142	332	3,577	1,434	23,432	10,033	76,502	0	0
Other Point Sources	96	7,162	100	1,222	122	1,085	19	2,489	14	167	0	0
Railroads	518	26	864	50	112	6	0	0	0	0	0	0
Solvent Utilization	0	314	0	821	0	82	0	40	0	310	0	0
Surface Coating	6	21	27	89	0	4	18	2	0	28	0	0
Total- Controllable	**16,119**	**90,999**	**7,039**	**15,032**	**15,290**	**5,397**	**4,809**	**26,948**	**11,588**	**77,826**	**6,590**	**46**
Biogenics	290	27,634	353	34,591	224	36,306	217	30,849	294	38,181	0	0
Agriculture- Livestock Waste	0	0	0	0	0	0	0	0	0	0	0	0
Wildfires	4	76	20	245	18	220	1	12	15	200	0	0
Total- Uncontrollable	**294**	**27,710**	**373**	**34,836**	**242**	**36,526**	**218**	**30,861**	**309**	**38,381**	**0**	**0**
Total- Controllable + Uncontrollable	**16,413**	**118,709**	**7,412**	**49,868**	**15,532**	**41,923**	**5,027**	**57,809**	**11,897**	**116,207**	**6,590**	**46**

A summary of the above tabular data is provided in the following graph, Figure 2-10.

Figure 2-10: 2011 Ozone Emissions for AQCR 11 and Surrounding Areas



The NO_X and VOC emissions in AQCR 11 and northeast Utah by county and the large and small point sources in northwest Colorado and northeast Utah are shown in Figures 2-11 and 2-12.

Figure 2-11: NW CO and NE Utah NO_x Emissions Map

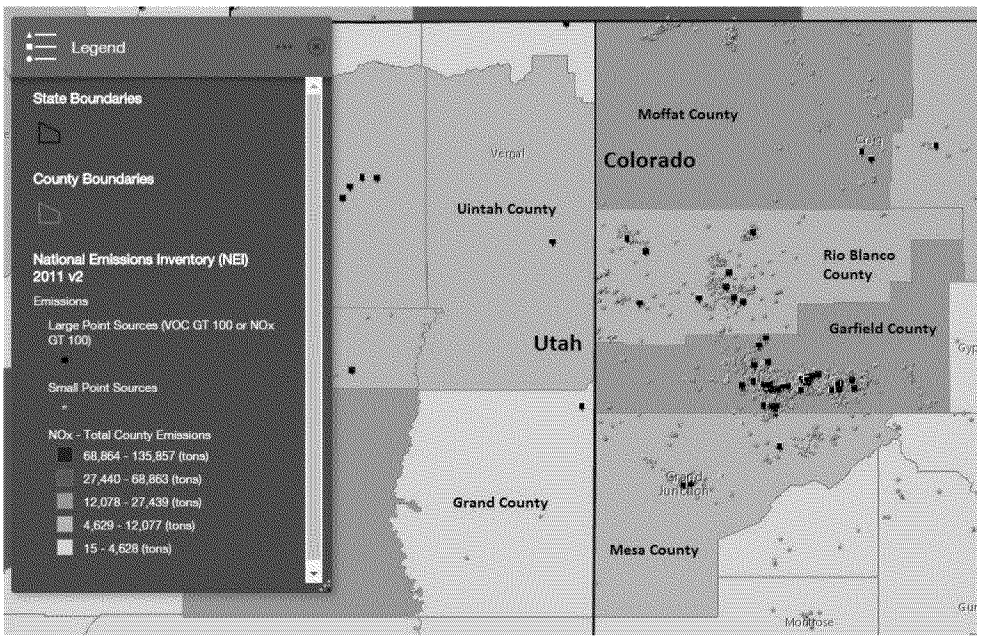
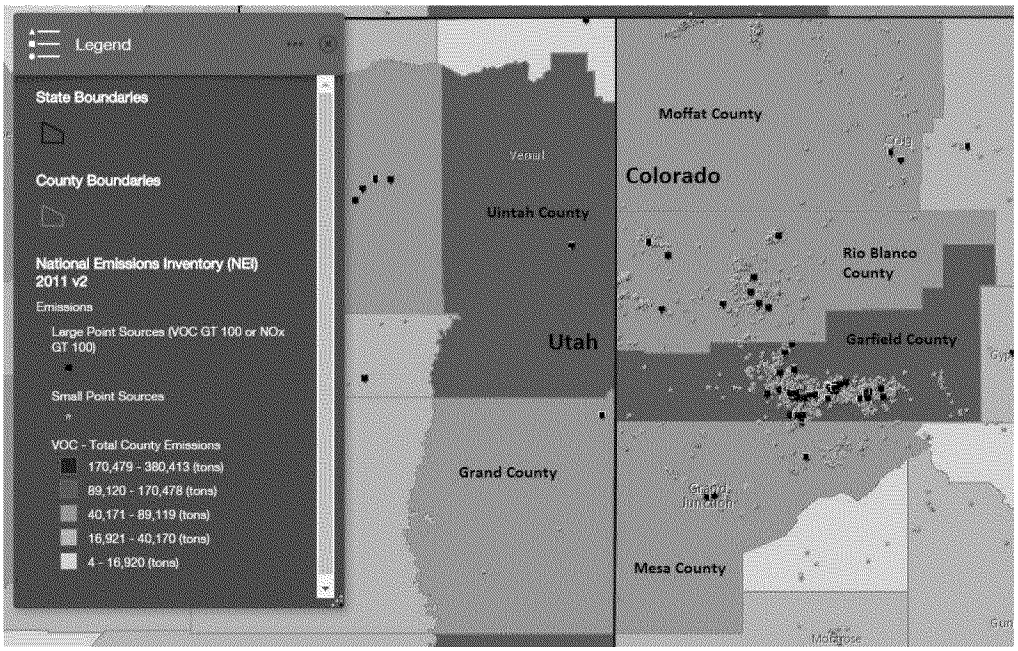


Figure 2-12: NW CO and NE Utah VOC Emissions Map



Emissions Data Conclusions

Based on Figure 2-10, the NO_x and VOC emissions in Rio Blanco County are substantially below other nearby counties, and about half of the total VOC precursor emissions are uncontrollable (biogenic, agricultural livestock and forest fire emissions). Oil and gas sources are a significant contributor to VOC emissions in Rio Blanco County, but are far below Uintah County, where oil and gas VOC emissions are more than double. Colorado's stringent oil and gas regulations in Regulation Number 7 require control VOC emissions from the majority of oil and gas sources.

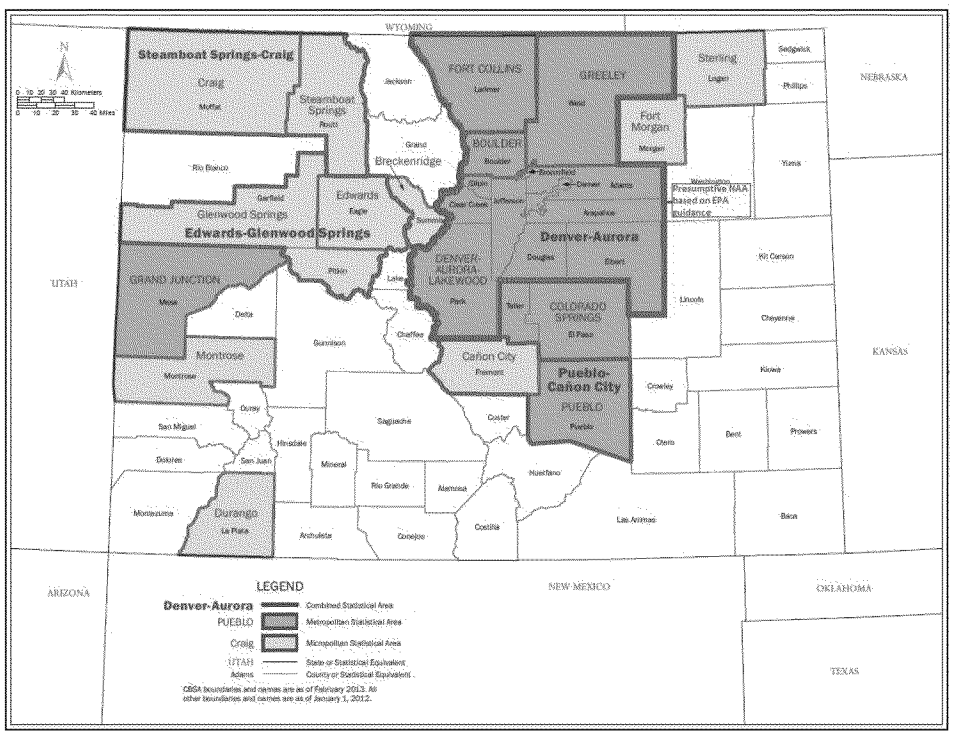
Because anthropogenic emissions in Rio Blanco County and Rangely are low and the State has implemented stringent oil and gas regulations, this supports the State recommending the area be designated as attainment/unclassifiable.

Population Density and Degree of Urbanization

<u>CSA and CBSA Analysis</u>

EPA suggests that because ground-level ozone and ozone precursor emissions are pervasive and readily transported, it is important to examine ozone-contributing emissions across a relatively broad geographic area. Accordingly, EPA states they will consider information associated with counties in Statistical Area (CBSA) or Combined Statistical Area (CSA) associated with a violating monitor(s). See Figure 2-13 for a map of CBSA and CSA areas in Colorado.

Figure 2-13: CBSAs and CSAs and Counties in Colorado



As shown in Figure 2-13, Rio Blanco County is not part of a CSA or CBSA. In the case of a violating monitor not being located in a CSA or CBSA, the EPA states that it will review information associated with the county and other adjacent nearby counties. To comply with this requirement, the State's analysis examines Rio Blanco County, nearby counties in AQCR 11 and Uintah County in Utah.

Population Density

Figure 2-14, below, shows the population density in northwest Colorado and northeast Utah and Table 2-3 summarizes the population.

Figure 2-14: Population Density and Degree of Urbanization of NW Colorado and NE Utah

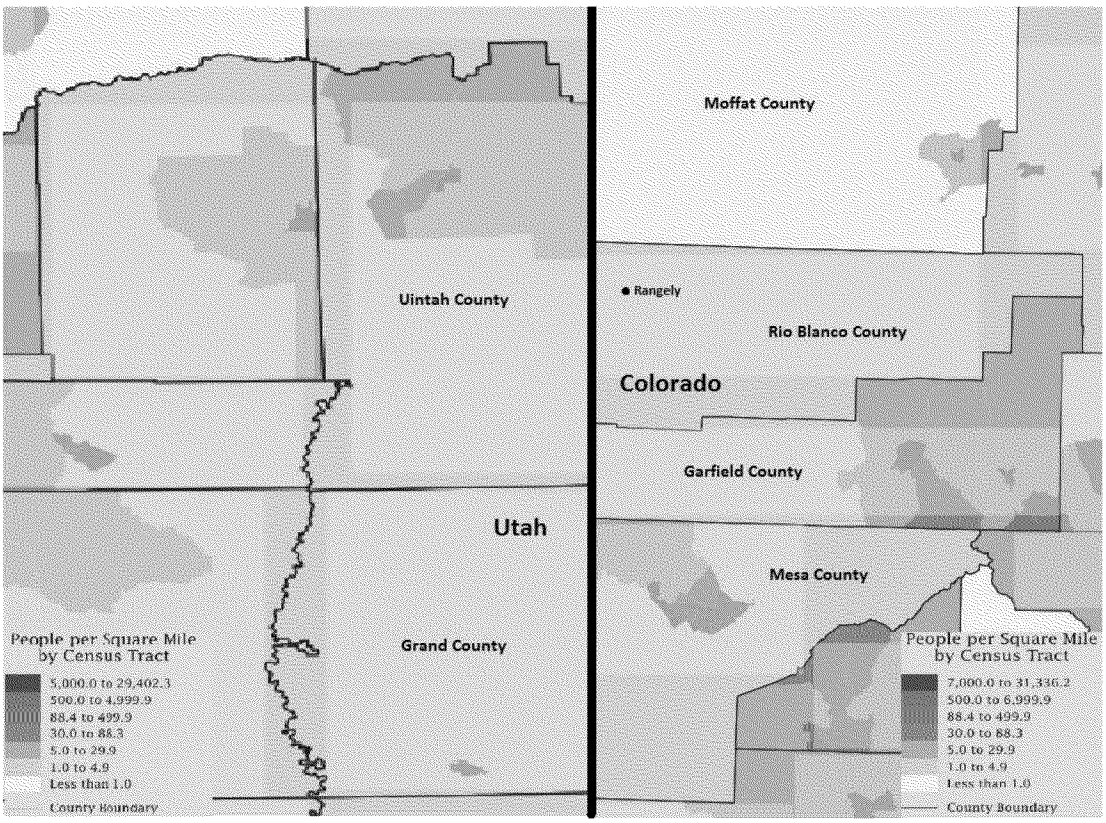


Table 2-3: County-Level Population

County	July 2010 (Estimate)	July 2015 (Estimate)	2010 to 2015 Total % Change	2010 to 2015 Annual % Change
Garfield	56,094	58,095	3.57%	0.71%
Mesa	146,489	148,513	1.38%	0.28%
Moffat	13,812	12,937	-6.34%	-1.27%
Rio Blanco	6,669	6,571	-1.47%	-0.29%
Uintah, UT	32,444	37,928	16.90%	3.38%

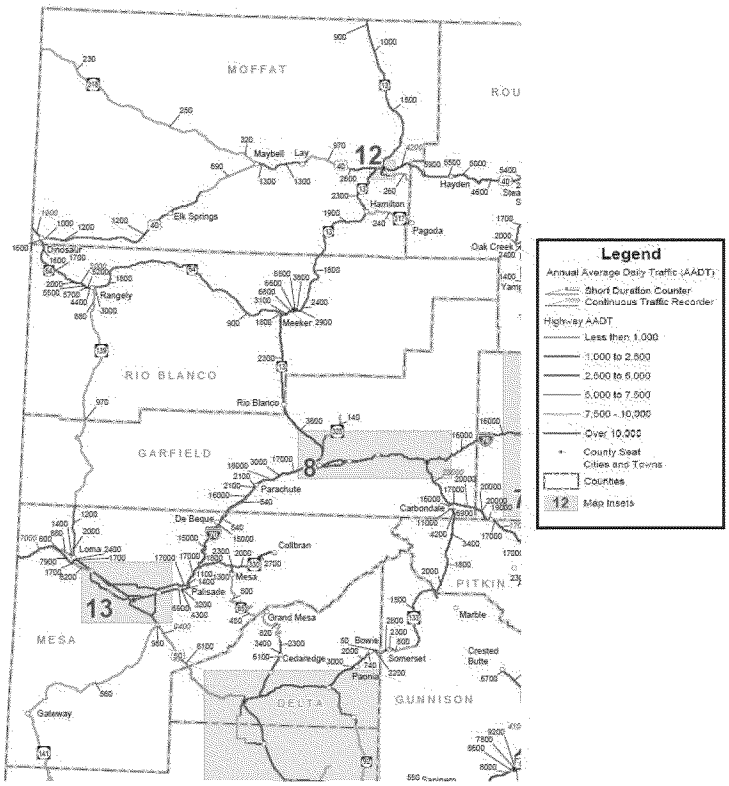
Population Density and Degree of Urbanization Conclusions

As shown in Figure 2-14, the population density in Rio Blanco County is less than 5 people per square mile. Table 2-3 shows the population in Rio Blanco County actually decreased from 2010 to 2015, whereas the population in Uintah County is increasing at a rate of about 3.4% per year. The sparse population density of Rio Blanco County and adjoining counties along with the other components of the 5-factor analysis support the State's recommendation of designating the area as attainment/unclassifiable.

