

# 2018 Emission Reductions from the Base 18b Emission Inventory

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# Changes in the 2018 Base Case Emissions from the 2000-04 "Planning" Emission Inventory

- All data taken from the spreadsheets located on the TSS > Resources > Emissions webpage:  
<http://vista.cira.colostate.edu/TSS/Results/Emissions.aspx>
- Review shows that there likely may be some errors in the compilation of this data. The WRAP is currently undertaking a review and update of the 2018 Emission Inventory in preparation for conducting a “Preliminary Reasonable Progress” model run before Summer '07. Correction of known errors will be made in that EI update.

- Pollutants included:
  - Carbon Monoxide (CO)
  - Ammonia (NH<sub>3</sub>)
  - Nitrogen Dioxide (NO<sub>2</sub>)
  - Nitrogen Monoxide (NO)
  - Elemental Carbon (PEC)
  - Coarse PM (PMC)
  - Fine PM (PMFINE)
  - Particulate Nitrate (NO<sub>3</sub>)
  - Organic Carbon (POA)
  - Particulate Sulfate (PSO<sub>4</sub>)
  - Sulfur Dioxide (SO<sub>2</sub>)
  - Sulfuric Acid (SULF)
  - Volatile Organic Compounds (VOC)
  - Nitrogen Oxides (NOX)

- This list contains Pollutant species as they come out of the SMOKE emission processor, thus some combination is necessary to facilitate analysis
- Combination of Pollutants was made as follows:
  - Nitrogen Dioxide (NO<sub>2</sub>) & Nitrogen Monoxide (NO) were eliminated as duplicative of Nitrogen Oxides (NO<sub>x</sub>)
  - Elemental Carbon (PEC), Organic Carbon (POA), Particulate Nitrate (NO<sub>3</sub>) & Particulate Sulfate (PSO<sub>4</sub>) particulate species were summed and added to the Fine PM (PMFINE) total
  - Sulfur Dioxide (SO<sub>2</sub>) and Sulfuric Acid (SULF) were summed to produce a single total for Sulfur Oxides (SO<sub>x</sub>)

# All Source Sectors: Annual Tons

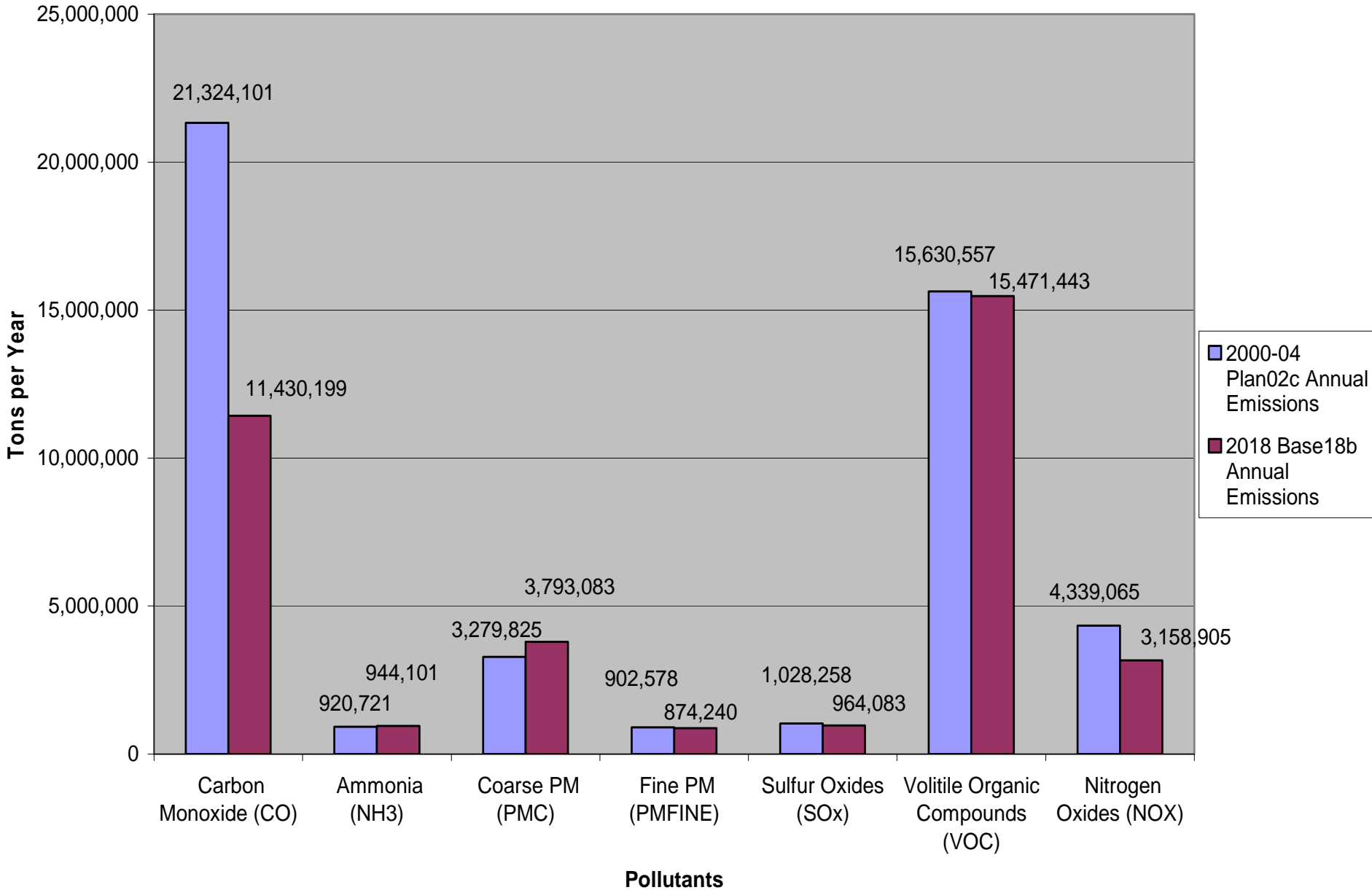
## Changes in the 2018 Base Case Emissions from the 2000-04 "Planning" Emission Inventory

