

UTAH AREA DESIGNATION RECOMMENDATIONS FOR THE 2015 8-HOUR OZONE NATIONAL AMBIENT AIR QUALITY STANDARD

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Purpose

The purpose of this document is to provide Utah's recommendation regarding area designations for the revised National Ambient Air Quality Standard (NAAQS) for ozone promulgated on October 1, 2015, under Section 109 of the Clean Air Act (Act).

Overview of Ozone in Utah

The occurrence of ozone in the State of Utah should be considered on a regional basis. In general, higher concentrations of ozone are monitored in certain core areas where the majority of Utah's population resides and where most major industry is located. These core areas are also where high local and interstate vehicular traffic predominate. In Utah, these core areas are part of a larger geographical region, better known as the Wasatch Front, extending from Weber County on the north to Utah County on the south, a distance of approximately 90 miles. This area is bounded on the east by the Wasatch Range and on the west by smaller north-south mountain ranges and the Great Basin. The Wasatch Range is actually an extension of the Northern Rocky Mountains which extends southward to Mount Nebo, in southern Utah County.

The yearly trend of NAAQS exceedances for ozone during the last twenty years shows a steady decline in ambient ozone concentrations (see Figure 1). This trend has occurred at the same time that the federal standard has twice been lowered. During this same timeframe, counties along the Wasatch Front maintained the applicable standard, if only by the slightest of margins. Ambient ozone data collected in recent years show violations of the 2015 8-hr standard at monitors located within the state's Wasatch Front area monitoring network, while permanent monitors located in areas outside the Wasatch Front typically do not. This is the basis for the State's position that ozone generated in the major core area of the Wasatch Front actually moves throughout the area and is the probable cause for increased ozone concentrations being recorded in some peripheral locations along the Wasatch Front. A further discussion of this phenomenon can be found later in this document. Elevated ozone levels are also observed in northeastern Utah in a geographic area known as the Uinta Basin (Basin). Figure 2 shows monitoring locations around the State and highlights the Wasatch Front and Uinta Basin for reference.

Data collected along the Wasatch Front and in the Basin also indicate that ozone is a seasonal problem. On the Wasatch Front we observe episodic elevated concentrations during the summer months, usually June through August, when daylight hours are longer. In the Basin, high ozone levels typically occur when there is snow cover and a persistent temperature inversion that acts to inhibit any substantial vertical movement of the air. A broader discussion of the unique nature of the Basin's winter ozone is found later in this document.

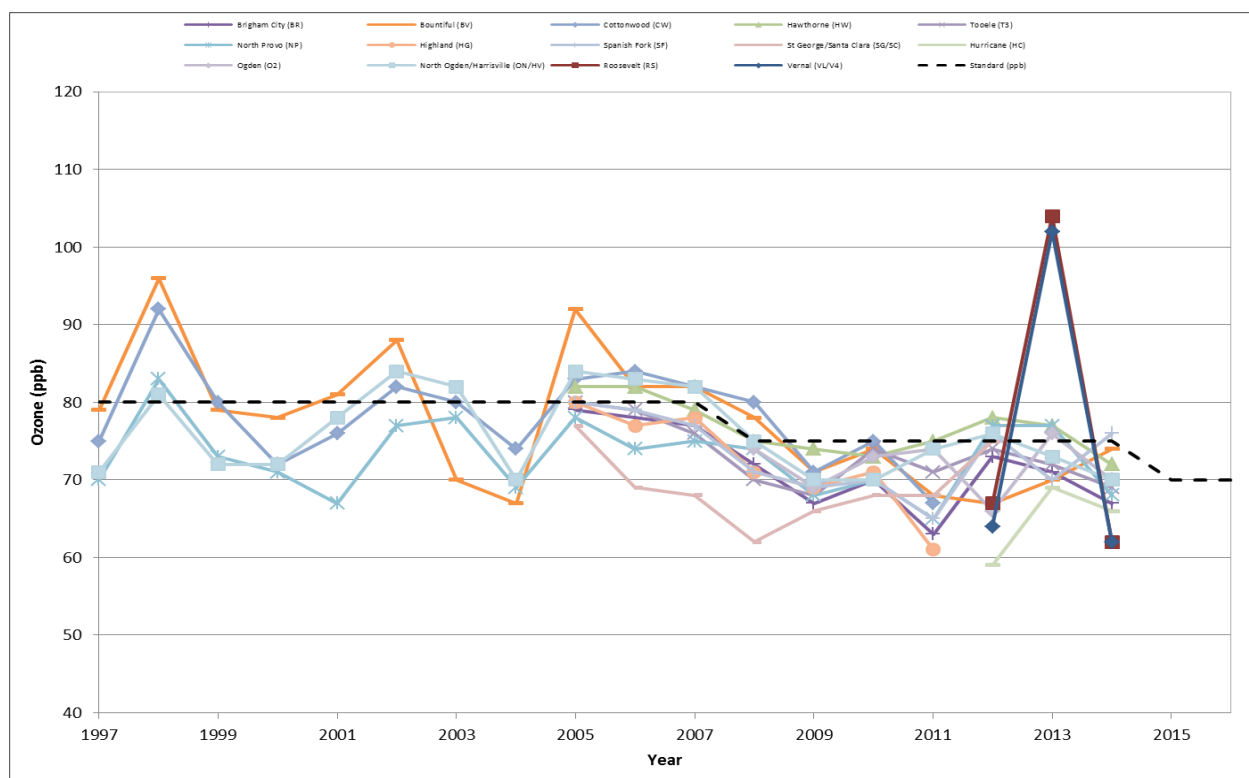


Figure 1. Yearly ambient ozone trends in Utah.

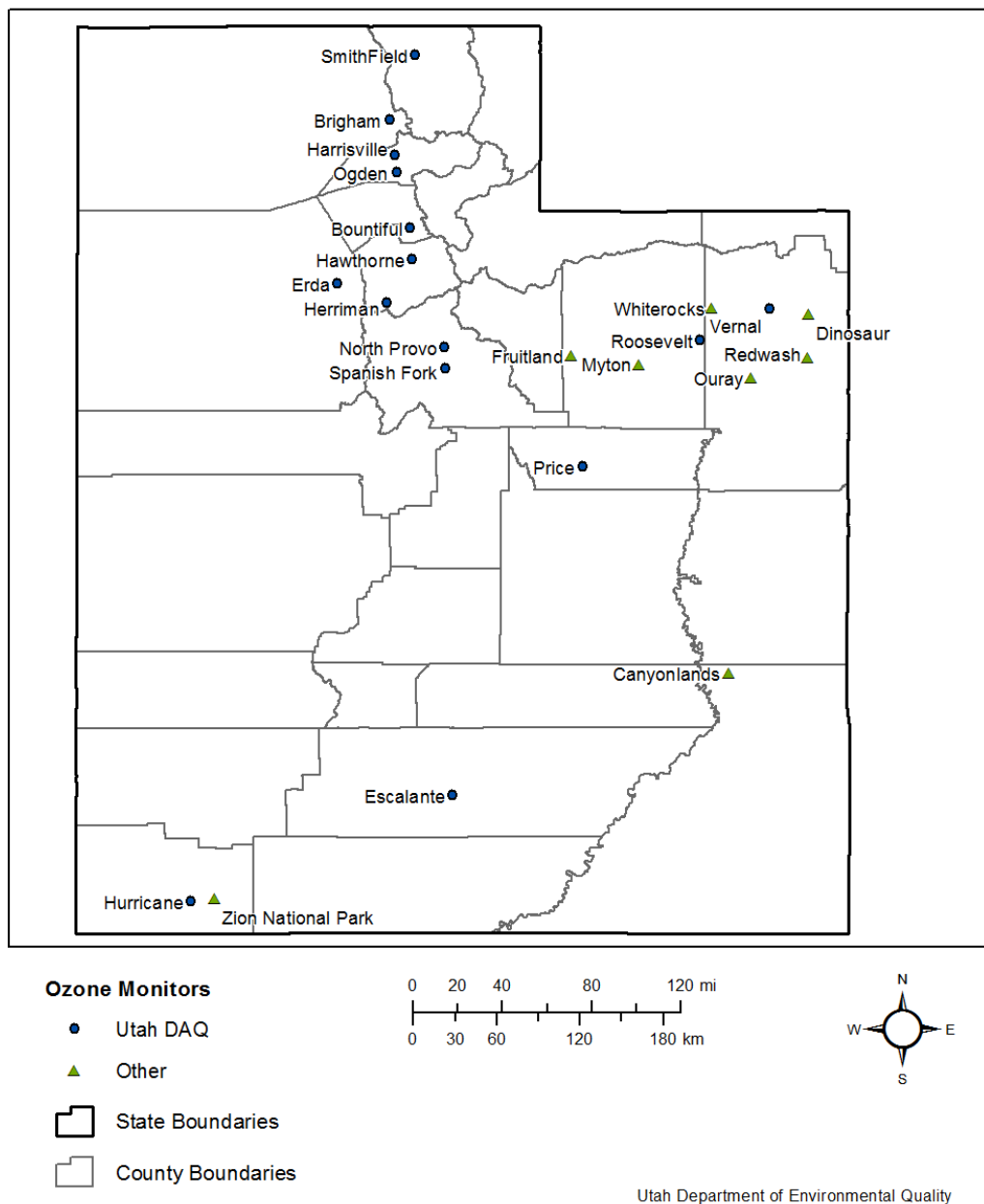


Figure 2. Utah ozone monitoring network.

Ozone concentrations along the Wasatch Front generally increase from mid-to-late morning until late afternoon when ultraviolet radiation reaches its maximum. As the solar radiation subsides and evening rush hour traffic increases, data suggests that some of the ozone is scavenged by NO_x and concentrations begin to decrease. Ozone concentrations generally remain at relatively low levels throughout the night and begin to increase the following morning after the rush hour traffic subsides. If clear skies and light winds persist over a period of two to three days, ozone can continue to form and accumulate along the Wasatch Front core area where it is contained vertically by nighttime subsidence and horizontally by the local topography as shown in Figure 3 below.

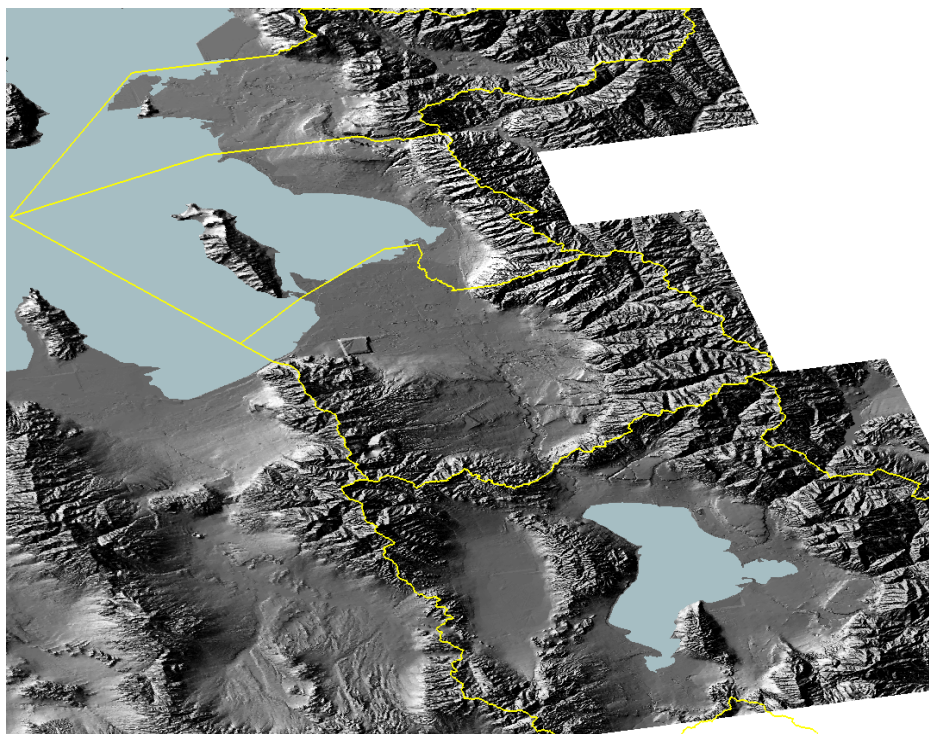


Figure 3. Utah's Wasatch Front extending from Utah County (Lower right) to Box Elder County (Upper left).

Data from both Utah Division of Air Quality (DAQ) and National Park Service (NPS) monitors located in more rural and remote areas of the state show lower concentrations of ozone than those recorded along the Wasatch Front. In many cases, these remote concentrations are substantially lower, and may reflect a normal regional background-level of ozone. At times, however, the regional background level of ozone may increase due to ozone transport or as a result of exceptional events, such as wildfires or stratospheric intrusions. A reasonable conclusion from available remote monitoring data is that, with the exception of wintertime ozone formation in the Basin, the NAAQS is generally not exceeded outside of the urbanized or semi-urbanized counties that make up the Wasatch Front.

Ozone is formed by a chemical interaction of VOCs and NO_x in the presence of solar radiation. Winds that occur during stagnant periods are generally of the diurnal mountain-valley variety, or very light breezes that flow generally north-south along the Wasatch Front. On many occasions under these conditions, areas of higher ozone concentration have been transported by these local breezes. By tracking daily ozone concentrations at various locations along the Wasatch Front, it has been noted that these concentrations increase and decrease in patterns that are consistent with local wind flows. For example, with a light southerly flow, concentrations that were originally higher in Utah or Salt Lake counties tended to decrease while concentrations that were originally lower in Weber and Box Elder counties tended to increase. Refer to Figure 4 for reference to the location of counties in northern Utah. With a light northerly flow, the opposite effect was noted (i.e., concentrations at northern monitors tended to decrease while concentrations at southern monitors tended to increase). The same phenomenon is true for light diurnal southeast-northwest flows.

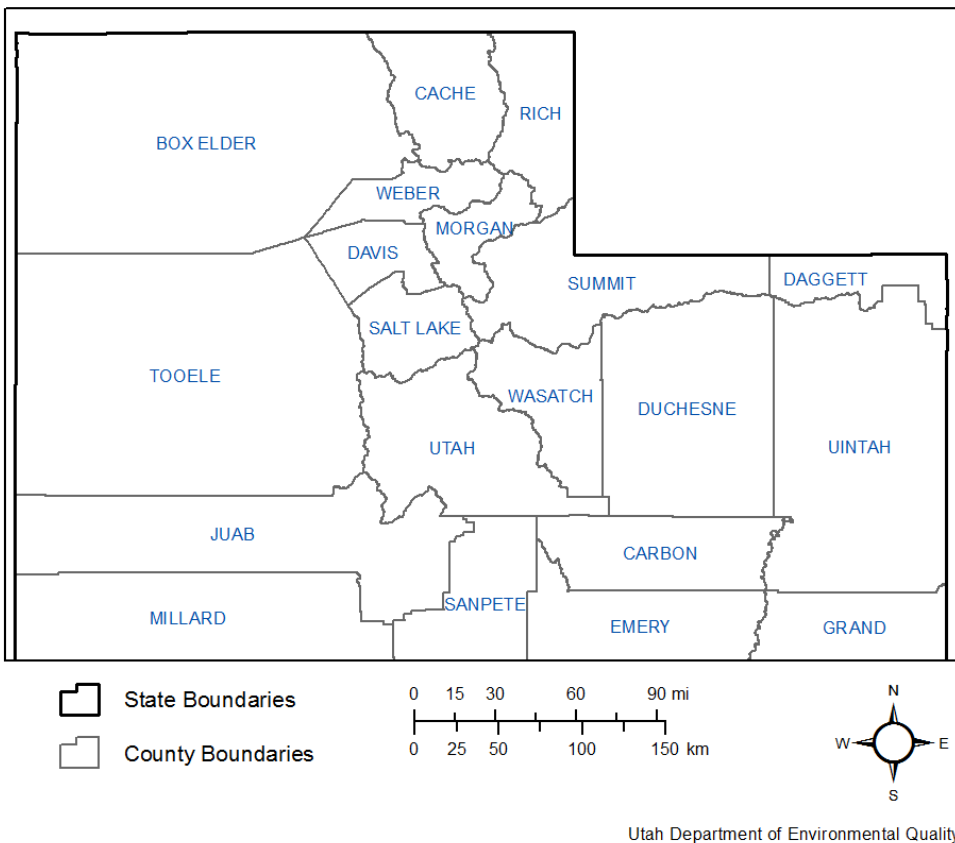


Figure 4. Counties of Northern Utah.

Ozone is generally considered an urban pollutant since the precursors needed for its formation are present in most urban environments and are generally not present in rural environments. This serves to highlight the distinction between urban areas that generally cause pollution and rural areas that may or may not contribute to an ozone problem. Much of this phenomenon is also due to the fact that the bulk of Utah's population (over 75%) is generally located within lowland valley areas along the Wasatch Front in which air is easily trapped by meteorological conditions and local topography. In other words, in Utah it is not simply the case of an urban area with an urban mix of emissions; there is also a barrier to dispersion which allows ozone concentrations to build up over a period of time and reach concentrations that can eventually exceed the NAAQS.

The foregoing characterization of Utah's ozone problem has shaped the State's approach to making these area designations. The vast majority of Utah is sparsely populated (see Figure 12). According to the 2010 U.S. Census, Utah's population was 2,763,885. Over 75% of that population lived in the four Wasatch Front counties (Weber, Davis, Salt Lake, and Utah). Most of the monitoring data has been collected in the heavily populated urbanized areas of the State. This suggests that most of the areas recommended for designation as either "attainment/unclassifiable" will be either in the rural areas of the State or in areas where precursors of ozone are not generated. Those areas recommended for the "nonattainment" designation will be urban areas where most of the sources of ozone precursors are found.

Regulatory Background

On October 1, 2015, the EPA promulgated revisions to the NAAQS for ground-level ozone. It revised the 8-hour primary (health-based) ozone standard to a level of 0.070 parts per million (ppm). The previous standard, set in 2008, was 0.075 ppm. Additionally, the EPA specified the level of the primary standard to three decimal places. The EPA also revised the 8-hour secondary (welfare-based) ozone standard to be identical to the revised primary standard.

Section 107(d) of the Act establishes that it is incumbent on each state to recommend initial designations for all areas within its respective geographic boundary following promulgation of a new or revised NAAQS. States are required to submit these recommendations to EPA, based on the most current three year data set, not later than one year after the promulgation of the new or revised standard.

Areas should be designated as attainment, nonattainment, or unclassifiable. The Act allows that areas may be designated as:

- a) attainment for any area other than an area identified in clause (b) that meets the national primary or secondary ambient air quality standard for the pollutant; or
- b) nonattainment for any area that does not meet (or that contributes to ambient air quality in a nearby area that does not meet) the national primary or secondary ambient air quality standard for the pollutant; or
- c) unclassifiable, for any area that cannot be classified on the basis of available information as meeting or not meeting the national primary or secondary ambient air quality standard for the pollutant.

EPA must finalize the area designations as expeditiously as practicable, but not later than two years following the effective date of the revised NAAQS. In the event that EPA intends to promulgate a designation that deviates from the State's recommendation, it must notify the State at least 120 days prior to promulgating the modified designation to provide the State an opportunity to comment. The EPA's designation of areas for the 8-hour ozone NAAQS will be based on the most current three consecutive years of air quality data at the time of the final designation.¹

Applicable Guidance

On February 25, 2016, EPA issued a guidance memorandum to assist States and Tribes in making their recommendations with respect to ozone.² The memorandum indicated that the Combined Statistical Areas (CSA) or, where appropriate, Core Based Statistical Areas (CBSA) be

¹ For the 8-hour ozone NAAQS, it is the three consecutive years of data obtained in accordance with 40 CFR part 50, Appendix I; data used will be quality-assured and meet 40 CFR part 58 requirements (e.g., for monitor siting). Recommended designations should generally be made based on 2013-2015 monitored air quality data and final designations on 2014-2016 data.

² "Area Designations for the 2015 Ozone National Ambient Air Quality Standards," Memorandum from Janet G. McCabe dated February 25, 2016.

used for analyzing whether nearby areas contribute to the violation in the violating area. The EPA also emphasized that these statistical area boundaries are not presumed to be the nonattainment area.³

Current CSAs and Metropolitan Statistical Areas (MSAs) in the State of Utah and the counties that are included in these areas are as follows (Figure 5):

- *Logan MSA:*
 - Cache County, Utah
 - Franklin County, Idaho
- *St. George MSA:*
 - Washington County
- *Ogden-Clearfield MSA:*
 - Box Elder County
 - Davis County
 - Morgan County
 - Weber County
- *Salt Lake City MSA:*
 - Salt Lake County
 - Tooele County
- *Provo-Orem MSA:*
 - Juab County
 - Utah County
- *Salt Lake City-Provo-Orem CSA:*
 - Ogden-Clearfield MSA
 - Salt Lake City MSA
 - Provo-Orem MSA
 - Summit County
 - Wasatch County

³ Section 107(d)(4)(A)(iv) of the Clean Air Act states that the CSA or CBSA is the presumptive boundary only if the area will be classified as Serious, Severe, or Extreme. The Wasatch Front will likely be classified as Marginal.