Traffic and Commuting Patterns

The traffic volumes in AQCR 11 are shown below in Figure 2-15.

Figure 2-15: CDOT Traffic Volume in AQCR 11



Traffic and Commuting Patterns Conclusions

Figure 2-15, displays the annual average daily traffic (AADT) volume for northwest Colorado. Generally, the highest traffic volumes in Rio Blanco County occur around the Meeker area but the Rangely area does have a peak AADT volume of 5,700 with the majority of the traffic volumes much lower. Since Rio Blanco County is very rural and far from major employment centers, it seems unlikely that a significant number of residents are commuting daily to neighboring counties. Commuters from other adjoining counties into Rio Blanco County are not expected to be a significant because of sparse population. Consequently, the very low traffic volumes in Rio Blanco County and adjoining counties along with likely insignificant commuter trips further supports the State's recommendation of attainment/unclassifiable for Rio Blanco County and Rangely.

Growth Rates and Patterns

The following two tables present growth rates and patterns for Rio Blanco County and neighboring counties.

Table 2-4: Population Projections for AQCR 11

County	July 2020 (State Estimate)	July 2025 (State Estimate)	July 2030 (State Estimate)	July 2035 (State Estimate)	July 2040 (State Estimate)	July 2045 (State Estimate)	July 2050 (State Estimate)
Garfield	64,080	72,030	80,631	88,974	97,153	105,205	113,249
Mesa	162,034	175,675	189,162	202,261	215,237	227,593	239,618
Moffat	12,987	13,366	13,947	14,403	14,733	15,033	15,325
Rio Blanco	6,688	6,787	6,985	7,185	7,377	7,556	7,724

Table 2-5: Annual Population Percent Change Projections for AQCR 11

County	2020 to 2025 (State Estimate)	2025 to 2030 (State Estimate)	2030 to 2035 (State Estimate)	2035 to 2040 (State Estimate)	2040 to 2045 (State Estimate)	2045 to 2050 (State Estimate)
Garfield	2.5%	2.4%	2.1%	1.8%	1.7%	1.5%
Mesa	1.7%	1.5%	1.4%	1.3%	1.1%	1.1%
Moffat	0.6%	0.9%	0.7%	0.5%	0.4%	0.4%
Rio Blanco	0.3%	0.6%	0.6%	0.5%	0.5%	0.4%

Growth Rates and Patterns Conclusions

Rio Blanco County is projected to have minimal growth through 2050, with the highest increase only being 0.6% in a year. Because the county is not growing at a significant rate, the State's recommendation of an attainment/unclassifiable designation for Rangely and Rio Blanco County is further supported.

Factor #3: Metrological Data

In recent years, ozone concentrations above the 2008 (75 ppb) standard have been observed in the Uinta Basin in northeastern Utah during the winter when snow cover is present within the basin. These exceedances of the standard are associated with a unique combination of conditions including large quantities of oil and gas emissions within the basin, cold temperatures and cold pooling in the basin, light winds, a shallow surface mixed layer of between 50 and 200 meters depth (Ahmadov et al., 2015; Oltmans et al., 2014) and the reflective nature of snow. The snow increases the strength and longevity of the shallow surface inversions and reflects sunlight which increases the radiation available for photochemistry. The winter, cold-pool, photochemistry in the center of the basin is highly VOC sensitive. High ozone concentrations require both the local VOC emissions from oil and gas activities in the basin and the intense and shallow decoupling of surface air, which will always be at a maximum at the core of the basin in Utah.

Figure 5 of the paper by Ahmadov et al., 2015, shows a west-east cross section of the basin with modeled ozone and winds. These reveal a shallow layer of high-concentration ozone of between 50 and 200 meters depth attached to the basin floor and sidewalls and influenced by terrain-mediated winds and vertical mixing. The vast majority of the high-concentration ozone is formed within the Utah portion of the basin. Occasionally, winds and mixing can transport this ozone into extreme western Rio Blanco County which is located within the easternmost corner of the basin. These transport events have caused exceedances of the standard at Rangely, Colorado, which is at an altitude of 5,200 feet (1,585 meters) above sea level compared to 4,700 feet (1,433 meters) for the center of the basin. The elevation difference between Rangely and the center of the basin is about 150 meters. The fourth maximum 8-hour ozone concentrations at Rangely

have been 73, 69, 91, 62, and 66 ppb for 2011 through 2015, respectively. High concentrations in 2013 were associated with winter cold pool events within the Uinta Basin.

Figure 2-16 shows the terrain of the basin and area daily maximum 8-hour ozone concentrations for February 14, 2011, a cold pool ozone event day. The highest concentrations are clearly located at the center of the basin at 106 to 146 ppb. Peak ozone drops to 88 ppb at Rangely and 54 ppb at Meeker which is outside the basin.

Figure 2-16: Daily max 8-hour ozone Contours in ppb and Site Concentrations in and Near the Uinta Basin on February 14, 2011

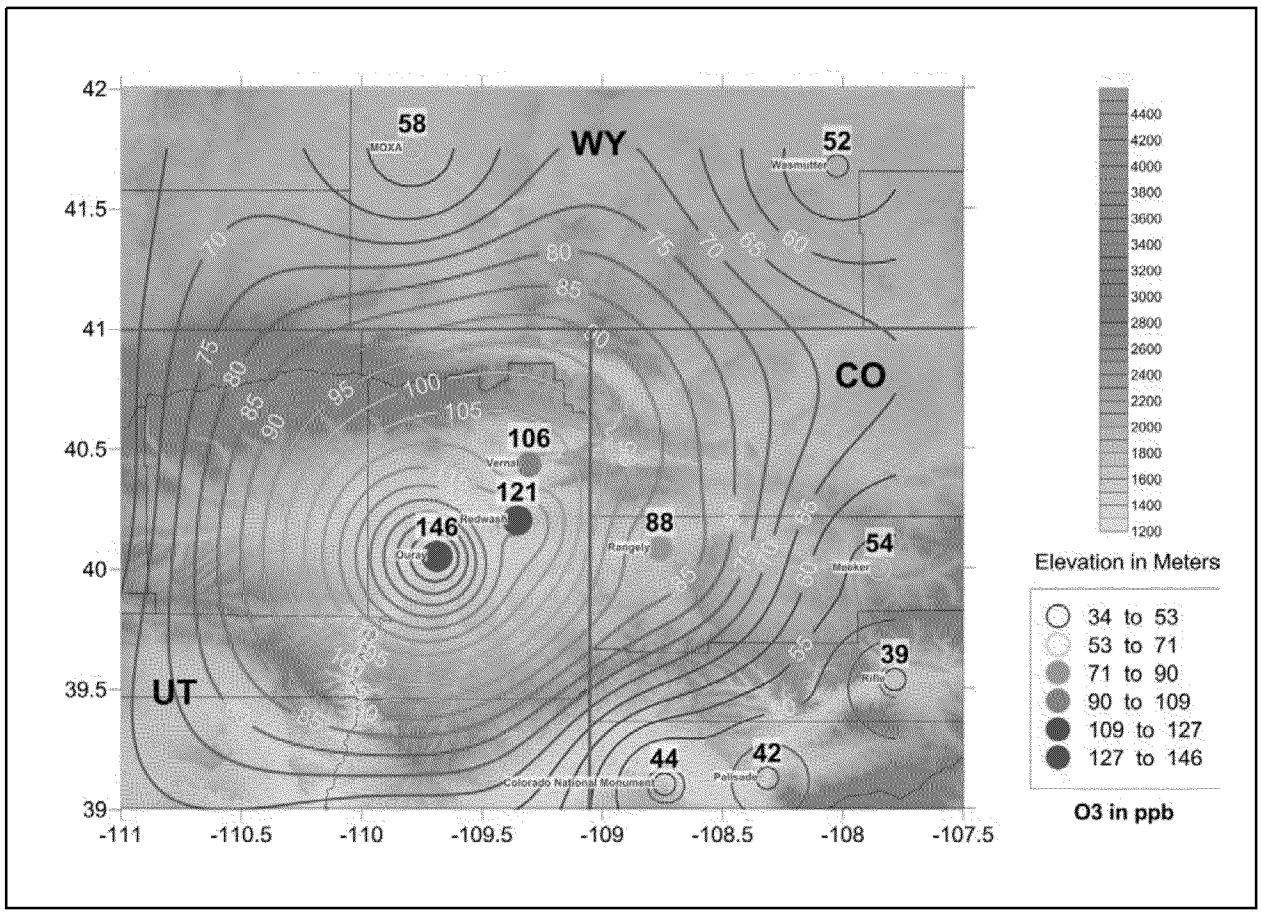


Figure 2-17 shows the hourly ozone concentrations from February 3 through 16, 2011, for select sites in and near the Uinta Basin, and these show that the highest concentrations were at sites within or closer to the core of the basin. Redwash and Ouray are in the center of the basin, and Dinosaur National Monument is closer to the edge of the basin. Meeker is outside of the basin and located to the east.

Figure 2-17: Hourly Ozone Concentrations in ppb from February 3 through 16, 2011, for Select Sites in and Near the Uinta Basin

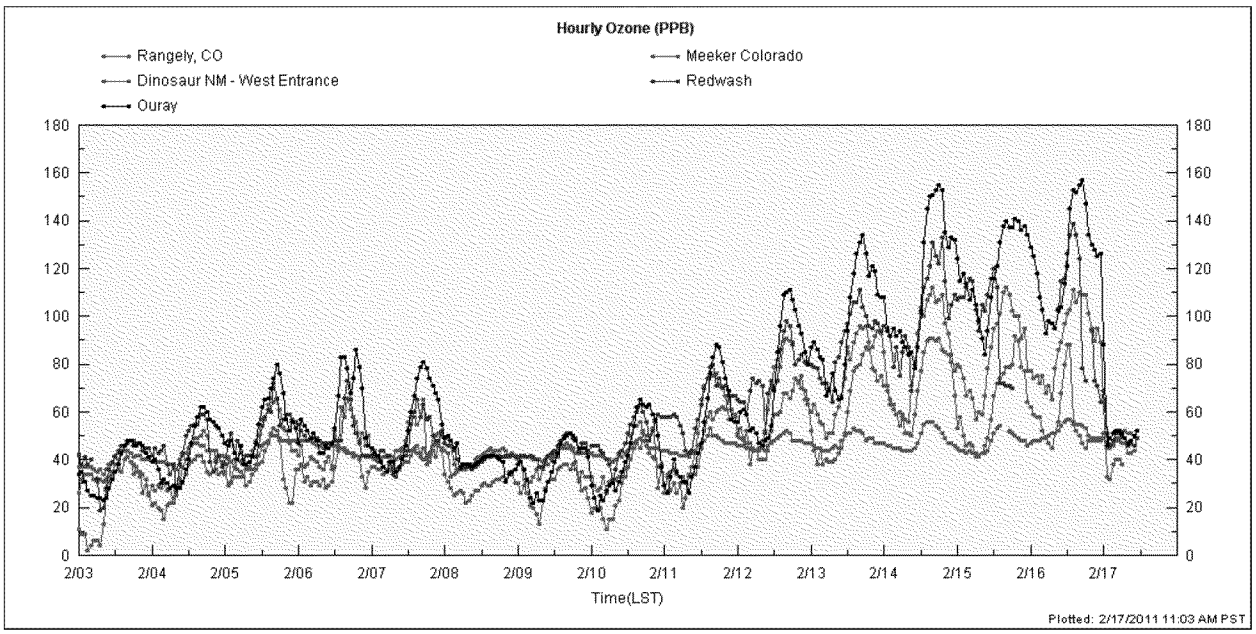


Figure 2-18 shows surface potential temperatures in the region for 13 MST on February 14, 2011. Blue and green contours in the basin reveal a temperature inversion and decoupled air mass near the core of the basin with Rangely located higher up within the inversion stratification. This horizontal and vertical gradient in surface potential temperatures indicates that mixing was poor and high concentrations in the core of the basin would need an assist from local transport winds in order to influence ozone at Rangely.

