3. EMISSIONS INVENTORY

3.1 Background

The ARB, in conjunction with local air districts, develops and maintains a Statewide inventory of emission sources. Because a regional modeling effort was conducted for the Plan, the Western Regional Air Partnership (WRAP), in coordination with the fifteen western states, developed a multi-state emissions inventory to support this work. This inventory was developed for 2002, reflecting the mid-point of the 2000-2004 baseline period. The WRAP 2002 planning inventory includes ARB's submission to the National Emission Inventory (2002 NEI), which reflects rules adopted through 2004. This inventory was then projected to 2018 using information on the growth and control of source categories. For regional continuity on a number of source categories which are primarily of natural origin, and which occur similarly throughout the region, WRAP developed new estimates for sources such as biogenic (plant) emissions, wildfires, and windblown dust.

The WRAP inventory is therefore slightly different from ARB's and does not include several recent updates that the ARB has made since the 2002 NEI submittal. Specifically, ARB recently updated California's mobile source inventory to reflect the impacts of new control measures, new vehicle emission factors, and updated vehicle activity estimates. Nevertheless, the WRAP inventory provides an appropriate regionally consistent basis for this Plan, and ARB updates will be incorporated in subsequent Plan revisions. Information on the WRAP inventory can be found at http://www.wrapedms.org.

3.2 Pollutants Addressed

The emissions inventory used for the Plan begins with the same inventory of criteria pollutants or health-impacting pollutants that is used in planning efforts to meet the National Ambient Air Quality Standards (NAAQS). The sources can be from both natural and anthropogenic activities.

Emissions that contribute to impairing visibility include sulfur oxides (SOx), nitrogen oxides (NOx), particulate matter (PM), both PM10 and PM2.5, volatile organic compounds (VOC), and ammonia (NH3). Not all of these contribute directly to the development of haze, but may undergo chemical reactions in the atmosphere to become haze components. The most pertinent of these species are noted below:

Oxides of Nitrogen (NOx). Fuel combustion is the primary source of nitrogen oxide emissions in the atmosphere. The vast majority of Statewide NOx emissions come from mobile sources. Combustion processes from stationary industrial sources, such as manufacturing, food processing, electric utilities, and petroleum refining, also contribute, with smaller contributions from area-wide

sources, such as waste burning and residential fuel consumption. Natural sources, primarily from wildfires, are not a major source of emissions. Nitrate particles, formed when nitrogen oxides react in the atmosphere, particularly with ammonia, are very effective at scattering light and contributing to haze formation.

Oxides of Sulfur (SOx). The mobile source categories of ships and commercial boats are the primary sources of sulfur oxide emissions along the coastline of California. These sources are not included in the California emission totals, but rather are included in a separate Pacific Offshore category developed by the WRAP. Other significant sources include petroleum refining, locomotives, mining, and cement manufacturing. Wildfire emissions, while a source of SOx, are not significant. Sulfate particles are generally formed when sulfur oxides interact with ammonia in the atmosphere. Similar to nitrate, sulfate particles are effective as scattering light and contributing to haze.

Particulate Matter (PM). PM10, also known as Respirable Particulate Matter, is comprised of both Coarse and Fine PM. PM Coarse, the fraction of PM10 larger than 2.5 and smaller than 10 micrometers in diameter, is primarily emitted from activities that suspend dust in the atmosphere, such as traffic on paved and unpaved roads, farming, and construction, as well as windblown dust.

Fine particulate matter, PM2.5 or PM Fine, is directly emitted into the atmosphere in the form of smoke, soot, and dust particles. These particles come from sources as diverse as mobile sources, managed and agricultural burning and residential fireplaces. Natural sources of PM include wildfires and biogenics (plant and animal matter). Sub-categories of Fine PM include Organic (OC) and elemental (EC) carbon particles, both directly emitted into the atmosphere, primarily through combustion processes. The remaining Fine PM comes primarily from dust and other non-combustion activities.