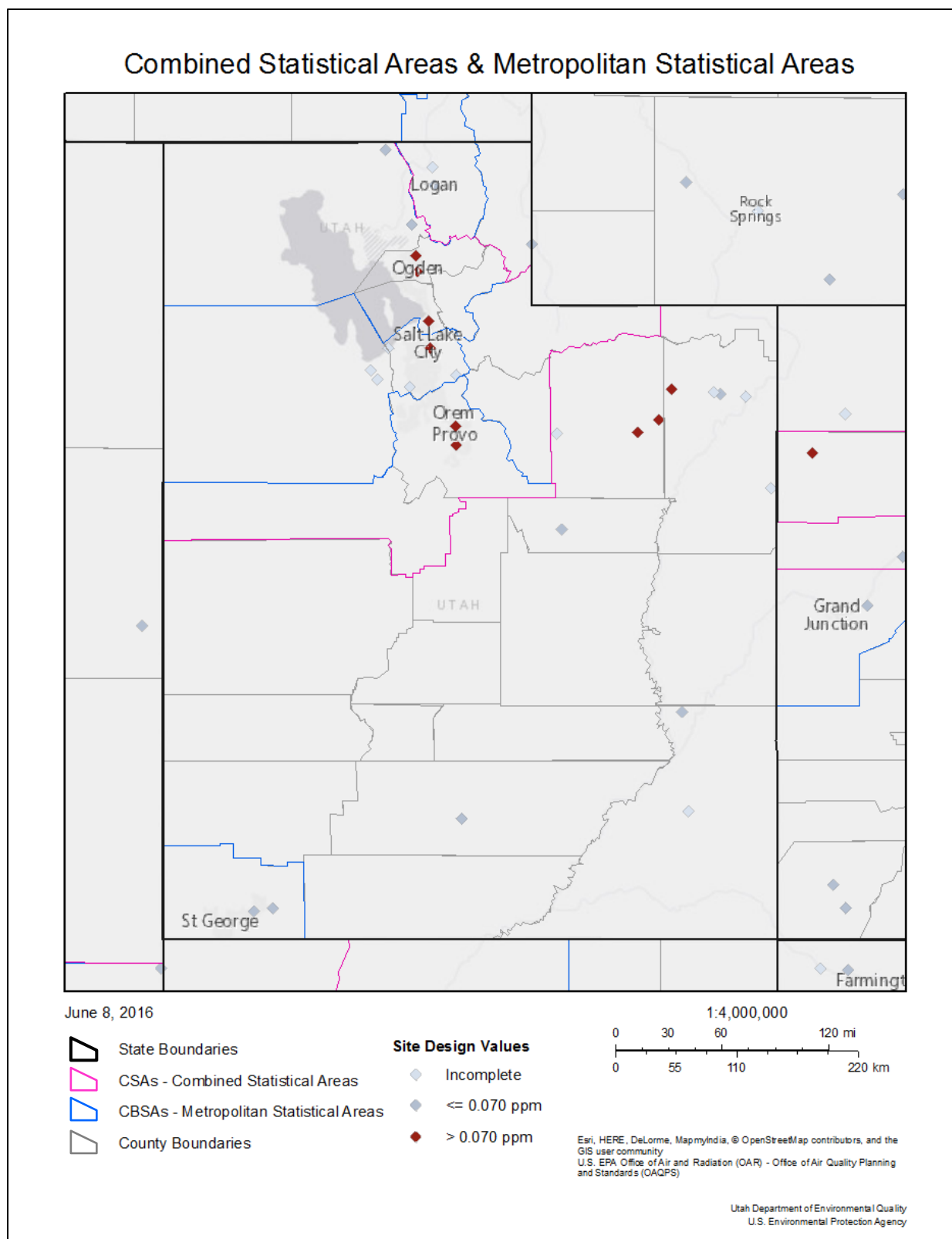


Figure 5. Utah Combined Statistical Areas and Metropolitan Statistical Areas.

Section 107(d) of the Act addresses the determination of when an area is to be designated nonattainment. With respect to the 8-hour ozone NAAQS, all areas are to be designated nonattainment if they do not meet the standard or contribute to the violation in the violating area. The guidance memorandum further stated that the EPA believes that the boundaries for each nonattainment area should be evaluated on a case-by-case basis, considering the following factors:

- 1) Air Quality monitoring data,
- 2) Emissions and emissions-related data,
- 3) Meteorological data,
- 4) Geography/Topography, and
- 5) Jurisdictional boundaries.

General Air Quality Data

The following table (Table 1) shows all regulatory monitors in Utah with three continuous years of ozone monitoring data. Highlighted monitors have a design value (DV) that exceeds the current 0.070 ppm ozone NAAQS.

Table 1. Utah ozone 2013-2015 design values in parts per million.

Site ID	Site Name	County	3-Year DV	2013 4th Max	2014 4th Max	2015 4th Max
49-003-0003	Brigham City	Box Elder	0.068	0.071	0.067	0.068
49-003-7001*	Portage	Box Elder	0.064	0.065	0.061	0.067
49-013-0002	Roosevelt	Duchesne	0.075	0.104	0.062	0.060
49-013-7011*	Myton	Duchesne	0.074	0.089	0.067	0.066
49-005-0004	Logan	Cache	0.064	0.066	0.059	0.067
49-007-1003	Price	Carbon	0.066	0.067	0.064	0.069
49-011-0004	Bountiful	Davis	0.072	0.070	0.074	0.073
49-017-0004*	Escalante National Monument	Garfield	0.065	0.067	0.060	0.068
49-035-3006	Hawthorn (Salt Lake City)	Salt Lake	0.076	0.077	0.072	0.081
49-037-0101*	Canyonlands National Park	San Juan	0.065	0.066	0.064	0.065
49-047-7022*	Whiterocks	Uintah	0.066	0.066	0.064	0.068
49-047-2002*	Redwash	Uintah	0.072	0.088	0.061	0.067
49-047-2003*	Ouray	Uintah	0.079	0.092	0.079	0.068
49-049-0002	North Provo	Utah	0.072	0.077	0.068	0.073
49-049-5010	Spanish Fork	Utah	0.072	0.070	0.076	0.071
49-053-0007	Hurricane	Washington	0.068	0.069	0.066	0.069
49-053-0130*	Zion National Park	Washington	0.067	0.070	0.065	0.066
49-057-0002	Ogden	Weber	0.072	0.076	0.070	0.072
49-057-1003	Harrisville	Weber	0.072	0.073	0.070	0.074

*Not maintained or operated by the State of Utah

Based on these DVs, the following counties should be designated attainment: Box Elder, Cache, Carbon, Garfield, San Juan, and Washington. The following counties, in whole or in part, should be considered as part of Utah's initial nonattainment area designation: Duchesne, Uintah, Davis, Salt Lake, Utah, and Weber. Along with counties where the DV exceeds the NAAQS, we will consider whether adjacent counties within the CSA or CBSA significantly contribute to the ozone exceedances. The additional counties considered are Box Elder, Juab, Morgan, Summit, Tooele, and Wasatch. Of these additional counties to be considered, it should be noted that Tooele and Box Elder counties do have ozone monitors. Box Elder County's Brigham City monitor is typically below the 2015 ozone NAAQS. Its 2013-2015 DV is 0.068. The preliminary DV for 2014-2016 is 0.067. While Tooele County monitors do not have three years of monitoring data (see Table 2), the fourth highest value at either monitor has exceeded the 2015 standard three out of the last four years.

Monitors without three continuous years of data

Several monitors in Utah do not have three continuous years with at least four days of data as required for calculating a DV. Table 2 shows the existing data for each of these monitors. Each of the counties containing these monitors is already being considered as part of this recommendation because they are either in the CSA or contain another monitor with three years of data and have a DV over 70 ppb.

Table 2. Utah monitors with incomplete design values.

Site ID	Site Name	County	2013 4th Max	2014 4th Max	2015 4th Max	2016 4 th Max*
49-013-1001	Fruitland	Duchesne	0.069			
49-035-2004	Beach	Salt Lake	0.075	0.064		
49-035-3013	Herriman	Salt Lake			0.074	0.076*
49-045-0003	Tooele	Tooele	0.072	0.069		
49-045-0004	Erda	Tooele			0.071	0.072*
49-047-1003	Vernal #3	Uintah	0.102	0.062		
49-047-1004	Vernal #4	Uintah			0.064	0.073*

*Data not certified

In addition to monitors without three years of continuous data, DAQ placed several temporary monitors throughout the State for research purposes. While the monitors are non-regulatory, the data collected at those sites is relevant to determining areas that contribute to the nonattainment counties. Because these temporary monitors were used to determine how ozone moves around the Salt Lake Valley and other parts of the State, it is more appropriate to address these studies as part of the meteorology factor.

The air quality data collected for Utah indicates that there are two distinct ozone issues within the State. There are the more typical summer time high ozone events along the Wasatch Front, and then the more unique wintertime events that occur in the Basin located in Duchesne and Uintah counties. As the emission sources, chemistry of ozone formation, meteorology and

jurisdictional complexity are unique to these two areas, they will be addressed separately within the ozone designation recommendation by the State of Utah.

Wasatch Area Analysis and Recommendation

Emissions and Emissions Related Data

Ozone is not directly emitted from any source. It is formed when two precursors, VOCs and NO_x, react when exposed to ultraviolet radiation. To determine which areas of Utah may be contributing to the ozone formation in Weber, Davis, Salt Lake, and Utah counties, we need to understand the sources of the emissions and analyze the total VOC and NO_x emissions in each of the counties within the Salt Lake City-Provo-Orem CSA. All of the following emissions figures are from the 2011 National Emissions Inventory (NEI).

VOC Emissions

While VOCs can come from a variety of sources, biogenics make up a vast majority of the VOC emissions in Utah's more rural counties. As an example, Tooele has the highest total VOC emissions of the ten counties within the CSA, but Figure 6 shows that 93% of those emissions come from biogenic sources. Other counties with high VOC emissions relative to the four Wasatch Front counties (Figure 7) are Box Elder, Juab, Summit, and Wasatch. Biogenics make up 90%, 98%, 85%, and 91%, respectively. Morgan County has very low VOC emissions overall and 90% of them are biogenic. While it is possible that these counties may be contributing VOCs that in turn contribute to the formation of ozone along the Wasatch Front, it is unreasonable to include them in the nonattainment area because the VOCs are coming from nonanthropogenic sources.

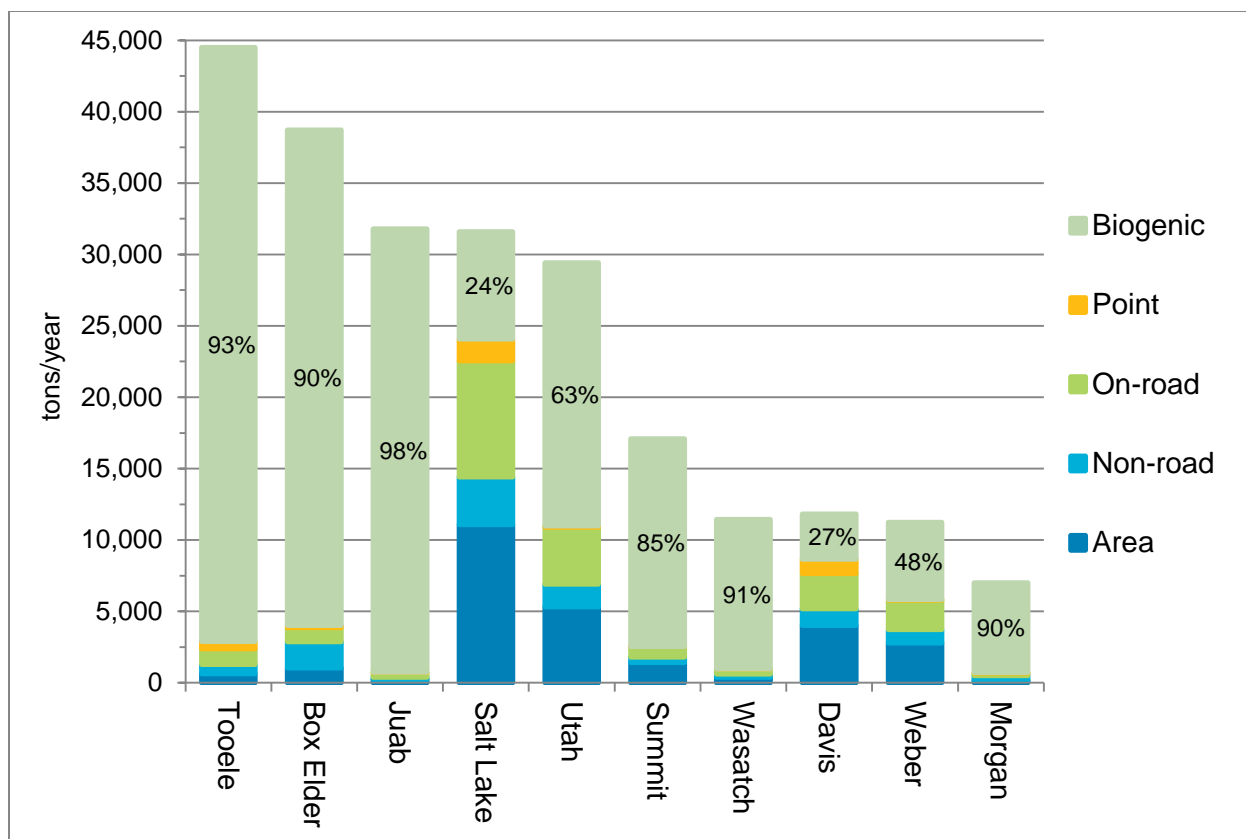


Figure 6. Total VOC emissions by county (Source: 2011 NEI).

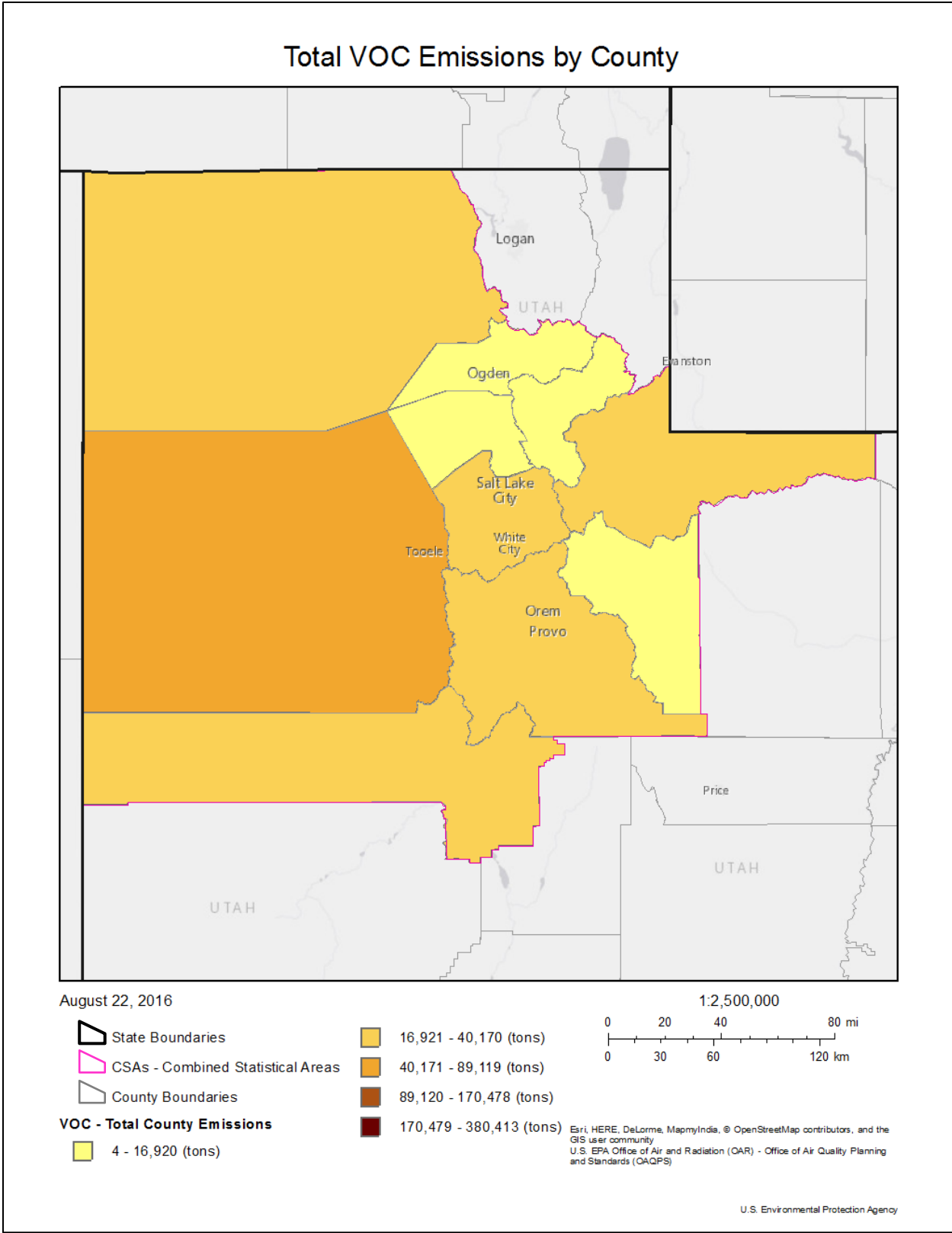


Figure 7. Map of total VOC emissions by county (Source: 2011 NEI).

NOx Emissions

As we look at emissions levels and sources of NOx emissions, it is important to recognize that there are only two ways in which emissions from one county can contribute to ozone exceedances in another county. The precursors can be transported meteorologically through the air currents or from mobile sources that originate in one county and travel to another county. Ozone itself can only be transported by meteorological means because it is not directly emitted by any source. In this section, the focus will be on transport by mobile sources. We will discuss meteorological transport in a following section. Of the six potentially contributing counties, Juab, Morgan, and Wasatch have so few mobile emissions that it is unlikely that they contribute a significant amount of NOx to affect the adjacent violating counties (see Figure 8 and Figure 9). Tooele, Box Elder, and Summit, however, could be contributing mobile emissions. For comparison, the mobile emissions for Juab are roughly half the amount of mobile emissions from Summit County.

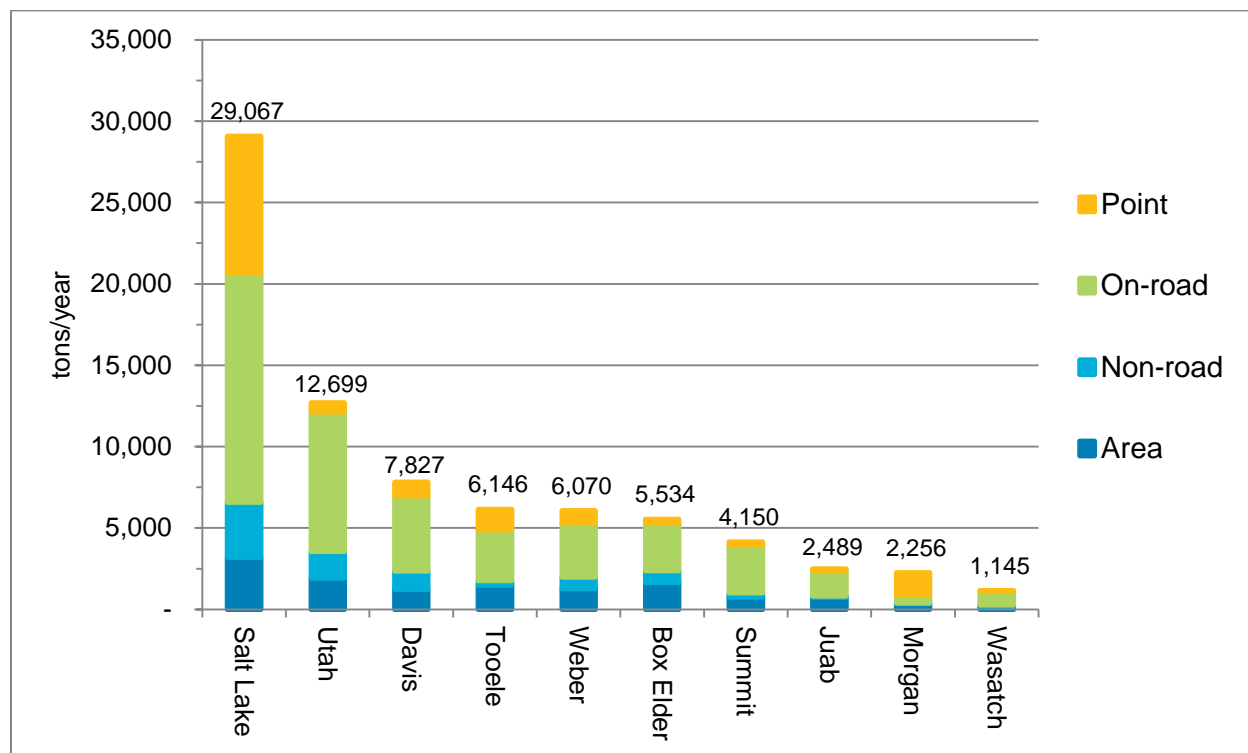
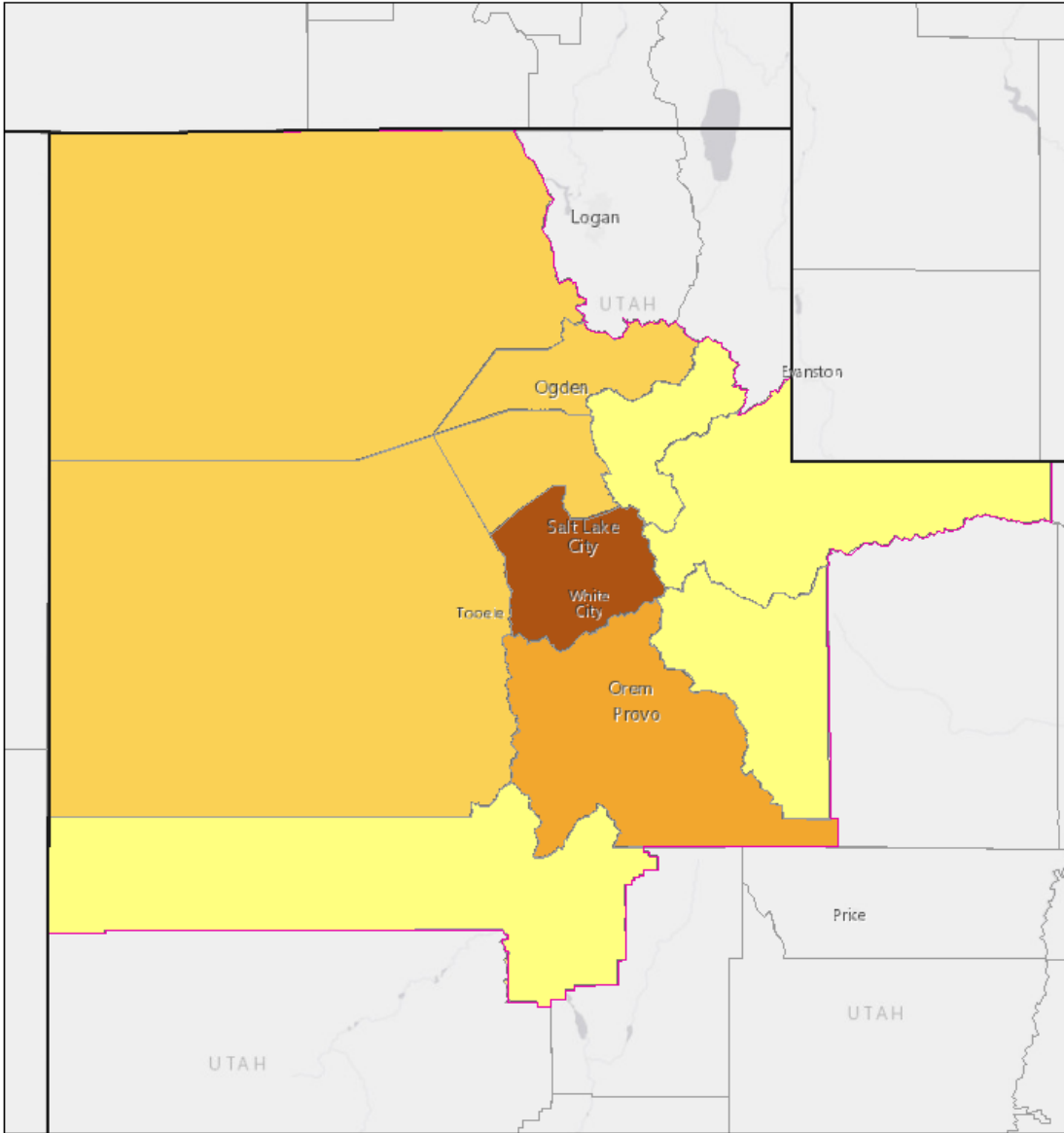