Figure 2-18: NOAA LAPS Analysis Surface Potential Temperatures in Degrees K for 13 MST February 14, 2011

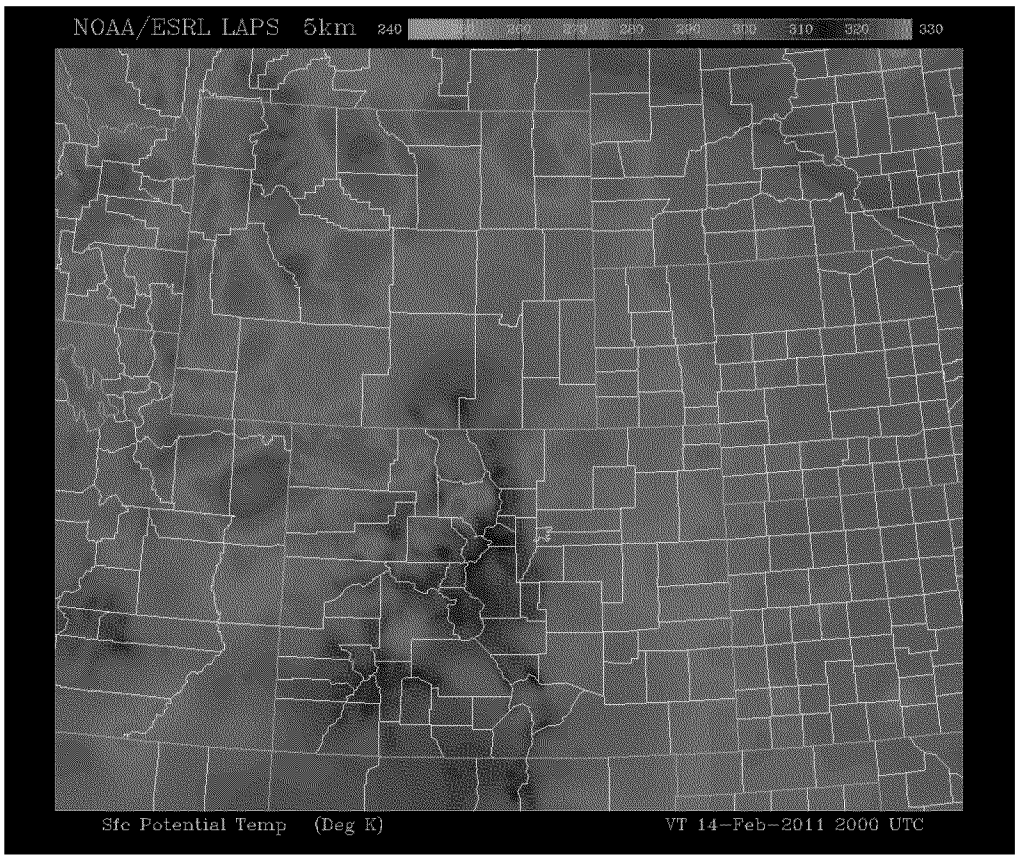
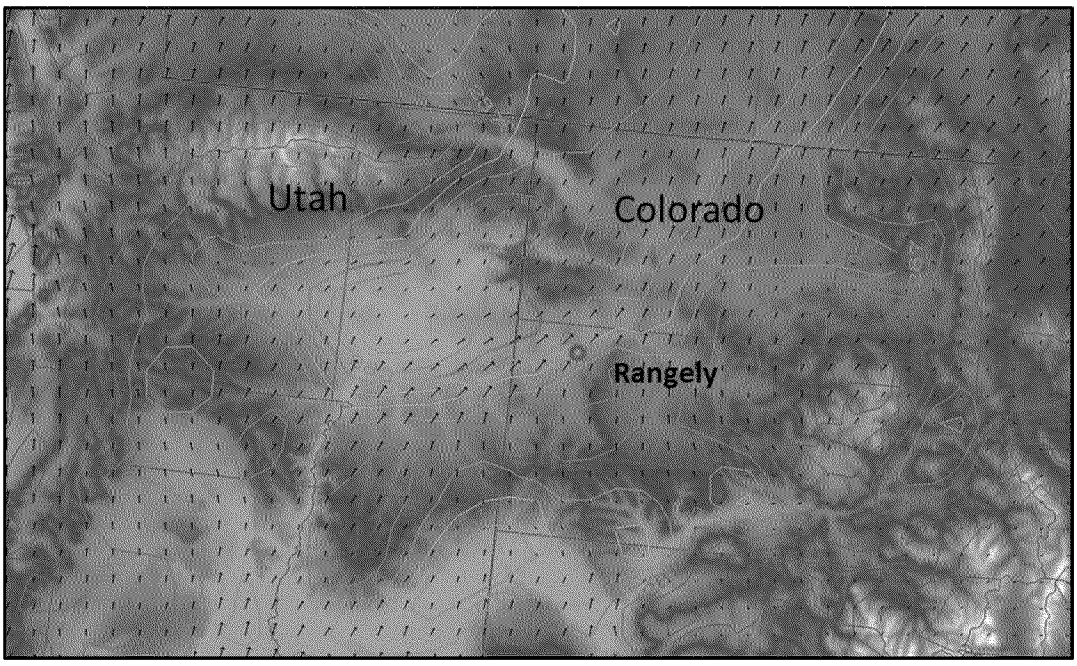


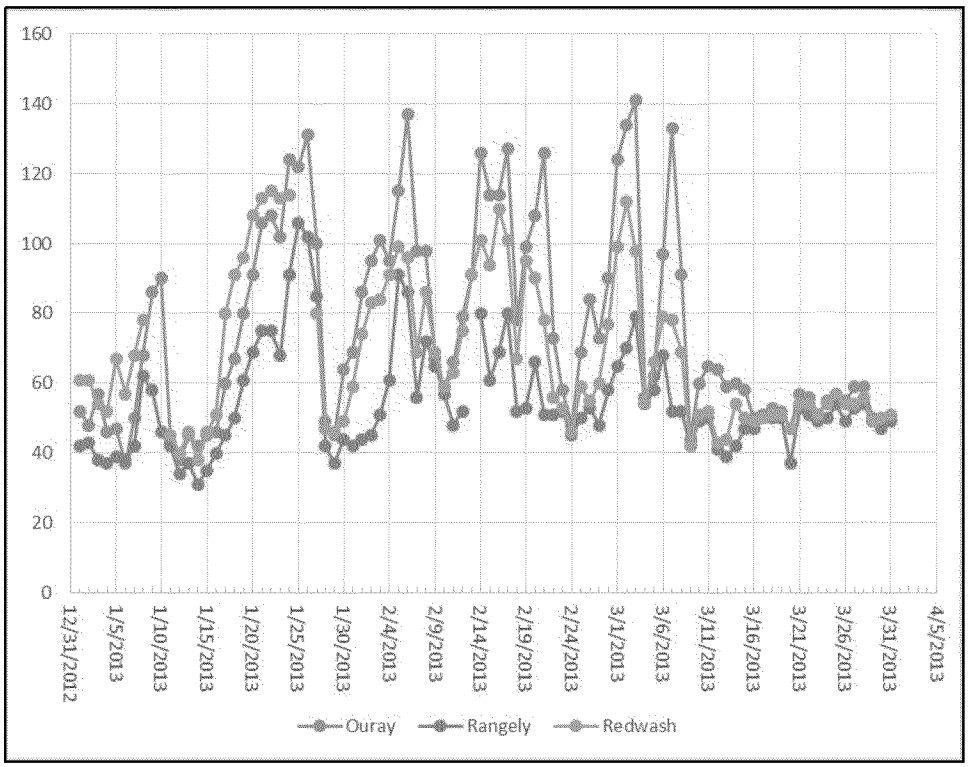
Figure 2-19 is a plot of surface potential temperatures and near-surface transport winds from the analysis run of the NAM12 model at 11 MST on February 14, 2011 (analysis runs reconcile a multitude of surface weather observations with model physics) showing surface potential temperature contours (blue through red lines) and near-surface winds at the 800 mb level in Utah and Colorado. Colder or blue contours over the Uinta Basin highlight a cold pooling event with a shallow, steep, surface inversion. Transport winds were moving air from near the core of the basin towards Rangely, and this is the likely cause of the exceedance at Rangely. HYSPLIT back trajectories were not used for this analysis because of poor simulation of transport out of the cold pool.

Figure 2-19: NAM12 Analysis Run at 18z or 11 MST Showing Surface Potential Temperature and Near-Surface Winds at the 800 mb Level for February 14, 2011, in Utah and Colorado



Since Rangely is not at the core of cold pool events or near the primary sources of ozone precursors for these events, high concentrations at Rangely are typically much lower than those within the center of the basin and often lag these sites by many hours or days. Figure 2-20, shows hourly ozone at Rangely and at two sites within the center of the basin (Ouray and Redwash) for January 1 through March 31, 2013, illustrates this point. The depth of the surface ozone layer must increase or this ozone must be transported eastward before there are significant impacts at Rangely.

Figure 2-20: Hourly Ozone Concentrations in ppb at the Ouray and Redwash Monitors in the Core of the Uinta Basin and Rangely, Colorado, from January 1 through March 31, 2013



Additional plots of near-surface transport winds and surface potential temperatures for the highest 5 concentration days at Rangely in 2013 are presented in Figures 2-21 – 2-25. These show conditions on January 24-26 and February 5-6, respectively. Surface potential temperature contours show that a cold pool and vertical and horizontal temperature stratification was in place and that near-surface winds were generally bringing some of this cold pool air into the Rangely area.

Figure 2-21: NAM12 Analysis Run at 18z or 11 MST Showing Surface Potential Temperature Contours (Blue Through Red Lines) and Near-Surface Winds at the 800 mb level for January 24, 2013, in Utah and Colorado

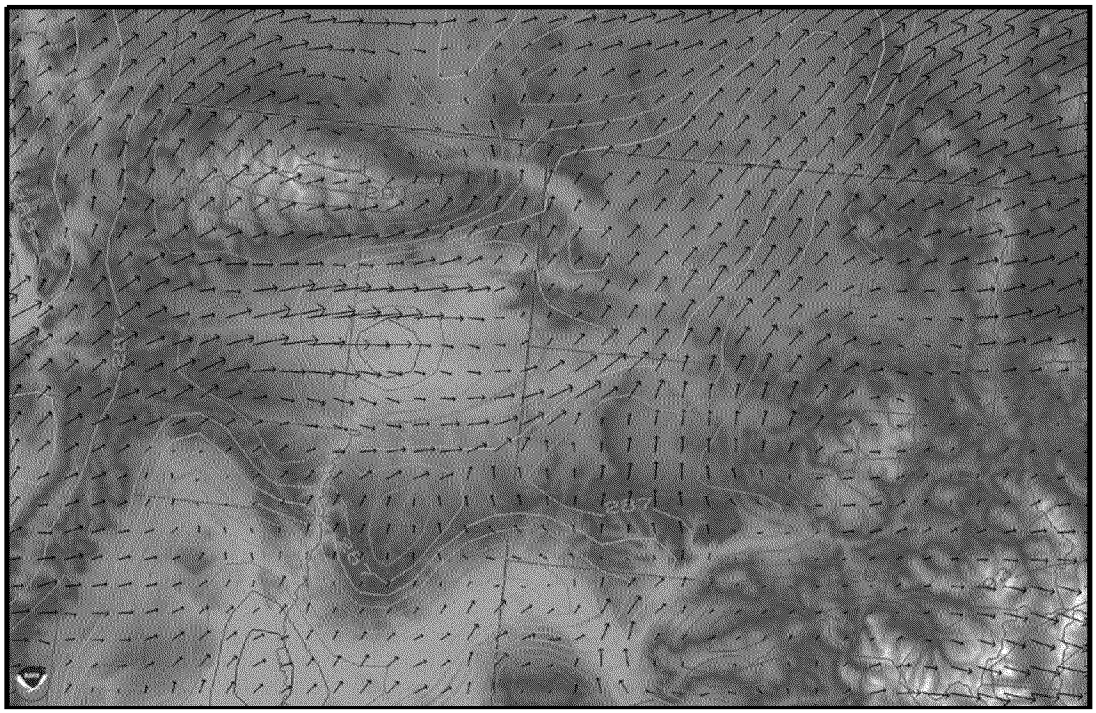


Figure 2-22: NAM12 Analysis Run at 18z or 11 MST Showing Surface Potential Temperature Contours (Blue Through Red Lines) and Near-Surface Winds at the 800 mb Level for January 25, 2013, in Utah and Colorado.

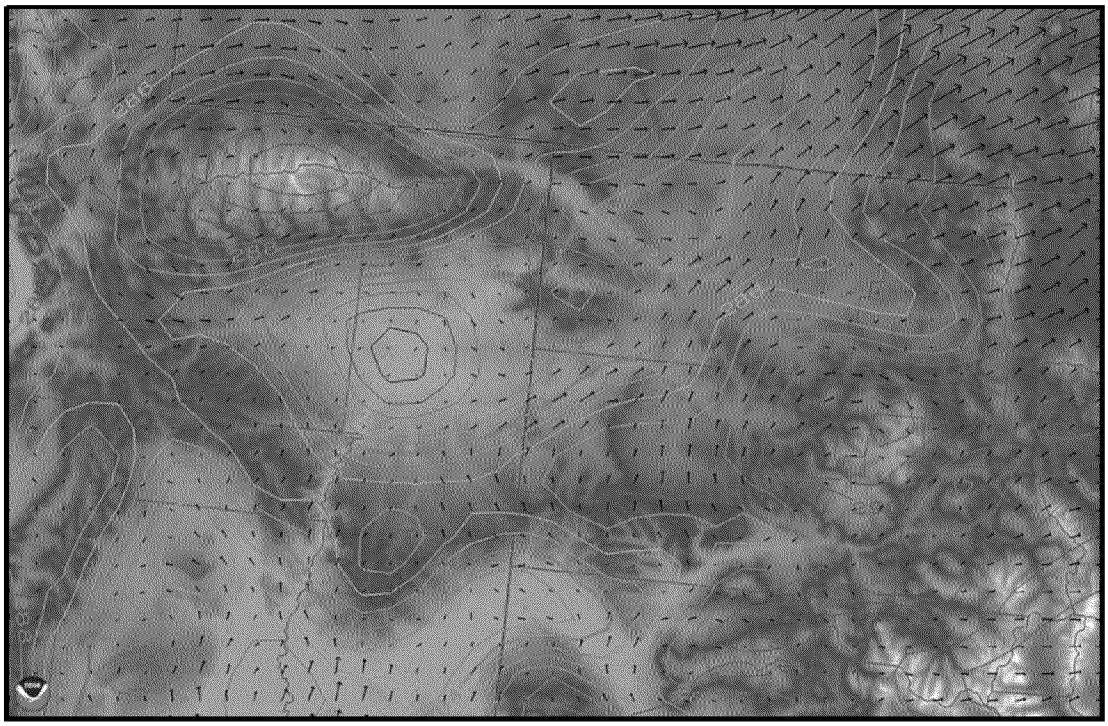


Figure 2-23: NAM12 Analysis Run at 0z (January 27, 2013) or 17 MST (January 26, 2013) Showing Surface Potential Temperature Contours (Blue Through Red Lines) and Near-Surface Winds at the 800 mb Level in Utah and Colorado.