Source Category	Carbon Monoxide (CO)	Ammonia (NH3)	Coarse PM (PMC)	Fine PM* (PMFINE)	Sulfur Oxides** (SOx)	Volatile Organic Compounds (VOC)	Nitrogen Oxides (NOX)
2000-04 Plan02c Annual Emissions	21,324,101	920,721	3,279,825	902,578	1,028,258	15,630,557	4,339,065
2018 Base18b Annual Emissions	11,430,199	944,101	3,793,083	874,240	964,083	15,471,443	3,158,905
Change in 2018	-9,893,902	23,380	513,258	-28,338	-64,175	-159,114	-1,180,160
Percent Change	-46.4%	2.5%	15.6%	-3.1%	-6.2%	-1.0%	-27.2%

\* Fine PM includes: Elemental Carbon (PEC) + Particulate Nitrate (NO3) + Particulate Sulfate (SO4) + Organic Carbon (POA)

\*\* Sulfur Oxides Includes: Sulfur Dioxide (SO2) + Sulfuric Acid (SULF)

# Changes in 2018 Emissions (All Source Sectors)



# Point Sources: Annual Tons

## Changes in the 2018 Base Case Emissions from the 2000-04 "Planning" Emission Inventory

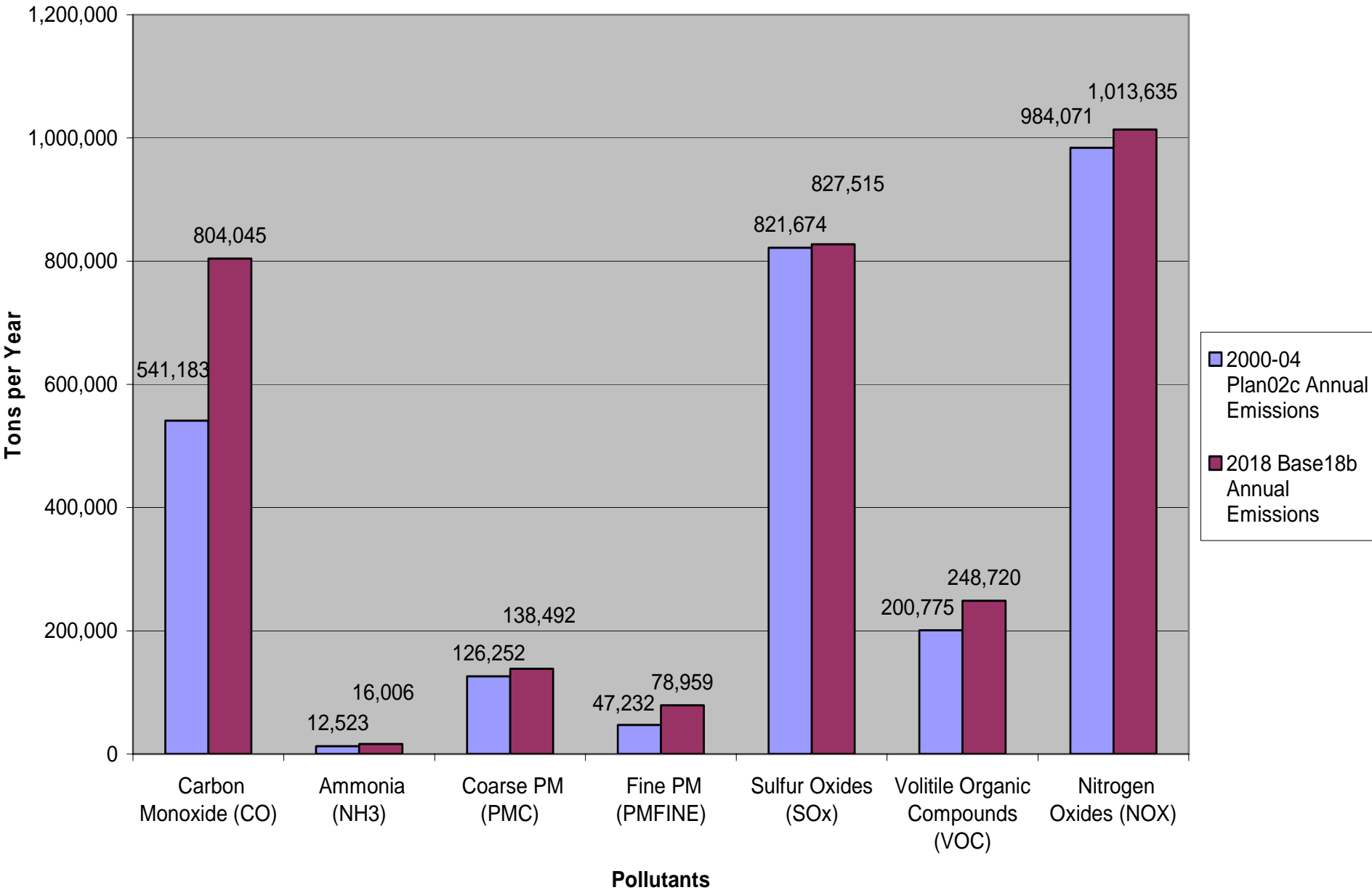