Figure 8. Total NOx emissions by county (Source: 2011 NEI).

Total NOx Emissions by County



August 22, 2016

- State Boundaries
- CSAs - Combined Statistical Areas
- County Boundaries

NOx - Total County Emissions

- 15 - 4,628 (tons)
- 4,629 - 12,077 (tons)
- 12,078 - 27,439 (tons)
- 27,440 - 68,863 (tons)
- 68,864 - 135,857 (tons)

1:2,500,000
0 20 40 80 mi
0 30 60 120 km

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U.S. EPA Office of Air and Radiation (OAR) - Office of Air Quality Planning and Standards (OAQPS)

U.S. Environmental Protection Agency

Figure 9. Map of total NOx emissions by county (Source: 2011 NEI).

Traffic and Commuting Patterns

The map in Figure 10 shows that the vehicle miles traveled (VMT) on the road network within the four violating counties is very high overall compared to the rest of the state. The VMT between Box Elder and Weber counties, Tooele and Salt Lake counties, and Summit and Salt Lake counties is elevated. Within the Weber-Davis-Salt Lake County area there are 42 million VMT per weekday. Of those VMT, 0.6% originates in Summit County, 1.2% originates in Tooele County, and 1.0% originates from Box Elder County.⁴ Slightly higher percentages in Tooele and Box Elder counties show that these likely have a large percentage of people who commute into one of the violating counties for work. According to the American Community Survey conducted from 2009 to 2013, over 10,000 people commute from Tooele to one of the four violating counties each day. This is approximately 40% of the total commuters in Tooele County. Just over 5,000 people commute from Box Elder County to a violating county. Only 24% of Box Elder and Summit County commuters go to one of the violating counties (see Table 3). Trips originating from a violating county to an adjacent county will increase the VMTs along a corridor but show that emissions from those VMTs are not being contributed from the adjacent County. Over 5,600 people commute from a violating county to work in Summit County.⁵ Summit County is also a tourist destination so it is safe to assume that a large portion of the VMTs between Salt Lake County and Summit County are due to people traveling from Salt Lake to Summit to recreate.

Based on mobile emissions and their origins, Utah recommends that Morgan, Wasatch, Juab, Box Elder, and Summit counties be excluded from the nonattainment area. We also recommend that some portion of Tooele County be included in the nonattainment area designation.

⁴ Utah Travel Study. 2013. Wasatch Front Regional Council (WFRC), Mountainland Association of Governments (MAG), Cache Metropolitan Planning Organization (CMPO), Dixie Metropolitan Planning Organization (DMPO), Utah Department of Transportation (UDOT), and Utah Transit Authority (UTA). Available at: http://www.wfrc.org/new_wfrc/publications/Utah_FinalReport_130228.pdf.

⁵ American Community Survey 2009-2013. U.S. Census Bureau. Available at: http://www2.census.gov/programs-surveys/acs/tech_docs/accuracy/MultiyearACSAccuracyofData2013.pdf

Table 3. County to County commuting flows within the 10-County CSA (Source: U.S. Census Bureau, American Community Survey 2009-2013. For more information see <http://www2.census.gov/programs-surveys/acs/tech_docs/accuracy/MultiyearACSAccuracyofData2013.pdf>).

County	Total # Commuting	Commuting within County	Commuting to other Counties	Violating Counties	# Commuting to four violating Counties	% Commuting to four violating Counties
BOX ELDER	21,325	14,796	6,529	Davis	1,053	5%
				Salt Lake	592	3%
				Utah	19	0%
				Weber	3,422	16%
DAVIS	140,788	75,279	65,509	Davis	X	X
				Salt Lake	44,509	32%
				Utah	860	1%
				Weber	17,205	12%
JUAB	4,277	2,585	1,692	Davis	5	0%
				Salt Lake	229	5%
				Utah	1,118	26%
				Weber	-	0%
MORGAN	4,067	1,399	2,668	Davis	706	17%
				Salt Lake	489	12%
				Utah	23	1%
				Weber	1,276	31%
SALT LAKE	504,160	468,609	35,551	Davis	10,020	2%
				Salt Lake	X	X
				Utah	11,416	2%
				Weber	1,628	0%
SUMMIT	19,261	13,697	5,564	Davis	219	1%
				Salt Lake	4,170	22%
				Utah	130	1%
				Weber	95	0%
TOOELE	25,377	14,097	11,280	Davis	390	2%
				Salt Lake	9,536	38%
				Utah	165	1%
				Weber	113	0%
UTAH	221,591	183,673	37,918	Davis	1,034	0%
				Salt Lake	31,971	14%
				Utah	X	X
				Weber	297	0%
WASATCH	11,059	5,796	5,263	Davis	3	0%
				Salt Lake	1,002	9%
				Utah	816	7%
				Weber	76	1%
WEBER	105,102	70,743	34,359	Davis	21,951	21%
				Salt Lake	8,513	8%
				Utah	360	0%
				Weber	X	X

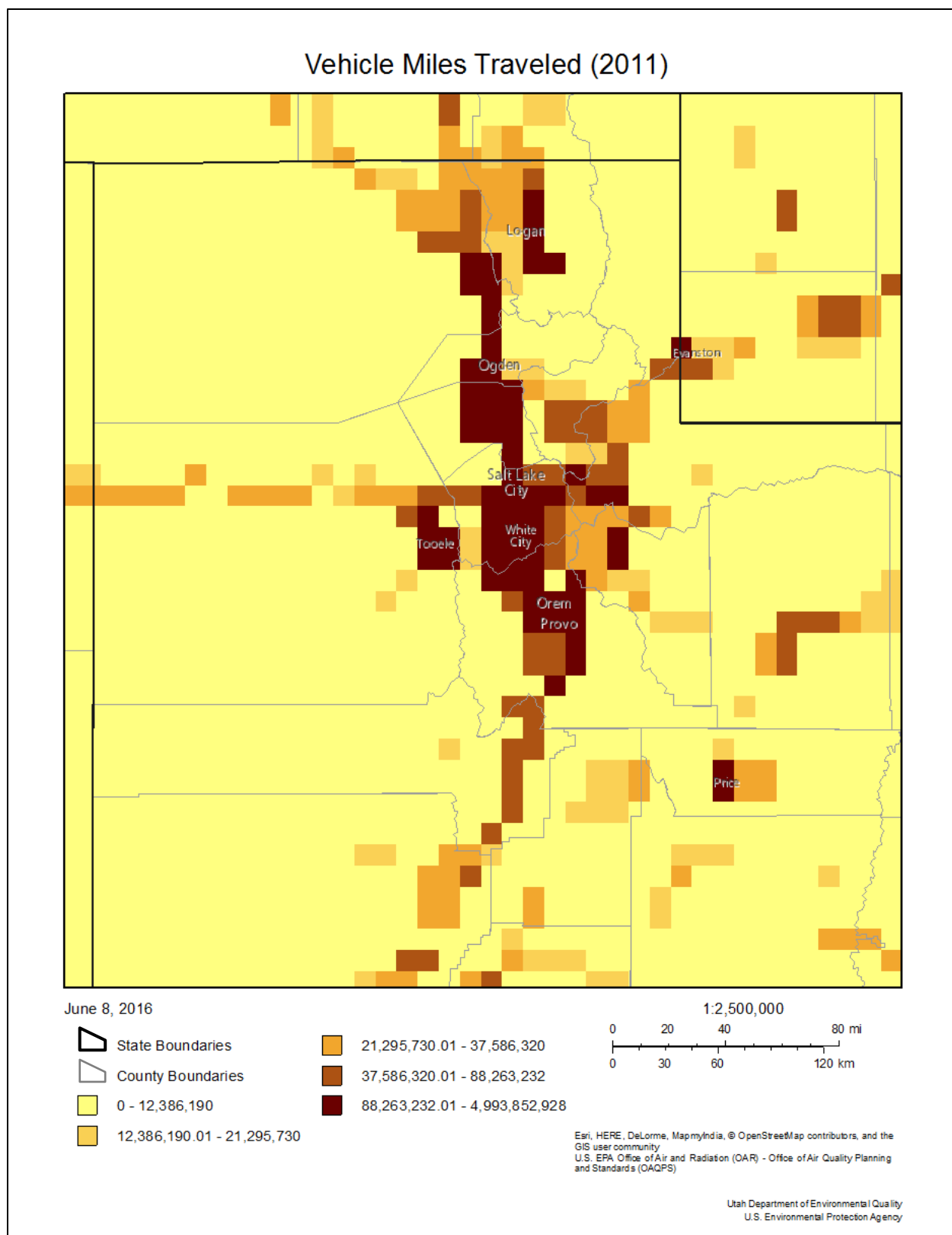


Figure 10. Vehicle Miles Traveled (VMT) on Utah roads (Source: Based on the 2011 NEI and data from the Federal Highway Administration and the U.S. Census Bureau).

Population Density and Degree of Urbanization

Some distinctions have been made in the EPA guidance document regarding urban versus rural areas, relating to the presumptive boundaries of nonattainment areas and to the level of assessment required in the case of a departure from the presumption. Urban areas are generally considered to be metropolitan areas surrounding core cities, whereas rural areas would be other areas not included in or adjacent to urban areas. In Utah there are several instances where both urban and rural areas can be found within a single MSA. In many of these instances urban and rural areas have no actual effect on each other. Reasons for this are significant separation due to topographical features, large areas of sparsely populated desert or rangeland, and very large MSAs. Figure 11 shows the population density of the counties in the CSA. Figure 12 shows the population density by census tract. The Salt Lake City-Provo-Orem CSA combines the Salt Lake City MSA, the Ogden-Clearfield MSA, the Brigham City Micropolitan Statistical Area (Box Elder County), and the Heber Micropolitan Statistical Area (Wasatch County).

There are two very noticeable features of the CSA. The first feature is the small area that is urbanized compared to the rural and uninhabited portions of the counties. The second feature is the large size of the CSA. The Salt Lake City-Provo-Orem CSA contains ten counties and covers 25,365 square miles (larger than West Virginia and nine other US states). It extends east/west from the Nevada border to the southern Wyoming border, a distance of over 220 miles, and south from the Idaho border approximately 100 miles. Each of the MSAs within the CSA includes densely populated areas, sparsely populated areas, and very large areas with no population at all. The sparse or unpopulated areas are due to extended desert in the west and extreme mountainous terrain in the east. The largest concentration of both population and industry is found in the low valleys west of, and adjacent to, the Wasatch Front. Smaller concentrations of population are also found in some of the higher valleys east of the Wasatch Range, but there are generally few or no major industrial sources located in these areas. For the reasons cited above, Utah feels it is more appropriate to designate nonattainment areas based on the core urban area rather than the CSA boundary.

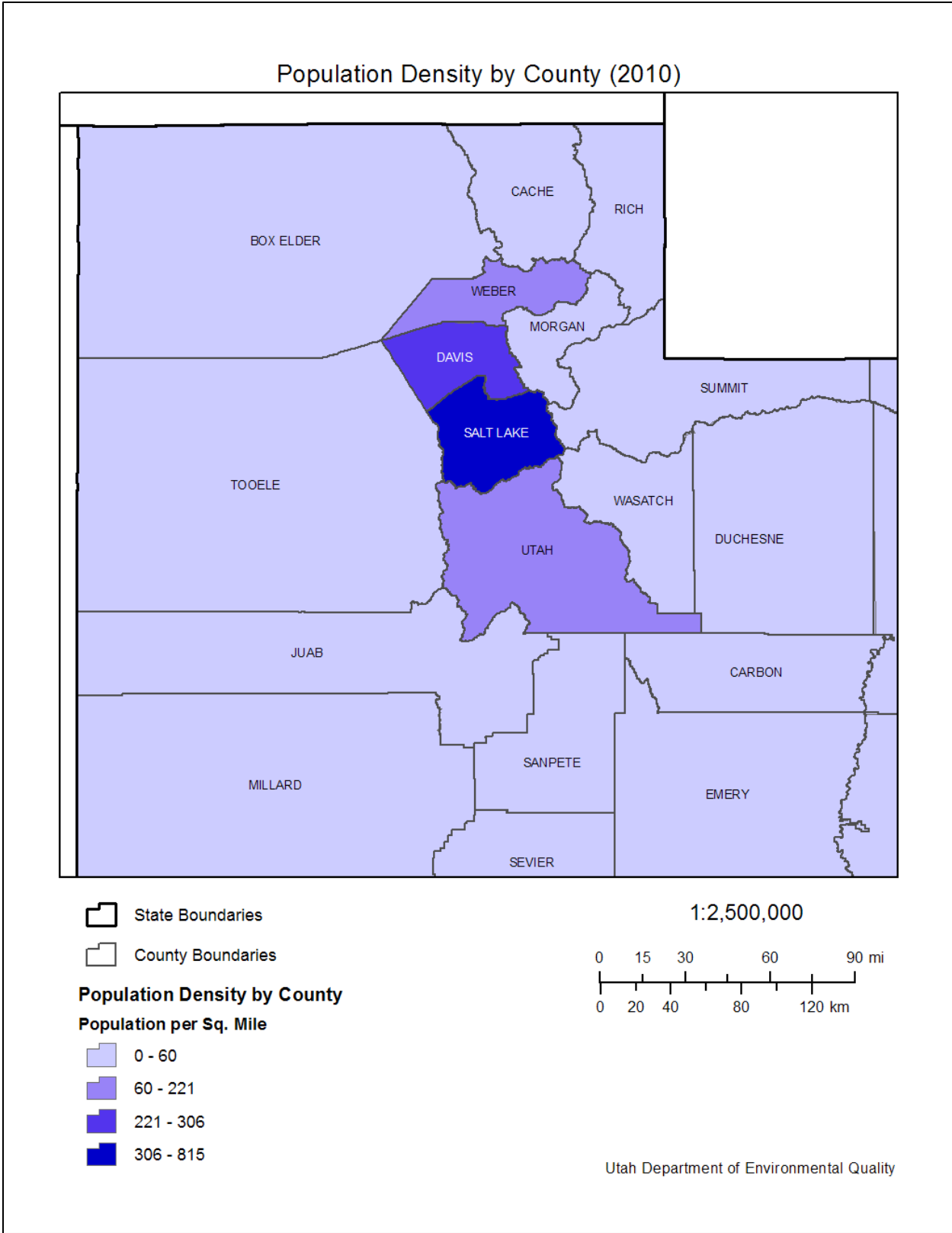


Figure 11. Population density (people/square mile) of counties in Utah. Based on the 2010 U.S. Census.

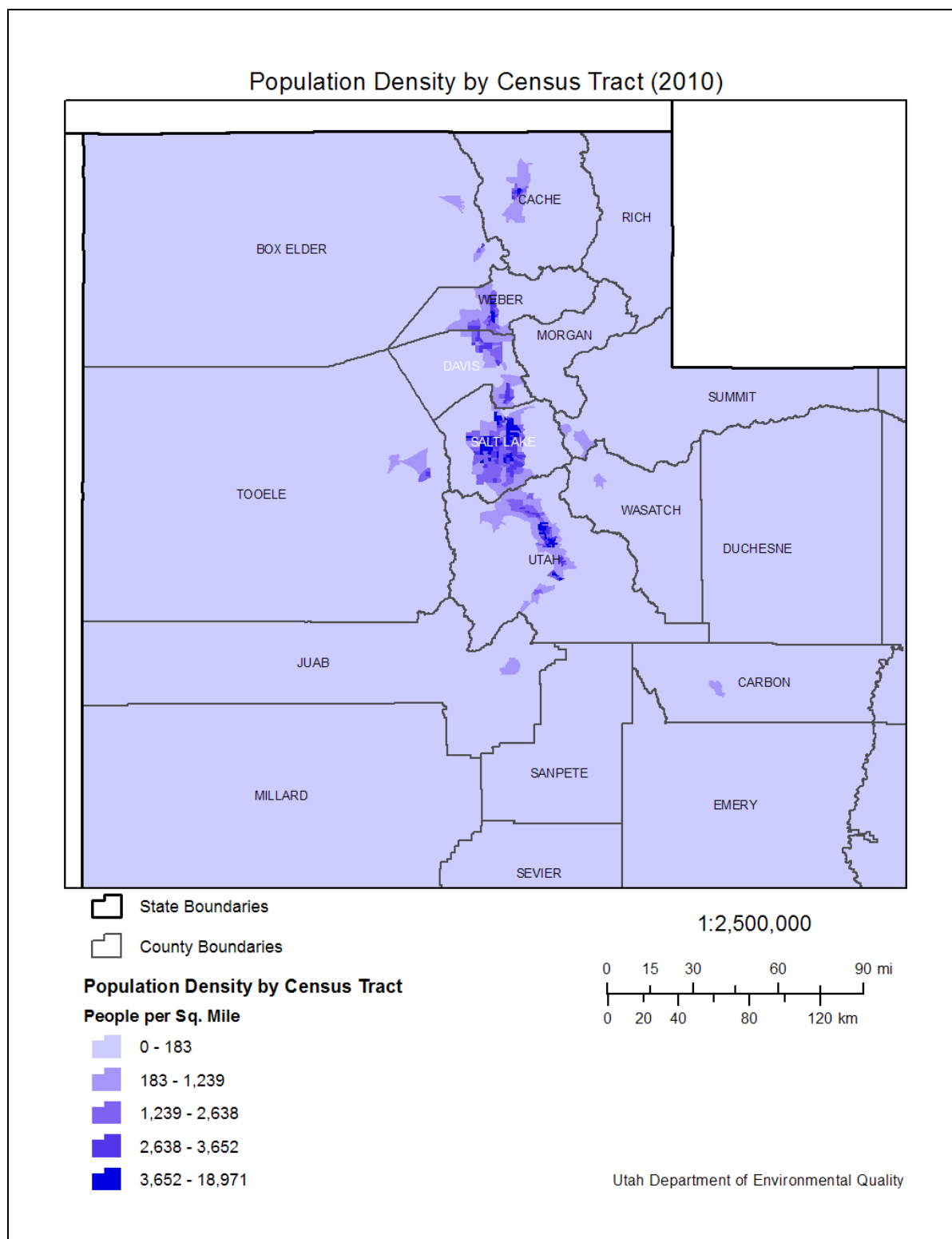


Figure 12. Population density (people/square mile) by census tract in Utah. Based on the 2010 U.S. Census.