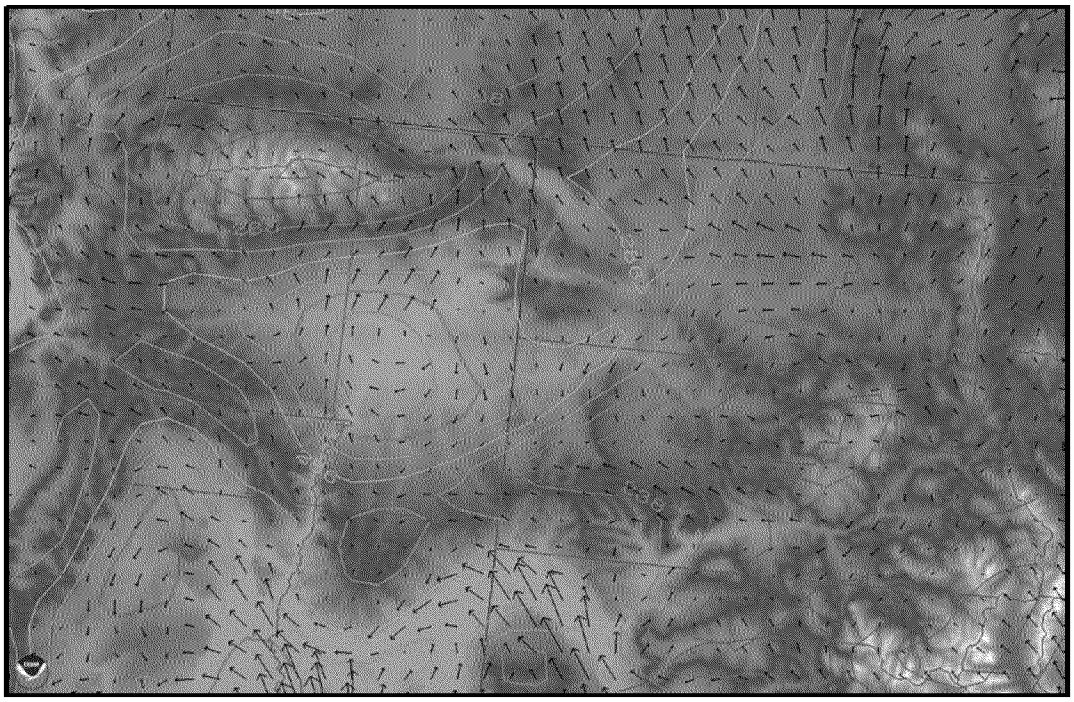


Figure 2-24: NAM12 Analysis Run at 18z or 11 MST Showing Surface Potential Temperature Contours (Blue Through Red Lines) and Near-Surface Winds at the 775 mb Level for February 5, 2013, in Utah and Colorado.

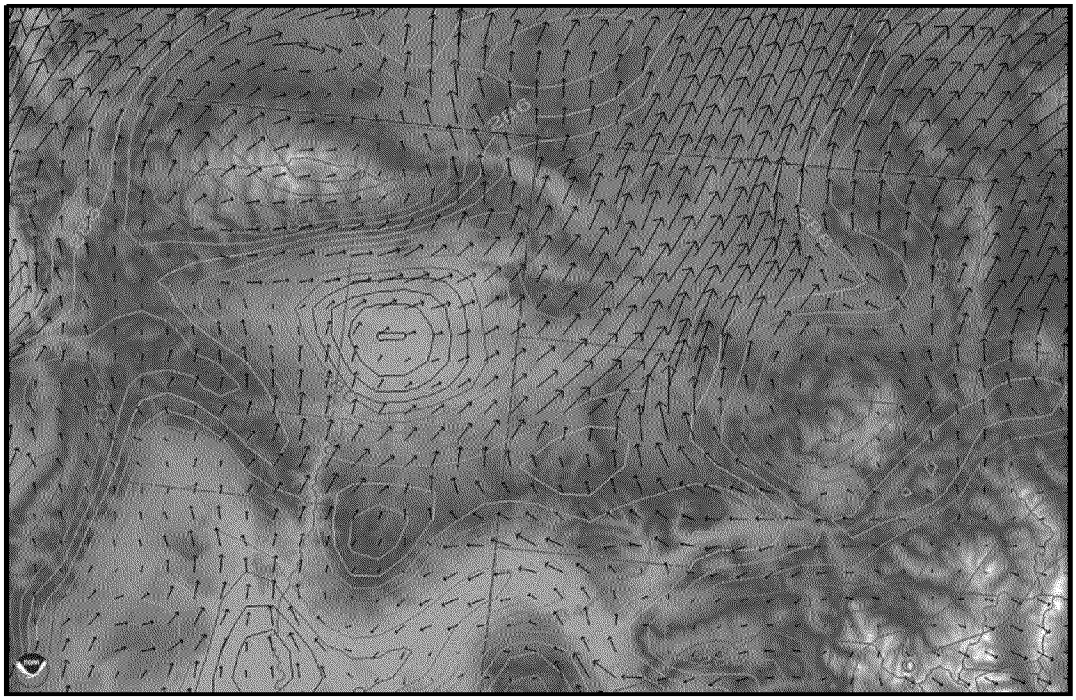


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Figure 2-25: NAM12 Analysis Run at 18z or 11 MST Showing Surface Potential Temperature Contours (Blue Through Red Lines) and Near-Surface Winds at the 800 mb Level for February 6, 2013, in Utah and Colorado.

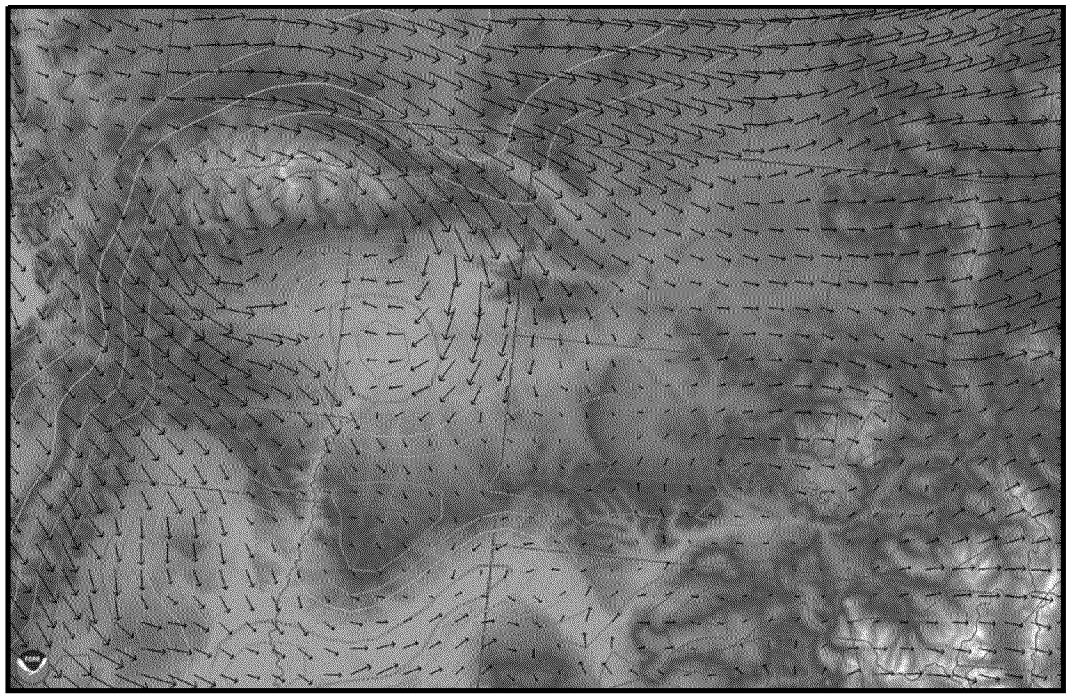
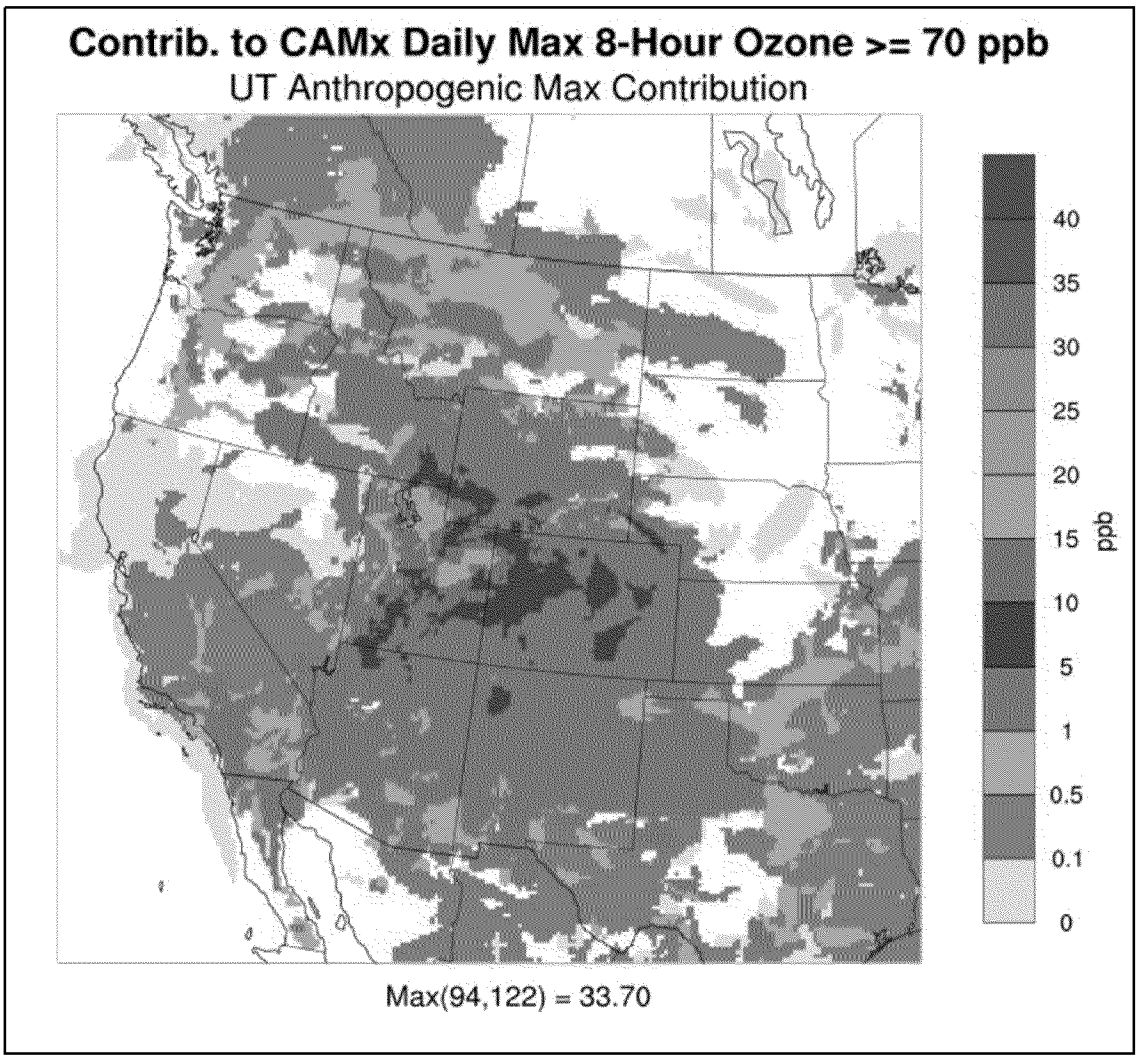


Figure 2-26 from Moore et al., 2014, shows CAMx modeling of Utah's 2008 contribution to regional daily maximum 8-hour ozone of 70 ppb or higher. This suggests that the Uinta Basin emissions in Utah would contribute as much as 15 ppb to maximum ozone near Rangely in the eastern corner of the basin. This is additional evidence that the source for the high ozone at Rangely during winter events is located in Utah.

Figure 2-26: WestJump Air Quality Modeling of Utah's 2008 Contribution to Regional Ozone at Max 8-Hour Concentrations of 70 ppb or Higher.



Maps and data from the Intermountain West Data Warehouse (IWDW) (http://views.cira.colostate.edu/TSDW/) and satellite-derived NO2 data provide further evidence that Utah is the primary source region for high wintertime ozone at Rangely. IWDW Western Air Quality Study 2011b base case inventory data shows that oil and gas related VOC emissions are 86,217 tons per year in Uintah County in Utah, which is almost entirely in the basin, and 24,417 tons per year in Rio Blanco County, which is almost entirely out of the basin. This is illustrated in Figure 2-27. Tropospheric column NO_2 amounts were acquired from measurements made by the Ozone Monitoring Instrument (OMI) aboard NASA's Aura satellite - Version 003 Level 3 NO_2 data cloud-screened at 30% with a grid resolution of 0.25° by 0.25° based on the NASA algorithm (Bucsela et al., 2013) obtained from the NASA Giovanni website http://giovanni.sci.gsfc.nasa.gov/giovanni/. The mean tropospheric column NO_2 in 10^{15} molecules per square centimeter for December 1, 2012, through February 28, 2013 is shown in Figure 2-28. Significantly higher amounts of NO_2 are found in Uintah County in Utah compared with Rio Blanco County in Colorado. Some of this higher NO_2 in Uintah County, however, may

be due to emissions from the Bonanza power plant, and these emissions are often above the surface decoupled layer (Oltmans et al., 2014).