Source Category	Carbon Monoxide (CO)	Ammonia (NH3)	Coarse PM (PMC)	Fine PM* (PMFINE)	Sulfur Oxides** (SOx)	Volatile Organic Compounds (VOC)	Nitrogen Oxides (NOX)
2000-04 Plan02c Annual Emissions	541,183	12,523	126,252	47,232	821,674	200,775	984,071
2018 Base18b Annual Emissions	804,045	16,006	138,492	78,959	827,515	248,720	1,013,635
Change in 2018	262,862	3,483	12,240	31,726	5,841	47,944	29,564
Percent Change	48.6%	27.8%	9.7%	67.2%	0.7%	23.9%	3.0%

\* Fine PM includes: Elemental Carbon (PEC) + Particulate Nitrate (NO3) + Particulate Sulfate (SO4) + Organic Carbon (POA)

\*\* Sulfur Oxides Includes: Sulfur Dioxide (SO2) + Sulfuric Acid (SULF)

- 2018 Changes based on ERG Projections using Growth & Control Assumptions run through EPA's EGAS Model
- Minimized SO2 increase primarily due to control @ certain EGU's (ie/ Mojave, Centrallia)
- Existing EGU's to reach maximum capacity in 2018, new EGU's projected as well
- Includes O&G as point sources in some states (ie/ CO 1T, WY 25T Point Definition)