Meteorology

In the previous section we discussed how mobile emissions move between counties due to traffic and commuting patterns. In this section we consider how meteorological and topographic patterns and features affect the distribution of emissions in the CSA. Utah's meteorology is unique because the mountain range on the east of the most urbanized area and the Great Salt Lake to the west. Over the past four years, several studies have been conducted in Utah, and specifically on the Wasatch Front, to understand how the unique meteorology and topography affect ozone formation and distribution.^{6, 7}

Monitoring done as part of these studies shows elevated ozone concentrations in high mountain valleys such as the area around Park City in Summit County. The higher values are due, in part, to local diurnal airflows that will be discussed later; however, many studies point to higher levels of ozone in the intermountain west, particularly in higher elevations being caused by ozone transport from other areas in the United States, and international sources in Mexico and Asia.^{8, 9} Figure 13 through Figure 16 show 24-hour back trajectory modeling using Hysplit. This model shows upper level air flow coming from neighboring states. It is important to note that there are limitations to the Hysplit model. The major limitation is the coarse model resolution. Data for these runs were based on a 40 kilometer grid. Because of this, the model does not account for large mountain ranges that block or alter air flow at lower altitudes.

High ozone levels in the Wasatch area usually occur episodically in association with a semi-permanent high pressure ridge that becomes stationary over the intermountain region, clear skies, intense direct sunlight, and stagnant air with very light surface wind movement. When these meteorological conditions occur together, they can aid in the formation of ozone while at the same time providing minimal vertical mixing.

Under these conditions, diurnal wind patterns caused by the Wasatch Mountains create mixing and dispersion of ozone along the entire Wasatch Front and adjacent counties.⁷ As a result, increased concentrations of ozone are able to build up over a period of several days and to actually meander or oscillate north/south along the Wasatch Front. Under proper conditions, air originating in a southern area could move northward along the Wasatch Front, and conversely, air originating in a northern area could travel southward along the same path.

Actual day-to-day transport of the ozone along the Wasatch Front is mainly influenced by the diurnal effects of the local on-shore/off-shore flow coupled with an up-slope/down-slope airflow

⁶ Utah Department of Environmental Quality. (2013), 2012 Utah Ozone Study.

⁷ Horel, J., Crosman, E., Jacques, A., Blaylock, B., Arens, S., Long, A., Sohl, J. and Martin, R. (2016), Summer ozone concentrations in the vicinity of the Great Salt Lake. *Atmos. Sci. Lett.* doi:10.1002/asl.680

⁸ Cooper, O. R., R.-S. Gao, D. Tarasick, T. Leblanc, and C. Sweeney. (2012), Long-term ozone trends at rural ozone monitoring sites across the United States, 1991-2010, *J. Geophys. Res.*, 117, D22307, doi: 10.1029/2012JD018261.

⁹ F. Dentener, T. Keating, H. Akimoto, Eds. (2010), Hemispheric transport of air pollution 2010, Part A: Ozone and particulate matter, Air Pollution Studies No. 17, (United Nations, New York and Geneva).

caused by the Great Salt Lake and Utah Lake on the west, and the very prominent Wasatch Range on the east (see Table 4). As mentioned above, areas of high ozone concentration have been shown to oscillate both north and south along the Wasatch Front. They also move east and west from areas adjacent to the Wasatch Front to areas over the Great Salt Lake in Weber, Davis, and Salt Lake counties, and over the Utah Lake in Utah County. In all cases the general westward movement occurs during the late evening and nighttime hours and the reverse eastward movement occurs during the daylight hours. This is a typical mountain valley flow.

In the case of counties east of the Wasatch Range, the diurnal air flow moves air containing “ozone clouds” into and out of these counties on a routine basis and is responsible for some of the higher concentrations monitored in these counties.⁶ This phenomenon is most pronounced in Summit County. Ozone studies conducted in Utah in 2012 and 2015 showed that peak daytime ozone concentrations in Summit County lagged behind those in Salt Lake County by about an hour. In other words, when 1-hour ozone levels spiked in Salt Lake County, they would then spike in Summit County approximately one hour later as the wind pushed the ozone up the canyon. In essence, Summit County is not a significant emitter of ozone or its precursors, but a receptor.

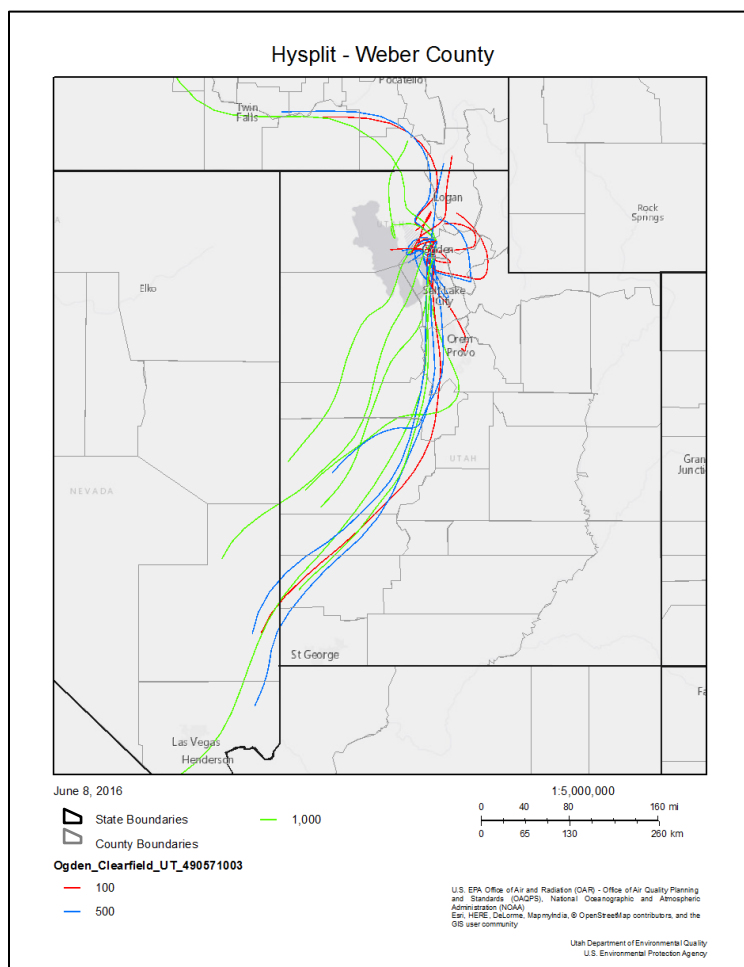


Figure 13. 24-hour back trajectory model of air flow to Weber County monitors during days where ozone concentrations exceeded the NAAQS.

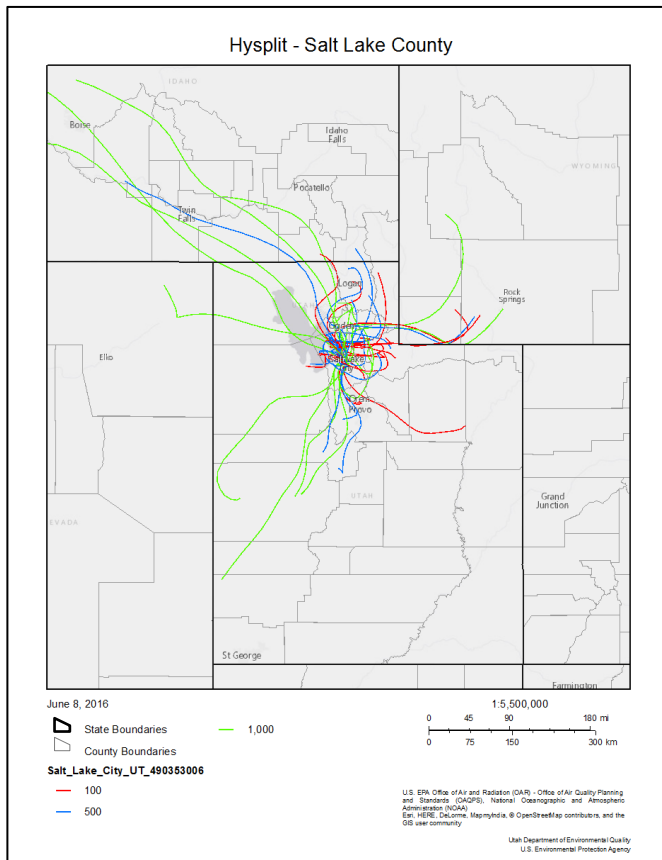


Figure 14. 24-hour back trajectory model of air flow to Salt Lake County monitors during days where ozone concentrations exceeded the NAAQS.

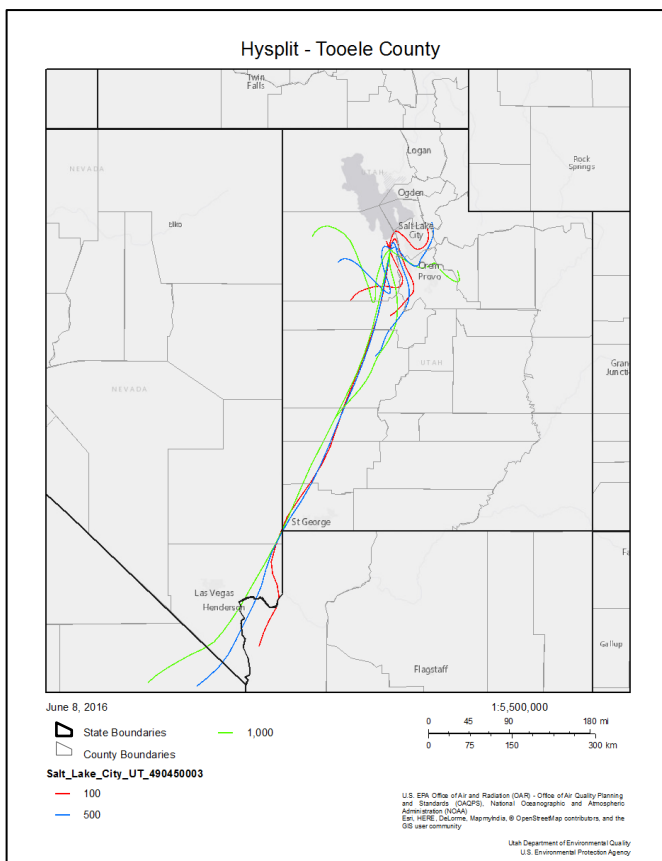


Figure 15. 24-hour back trajectory model of air flow to Tooele County monitors during days where ozone concentrations exceeded the NAAQS.

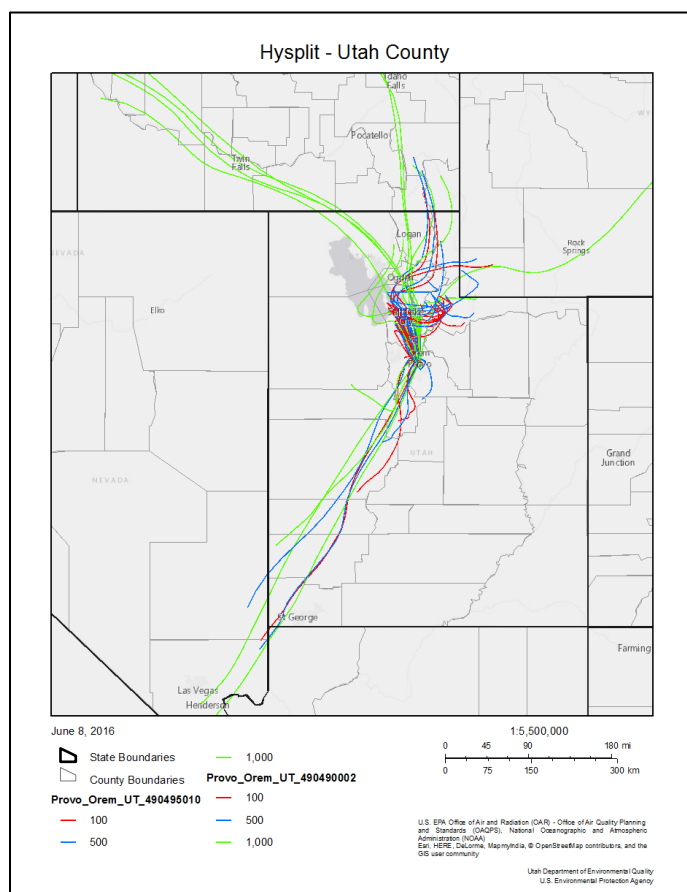


Figure 16. 24-hour back trajectory model of air flow to Utah County monitors during days where ozone concentrations exceeded the NAAQS.

Geography and Topography

The Wasatch Front is located along the eastern edge of the Great Basin. The Wasatch Range, extending from near the Idaho border to Mt. Nebo at the southern tip of the Northern Rocky Mountains, is a formidable obstacle to surface air mass movement to and from the east. A map of the terrain of the region is provided in Figure 17. The Wasatch Mountains rise abruptly to elevations of between 4,000 to 6,000 feet above the valley floor and help to define the Wasatch Front urban areas from Brigham City on the north to the numerous metropolitan areas in Utah County on the south. These valleys are bound on the West by the Great Salt Lake in the north and the Oquirrh Mountains, which also rise 4,000 to 5,000 feet above the valley floor, in the south. In an area of flat terrain one would expect an air mass to gradually be transported in a direction consistent with the prevailing air flow. Conversely, in an area of mountainous terrain, as is the case of the valleys along the Wasatch Front, one would expect the terrain to define the air mass boundaries and movement. With prevailing winds from the west through the north, the high terrain with its bowl shaped valleys that open to the north and west routinely functions to block any eastward horizontal movement of a stagnant air mass. In effect, the local topography actually contains stagnant air masses within these valleys.

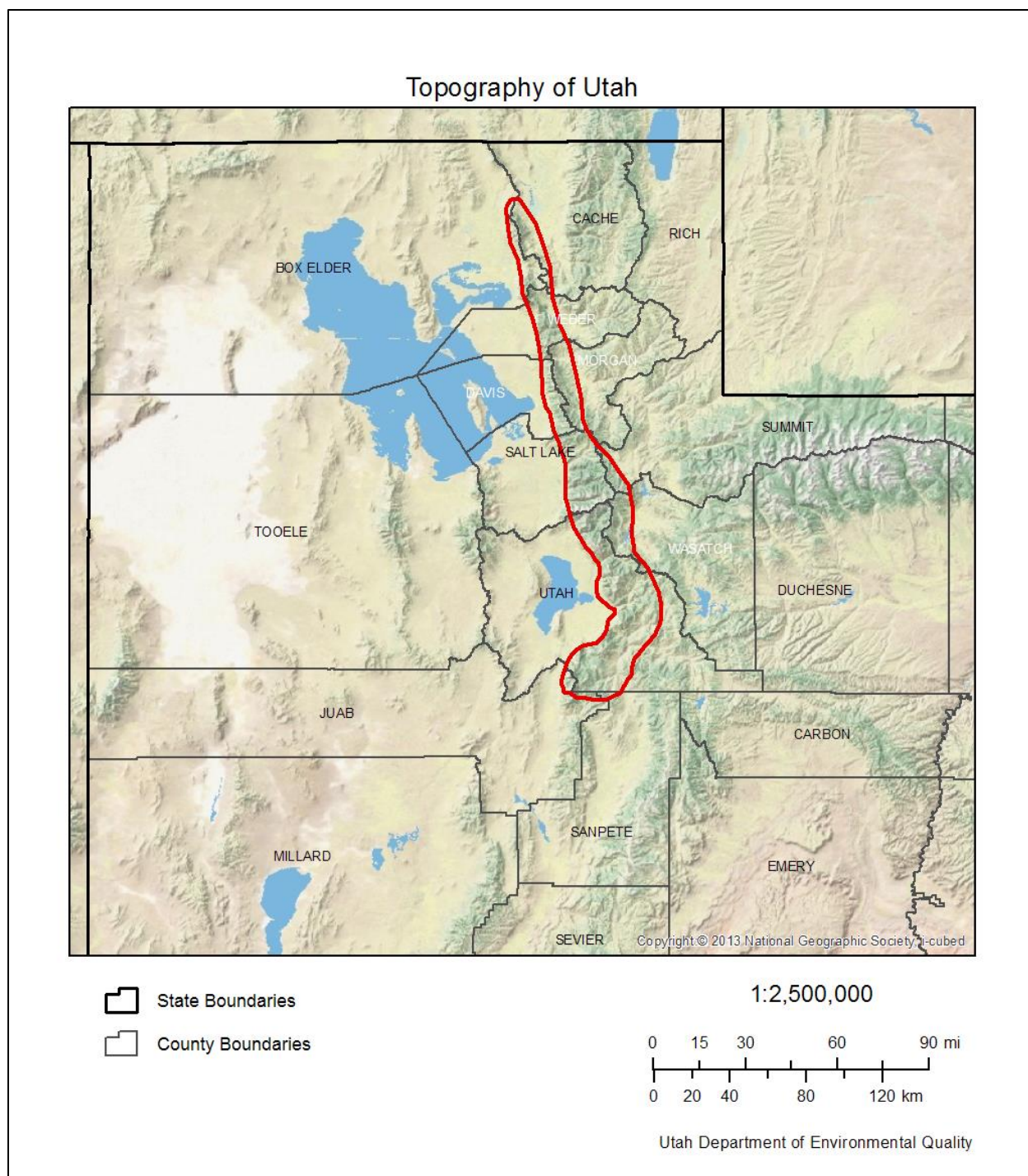


Figure 17. Wasatch Front topography.

To help appreciate the significance of the barrier that the Wasatch Front Range poses to the eastward horizontal movement of air, Table 4 gives the average valley floor elevation at several sites along the Wasatch Front and the average elevation of the Wasatch Mountain Range directly east of the valley floor location.

Table 4. Elevations of Valley Floor and Adjacent Mountains along the Wasatch Front.

	Valley Elevation	Mountain Elevation	Elevation difference
Box Elder County			
Tremonton	4,320 ft	8,979 ft	4,659 ft
Honeyville	4,291 ft	9,330 ft	5,039 ft
Brigham City	4,363 ft	8,035 ft	3,672 ft
Weber County			
Harrisville	4,390 ft	9,196 ft	4,786 ft
Ogden	4,350 ft	9,238 ft	4,888 ft
Davis County			
Kaysville	4,363 ft	9,297 ft	4,934 ft
Bountiful	4,283 ft	8,819 ft	4,536 ft
Salt Lake County			
Salt Lake City	4,363 ft	9,107 ft	4,744 ft
Cottonwood	4,455 ft	9,176 ft	4,721 ft
Utah County			
Highland	4,950 ft	10,698 ft	5,748 ft
Provo	4,691 ft	10,630 ft	5,939 ft
Spanish Fork	4,590 ft	9,430 ft	4,840 ft
Average	4,451 ft	9,328 ft	4,876 ft

As discussed in the meteorology section, it has been found in several studies that concentrations of ozone trapped in large mountain valleys along the Wasatch Front, such as the Salt Lake Valley and Utah Valley, actually move horizontally within or in and out of the valleys with the diurnal mountain-valley flow. In the Salt Lake Valley, for instance, the nighttime flow generally moves the air to the northwest over the eastern portion of the Great Salt Lake while the daytime flow moves the same air back southeastward into the valley where it is contained by the Wasatch Range. In Utah Valley, the air is more contained and generally moves westward over Utah Lake in the evening and eastward during the day. In some instances, however, the air mass in either the Salt Lake Valley or Utah Valley has moved north or south to affect the other valley. In the region north of Salt Lake City, air masses have a tendency to move both north and south along the Wasatch Front, as well as east and west with the diurnal flow.

Not only does the topography of these regions act as a barrier to air movement during conditions which lead to elevated concentrations of ozone, it also acts as the primary factor in determining where the population is located. In other words, the lower valleys which contain the air during periods of summertime stagnation are also the areas within which most people choose to live. These populations produce the emissions which lead to ozone formation under the conditions described above.

Both Figure 17 and Table 4 show that much of the eastern area of the Wasatch Front counties is at a much higher elevation than the adjacent western valleys, and should generally not experience the high concentrations of ozone produced in these urban valleys. While there may

be limited pathways through the canyons, these regions do not have the sources of emissions necessary to produce high ozone concentrations to impact downwind urban areas.

Thus, the topography, when considered alongside the predominant meteorology, would suggest that these areas of high mountainous terrain not be included in a description of nonattainment area(s).

Jurisdictional Boundaries

In the EPA's guidance document it is noted that "... an assessment of relevant information may support inclusion of only part of a county."¹⁰ Because on-road mobile and area sources account for much of the VOCs and NOx emitted in Tooele County, it would be fair to include only the more densely populated portion of the county that is shown in Figure 12. However, because VOCs and NOx are precursors to both ozone and PM_{2.5}, it is logical that the area of Tooele County be expanded to the same boundary of Utah's current PM_{2.5} nonattainment area. This recommendation will allow the State and EPA to implement and enforce controls in a more uniform manner across Utah.

Within the Salt Lake City-Provo-Orem CSA there are three MSAs and two distinct metropolitan planning organizations (MPO) that carry out transportation planning for those MSAs. Wasatch Front Regional Council is the MPO that carries out regional transportation planning in Salt Lake, Tooele, Davis, Weber, Morgan, and Box Elder counties. The Mountainland Association of Governments (MAG) is the MPO responsible for transportation planning in Utah County. These two areas are also designated as two separate nonattainment areas for PM_{2.5}. Designating all of these counties as one nonattainment area would create major hurdles for MAG and WFRC within the transportation planning and conformity requirements and obligations under the Act. Utah therefore recommends that Utah County be designated as a separate nonattainment area from the rest of the nonattainment area (Salt Lake, Tooele, Davis, and Weber counties).