Figure 2-27: Western Air Quality Study 2011b Base Case VOC Emissions Inventory Data for Oil and Gas Related Sources.

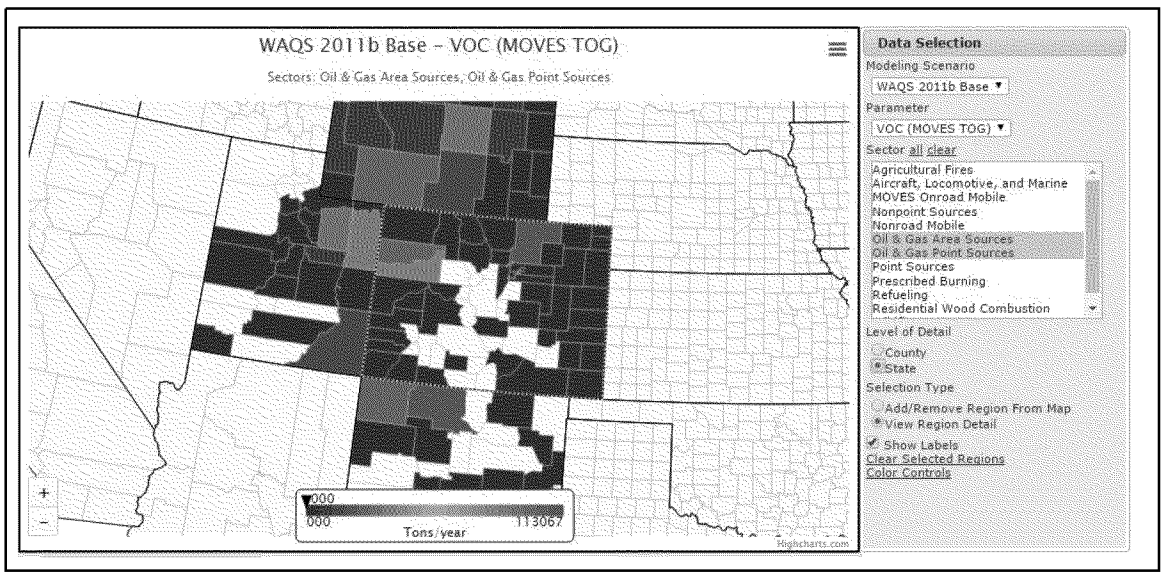
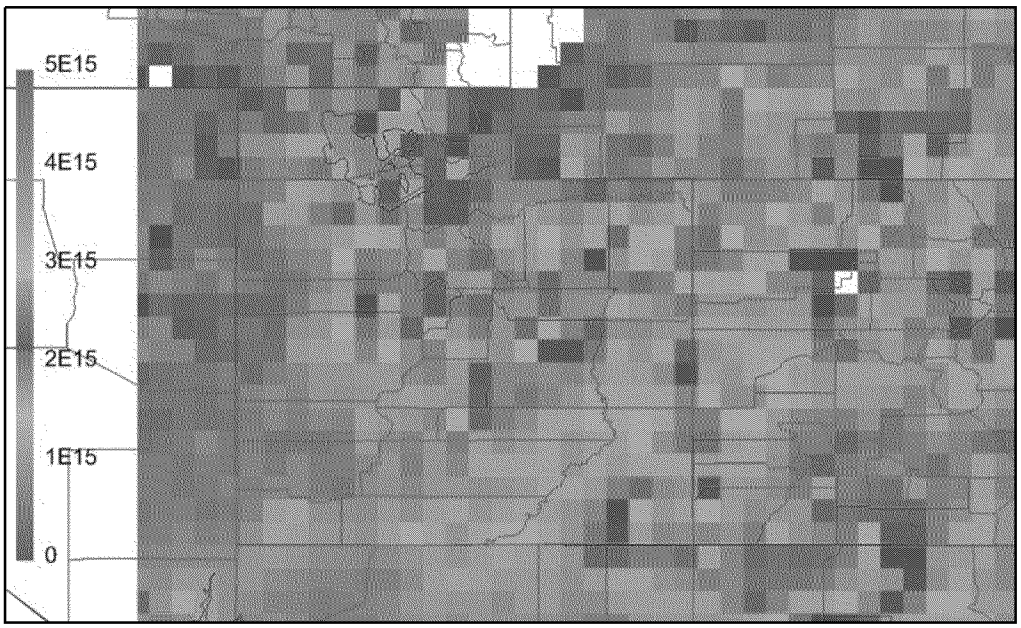


Figure 2-28: Mean OMI Satellite Tropospheric NO_2 in 10^{15} Molecules per Square Centimeter for December 1, 2012, through February 28, 2013



Meteorological Conclusions

In summary, meteorological data, evidence from recent research (Ahmadov et al., 2015), air quality modeling results, satellite-derived NO_2 data, and emissions inventory data suggest that the Utah portion of the Uinta Basin is responsible for the high ozone concentrations at Rangely,

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Colorado, during winter cold pool events. The winter, cold-pool, photochemistry in the center of the basin is highly VOC sensitive. High ozone concentrations require both the local VOC emissions from oil and gas activities in the basin and the intense and shallow decoupling of surface air which will always be at a maximum at the core of the basin in Utah. Because of this, the State is recommending Rangely area of Rio Blanco County be designated as attainment/unclassifiable for the revised standard.

References

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Bucsela, E. J., N. A. Krotkov, E. A. Celarier, L. N. Lamsal, W. H. Swartz, P. K. Bhartia, K. F. Boersma, J. P. Veefkind, J. F. Gleason, and K. E. Pickering (2013), A new stratospheric and tropospheric NO2 retrieval algorithm for nadir-viewing satellite instruments: Applications to OMI, Atmos. Meas. Tech., 6(10), 2607–2626, doi:10.5194/amt-6-2607-2013.

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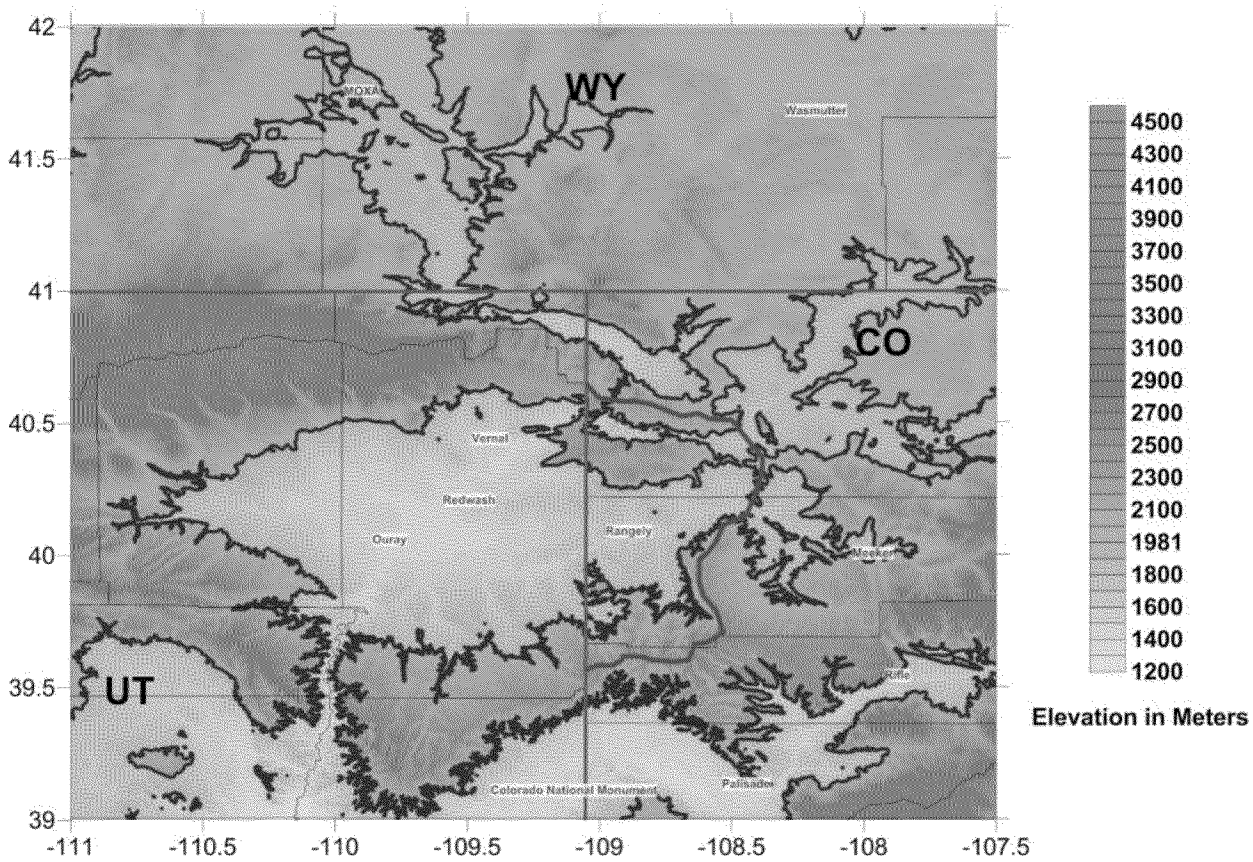
Oltmans S, Schnell R, Johnson B, Pétron G, Mefford T, et al. 2014. Anatomy of wintertime ozone associated with oil and natural gas extraction activity in Wyoming and Utah. *Elem. Sci. Anth.* **2**: 000024. doi: 10.12952/journal.elementa.000024

Factor #4: Geography/Topography

The town of Rangely is at an altitude of 5,200 feet (1,585 meters) above sea level. The center of the Uinta Basin is 4,700 feet (1,433 meters). The elevation difference between Rangely and the center of the basin is about 150 meters. As stated in the section above, the geography and meteorology of the Uinta Basin cause high levels of ozone in Utah to be transported to Colorado and impact ozone levels in Rangely. Figure 2-29, below, shows the elevation of Rangely and surrounding areas relative to the Uinta Basin.

Figure 2-28: Rangely and Uinta Basin Elevation Map



Geography/Topography Conclusions

The geography and meteorology of the Uinta Basin combine to cause the high levels of ozone in Utah to impact ozone levels in Rangely. Because of this, the state recommends that the Rangely area of Rio Blanco County be designated as attainment/unclassifiable for the revised ozone standard.

Factor #5: Jurisdictional Boundaries

The State of Colorado's Air Quality Control Commission and Air Pollution Control Division have jurisdictional authority for air quality management in Rio Blanco County and surrounding Colorado counties. Air quality regulatory authority for the tribal lands of the Ute Indian Tribe of the Uintah and Ouray Reservation are presently administered by the EPA. The Utah DEQ exercises air quality jurisdiction in non-tribal areas of Uintah County. Colorado would note for EPA's consideration that the inclusion of Rio Blanco County or portion thereof within any potential nonattainment area, would add notable multi-jurisdictional complexity in the management of a nonattainment area.

Level of Control of Emission Sources

The State has implemented numerous and effective emission control programs throughout the state. Some of these programs include but are not limited to the following:

- Oil and gas controls
    - 95% control efficiency for new and modified condensate tanks
    - Low-bleed pneumatics or no-bleed where on-site electrical grid power is being used for new pneumatics
    - 95% control efficiency for air pollution control equipment
    - Leak detection and repair program
    - Auto-igniters required on combustion devices for VOC control
- Stationary source controls for VOCs and NOx in Regulations 3, 6, 7 and 8
- Paint shops, solvent usage, industrial process changes
- Regional Haze SIP provisions – contained in regulation No. 3

Mobile Source Emission Controls:

- Federal diesel fuel standards
- 7.8 reid vapor pressure with 1 PSI Ethanol Waiver (8.8 RVP)
- Stage I vapor recovery
- Tier II Low Sulfur Gasoline
    - 30ppm average/80ppm max
        - Statewide/Year Round
        - Phased-in from 2004
- Federal tailpipe standards – TIER II
- Diesel school bus retrofits
- Federal alternative fuels programs
- Federal/state tax credits for hybrids/alternative fuels use
- Federal on-road and non-road mobile source standards and regulations
- Non-Road Engines, Vehicles, Equipment
    - Large Non–Road Diesel Engine Rule – Tier 4 (Phased–In Model Years (MY) 2008–2015)
    - Locomotive Engine Rule (MY 2015+)
    - Federal Non–Road Spark–Ignition Engines and Equipment (Phased–In MY 2008–2016)
    - Recreational Spark–Ignition (SI) Engine Standards (Phased–In MY 2008+)
- On-Road Engines and Vehicles
    - Tier 2 Standards for Light–Duty and some Medium–Duty Vehicles (Phased–In MY 2004– 2009)
    - Tier 3 Standards for Light–Duty and some Medium–Duty Vehicles (Phased–In MY 2017– 2025)
    - Heavy–Duty Engine and Vehicle Standards (Phased–In MY 2007+)
    - Light–Duty Vehicle Greenhouse Gas Rule (Phase 1 (Phased–In MY 2012–2016); Phase 2 – (Phased–In MY 2017–2025))
    - Medium and Heavy–Duty Vehicle Greenhouse Gas Rules (Phase 1 (Phased–In MY 2014– 2018))
- Fuels
    - Tier 3 Fuel Standards (Effective 2017 for large refineries, 2020 for small refineries)

- Renewable Fuel Standard Program (RFS2) (Effective 2015)
- Control of Hazardous Air Pollutants From Mobile Sources (Effective 2007)
- Ultra–Low–Sulfur Diesel (ULSD) (Effective 2006)

Area Source Emission Controls:

- Architectural/traffic/industrial and consumer products standards
- Prescribed burning limits
- Low emission gasoline cans

Summary Conclusions for Rangely

The data and analysis presented in the five factor review provide documentation and compelling evidence supporting a finding that the Rangely area of Rio Blanco County should be designated as attainment/unclassifiable for the 2015 ozone NAAQS, despite recorded violations of the ozone standard at the Rangely monitor.

A summary of the basis for recommending that Rangely area of Rio Blanco County should be designated as attainment/unclassifiable are as follows:

1. Ozone monitoring in Rangely only violates standard because of exceptionally high values in 2013 that are associated with wintertime ozone formation, and 2013 data will not be used by the EPA in determining compliance with the standard
2. Oil/gas emissions sources in Colorado are already well controlled; and
3. Population density, expected population growth and traffic volumes in the Rangely area are extremely low.