Volatile Organic Compounds (VOC). Incomplete fuel combustion and the evaporation of chemical solvents and fuels contribute to the presence of volatile organic compounds in the atmosphere. These gases are also emitted from natural, biogenic, sources such as plants and trees. VOCs can react and condense in the atmosphere to form organic aerosols which can then contribute to visibility impairment.

Ammonia (NH3). Mobile sources contribute only a small amount of the ammonia in the atmosphere. Most emissions are from livestock operations and fertilizer applications. Natural biogenic sources such as soil and vegetation contribute almost as much ammonia to the atmosphere as livestock operations (about 40 percent). Ammonia can combine with oxides of sulfur and nitrogen in the atmosphere to form ammonium sulfates and ammonium nitrates.

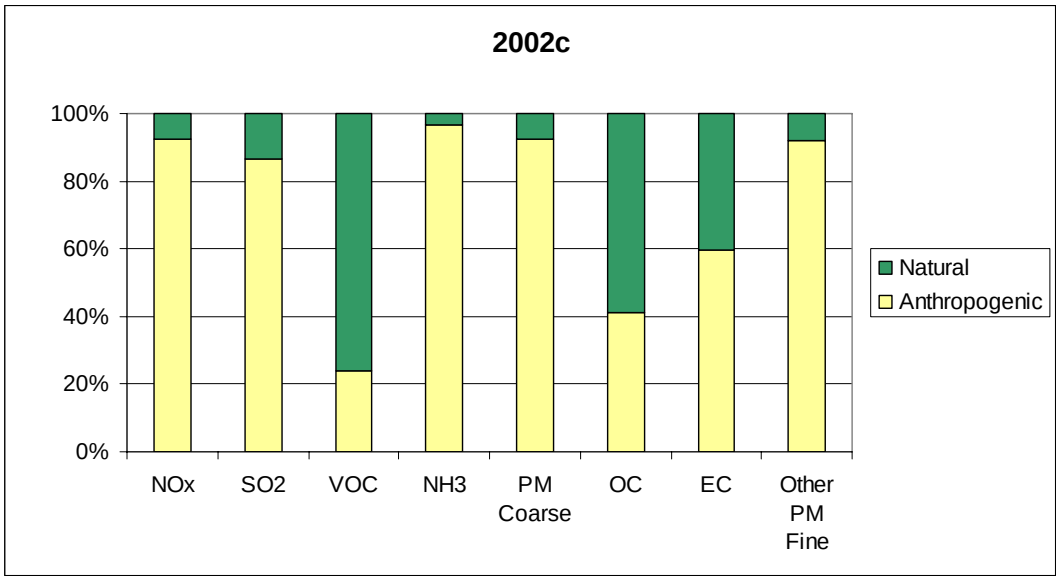
3.3 Statewide Inventory

The overall emissions inventory for the State of California for the 2002 base year is shown in Table 3-1 and Figure 3-1. Statewide, natural, biogenic sources account for a large portion of the emissions for several pollutants such as VOCs, Fine PM, OC, and EC. Biogenics are the largest contributor to natural VOC emissions, while wildfires account for the majority of Fine OC and EC natural emissions. As will be discussed in subsequent chapters, understanding the contributions from natural versus anthropogenic emissions will be important in assessing the level of improvement in future visibility that can be expected to occur. More detailed emissions inventory on a sub-regional basis can be found in Appendix I.

Table 3-1 Overall Emission Source Inventory (Anthropogenic versus Natural Sources)

Species	Source - Plan 02c (tons/year)	
	Anthropogenic	Natural
NOx	1,127,359	93,043
SO2	62,954	9,840
VOC	908,151	2,890,198
NH3	225,157	7,595
PM Coarse	279,148	23,124
OC Fine PM	64,491	92,097
EC Fine PM	28,397	19,078
Other PM Fine	67,667	5,880

Figure 3-1 2002 Magnitude of Anthropogenic versus Natural Sources



3.4 Emissions Categories

The WRAP inventory for California includes both natural and anthropogenic sources. Anthropogenic sources are composed of the three major categories below:

- **Stationary Sources** – sources which can be identified by name and location, such as general industrial facilities.
    - Stationary sources in the WRAP inventory are noted as Point Sources.
- **Area-wide Sources** - sources that cannot be tied to a single location, such as consumer products and dust from unpaved roads, or small individual sources, such as residential fireplaces.
    - Area sources in the WRAP inventory include the following categories: Area, Road Dust, Fugitive Dust, Wind Blown Dust, and Anthropogenic Fire.
- **Mobile Sources** – sources that use roads to move from one location to another, such as on-road cars, trucks, buses, etc. Off-road mobile sources are those that move from one location to another, but not necessarily via roads, such as boats and ships, off-road recreational vehicles, aircraft, trains, portable industrial and construction equipment, farm equipment, and other easily moved equipment.
    - WRAP mobile source categories include: On-Road Mobile and Off-Road Mobile. Offshore California emissions are reported as part of a separate Pacific Offshore emissions category and are, therefore, not included here.

In addition, a fourth category addresses natural emission sources:

- **Natural Sources** – sources that are not directly human-caused (not anthropogenic) such as biological and geogenic sources, and wildfires.
    - WRAP natural source categories include: Natural Fire and Biogenics (plant emissions).

Table 3-2 provides a breakdown of the emissions of each pollutant into these key categories.

Table 3-2 Individual Pollutants and Source Categories

Species	Stationary (tpy)		Area (tpy)		Mobile (tpy)		Natural (tpy)	
	2002	2018	2002	2018	2002	2018	2002	2018
NOx	104,991	109,514	112,988	112,789	909,380	370,385	93,043	93,043
SO2	42,227	49,632	9,139	10,134	11,588	3,800	9,840	9,840
VOC	54,632	54,631	335,114	594,843	518,405	232,839	2,890,198	2,890,198
NH3	433	0	202,045	193,486	22,679	30,430	7,595	7,595
PM Coarse	10,172	13,700	263,902	291,429	5,075	6,389	23,124	23,124
Fine PM OC	5,515	3,696	44,986	36,777	13,991	15,834	92,097	92,097
Fine PM EC	933	835	5,887	5,503	21,577	12,589	19,078	19,078
Other PM Fine	10,537	12,317	55,005	54,016	2,125	2,929	5,880	5,880

Mobile sources, both on-road and off-road, account for the majority of NOx emissions, approximately 70 percent, with almost 50 percent from on-road and over 20 percent from off-road sources. The mobile source contribution, however, decreases significantly by 2018 with overall NOx emissions dropping by nearly 44 percent. Natural sources contribute less than 10 percent.

Sulfur Dioxide, the most common form of the sulfur oxides, is primarily from anthropogenic stationary/point sources; this is expected to increase slightly by 2018. A little over 10 percent is contributed by biogenic sources. Stringent motor vehicle emissions regulations will decrease the contribution from mobile sources significantly, almost 70 percent by 2018, particularly in the off-road category.

Biogenic sources, consisting of plants, crops, and trees, account for 80 percent of Volatile Organic Compound emissions. This natural emission source is expected to remain constant. Total emissions from anthropogenic sources is expected to decrease, due primarily to mobile source controls.

Ammonia is dominated by area sources, primarily livestock operations, with very little contribution from natural sources. Area sources of ammonia are expected to decrease 4 percent by 2018.

The sources of coarse PM (PM larger than PM2.5 and smaller than PM10) are dominated by fugitive dust sources such as windblown dust and emissions from paved and unpaved roads. Natural contributions are slight and are expected to remain constant. Coarse PM emissions are expected to increase in most other source categories due to population growth.

Fine PM (PM2.5) can be further broken into sub-categories including OC and EC. OC and EC are emitted directly into the atmosphere from combustion sources such as wood burning, mobile sources, and commercial cooking. The primary source of OC and EC are natural fires and these are expected to remain relatively constant. However, mobile source EC decreases significantly in 2018 due to the effects of California's diesel control program. The remaining portion of Fine PM, or Other Fine PM, is primarily derived from area sources, particularly fugitive dust source categories.

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