State Recommendation for the Wasatch Front

As shown on Figure 18, Utah is recommending the establishment of two Wasatch Front nonattainment areas; the **Northern Wasatch Front** and **Southern Wasatch Front**.

The Northern Wasatch Front nonattainment area includes the following:

- All of Salt Lake County
- All of Davis County
- All portions of Weber County west of and including Townships 5, 6, and 7 North Range 1 West that are in Weber County and west of the ridgeline that traces the Wasatch Mountains from the southeast corner of the township to the easternmost extension of the county boundary.
- In Tooele County, the following Townships or portions thereof as noted (including Tooele City):

¹⁰ Memorandum: Area Designations for the 2015 Ozone National Ambient Air Quality Standards. Signed by Janet McCabe, Acting Assistant Administrator. February 25, 2016.

- Township 1 South Range 3 West
- Township 2 South Range 3 West
- Township 3 South Range 3 West
- Township 3 South Range 4 West
- Township 2 South Range 4 West
- Township 2 South Range 5 West
- Township 3 South Range 5 West
- Township 3 South Range 6 West
- Township 2 South Range 6 West
- Township 1 South Range 6 West
- Township 1 South Range 5 West
- Township 1 South Range 4 West
- Township 1 South Range 7 West
- Township 2 South Range 7 West
- Township 3 South Range 7 West
- Township 4 South Range 7 West
- Township 4 South Range 6 West
- Township 4 South Range 5 West
- Township 4 South Range 4 West
- Township 4 South Range 3 West

The Southern Wasatch Front nonattainment area includes the following:

- All portions of Utah County west of and including any portion of the following townships located within Utah County:
 - Township 3 South Range 1 East
 - Township 4 South Range 2 East
 - Township 5 South Range 3 East
 - Township 6 South Range 3 East
 - Township 7 South Range 3 East
 - Township 8 South Range 3 East
 - Township 9 South Range 3 East
 - Township 10 South Range 2 East

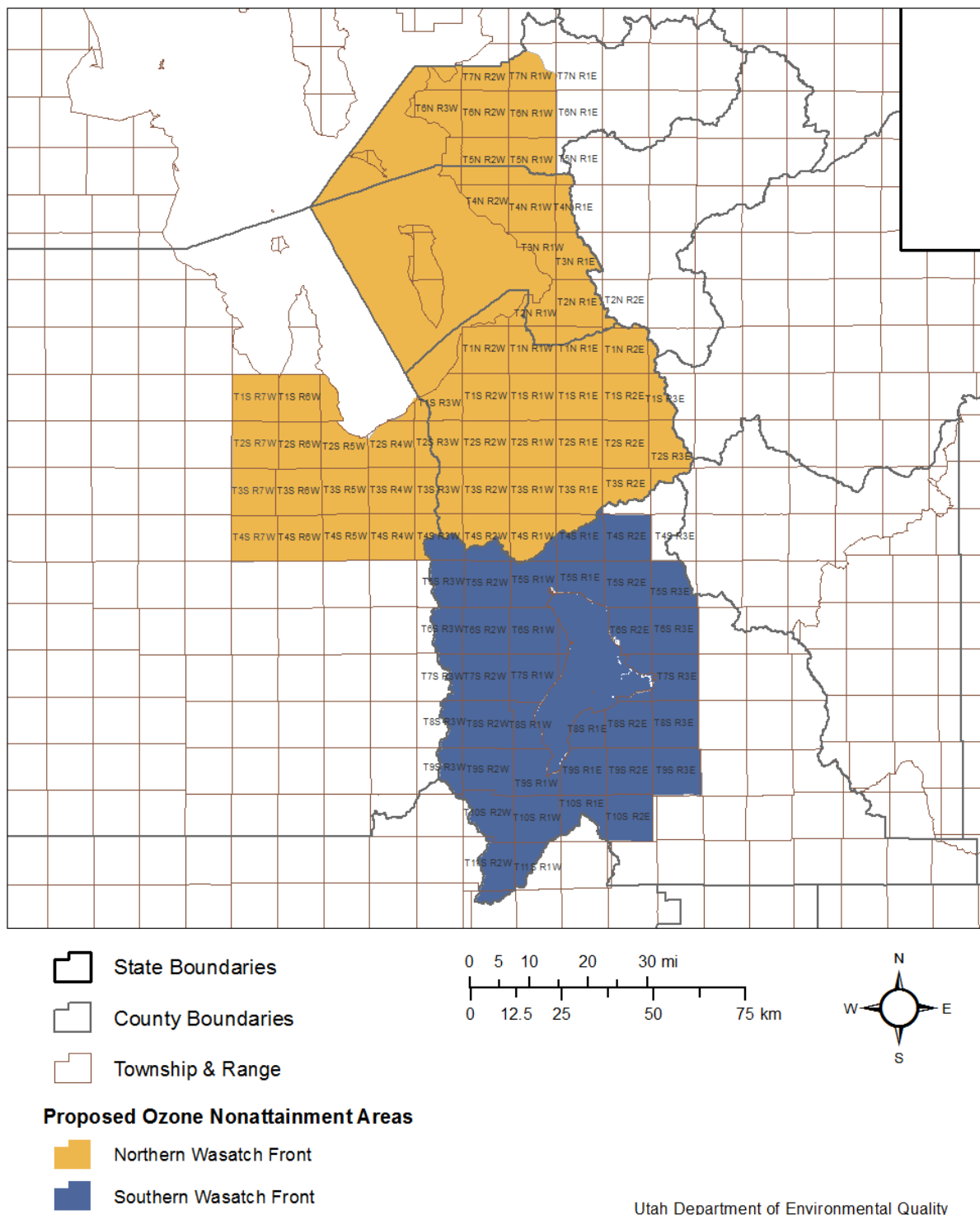


Figure 18. Recommended Wasatch Front Ozone Nonattainment Areas.

Uinta Basin Area Analysis and Recommendation

Overview

The Basin lies in the northeast corner of Utah and is bounded on the north by the Uinta Mountains, on the south by the Tavaputs Plateau, on the west by the Wasatch Range, and on the east by elevated terrain that separates it from the Piceance Basin in Colorado. The Green River runs through the Basin from northeast to southwest, exiting through Desolation Canyon. The lowest point in the Basin is near Ouray and is approximately 4,800 feet above sea level. Duchesne and Uintah counties contain most of the Basin, and the Uintah and Ouray reservation covers a significant portion of basin lands. The Basin presents a very different ozone issue than the more typical summertime urban issue found along the Wasatch Front and therefore warrants a separate discussion and analysis.

In 2006, DAQ began air quality monitoring in the Basin. DAQ's main focus was to measure potential fine particulate (PM_{2.5}), but also monitored for ozone and NO_x. No concentrations exceeding the NAAQS for ozone were measured at that time. In 2009, EPA established two monitoring sites at Ouray and Redwash in the oil and gas production area of the Basin and measured PM_{2.5}, NO_x, ozone and meteorological parameters. It was the winter of 2009-10 when the first high levels of ozone were observed in the Basin. In the winter of 2010-11, Utah State University and DAQ conducted a special study to confirm the presence of high winter ozone and to map out the spatial extent of elevated ozone levels. Results from the study showed that ozone values were elevated throughout the Basin, with the highest concentrations tending to occur at lower elevations in the center of the Basin. The data also showed that elevated ozone correlated highly with the presence of snow-covered ground and a strong temperature inversion, and that elevated ozone values did not occur when these conditions were absent.

With this data confirming a wintertime ozone issue in the Basin, the Uinta Basin Winter Ozone Studies (UBOS) formally began in 2011 to characterize emission sources, identify chemical pathways unique to the Basin, and develop effective mitigation measures. This multi-year effort, led by DAQ, has brought together knowledgeable scientists to study this wintertime ozone phenomenon. Participants included the EPA, National Oceanic Atmospheric Administration (NOAA), Utah State University, University of Utah, and a number of other universities in both the United States and Canada. The UBOS is important for understanding the atmospheric chemistry responsible for winter ozone and developing control strategies that reduce the precursor gases that contribute to its formation. Over the past few years of study, much has been learned about the unique winter chemistry that exists in the Basin.

Since 2011, the wintertime ozone issue has continued to follow the original observation that there needs to be snow-covered ground, sunshine, and a strong temperature inversion to see high ozone values. Ozone levels outside of this set of conditions have remained below the ozone standard; therefore, exceedances of the standard do not occur every year. The UBOS has also confirmed that transport is not a major contributor to high ozone episodes. This is evidenced by seeing higher concentrations of VOC and NO_x within the Basin than without and by correlations of VOC and NO_x concentrations in proximity to known sources. Also the stable meteorological conditions during ozone production are not conducive to transport from outside

the Basin, and VOC speciation in the Basin is characteristic of oil and gas operations, not of upwind urban sources. Vertical profiles collected during high ozone events show that the polluted air mass is confined to a shallow boundary layer that varies in height from 230 - 1,300 feet above ground level (UBOS 2012).

The focus of the UBOS for the past couple years has been on the chemistry of the formation of ozone and obtaining a Basin-specific emission inventory from the oil and gas industry. The development of a comprehensive and accurate winter emission inventory, including sufficient speciation of chemical compounds, is critical to support the development of air quality modeling that represents the unique wintertime ozone events in the Basin.

Air Quality Data

The State of Utah operates two Federal Reference Method (FRM) or Federal Equivalent Method (FEM) monitoring stations in the Basin that collect data in accordance with 40 CFR Part 58. These stations are located at and named for the most populated towns in the Basin—Roosevelt and Vernal. However, the site for the Vernal station was repurposed by the land owner, and the station had to be moved to a new location on January 1, 2015, and therefore, does not have three years of continuous data to be used for official attainment determination. There are other regulatory monitors located in the Basin that are managed by other agencies for which a DV can be calculated. The Ute Tribe manages four monitors on tribal land: the Myton, Whiterocks, Redwash and Ouray monitors (Figure 19). The Fruitland monitor has been in intermittent operation and is not considered to be a regulatory monitor, but provides valuable information for determining the extent of the observed wintertime inversion and ozone concentrations. The Dinosaur National Monument monitor is in its third year of monitoring, so it is not yet able to provide a DV, but it is also included as part of the air quality evaluation as it also provides additional information for this analysis.

States are to identify violating areas using the most recent three-year set of air quality data. For the state's evaluation, this encompasses the years 2013 through 2015. For the Basin, high ozone events occur during the winter months, December to March, so we consider those months the ozone season. The final designation by EPA will be made by October 2017; therefore, data collected during the 2015-2016 ozone season, which has already passed, will be evaluated as part of that decision. As such we will also consider data from the 2015-2016 ozone season, though the data has not yet been certified. Table 5 below shows the 4th highest ozone concentration as well as the three-year average of the 4th highest ozone concentrations (DV) recorded at the monitors located in the Basin. Figure 19 shows the location of these monitors. For the timeframe identified by the EPA's ozone designation guidance to be evaluated by states for their recommendation, the monitors indicating nonattainment are the tribal monitors at Myton, Roosevelt, Redwash and Ouray. Roosevelt is the only monitor that is under the control and management of the State that has a DV for 2013-2015. For the final designation timeframe that will be utilized by EPA, preliminary data indicate nonattainment at the Myton, Whiterocks, and Ouray stations. The conclusion that can be made from either the 2013-2015 DVs or 2014-2016 preliminary DVs is that several areas monitored in the Basin are nonattainment for the 2015 ozone standard.

Table 5. Ozone 4th high values and design values for Uinta Basin monitors.

Site ID	Site	2011 4 th Max	2012 4 th Max	2013 4 th Max	2014 4 th Max	2015 4 th Max	2016 4 th Max ¹	2013- 2015 DV	2014- 2016 DV ¹
49-013-7011	Myton ²	0.065		0.089	0.067	0.066	0.085	0.074	0.073
49-047-7022	Whiterocks ²	0.064		0.066	0.064	0.068	0.081	0.066	0.071
49-013-0002	Roosevelt		0.069	0.0104	0.062	0.060	0.081	0.075	0.068
49-013-1001	Fruitland ³	0.065	0.070	0.069				n/a	n/a
49-047-1002	Dinosaur NM ⁴				0.064	0.067	0.075	n/a	0.069
49-047-1003	Vernal		0.064	0.0102	0.062			n/a	
49-047-1004	Vernal #4					0.064	0.073		n/a
49-047-2002	Redwash ²			0.088	0.061	0.067	0.083	0.072	0.070
49-047-2003	Ouray ²			0.092	0.079	0.068	0.096	0.080	0.081

1. Data not quality assured

2. Tribal monitors

3. Previous DAQ, taken over by BLM in January 2014, not certified as a regulatory monitor

4. National Park Service monitor



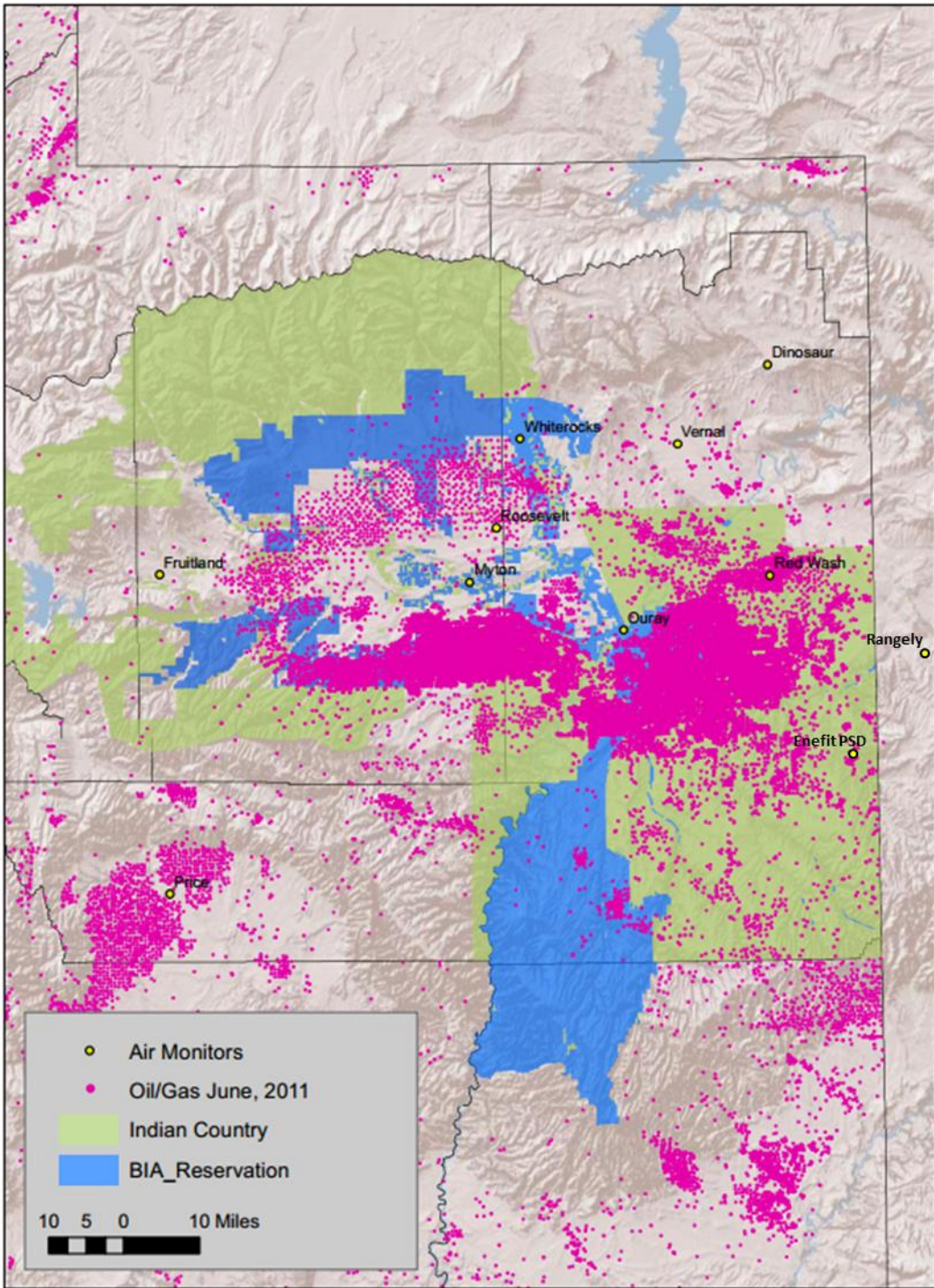
Figure 19. Map of ozone monitors in the Uinta Basin.

Emissions and Emissions Related Data

Ground-level ozone is primarily formed from reactions of VOCs and NO_x in the presence of sunlight; therefore, the emissions data evaluated will focus on these precursor pollutants. As the proposed nonattainment area of the Basin primarily resides in Uintah and Duchesne counties, theirs will be the inventory data utilized for this analysis. The ozone designation guidance

memorandum recommends the use of the 2011 NEI as that is the most recent information available during the timeframe for development of the State recommendation. The 2011 NEI for Uintah and Duchesne counties reflected that 97% of the VOC emissions and 60% of NO_x emissions were from oil and gas sources. The above numbers do not include VOC emissions from biogenic sources as they are not a significant contributor to the emissions in the Basin. This is especially true in the wintertime when high ozone levels are observed.

The Basin is a rural area with a combined population of about 55,000 people who primarily live in three main towns (Duchesne, Roosevelt, and Vernal). The population density is about 6.6 per square mile. Urban areas have historically been the main focus of area designations as the precursor emission sources associated with human, industrial, and motor vehicle activities occur with greater frequency in more populous areas. This is not the case for the Basin, where the economy is driven by energy production associated with the large petroleum resources. There are currently about 11,000 oil and gas wells located in Uintah and Duchesne counties, with approximately 20% of those on state lands, and 80% on the Ute Indian Reservation and Indian Country lands (Utah Division of Oil, Gas and Mining). The activities associated with the development and operation of oil and gas wells are the main source of ozone precursors in the Basin. Population density and traffic/commuting patterns are not relevant factors for the Basin's nonattainment analysis. Figure 20 provides a view of the oil and gas wells located within Duchesne and Uintah counties with the Ute Indian Reservation and Indian lands identified.



Utah Division of Air Quality January, 2011

Figure 20. Locations of oil and gas wells in Uintah and Duchesne counties.

As part of the on-going study and work the State has implemented in the Basin since the wintertime ozone issue was discovered, it was determined a Basin specific oil and gas emission inventory would be vital to developing air quality management plans and meteorological and photochemical models. In cooperation with the oil and gas producers, an oil and gas emissions

inventory specific to the Basin for 2014 has been collected and is available for study. This inventory requested emission information from all oil and gas producers operating in the Basin on both State and Indian lands and received information for approximately 96% of the registered wells in Uintah and Duchesne counties. Table 6 shows a breakdown of the NOx and VOC emissions by equipment and operations and by county. These emissions are also presented in Figure 21 through Figure 24 below.

Table 6. NOx and VOC emissions by equipment and operations and by county.

2014 Utah O&G EI	NOx (tons/year)		VOC (tons/year)	
	Duchesne	Uintah	Duchesne	Uintah
Dehydrators	1.96	4.49	198.93	3,686.32
Fugitives			3,362.78	11,383.67
Pneumatic Controllers			9,004.30	16,058.31
Pneumatic Pumps			305.64	11,049.57
Engines	4,127.68	31,502.35	685.50	1,977.45
Separators & Heaters	1,061.94	1,861.65	58.41	102.39
Tanks	12.33	11.57	4,309.02	8,799.15
Truck Loading			923.39	725.39
Well Completions (Drilling)	405.87	918.96	282.35	639.28
All Sources	5,609.79	34,299.03	19,130.31	54,421.53

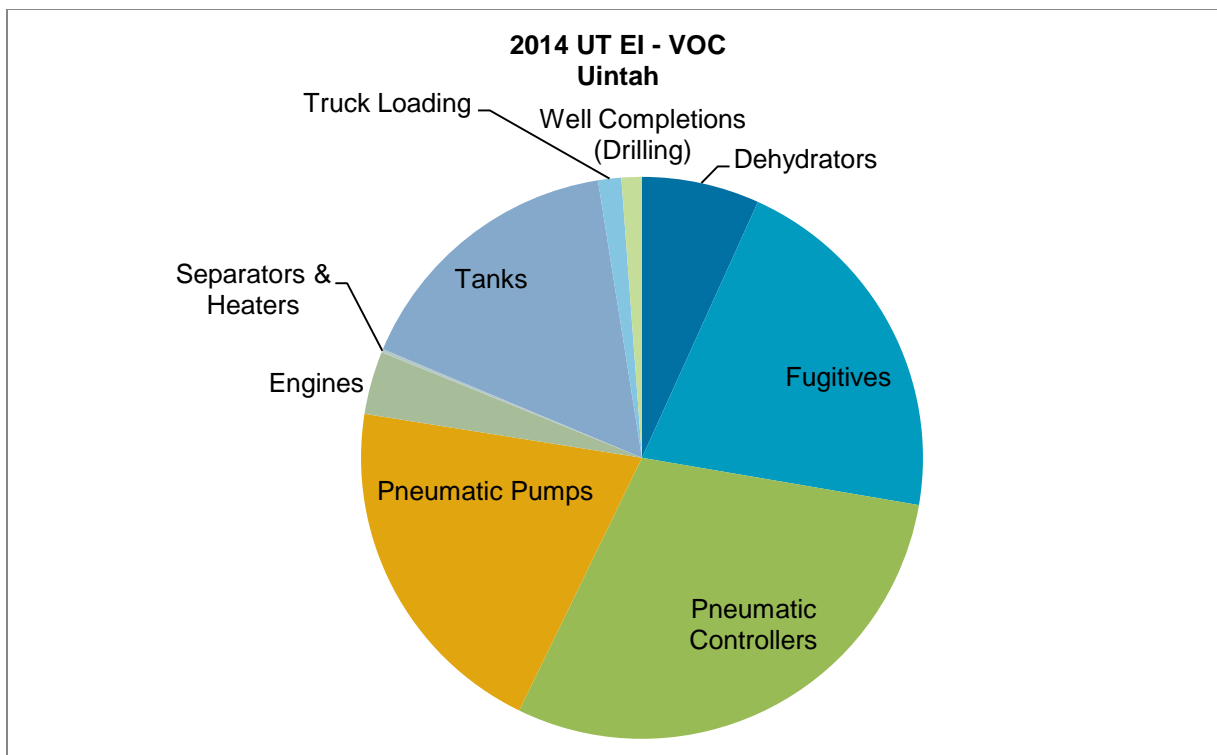


Figure 21. Uintah County VOC emissions from oil and gas production.