SECTION 3

Remainder of Colorado

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SECTION 3: Remainder of Colorado

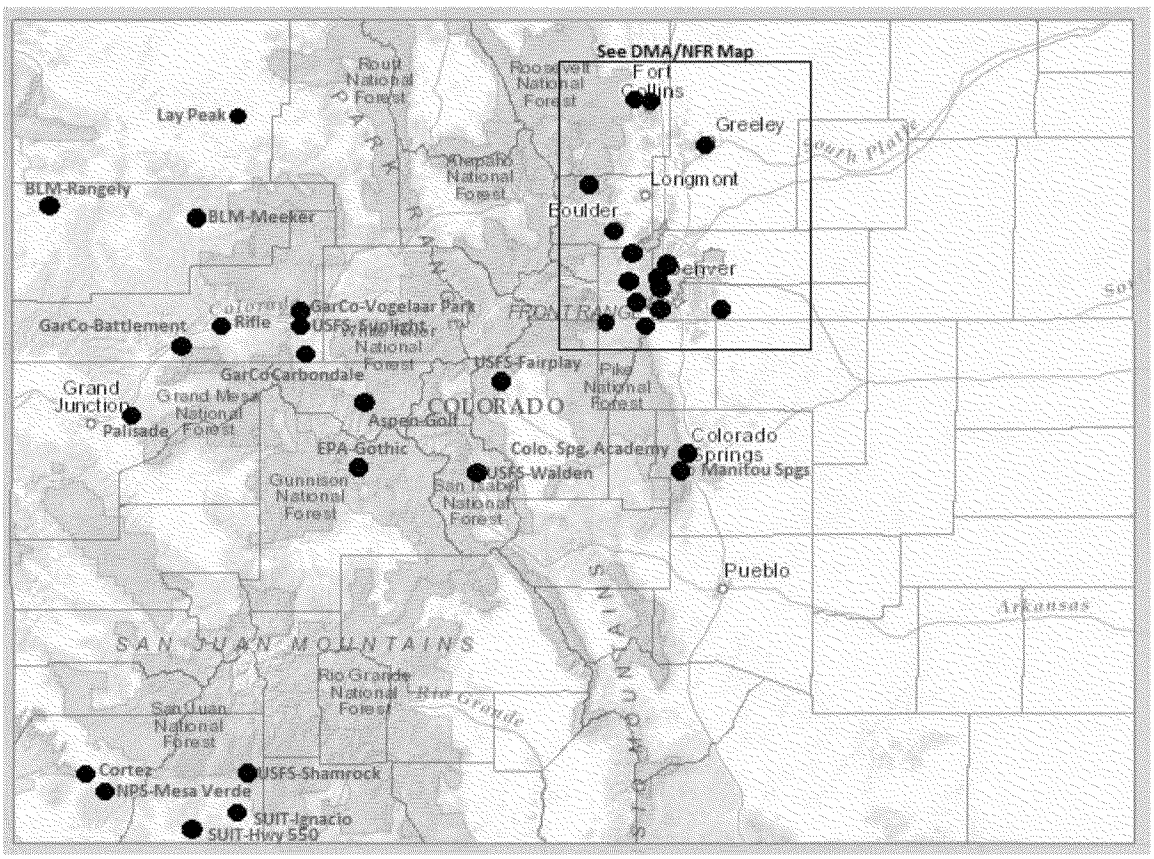
Designation Recommendation

Although there are population centers and emission sources throughout Colorado that cause or contribute to elevated ozone levels, the State presumes that the rest of the State is attaining the 2015 8-hour ozone standard and recommends a designation of attainment/unclassifiable for all other Air Quality Control Regions in the remainder of Colorado. The tribal lands of the Southern Ute (located in Archuleta, La Plata and Montezuma Counties) and Ute Mountain Ute (located in La Plata and Montezuma Counties) are excluded from the recommended designations because those tribes or the EPA are responsible for making such recommendations and determinations. The State reached this conclusion based on reviewing the ambient air monitoring data, and examining precursor emissions in the State's AQCRs.

Map of Ozone Monitor Locations

The State is recommending the designation of attainment/unclassifiable based on monitoring data from CDPHE operated ozone monitors along with information from other agencies' ozone monitors in the state. A map showing the monitors operated by CDPHE and other agencies throughout the state is shown in Figure 3-1.

Figure 3-1: Ozone Monitoring Sites for Areas Outside of the Denver Metro/North Front Range Region



Ozone Monitoring Data from CDPHE and Other Agency Sites

There are five active ozone monitors (see Table 3-1) operated by CDPHE in the state of Colorado outside of the DM/NFR region. The Lay Peak monitor was discontinued at the end of 2014 due to the site meeting its monitoring objectives. The table below, Table 3-1, summarizes 4th maximum 8-hour concentrations for all monitoring locations in the state of Colorado from 2013-2015.

Table 3-1: Ozone Monitoring Data for Areas Outside of the Denver Metro/North Front Range Region

Colorado Sites Outside DMA/NFR 4th Maximum 8-Hour Ozone Values and 3-Year Averages					
		Year			3-Year
Site Name	AQS#	2013	2014	2015	Average
CDPHE-APCD Sites					
Colorado Springs- Academy, CO	08-041-0013	0.074	0.064	0.067	0.068
Manitou Springs, CO	08-041-0016	0.072	0.062	0.065	0.066
Rifle	08-045-0012	0.062	0.061	0.068	0.063
Palisade	08-077-0020	0.066	0.062	0.065	0.064
Lay Peak	08-081-0002	0.065	0.062	-	-
Cortez	08-083-0006	0.064	0.062	0.061	0.062
Other Agency Sites					
USFS-Sunlight Mtn	08-045-0016	-	0.055	-	-
GarCo-Battlement	08-045-0019	0.069	0.061	-	-
GarCo-Vogelaar Park	08-045-0020	-	-	0.064	
GarCo-Carbondale	08-045-0021	0.058	0.059	0.066	0.061
EPA-Gothic	08-051-1991	0.064	0.063	0.068	0.065
USFS-Walden	08-057-0003	0.064	0.059	0.061	0.061
USFS-Shamrock	08-067-1004	0.072	0.064	0.068	0.068
SUIT-Ignacio	08-067-7001	0.069	0.067	0.068	0.068
SUIT-Hwy 550	08-067-7003	0.067	0.065	0.066	0.066
NPS-Mesa Verde	08-083-0101	0.069	0.065	0.066	0.066
USFS-Fairplay	08-093-0002	-	-	0.067	-
Aspen-Golf	08-097-0007	-	0.062	0.065	-
BLM-Meeker	08-103-0005	0.064	0.062	0.064	0.063
BLM-Rangely	08-103-0006	0.091	0.062	0.066	0.073

As the table demonstrates, all monitoring locations outside of the DM/NFR are in compliance with the revised 2015 8-hour ozone standard excluding the BLM-Rangely site (see Section 2 of this TSD for discussion around its area designation). This supports the states recommendation that the remainder of the state be classified as attainment/unclassifiable.

Ozone Monitoring Trends for Areas Outside of the Denver Metro/North Front Range Region

The following figures provide historical trend data of the 8-hour ozone 4th maximum for areas in the state outside of the DM/NFR Region. For discussion of Rangely area of Rio Blanco County, please see Section 2 of this Technical Support Document.

Figure 3-2: Ozone Monitoring Trends for Southeastern Colorado

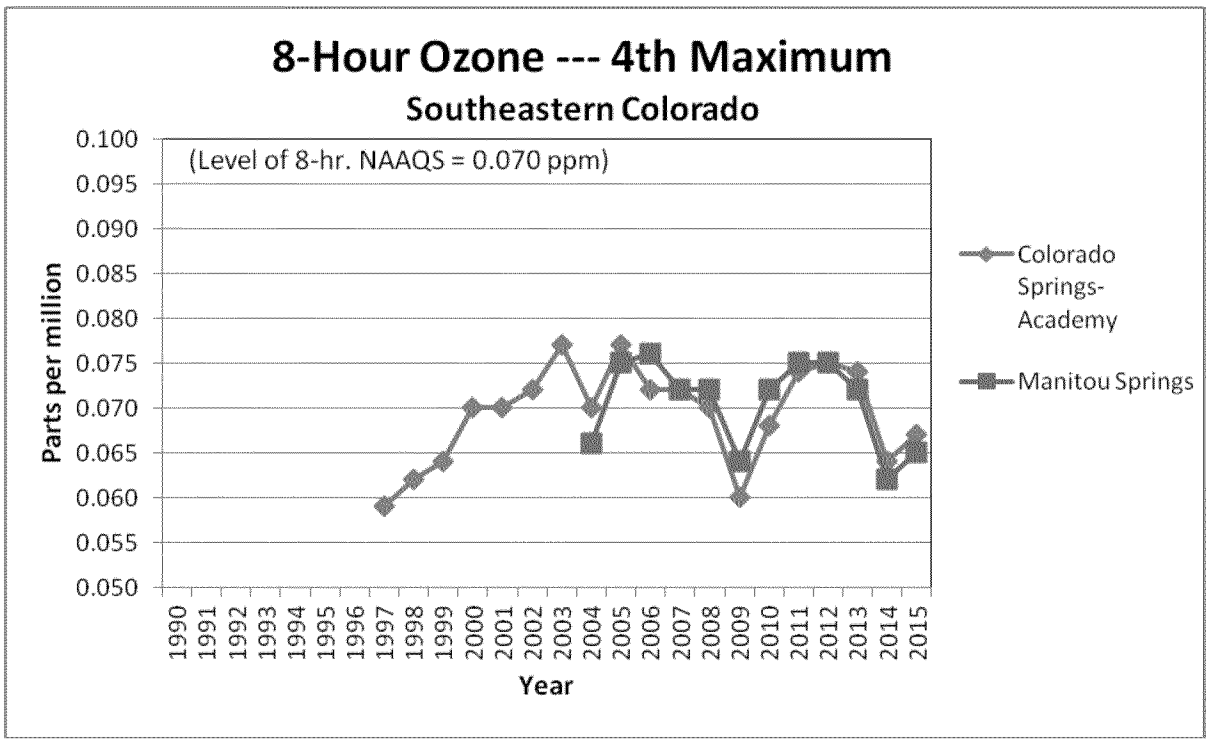


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Figure 3-3: Ozone Monitoring Trends for Central Colorado