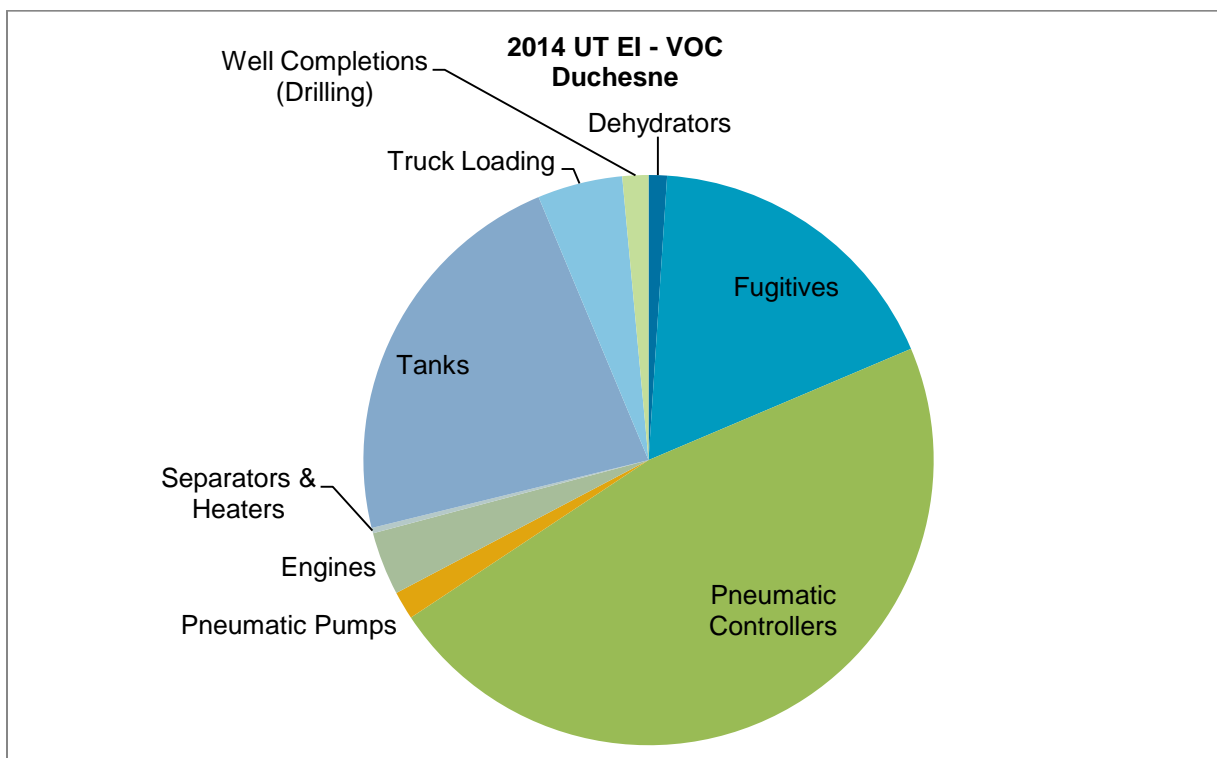


Figure 22. Duchesne County VOC emissions from oil and gas production.

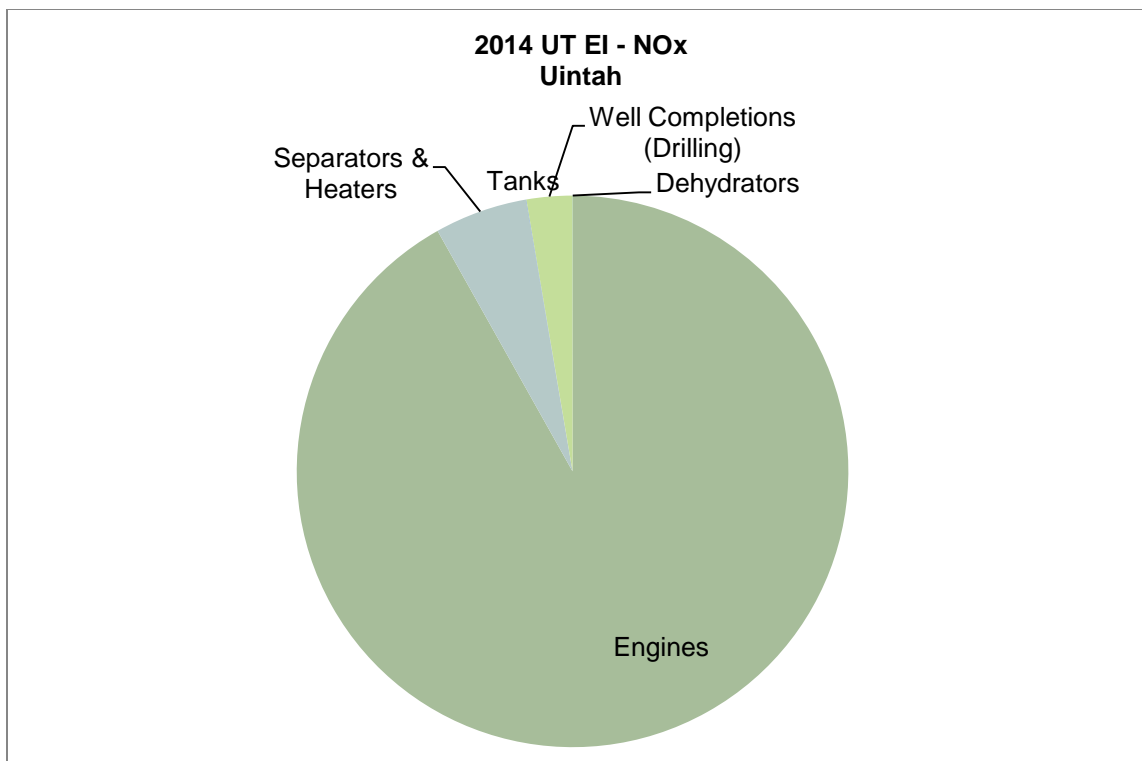


Figure 23. Uintah County NOx emissions from oil and gas production.

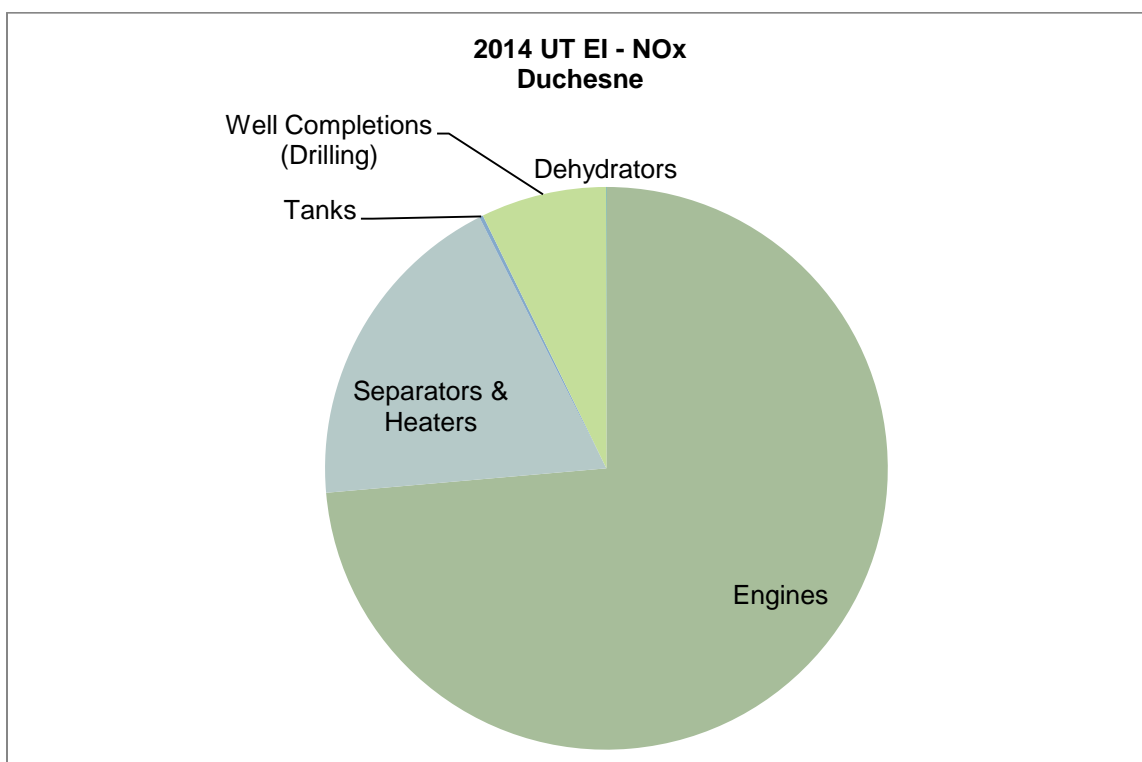


Figure 24. Duchesne County NOx emissions from oil and gas production.

In combination with the 2014 inventories, the UBOS have identified that days of high ozone coincide with elevated levels of methane, VOCs and nitrogen species indicative of the oil and gas industry (UBOS 2013). The chemistry involved in the wintertime ozone events is extremely important to understand so as to develop the most effective emission controls and mitigation efforts. Oxidation of VOCs is a key step in ozone accumulation. While the reactivity of VOCs varies widely, the relative contribution of individual VOC species to ozone formation depends on their abundance as well as their reactivity. Data collected during the winters of 2012 and 2013 in the Basin show that the characteristics of the VOC mixture in the Basin are very different from those found in urban areas. VOCs in the Basin are dominated by relatively unreactive alkanes associated with natural gas exploration and production sources as is the case in other oil and gas producing basins. In contrast, highly reactive alkenes are nearly absent in the Basin, which is in sharp contrast to typical urban VOC mixtures where gasoline powered motor vehicles and other combustion and evaporative sources of alkenes are more common.

With the emission inventory data and evidence provided by the wintertime ozone studies, it can be concluded that oil and gas production and development is the most significant emission source in the Basin. Below is a map (Figure 25) that provides the oil and gas wells located within Duchesne and Uintah counties and the location of wells with the 6,000 foot elevation highlighted.

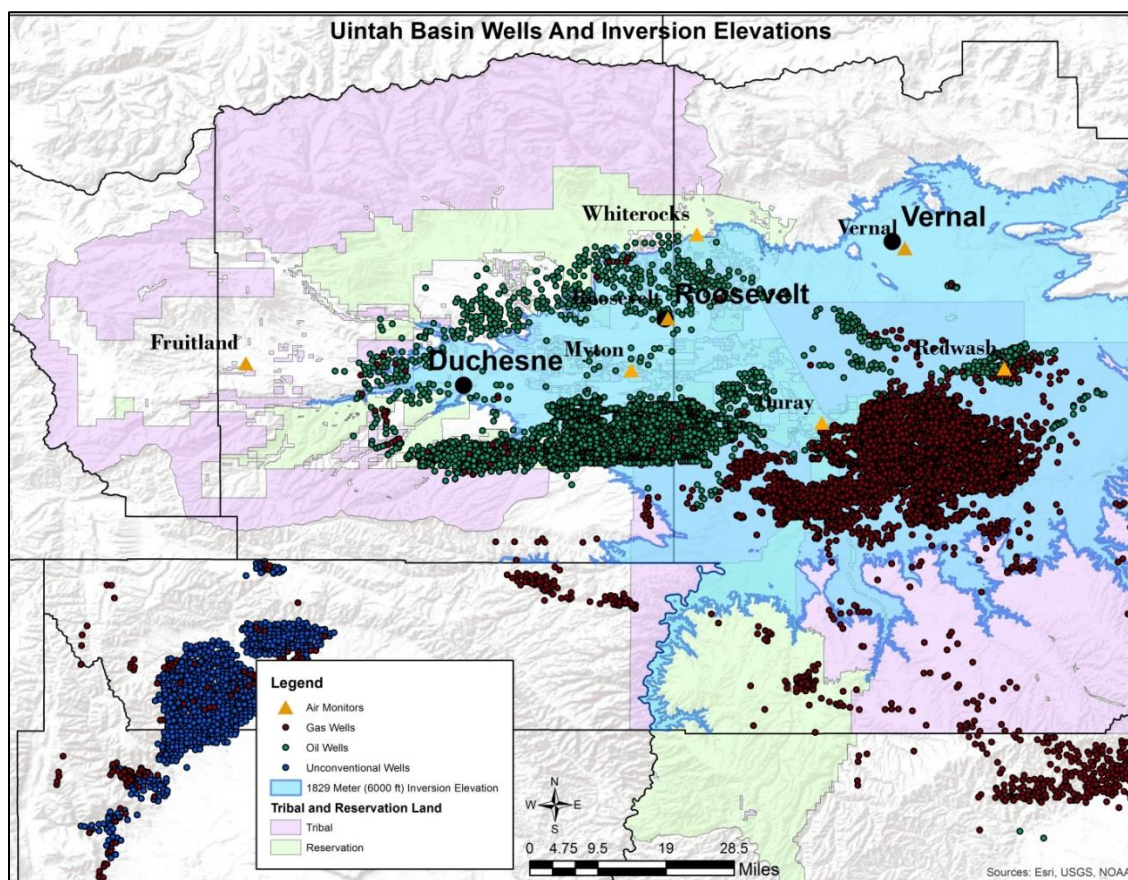


Figure 25. Uintah Basin oil and gas wells with a 6,000-foot elevation.

As we are recommending the use of a maximum elevation boundary for the ozone nonattainment area, we acknowledge that there are gas and oil sources outside of the recommended boundary. However, the wintertime cold temperature inversion that is required for ozone development effectively keeps emissions trapped within the vertical limit of the inversions. These inversion events also do not allow the transport of emissions from outside sources into the Basin during high ozone episodes.¹¹ This will be discussed in further detail in the meteorology analysis section. Further refinement of the Basin specific inventory is continuing as well as the UBOS study of the chemistry associated with wintertime ozone development.

Meteorology

The quality of air in the Basin is generally good, with the exception of certain episodic periods in the winter months where exceedances of the ozone standard are observed. These occurrences are associated with winter inversion periods with snow cover, light wind conditions, and strong temperature inversions. They are most common in February when the days are beginning to get longer and snow cover is still likely to be present, creating more ultraviolet rays to facilitate the photochemical reaction between NO_x and VOCs. Figure 26 below illustrates ozone time series from 2009 through the winter of 2016. This shows the Basin does experience the more standard annual pattern of winter minimums and summer maximums following the availability of sunlight for ozone photolysis; this is fairly consistent each year. However, we see the spikes of high ozone values during winter months, but not consistently. The winters of 2012 and 2015 did not see the spike in ozone and exceedance of the standard. The common denominator for the winters without ozone spikes was the lack of snow on the ground and the absence of cold temperature inversions.

¹¹ Uinta Basin: 2013 Winter Ozone Study: Final Report. Chapter 8 [Tethered Ozonesonde and Surface Ozone Measurements in the Uinta Basin, Winter 2013](http://www.deq.utah.gov/locations/U/uintahbasin/ozone/docs/2014/06Jun/UBOS2013FinalReport/UBOS_2013Sec_8_NOAAsondes.pdf)
http://www.deq.utah.gov/locations/U/uintahbasin/ozone/docs/2014/06Jun/UBOS2013FinalReport/UBOS_2013Sec_8_NOAAsondes.pdf

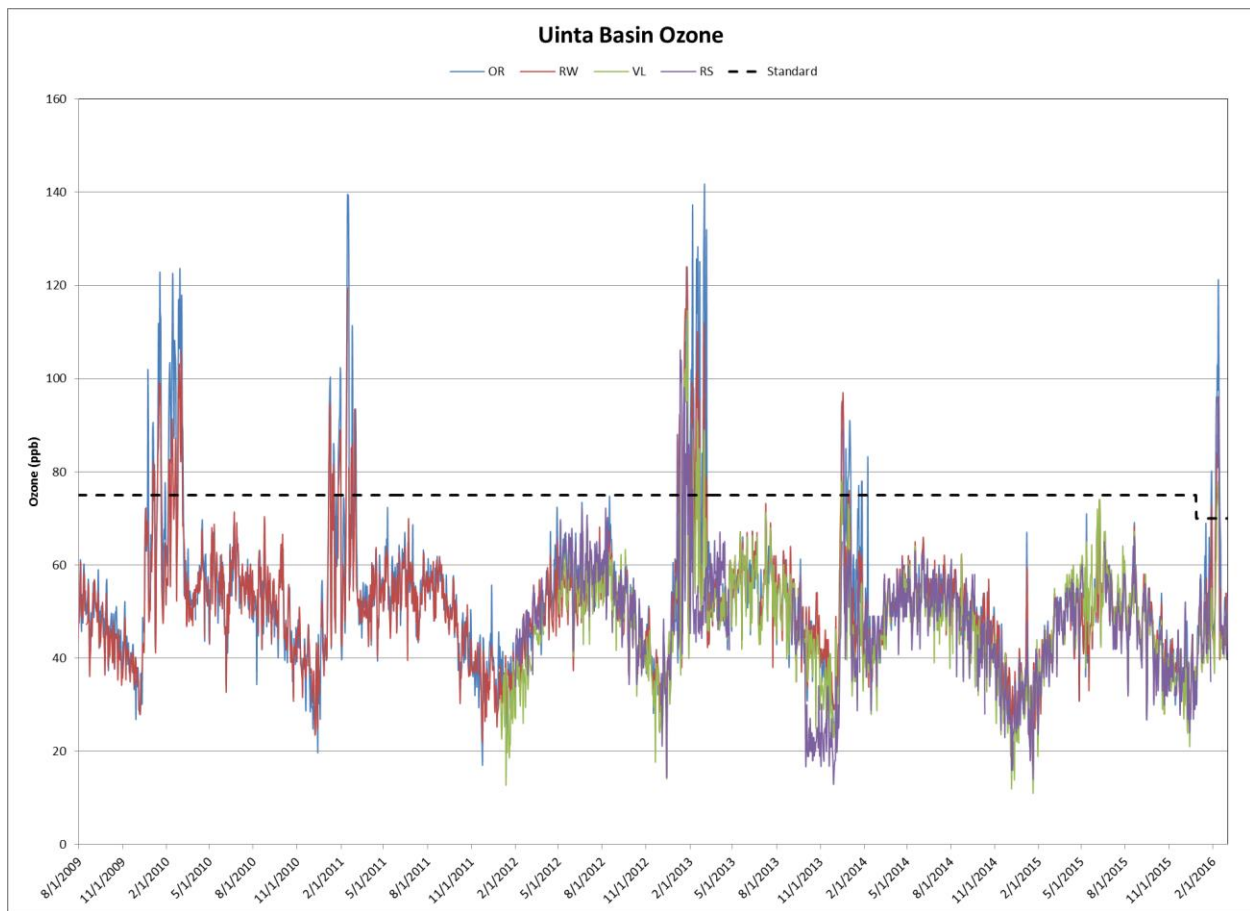


Figure 26. Time series ozone data from the Ouray, Red Wash, Vernal, and Roosevelt monitors.

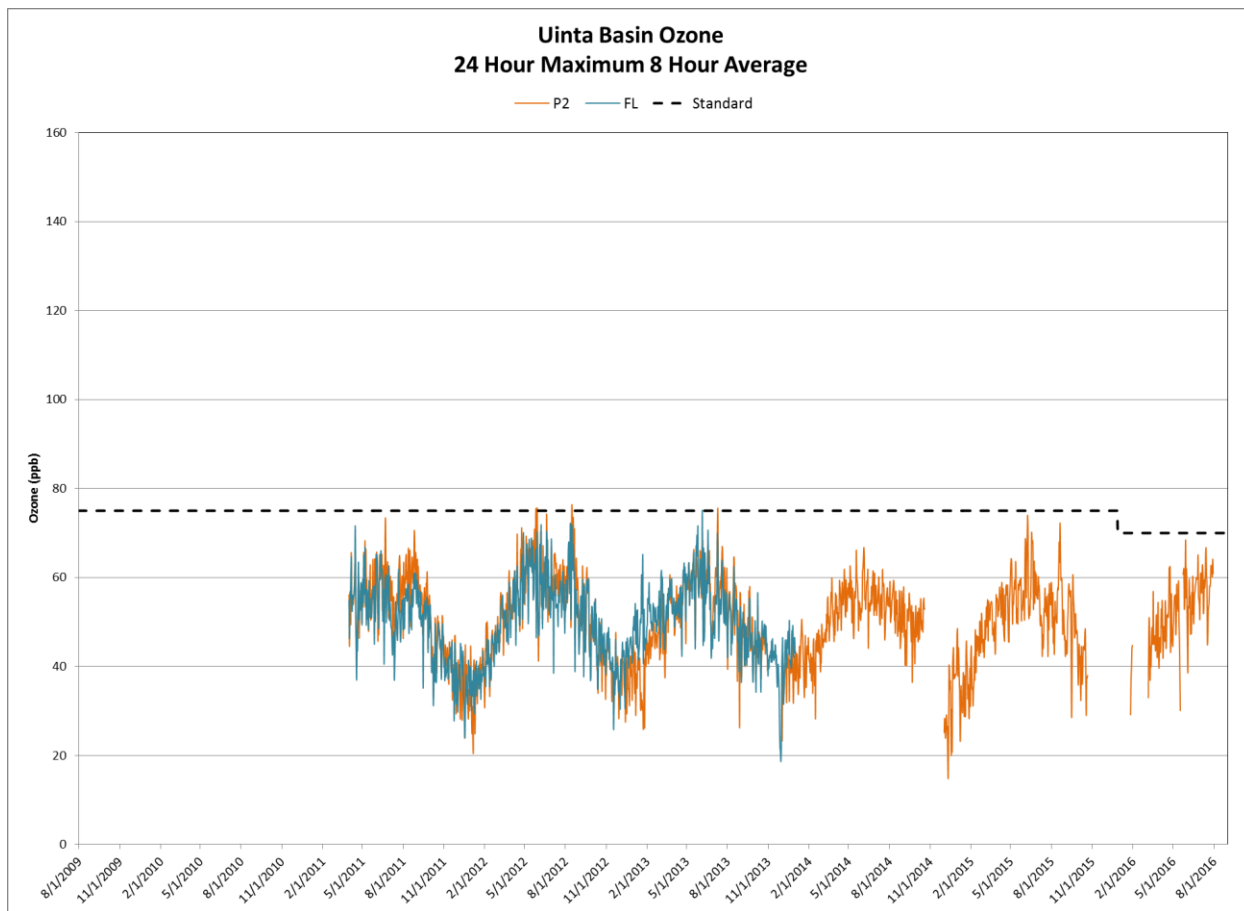


Figure 27. Time series ozone data from the Fruitland and Price monitors.

Figure 27 shows the time series ozone data for the same time period for the Fruitland and Price monitors, which are located on the rim and just outside of the basin respectively. In sharp contrast to Figure 26 for the four monitors located in the central basin below the inversion height, there are no instances of elevated ozone. This is direct evidence that the chemistry leading to elevated ozone values is contained below the 6,000 foot inversion height.

The high levels of ozone observed in the Basin are mainly associated with meteorology rather than changes in precursor emissions. The emissions from the oil and gas industry associated with all phases of production (construction, drilling, completion, production, recompletion, closure) have remained fairly consistent over time. As can be seen in the charts below (Figure 28 and Figure 29), there has been some fluctuation in production, with a downturn in 2015 and the first half of 2016, but it does not correlate with the episodes of ozone exceedances versus the correlation seen with meteorological conditions (Division of Oil, Gas and Mining).

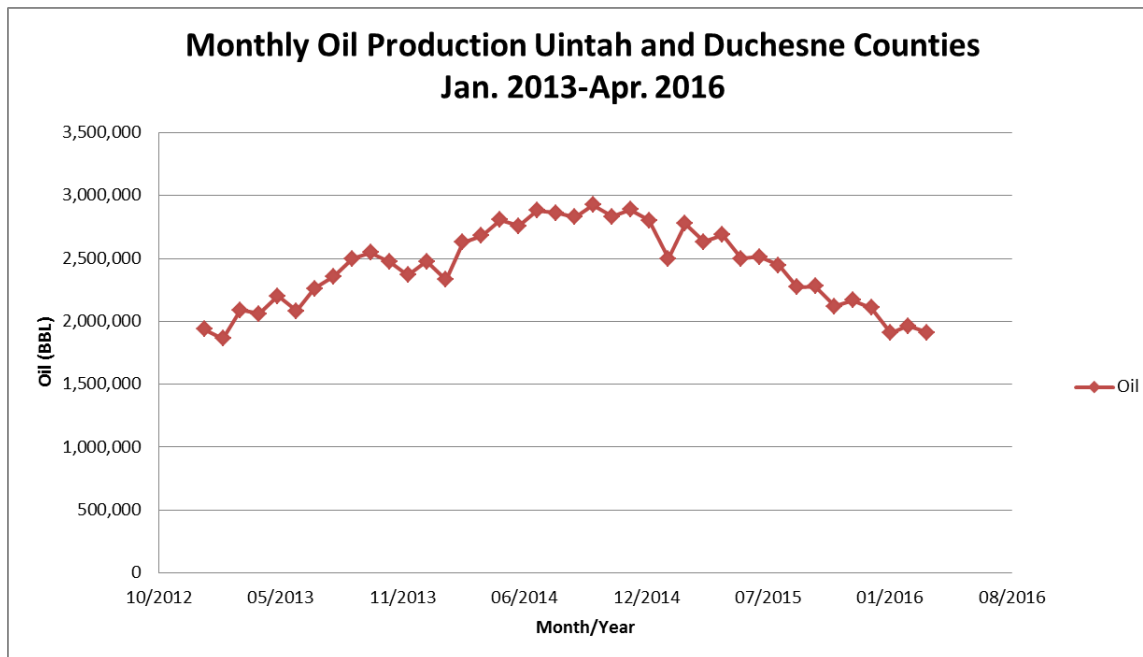


Figure 28. Monthly oil production in Uintah and Duchesne counties.

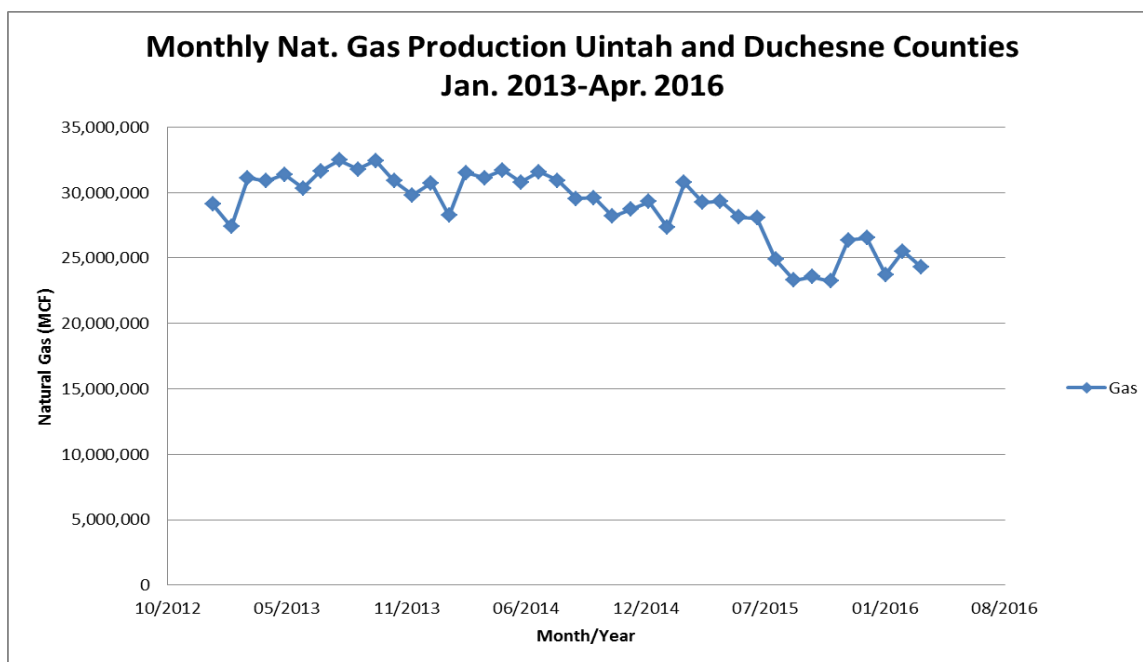


Figure 29. Monthly gas production in Uintah and Duchesne counties.

The meteorology of the wintertime inversion is also the main factor supporting the proposed nonattainment boundary being set at an elevation rather than the use of a jurisdictional boundary.

The UBOS included collecting data on vertical and spatial distribution of wintertime ozone^{12,13} (UBOS 2012 and 2013). The studies collected ozone and temperature profiles from the surface to 500 meters above ground level with the use of tethered ozonesondes (ozone measuring devices) being released during high ozone episodes. The study also looked at different elevations through use of ozonesondes on a vehicle driving throughout the Basin during a high ozone event. Also free-flying ozonesondes were released during high ozone events to profile ozone values from the basin floor to 30,000 meters. These studies were performed during a non-ozone event winter (2012) and a high ozone event winter (2013). The 2013 study provides very compelling data that indicates there is no influence from ozone transport or sources outside the inversion layer.

Data from a drive around the basin during the February 6, 2013, ozone event is presented in Figure 30 below for surface ozone concentrations plotted against elevation above sea level over time. From this figure it can be seen that ozone concentrations were in the 75 ppb range when leaving Vernal, rising to 115 ppb then decreasing to 90 ppb at Red Wash (point 3) as the elevation of the road was high enough (1,720 m) that the van was beginning to poke through the top of the inversion layer. When the elevation of the road decreased, ozone concentrations increased to 120 ppb near Fantasy Canyon (point 5) and Horsepool (point 6). At Point 7, near the Ouray EPA site, surface ozone was 140 ppb. Driving up the south rim of the basin, ozone began to decrease at 1,650 m as the van ascended through the base of the inversion layer, decreasing to background ozone concentration of 50 ppb at 2,000 m. The pattern was repeated in reverse on the descent. High ozone beneath the inversion and background concentrations above the inversion layer were consistently observed in the tethered ozonesondes and aircraft data collected.

¹² 2012 Uinta Basin Winter Ozone & Air Quality Study: Final Report. Chapter 5 [Tethered Ozonesonde Measurements in the Uinta Basin](http://www.deq.utah.gov/locations/U/uintahbasin/ozone/docs/2014/03Mar/ubos_2011-12_final_report.pdf), http://www.deq.utah.gov/locations/U/uintahbasin/ozone/docs/2014/03Mar/ubos_2011-12_final_report.pdf

¹³ Uinta Basin: 2013 Winter Ozone Study: Final Report. Chapter 8 [Tethered Ozonesonde and Surface Ozone Measurements in the Uinta Basin, Winter 2013](http://www.deq.utah.gov/locations/U/uintahbasin/ozone/docs/2014/06Jun/UBOS2013FinalReport/UBOS_2013Sec_8_NOAAsondes.pdf), http://www.deq.utah.gov/locations/U/uintahbasin/ozone/docs/2014/06Jun/UBOS2013FinalReport/UBOS_2013Sec_8_NOAAsondes.pdf

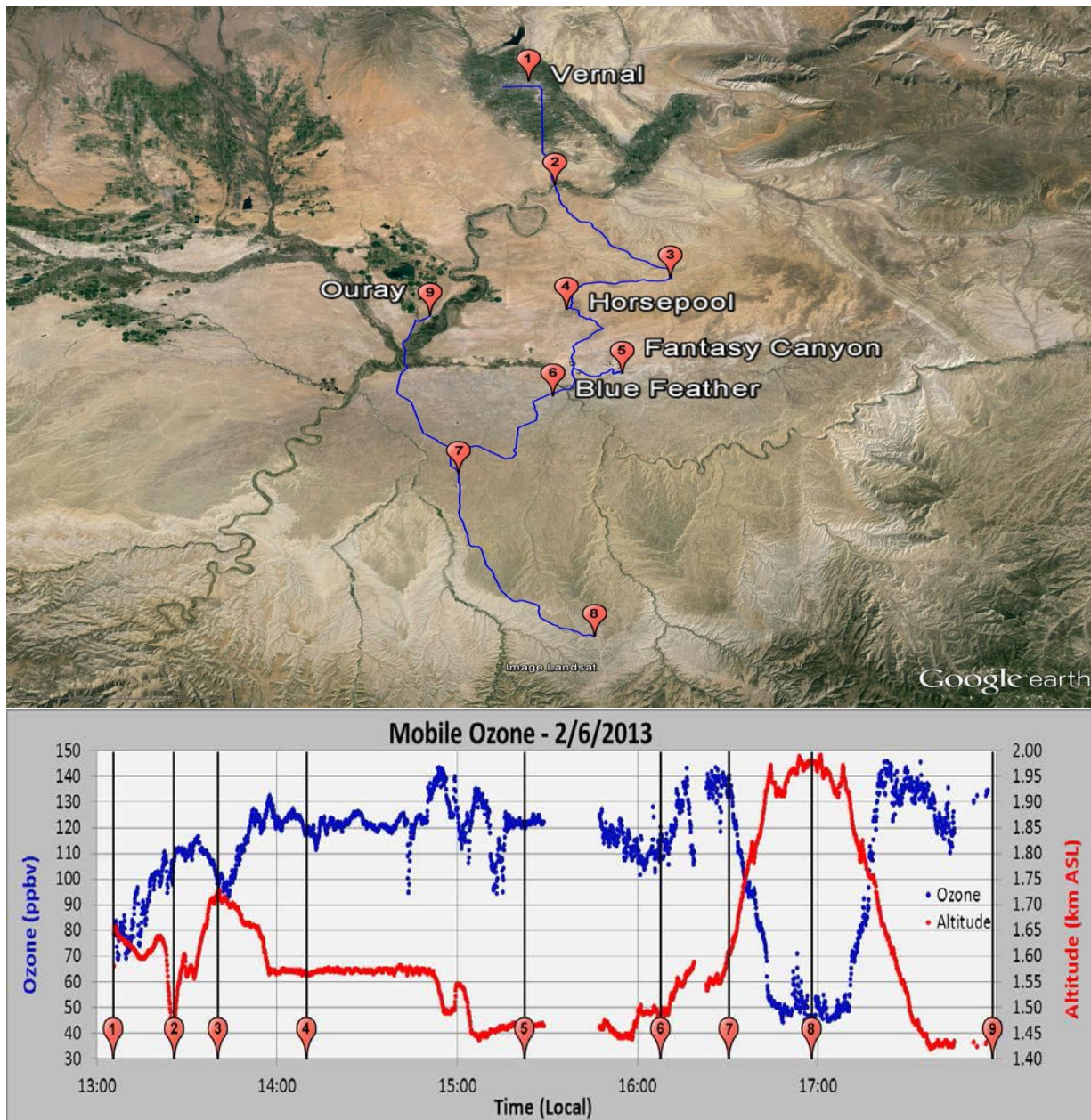


Figure 30. Surface ozone data from a drive around the basin during the February 6 ozone event plotted against elevation above sea level over time.

The conclusion of the study is that during high ozone events, the air in the Basin below 1,650-1,700m is isolated from the rest of the atmosphere and emissions at the surface are trapped in this shallow layer. There is some horizontal and vertical transport within the basin with light winds, described as 'sloshing' within the inversion.

The reasoning for use of elevation as a nonattainment boundary is supported by the characteristics of a winter inversion. The wintertime photochemical ozone production in the Basin requires snow on the ground, a shallow boundary layer, stagnation and a persistent temperature inversion capping the shallow ozone production layer. The snow helps to keep the

surface cold, reinforcing the production and maintenance of the temperature inversion. Snow also reflects daytime solar radiation that enhances photochemical ozone production. The inversion layer traps the emissions from the wells, pipelines, and compressor stations in a shallow layer where the rapid photochemical ozone production occurs. Outside of the inversion, normal background ozone levels are observed that are not above the 0.070 ppm standard.

The EPA ozone designation guidance memorandum discusses the use of the HYSPLIT modeling system for the meteorological analysis of potential source- receptor relationships in areas during high ozone events using wind speed and direction data. This is to try and model trajectories of air towards a violating monitor, called back trajectories. The HYSPLIT model does not accurately demonstrate the relationship between source and monitor for the Basin. The high ozone events are created by the development of a strong temperature inversion that effectively traps air in the Basin containing locally produced precursor emissions and effectively keeping out any possible emissions from outside the inversion. Initial attempts at modeling meteorological conditions during these high ozone episodes in the Basin indicate that obtaining accurate results with current modeling techniques will be very challenging. The information gained from utilizing the HYSPLIT model does not accurately reflect the real conditions occurring. Work has been initiated through a cooperative effort involving the DAQ, EPA, BLM, University of Utah, Utah State University and others to develop a multi-layer, grid-based photochemical model specific to the Basin. Additional data collection and model development and testing will be required to produce a good working model suitable for evaluating alternative regulatory strategies.

Geography and Topography

The Basin and Mountains are located in the northeast corner of the state and are part of a larger physiographic area known as the Colorado Plateau Province. The Uinta Mountains (the Uintas) are 150 miles long and thirty miles wide, and are oriented in an east-west direction. The Uintas contain some of the highest mountain peaks in the State, Kings Peak being the highest at 13,520 feet. The Basin lies south of the Uintas. The southern rim of the basin is formed by the Tavaputs Plateau of the Book Cliffs, and the western rim is formed by the Wasatch Mountains. The basin is 5,000 to 10,000 feet (1,500 to 3,000 meters) above sea level and corresponding to this depression is a broad east-west strip of higher plateau that rises sharply above the country to the south. On the south side of the plateau, the descent of 3,000 feet (900 meters), to the general level of eastern Utah on the south, is made in two steps. The first is the Roan Cliffs, and the second is the Book Cliffs. Eastward in Colorado, the two lines of cliffs are not very distinguished. The average annual precipitation for the Basin is less than 8.5 inches; nevertheless, the basin is well watered. The Strawberry River drains the eastern slope of the Wasatch Mountains. The south flank of the Uintas is drained by Current Creek, the Duchesne River, Lake Creek, the Uinta River, Ashley Creek, and Big and Little Brush creeks. The southern portion of the Basin contains fewer streams that carry much less water than those of the northern portion. The Green River slices through the Uintas at Split Mountain and flows through the Basin in a southwesterly direction. Below Ouray, the Green River is joined by the Duchesne River the flows from the east, and the White River that flows from the west.

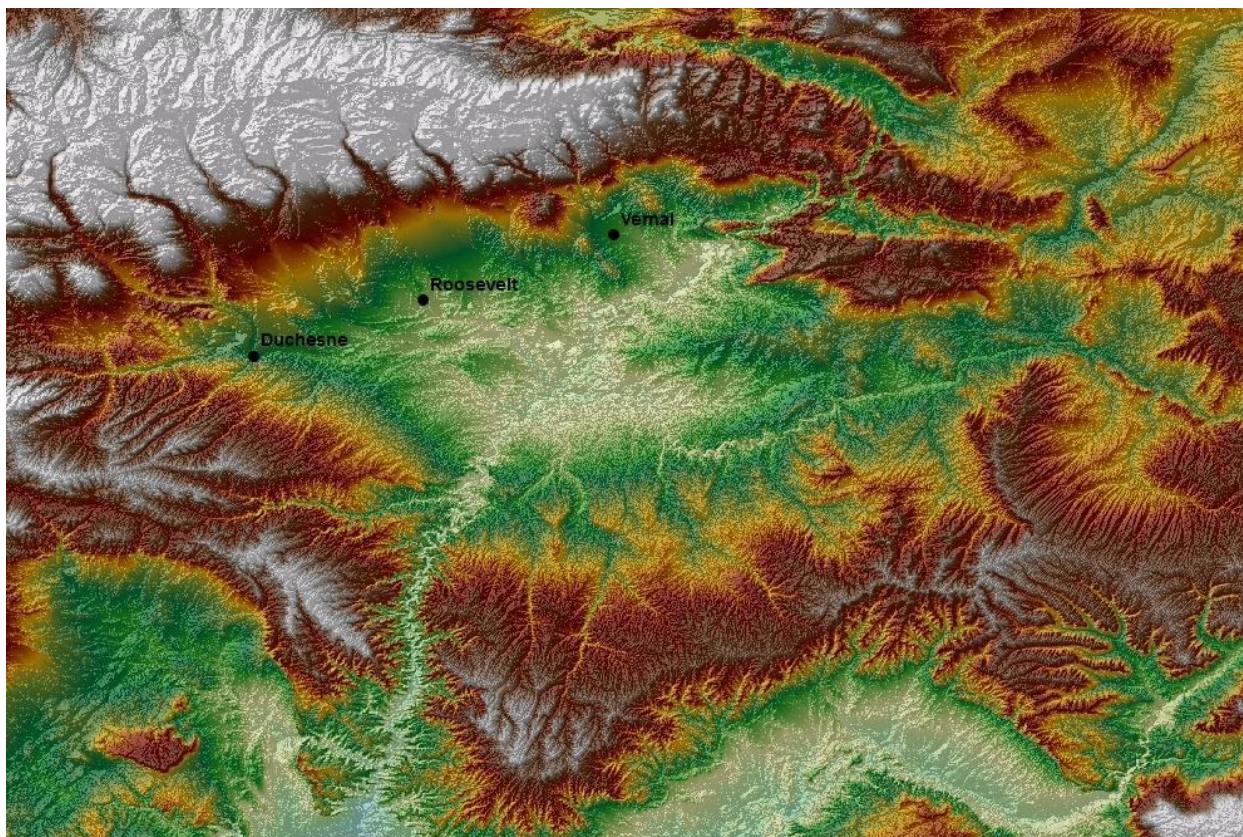


Figure 31. Uinta Basin topography.