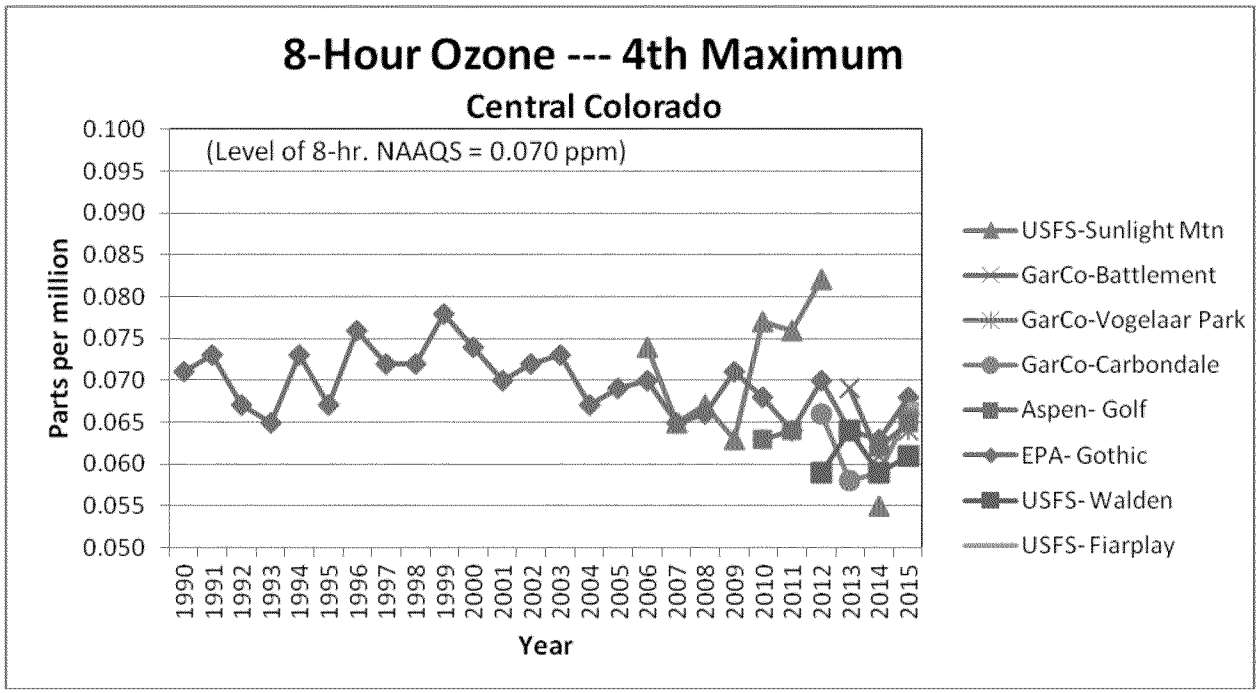


Figure 3-4: Ozone Monitoring Trends for Southwestern Colorado

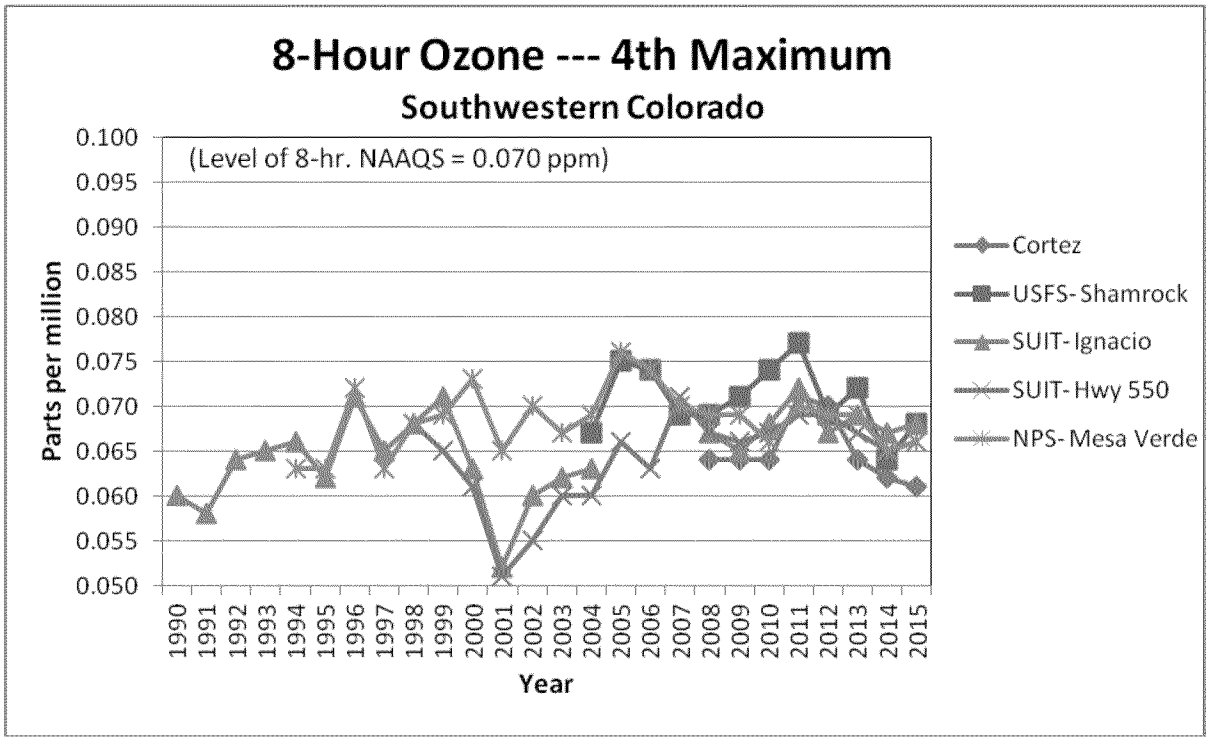
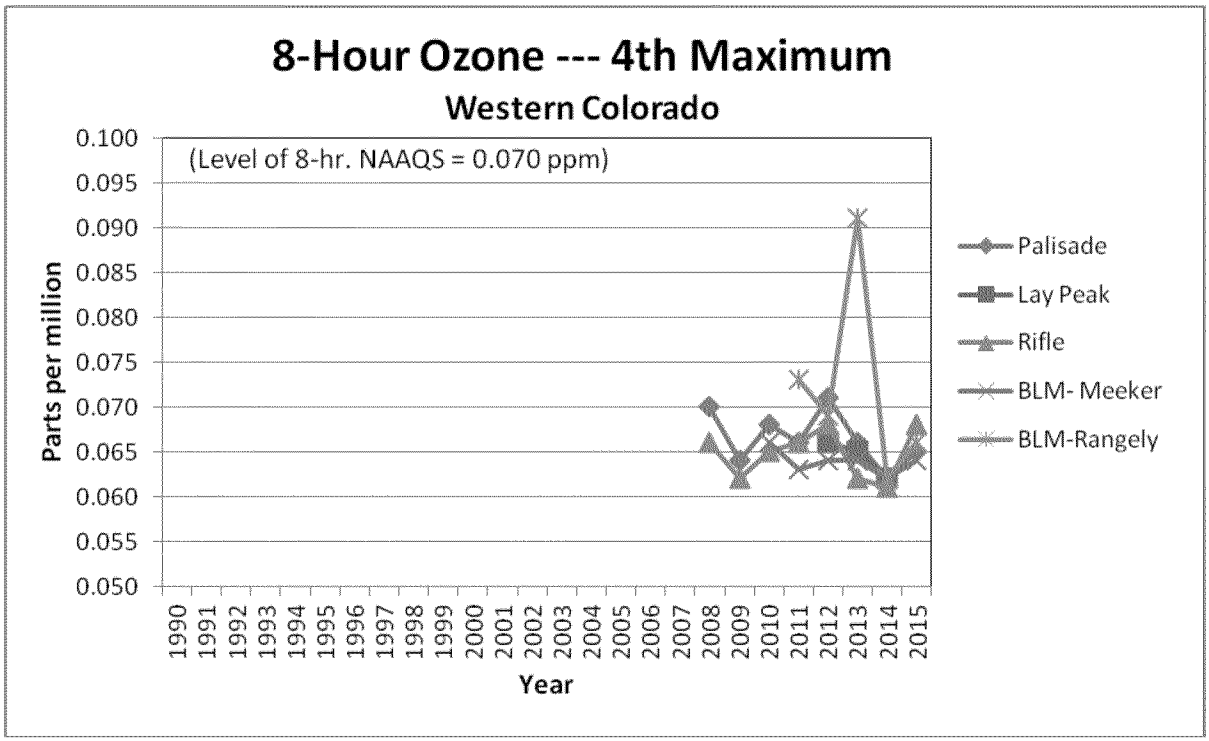


Figure 3-5: Ozone Monitoring Trends for Western Colorado

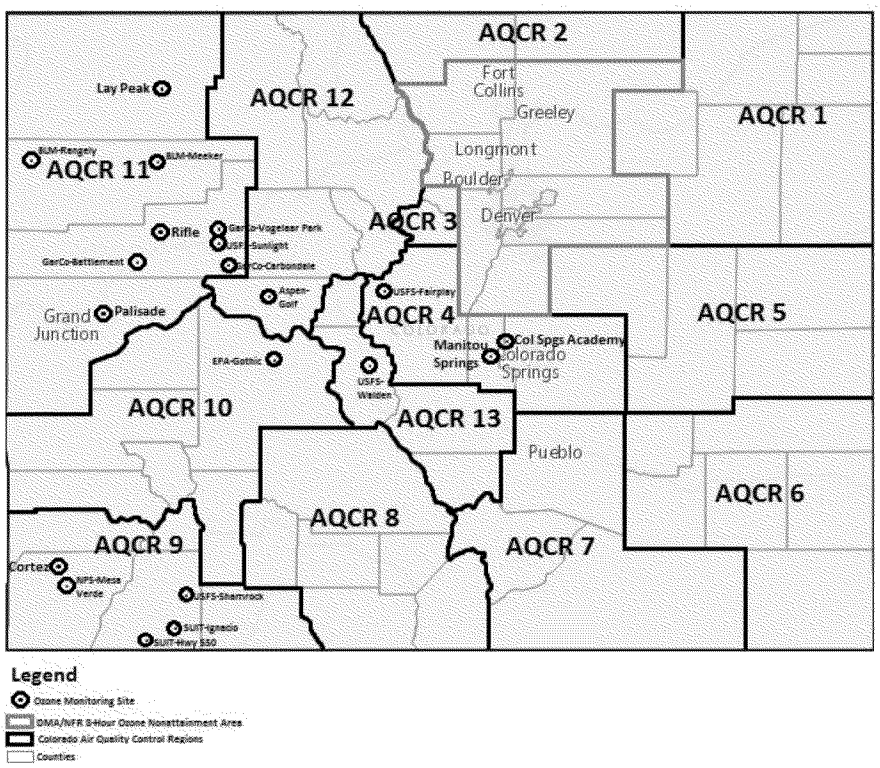


AQCRs and Emission Inventory

Air Quality Control Regions

There are 13 air quality control regions (AQCR's) in Colorado. The figure below (Figure 3-6) shows the 13 AQCR's relative to the monitoring locations in the state (including monitors operated by other agencies) outside of the existing nonattainment area.

Figure 3-6: Ozone Monitoring Sites in Colorado Relative to AQCR's



Emissions Inventory

In support of the recommendation of attainment/unclassifiable designation for the remainder of the state, an analysis of NO_x and VOC emissions are provided. The two figures and table below show the NO_x and VOC emissions by county based on the 2011 V2 NEI. In Table 3-2 the emission sources are categorized into controllable and uncontrollable emissions. Biogenic, agricultural livestock waste and wildfire emissions comprise the uncontrolled emission sources.

Figure 3-7: 2011 NO_x Emissions Map by County

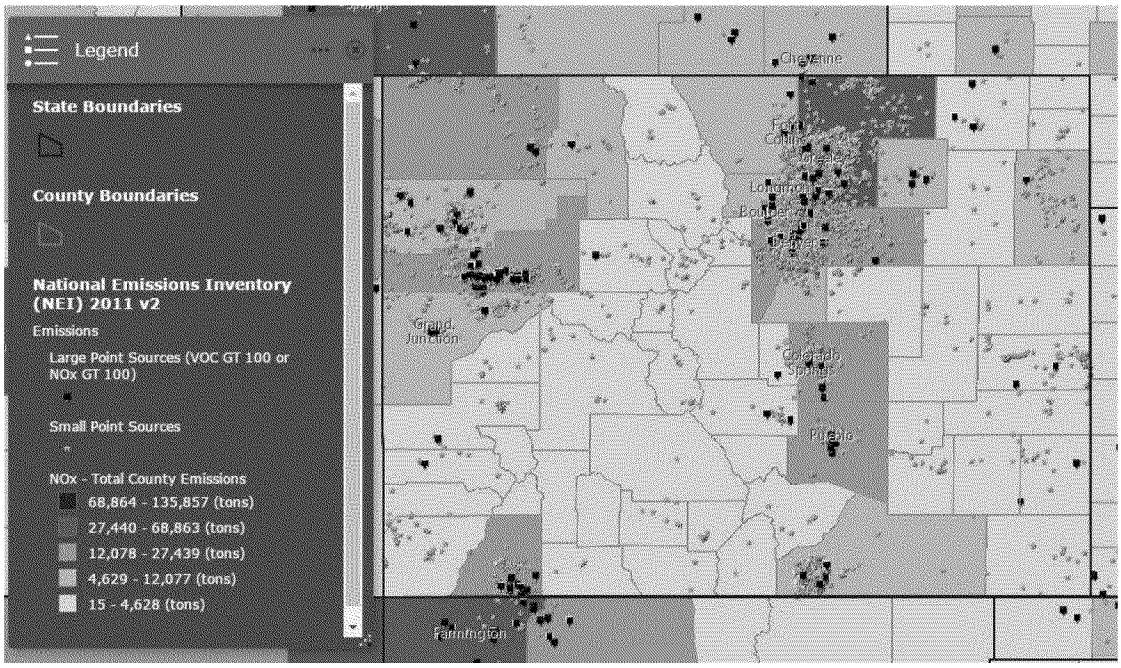


Figure 3-8: 2011 VOC Emissions Map by County

Table 3-2: Ozone Precursor Emissions by AQCR in Colorado

County	AQCR	Recommended 8-Hour Ozone Designation	2011 NOx Emissions			2011 VOC Emissions			Total Precursors		
			Total (tpy)	Controllable (tpy)	Uncontrolled (tpy)	Total (tpy)	Controllable (tpy)	Uncontrolled (tpy)	Total (tpy)	Controllable (tpy)	Uncontrolled (tpy)
Logan	1	Attainment/Unclassifiable	4,374	3,268	1,106	11,066	2,494	8,572	15,440	5,762	9,678
Morgan	1	Attainment/Unclassifiable	7,997	7,078	920	9,786	2,311	7,475	17,784	9,388	8,395
Phillips	1	Attainment/Unclassifiable	1,652	1,105	548	4,204	892	3,313	5,857	1,997	3,860
Sedgwick	1	Attainment/Unclassifiable	1,346	952	394	3,045	353	2,692	4,391	1,306	3,086
Washington	1	Attainment/Unclassifiable	2,991	1,453	1,538	14,919	3,649	11,270	17,910	5,102	12,808
Yuma	1	Attainment/Unclassifiable	6,254	4,655	1,599	24,071	12,538	11,533	30,325	17,194	13,132
Clear Creek	3	Attainment/Unclassifiable	1,829	1,767	62	5,139	729	4,409	6,967	2,496	4,471
Gilpin	3	Attainment/Unclassifiable	490	457	33	3,924	260	3,664	4,414	717	3,698
El Paso	4	Attainment/Unclassifiable	21,605	20,752	853	32,833	18,236	14,597	54,438	38,988	15,450
Park	4	Attainment/Unclassifiable	1,438	955	483	17,398	3,485	13,913	18,836	4,440	14,396
Teller	4	Attainment/Unclassifiable	1,600	1,479	121	10,454	2,057	8,397	12,054	3,536	8,518
Cheyenne	5	Attainment/Unclassifiable	4,204	3,116	1,088	11,818	1,155	10,663	16,022	4,271	11,751
Elbert	5	Attainment/Unclassifiable	2,411	1,490	921	10,363	1,169	9,194	12,774	2,660	10,114
Kit Carson	5	Attainment/Unclassifiable	3,329	1,841	1,488	11,521	933	10,588	14,850	2,774	12,075
Lincoln	5	Attainment/Unclassifiable	2,672	1,298	1,374	14,262	868	13,395	16,934	2,166	14,768
Baca	6	Attainment/Unclassifiable	3,224	1,631	1,593	19,206	822	18,384	22,429	2,453	19,977
Bent	6	Attainment/Unclassifiable	2,308	1,249	1,059	15,476	661	14,815	17,784	1,911	15,873
Crowley	6	Attainment/Unclassifiable	800	323	476	6,608	243	6,365	7,407	566	6,841
Kiowa	6	Attainment/Unclassifiable	1,524	467	1,057	11,869	704	11,165	13,393	1,171	12,222
Otero	6	Attainment/Unclassifiable	2,223	1,444	779	10,913	1,040	9,873	13,136	2,485	10,651
Prowers	6	Attainment/Unclassifiable	3,120	2,039	1,081	13,102	858	12,245	16,222	2,897	13,326
Huerfano	7	Attainment/Unclassifiable	1,653	1,149	504	15,342	1,113	14,229	16,996	2,262	14,734
Las Animas	7	Attainment/Unclassifiable	8,570	6,184	2,386	56,008	3,757	52,251	64,579	9,942	54,637
Pueblo	7	Attainment/Unclassifiable	12,670	11,568	1,102	23,375	5,576	17,799	36,045	17,143	18,901
Alamosa	8	Attainment/Unclassifiable	859	713	146	7,297	1,933	5,364	8,156	2,646	5,511
Conejos	8	Attainment/Unclassifiable	747	494	254	10,988	1,188	9,799	11,735	1,682	10,053
Costilla	8	Attainment/Unclassifiable	922	748	175	18,966	9,154	9,813	19,889	9,901	9,988
Mineral	8	Attainment/Unclassifiable	389	244	145	9,052	1,004	8,049	9,441	1,248	8,194
Rio Grande	8	Attainment/Unclassifiable	980	758	222	10,419	3,366	7,053	11,399	4,124	7,275
Saguache	8	Attainment/Unclassifiable	1,070	559	511	25,719	2,895	22,825	26,789	3,454	23,336
Archuleta	9	Attainment/Unclassifiable	1,024	884	139	23,561	1,567	21,994	24,585	2,451	22,134
Dolores	9	Attainment/Unclassifiable	701	523	177	14,504	1,754	12,750	15,204	2,277	12,927
La Plata	9	Attainment/Unclassifiable	12,428	12,189	240	28,261	6,744	21,517	40,689	18,932	21,757
Montezuma	9	Attainment/Unclassifiable	3,078	2,779	298	33,617	10,375	23,243	36,695	13,154	23,541
San Juan	9	Attainment/Unclassifiable	174	96	78	3,944	1,097	2,847	4,118	1,193	2,925
Delta	10	Attainment/Unclassifiable	1,663	1,437	226	14,234	1,189	13,045	15,897	2,626	13,271
Gunnison	10	Attainment/Unclassifiable	1,525	1,192	333	32,033	3,510	28,522	33,557	4,702	28,856
Hinsdale	10	Attainment/Unclassifiable	262	87	175	10,252	1,408	8,844	10,514	1,495	9,019
Montrose	10	Attainment/Unclassifiable	3,038	2,736	302	27,603	4,545	23,058	30,642	7,281	23,361
Ouray	10	Attainment/Unclassifiable	463	355	108	7,710	938	6,772	8,173	1,292	6,880
San Miguel	10	Attainment/Unclassifiable	876	717	159	14,015	1,134	12,881	14,891	1,851	13,040
Garfield	11	Attainment/Unclassifiable	16,413	16,119	294	118,709	90,999	27,710	135,122	107,118	28,003
Mesa	11	Attainment/Unclassifiable	7,412	7,039	373	49,868	15,032	34,836	57,280	22,071	35,210
Moffat	11	Attainment/Unclassifiable	15,532	15,290	242	41,923	5,397	36,526	57,456	20,688	36,768
Rio Blanco	11	Attainment/Unclassifiable	5,027	4,809	218	57,809	26,948	30,861	62,836	31,757	31,079
Eagle	12	Attainment/Unclassifiable	3,412	3,252	161	18,568	2,973	15,596	21,981	6,224	15,757
Grand	12	Attainment/Unclassifiable	2,564	2,378	186	34,100	14,328	19,772	36,664	16,706	19,958
Jackson	12	Attainment/Unclassifiable	632	431	202	20,813	5,239	15,575	21,445	5,669	15,776
Pitkin	12	Attainment/Unclassifiable	834	696	138	11,400	1,049	10,350	12,234	1,746	10,488
Routt	12	Attainment/Unclassifiable	7,951	7,723	228	29,165	3,583	25,582	37,116	11,306	25,810
Summit	12	Attainment/Unclassifiable	1,634	1,536	98	8,919	2,131	6,788	10,554	3,667	6,886
Chaffee	13	Attainment/Unclassifiable	872	673	199	11,012	1,501	9,512	11,884	2,173	9,711
Custer	13	Attainment/Unclassifiable	632	223	409	13,961	1,309	12,652	14,593	1,533	13,061
Fremont	13	Attainment/Unclassifiable	3,406	3,110	297	19,952	3,442	16,510	23,359	6,551	16,807
Lake	13	Attainment/Unclassifiable	283	198	85	3,837	547	3,290	4,120	745	3,375
Adams	NAA	Non-Attainment	25,245	24,521	724	22,243	17,195	5,048	47,488	41,716	5,772
Arapahoe	NAA	Non-Attainment	13,022	12,538	484	19,381	15,317	4,064	32,403	27,855	4,548
Boulder	NAA	Non-Attainment	9,764	9,533	231	19,497	9,674	9,823	29,260	19,206	10,054
Broomfield	NAA	Non-Attainment	1,552	1,492	60	2,783	2,125	658	4,335	3,617	718
Denver	NAA	Non-Attainment	20,042	19,920	122	17,144	15,593	1,551	37,185	35,513	1,672
Douglas	NAA	Non-Attainment	8,048	7,809	239	17,384	6,933	10,451	25,432	14,742	10,690
Jefferson	NAA	Non-Attainment	14,406	14,279	127	27,388	15,287	12,100	41,794	29,566	12,228
Larimer	NAA	Non-Attainment	11,577	10,905	672	53,798	22,142	31,656	65,375	33,047	32,328
Weld	NAA	Non-Attainment	32,696	30,463	2,233	150,982	133,972	17,010	183,678	164,434	19,243
Southern Ute	N/A		5,139	5,139	-	2,033	2,033	-	7,173	7,173	-
Ute Mountain	N/A		6,590	6,590	-	46	46	-	6,636	6,636	-

Top 5 Emissions Top 5 Emissions Top 5 Emissions

Controllable= Anthropogenic emissions excluding livestock waste
Uncontrollable= Biogenic emissions including livestock waste

The two AQCR's that contain counties with high ozone precursor emissions outside of the DM/NFR area are AQCR 4 and 11.

AQCR 4 is made up of El Paso, Park and Teller counties. El Paso County has the 3rd highest NO_x, 5th highest VOC and the 4th highest total precursor emissions in the state. There are two CDPHE monitors (Colorado Springs- Academy and Manitou Springs) and one USFS monitor (USFS- Fairplay) operating in the AQCR and these monitors show compliance with the revised 2015 8-hour standard.

AQCR 11 is made up of Garfield, Mesa, Moffat and Rio Blanco counties. Garfield County has the 5th highest NO_x, 2nd highest VOC and 2nd highest total precursor emissions in the state. There are three CDPHE monitors (Rifle, Palisade and Lay Peak), two BLM monitors (BLM- Meeker, BLM- Rangely), three Garfield County (GarCo) monitors (GarCo-Battlement, GarCo- Vogelaar Park, GarCo- Carbondale) and one USFS monitor (USFS- Sunlight Mtn) operating in the AQCR and these monitors show compliance with the revised 2015 8-hour standard (excluding BLM-Rangely, as detailed in Section 2).

As stated above, monitoring data in the AQCRs with the highest precursor emissions outside of the DM/NFR in AQCR 4 and 11 are showing compliance with the revised standard (excluding Rangely, see Section 2 for discussion). It is therefore reasonable to presume that that if these regions with the greatest amount of emissions are not showing violations of the 2008 ozone standard, counties and AQCRs with less emissions (and without monitoring data) are also likely to be in attainment. Therefore, the State recommends that all counties and AQCRs outside of the DM/NFR nonattainment area be designated as attainment/unclassifiable.

Population

The population data for the state of Colorado by county is shown in the table below.

Table 3-3: Population by County

County	AQCR	Recommended 8-Hour Ozone Designation	July 2010 (Estimate)	July 2015 (Estimate)	2010 to 2015 Total % Change	2010 to 2015 Annual % Change
Logan	1	Attainment/Unclassifiable	22,130	22,036	-0.42%	-0.08%
Morgan	1	Attainment/Unclassifiable	28,172	28,360	0.67%	0.13%
Phillips	1	Attainment/Unclassifiable	4,463	4,349	-2.55%	-0.51%
Sedgwick	1	Attainment/Unclassifiable	2,370	2,399	1.22%	0.24%
Washington	1	Attainment/Unclassifiable	4,801	4,864	1.31%	0.26%
Yuma	1	Attainment/Unclassifiable	10,025	10,146	1.21%	0.24%
Clear Creek	3	Attainment/Unclassifiable	9,083	9,303	2.42%	0.48%
Gilpin	3	Attainment/Unclassifiable	5,461	5,828	6.72%	1.34%
El Paso	4	Attainment/Unclassifiable	626,916	674,471	7.59%	1.52%
Park	4	Attainment/Unclassifiable	16,262	16,510	1.53%	0.31%
Teller	4	Attainment/Unclassifiable	23,450	23,385	-0.28%	-0.06%
Cheyenne	5	Attainment/Unclassifiable	1,831	1,829	-0.11%	-0.02%
Elbert	5	Attainment/Unclassifiable	23,095	24,735	7.10%	1.42%
Kit Carson	5	Attainment/Unclassifiable	8,247	7,758	-5.93%	-1.19%
Lincoln	5	Attainment/Unclassifiable	5,469	5,557	1.61%	0.32%
Baca	6	Attainment/Unclassifiable	3,790	3,615	-4.62%	-0.92%
Bent	6	Attainment/Unclassifiable	6,509	5,830	-10.43%	-2.09%
Crowley	6	Attainment/Unclassifiable	5,853	5,562	-4.97%	-0.99%
Kiowa	6	Attainment/Unclassifiable	1,396	1,423	1.93%	0.39%
Otero	6	Attainment/Unclassifiable	18,883	18,343	-2.86%	-0.57%
Prowers	6	Attainment/Unclassifiable	12,562	11,954	-4.84%	-0.97%
Huerfano	7	Attainment/Unclassifiable	6,668	6,492	-2.64%	-0.53%
Las Animas	7	Attainment/Unclassifiable	15,394	14,058	-8.68%	-1.74%
Pueblo	7	Attainment/Unclassifiable	159,520	163,591	2.55%	0.51%
Alamosa	8	Attainment/Unclassifiable	15,926	16,496	3.58%	0.72%
Conejos	8	Attainment/Unclassifiable	8,292	8,130	-1.95%	-0.39%
Costilla	8	Attainment/Unclassifiable	3,527	3,584	1.62%	0.32%
Mineral	8	Attainment/Unclassifiable	704	726	3.13%	0.63%
Rio Grande	8	Attainment/Unclassifiable	12,018	11,543	-3.95%	-0.79%
Saguache	8	Attainment/Unclassifiable	6,136	6,251	1.87%	0.37%
Archuleta	9	Attainment/Unclassifiable	12,056	12,352	2.46%	0.49%
Dolores	9	Attainment/Unclassifiable	2,065	1,978	-4.21%	-0.84%
La Plata	9	Attainment/Unclassifiable	51,371	54,688	6.46%	1.29%
Montezuma	9	Attainment/Unclassifiable	25,548	26,168	2.43%	0.49%
San Juan	9	Attainment/Unclassifiable	708	701	-0.99%	-0.20%
Delta	10	Attainment/Unclassifiable	30,878	29,979	-2.91%	-0.58%
Gunnison	10	Attainment/Unclassifiable	15,379	16,067	4.47%	0.89%
Hinsdale	10	Attainment/Unclassifiable	844	774	-8.29%	-1.66%
Montrose	10	Attainment/Unclassifiable	41,194	40,946	-0.60%	-0.12%
Ouray	10	Attainment/Unclassifiable	4,466	4,691	5.04%	1.01%
San Miguel	10	Attainment/Unclassifiable	7,359	7,879	7.07%	1.41%
Garfield	11	Attainment/Unclassifiable	56,094	58,095	3.57%	0.71%
Mesa	11	Attainment/Unclassifiable	146,489	148,513	1.38%	0.28%
Moffat	11	Attainment/Unclassifiable	13,812	12,937	-6.34%	-1.27%
Rio Blanco	11	Attainment/Unclassifiable	6,669	6,571	-1.47%	-0.29%
Eagle	12	Attainment/Unclassifiable	52,085	53,605	2.92%	0.58%
Grand	12	Attainment/Unclassifiable	14,783	14,615	-1.14%	-0.23%
Jackson	12	Attainment/Unclassifiable	1,385	1,356	-2.09%	-0.42%
Pitkin	12	Attainment/Unclassifiable	17,156	17,787	3.68%	0.74%
Routt	12	Attainment/Unclassifiable	23,450	24,130	2.90%	0.58%
Summit	12	Attainment/Unclassifiable	28,065	30,257	7.81%	1.56%
Chaffee	13	Attainment/Unclassifiable	17,803	18,658	4.80%	0.96%
Custer	13	Attainment/Unclassifiable	4,275	4,445	3.98%	0.80%
Fremont	13	Attainment/Unclassifiable	46,857	46,692	-0.35%	-0.07%
Lake	13	Attainment/Unclassifiable	7,267	7,485	3.00%	0.60%
Adams	NAA	Non-Attainment	443,680	491,337	10.74%	2.15%
Arapahoe	NAA	Non-Attainment	574,727	631,096	9.81%	1.96%
Boulder	NAA	Non-Attainment	295,986	319,372	7.90%	1.58%
Broomfield	NAA	Non-Attainment	56,271	65,065	15.63%	3.13%
Denver	NAA	Non-Attainment	603,300	682,545	13.14%	2.63%
Douglas	NAA	Non-Attainment	286,964	322,387	12.34%	2.47%
Jefferson	NAA	Non-Attainment	535,625	565,524	5.58%	1.12%
Larimer	NAA	Non-Attainment	300,524	333,577	11.00%	2.20%
Weld	NAA	Non-Attainment	254,166	285,174	12.20%	2.44%

Top 5 Population Top 5 Annual Growth

As shown in Table 3-3, of the five highest county populations in the state, four are within the DM/NFR. El Paso is represents the 2nd highest county population, however as stated above, all monitoring locations in AQCR 4 show compliance with the revised 8-hour standard. Also, of the five highest growth areas by population from 2010 to 2015, all five are in the current DM/NFR nonattainment area.

Summary Conclusions for Remainder of Colorado

The State recommends that the remainder of the State be designated as attainment/unclassifiable for the revised 2015 8-hour ozone standard. This recommendation is based on (1) monitoring information that indicates compliance with the revised standard (2) precursor emission levels that are presumed to not result in violations of the 2015 8-hour ozone standard, and (3) relatively low population levels.

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