As can be seen in Figure 31, the western side of the basin is surrounded by the higher elevations of the Uinta Mountains, Wasatch Mountains, and Book Cliffs. There is a gradual tapering of elevation towards the eastern edge of the Basin towards the Colorado state line. The terrain of the Basin has an impact on the local meteorology (wind speed, wind direction and atmospheric stability). In such mountain-valley areas, during the night, cold air moves down into the valley (downslope winds), then during the day, warmer air will flow up valley sides (upslope winds). This creates a cold pool of air at night that is denser than warm air, thus inhibiting the mixing of air. Because wind speed will be lower at the valley floor than in open plains, the terrain surrounding the Basin cuts off potential air that might normally flow through the valley. This is then compounded when a high pressure system sets in, starting the formation of a temperature inversion. The day and night varying patterns of light winds have the potential to produce gradual intra-basin transport of ozone and precursors, but combined with the temperature inversion not strong enough to move out of the Basin. This lack of movement allows the buildup of precursor emissions and eventually ozone such that the standard is exceeded.

The combined meteorology and geography of the Basin provide the strongest basis for the use of an elevation boundary for nonattainment. Any emissions from sources outside of the inversion layer that is created in the Basin do not influence or contribute to the ozone event occurring within the inversion.

Jurisdictional Boundaries

The Basin is primarily located within Duchesne and Uintah counties. As was discussed in the air quality data analyses section, there is a state run air monitor located in each county. However, only the Roosevelt monitor located in Duchesne County has the required three years of certified data to support a designation decision. The DV of the Roosevelt monitor for 2013-2015 is calculated to be 0.075 ppm and exceeds the 2015 ozone standard. Preliminary data for the 2014-2016 three year timeframe that will be utilized by EPA indicates a DV of 0.068 ppm and is below the 2015 ozone standard.

As explained above, the Vernal monitor in Uintah County was relocated in January of 2015, thus does not have the required three years of certified data for this analysis, nor will it when the EPA makes its final designation decision in October of 2017. Though its data is not certified, the Vernal monitor does provide supporting evidence indicating that the air quality has exceeded the 2015 ozone standard. The new location experienced a fourth highest maximum value of 0.073 ppm during the winter of 2016. The previous Vernal monitor location does have certified data from years 2012-2014 and would have had a potential DV of 0.076 ppm for those years, which would have exceeded the 2008 ozone standard in place for that time period of 0.075 ppm.

This air quality monitoring data would indicate that Duchesne and Uintah counties should be proposed as nonattainment based upon jurisdictional county boundaries. However, the Basin does not follow the more standard summertime ozone issue associated with areas of high population, major industries, and high local and interstate vehicular traffic. These two counties are very rural areas with low population density and low vehicle traffic.¹⁴ The high ozone events are driven by the unique geography and meteorology of the Basin combined with emission sources of ozone precursors from the oil and gas industry. Thus, use of county lines alone does not accurately reflect the origination and extent of the elevated ozone values. The high wintertime ozone events are built within the geographical boundaries of the Basin. The portions of the Duchesne and Uintah counties not located in the Basin are not affected by the high ozone events nor do they contribute to them. As previously discussed, a 6,000 foot elevation within the Basin will define the extent of the intense wintertime inversions and bound the ozone impact.

As there is not a legal definition for the Basin to establish boundaries, it was determined to use townships and ranges and county lines combined with the maximum 6,000 foot elevation to frame the ozone nonattainment area. When the townships were overlaid on the 6,000 foot elevation line, several townships were included that had minimal contact with the elevation line. It was determined to remove those townships that had less than 10% of their area within the 6,000 foot elevation. Figure 32 provides a map of the townships to be included in the recommended nonattainment area.

¹⁴ United States Census Bureau, Quick Facts found at <http://www.census.gov/quickfacts/table/PST045215/49047,00>

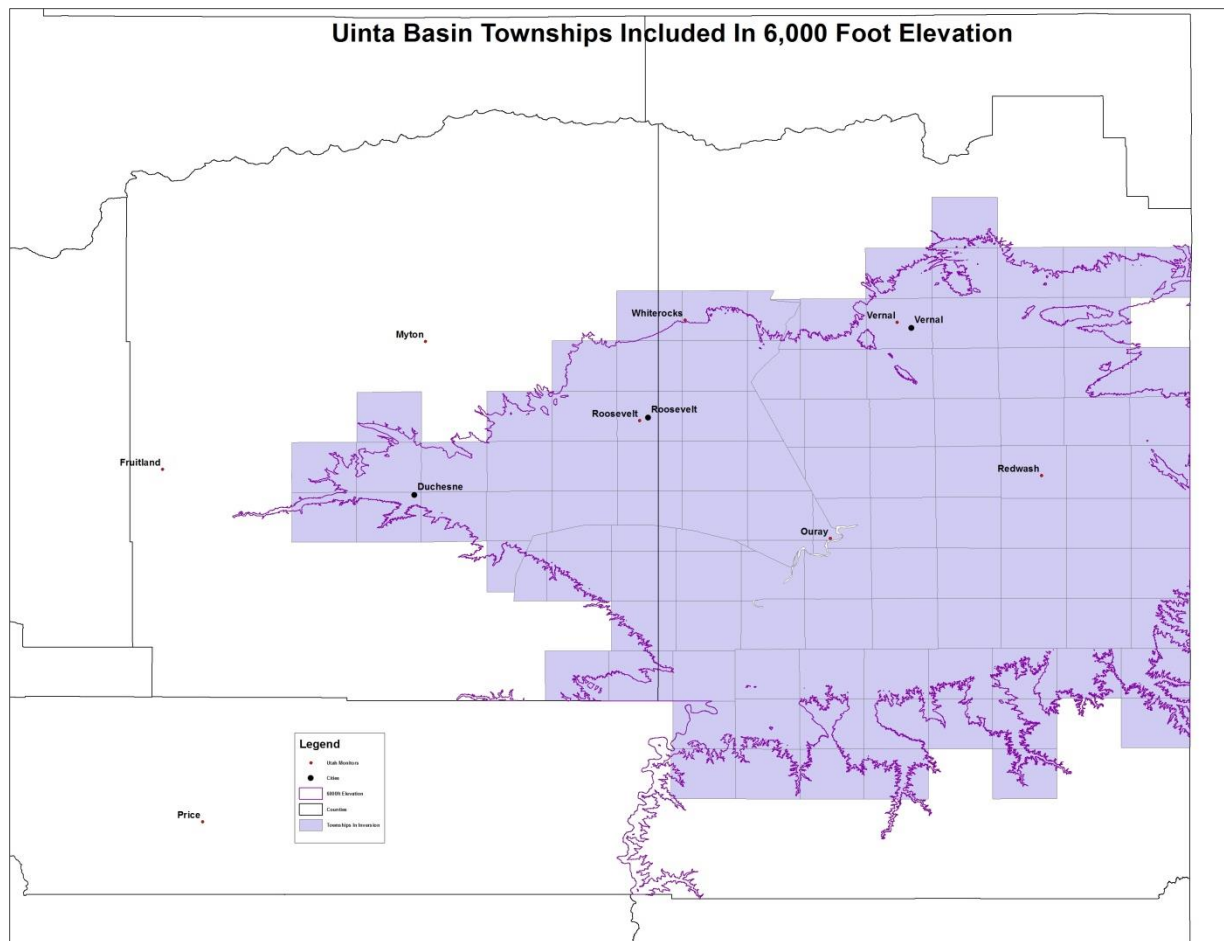


Figure 32. Uinta Basin Townships.

Uintah County is bounded to the east by the Colorado State line, which in essence coincides with the eastern most boundary of the geographic terrain that created the Basin. However, the proposed nonattainment boundary of an elevation of 6,000 feet above sea level along the mountains bounding the Basin does extend across the Colorado state line. There is a certified regulated monitor (operated by the Bureau of Land Management) located east of the Basin in Colorado identified as the Rangely monitor. There is elevated terrain between the eastern ridge of the Basin and the Rangely monitor. The Rangely monitor has not experienced an ozone exceedance since the wintertime inversion of 2013. The monitor did not measure an exceedance of the 2015 ozone standard during the wintertime inversion of 2016 where several exceedances were recorded in the Basin from Utah state monitors and Tribal monitors. There are small emission sources in the area of the Rangely monitor that are mostly associated with the oil and gas industry. Colorado has some of the strongest oil and gas regulations in the nation, as well as a comprehensive enforcement program that has had positive impacts on the air quality in the region. It would not benefit ozone attainment efforts in Utah to extend the elevation boundary into Colorado, as that area does not impact the air quality within the proposed nonattainment boundary. Thus, the eastern extent of the proposed nonattainment area is bounded by the Utah/Colorado state line.

The Basin has very complex jurisdictional boundaries. The counties are covered by the Uintah and Ouray Indian Reservations and Indian Country, which creates a complicated regulatory landscape for compliance with the Act requirements. Approximately two-thirds of currently producing oil and gas wells, three quarters of the gas production, and half of the oil production in the Basin, is located in Indian Country where, under 42 U.S. Code §7601 (d)(2), the tribes and the EPA have regulatory authority for air quality purposes. Utah has jurisdictional responsibility for the lands outside of Indian Country, where approximately 90% of the population is located. As there are distinct and separate regulatory authorities within the Basin, the recommendation for nonattainment provided by the State of Utah does not include reservation or Indian country lands.

Summary

The February 25, 2015, area designation guidance memorandum issued by EPA recommends that the presumptive boundary for designation begins with counties in the Core Based Statistical Areas (CSBA) or the CSA where a violating monitor is located. The Basin is primarily located in the Duchesne and Uinta counties which are not part of a CSBA or CSA. EPA then recommends that states evaluate relevant information associated with the county that contains the violating monitor and use a weight-of-evidence analysis for five factors. The five factors to be analyzed are air quality data, emissions and emissions-related data, meteorological data, geography/topography, and jurisdictional boundaries.

For the years 2013-2015, four regulatory monitors located within Duchesne and Uintah counties exceeded the 2015 ozone standard of 0.070 ppm. These four monitors are located within the geographical/topological boundaries of the Basin. Of the four monitors, one is located on and managed by the State of Utah and three are located on and managed by the Ute Indian Tribe. The ozone exceedances are associated with very specific meteorological conditions during winter temperature inversions when the ground is covered by snow with very light low-level winds and sunshine. These events are further bounded by the topographical influence of being located within a basin created by mountains on the north, west and south. Studies conducted during these strong wintertime inversions have determined that there is a vertical boundary to the inversion that traps ozone and ozone precursors within the limits of the inversion. It has been demonstrated that that ozone does not migrate outside of the vertical limit of the inversion nor are precursor emissions able to transport into the inversion. This vertical limit to the high ozone and the chemistry that forms high ozone was observed at 1,700 meters (5,577 feet) during one of the strongest winter inversions studied and experienced the highest ozone values recorded (UBOS 2013). To provide a level of conservatism, the State recommends an elevation of 6,000 feet above sea level as the upper boundary to the proposed nonattainment area. The February 25, 2015, designation guidance memorandum states that though EPA generally believes in the inclusion of the entire violating or contributing county in an ozone nonattainment area, they recognize that the assessment of relevant information may support the inclusion of only part of a county. The guidance also explains that there may be low elevation areas with poor air quality in violation of the NAAQS, yet the higher elevation mountainous areas in the same county can be shown not to have emission sources that contribute to the violation. That is the case for the Basin and this is documented via the UBOS.

The Basin is a very rural area, with a population density of about 6 people per square mile¹⁵; therefore, the factors of population density, traffic and commuting patterns and growth rates are not significant contributors to ozone precursor emissions. The emissions of ozone precursors are primarily from the oil and gas industry that drives the economy of the Basin. Approximately 95% of VOCs, which the UBOS has shown to be the limiting precursor to ozone formation in the Basin, come from oil and gas production (WRAP 2011 EI). Though some of the oil and gas emission sources can be found outside of the proposed nonattainment area, again it has been shown through scientific studies that during the high ozone events, ozone does not migrate out nor do emissions break through into the inversion. The air masses above and below the inversion height are essentially decoupled and thus sources outside of the proposed elevation do not contribute to the high ozone values measured within the Basin.

The jurisdictional boundaries of Duchesne and Uintah counties very closely follow the natural boundary created by the surrounding mountains on the south, west and north and closely match the upper elevation boundary of 6,000 feet. Therefore, the county jurisdictional boundaries in the southern part of Uinta Basin become a reasonable boundary for the proposed nonattainment area. To the east, with the declining elevation of mountains the topographical boundaries are less dramatic; yet, there are still scattered buttes and mountains that closely coincide with the Utah and Colorado state line that the state line makes a reasonable boundary for nonattainment.

The proposed nonattainment area for the Basin encompasses the one state monitor that has violated the ozone standard for years 2013-2015 (but currently meets the standard for the DVs years of 2014-2016) and the sources most likely contributing to ozone formation with the emissions of ozone precursors. It also represents the conclusions from several years of intense study that has established the relationship of high ozone occurrences to specific meteorological events combined with topographical constraints where ozone and its precursors are trapped within a defined inversion that is so strong that precursor emissions and ozone can transport neither in nor out.

State Recommendation for the Uinta Basin

The State of Utah is recommending the establishment of a nonattainment area for the 2015 ozone standard in the counties of Duchesne and Uintah, for lands under state air jurisdiction, and a maximum elevation limit based on the temperature inversion height. The nonattainment area proposed would be at and below the 6,000 foot elevation in the southern slopes of the Uinta Mountains in the north, the eastern slopes of the Wasatch Range in the west and the northern slopes of the Tavaputs Plateau and Book Cliffs in the south. To provide legally defined boundaries, townships and ranges were overlaid onto the 6,000 foot elevation line to encompass the Basin. The townships that are at least 10% or more within the elevation line are included in the proposed nonattainment area. Therefore the proposed **Uinta Basin** nonattainment area, as shown in Figure 33, includes the areas within the following townships in Duchesne and Uintah

¹⁵ United States Census Bureau, Quick Facts found at <http://www.census.gov/quickfacts/table/PST045215/49047,00>

County that are not under EPA or tribal jurisdiction for air quality purposes under 42 U.S.C §7601(d)(2)¹⁶:

- Duchesne County – Salt Lake Meridian:
 - Township 10 South Range 17 East
 - Township 11 South Range 16 East
 - Township 11 South Range 17 East
 - Township 8 South Range 15 East,
 - Township 8 South Range 16 East
 - Township 9 South Range 15 East
 - Township 9 South Range 16 East
- Duchesne County – Uintah Meridian:
 - Township 4 South Range 1 West
 - Township 1 North Range 1 West
 - Township 1 South Range 1 West
 - Township 1 South Range 2 West
 - Township 2 South Range 1 West
 - Township 2 South Range 2 West
 - Township 2 South Range 3 West
 - Township 2 South Range 5 West
 - Township 3 South Range 1 West
 - Township 3 South Range 2 West
 - Township 3 South Range 3 West
 - Township 3 South Range 4 West
 - Township 3 South Range 5 West
 - Township 3 South Range 6 West
 - Township 4 South Range 2 West
 - Township 4 South Range 3 West
 - Township 4 South Range 4 West
 - Township 4 South Range 5 West
 - Township 4 South Range 6 West
 - Township 5 South Range 3 West
- Uintah County – Salt Lake Meridian:
 - Township 10 South Range 25 East
 - Township 11 South Range 25 East
 - Township 12 South Range 25 East
 - Township 2 South Range 22 East
 - Township 3 South Range 21 East
 - Township 3 South Range 22 East
 - Township 3 South Range 23 East
 - Township 3 South Range 24 East

¹⁶ The map used to define portions of Duchesne and Uintah counties under EPA or tribal jurisdiction originated with EPA Region VIII.

- Township 3 South Range 25 East
- Township 4 South Range 19 East
- Township 4 South Range 20 East
- Township 4 South Range 21 East
- Township 4 South Range 22 East
- Township 4 South Range 23 East
- Township 4 South Range 24 East
- Township 5 South Range 19 East
- Township 5 South Range 20 East
- Township 5 South Range 21 East
- Township 5 South Range 22 East
- Township 5 South Range 23 East
- Township 5 South Range 24 East
- Township 5 South Range 25 East
- Township 6 South Range 19 East
- Township 6 South Range 20 East
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- Township 6 South Range 25 East
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- Township 7 South Range 20 East
- Township 7 South Range 23 East
- Township 7 South Range 24 East
- Township 7 South Range 25 East
- Township 8 South Range 17 East
- Township 8 South Range 18 East
- Township 8 South Range 25 East
- Township 9 South Range 19 East
- Township 9 South Range 25 East
- Uintah County – Uintah Meridian:
 - Township 1 North Range 1 East
 - Township 1 North Range 1 West
 - Township 1 North Range 2 East
 - Township 1 South Range 1 East
 - Township 1 South Range 1 West
 - Township 1 South Range 2 East
 - Township 2 South Range 1 East
 - Township 2 South Range 1 West
 - Township 2 South Range 2 East
 - Township 3 South Range 1 East
 - Township 3 South Range 1 West
 - Township 3 South Range 2 East
 - Township 4 South Range 1 East
 - Township 4 South Range 1 West

- Township 4 South Range 2 East
- Township 4 South Range 3 East
- Township 5 South Range 2 East
- Township 5 South Range 3 East

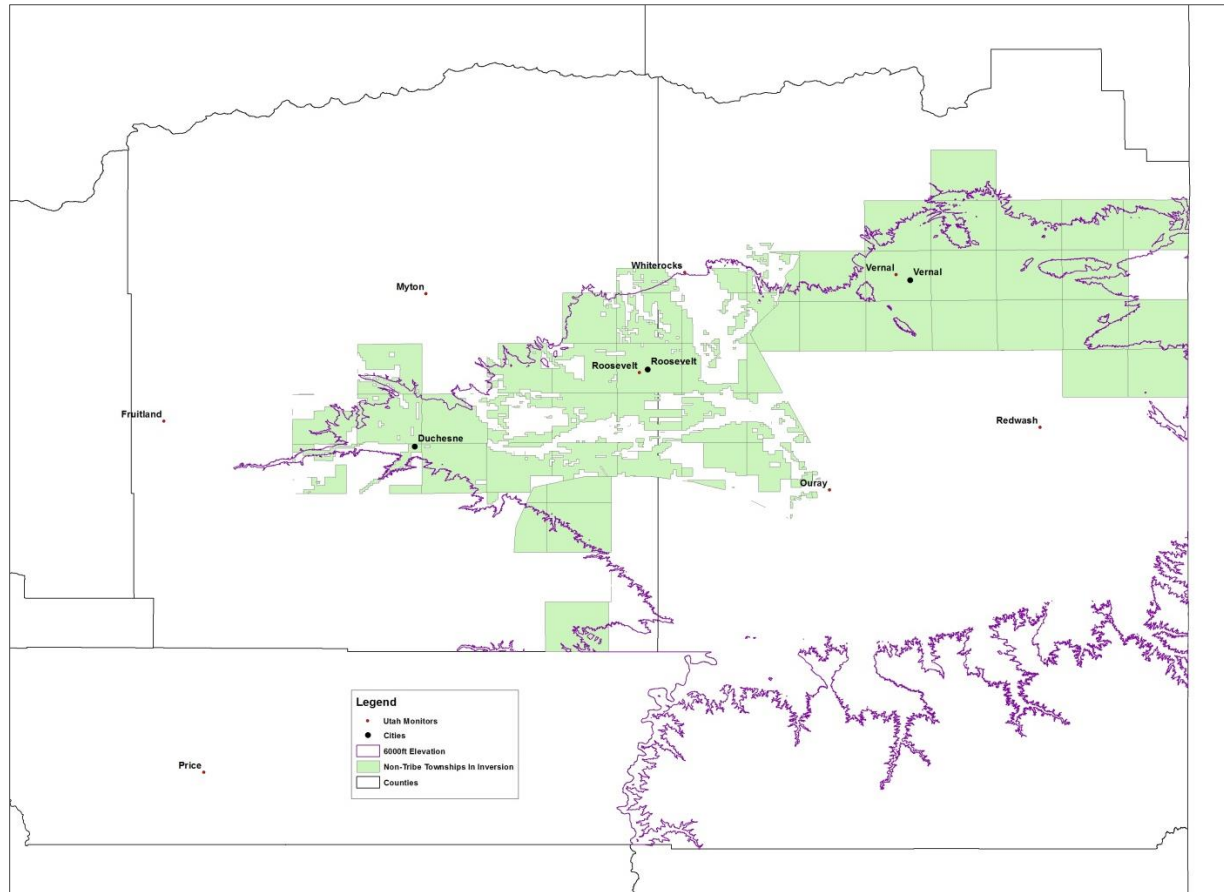


Figure 33. Recommended Uinta Basin Ozone Nonattainment Area.

State Recommendation for other Areas of Utah

Based on monitored DVs, Utah recommends that the following counties be designated attainment: Box Elder, Cache, Carbon, Garfield, San Juan, and Washington. All other areas of the State of Utah not included in the above recommendations should be designated attainment/unclassifiable.