# Changes in 2018 Point Source Emissions



# Area Sources: Annual Tons

## Changes in the 2018 Base Case Emissions from the 2000-04 "Planning" Emission Inventory

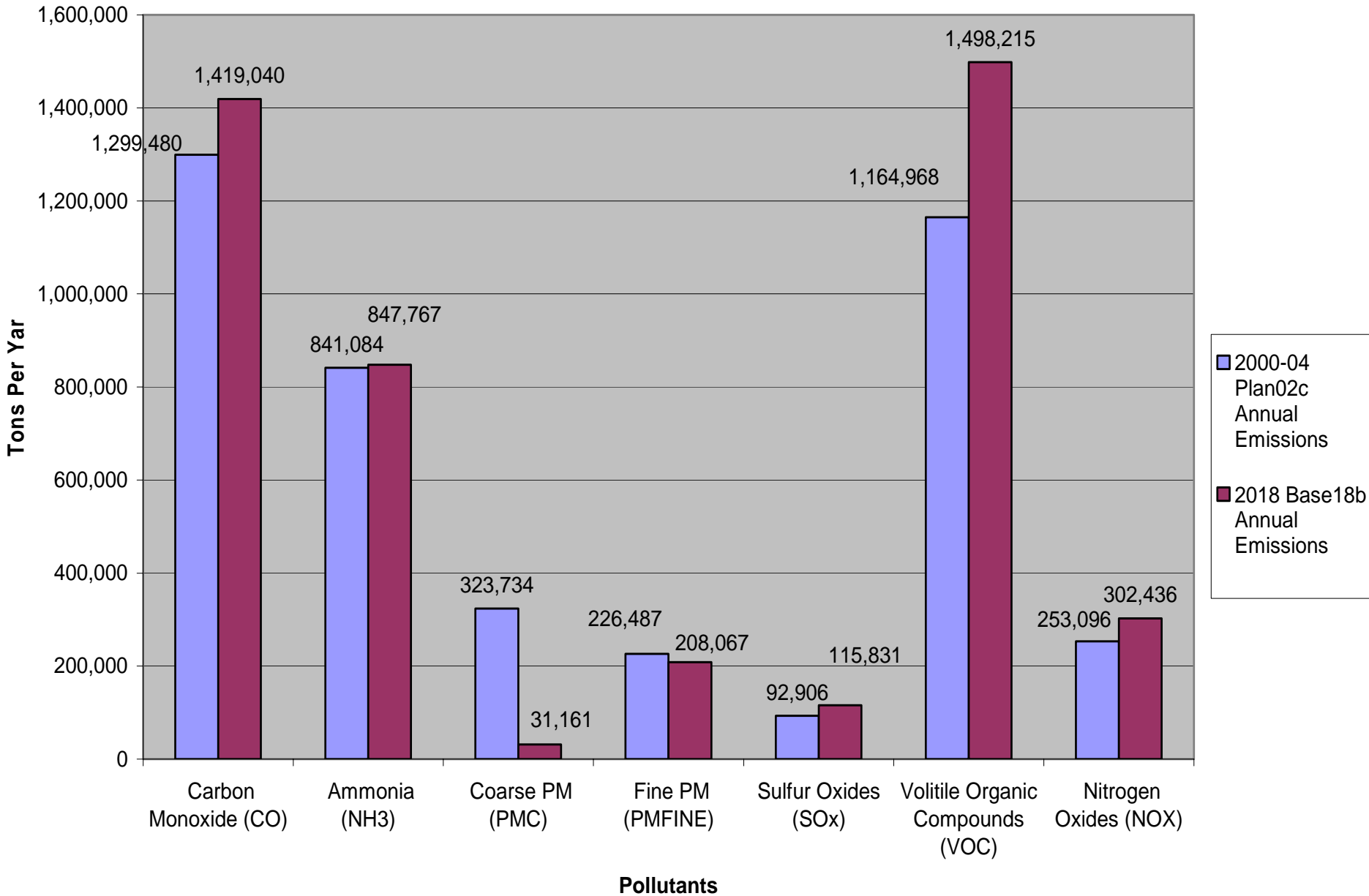
Source Category	Carbon Monoxide (CO)	Ammonia (NH3)	Coarse PM (PMC)	Fine PM* (PMFINE)	Sulfur Oxides** (SOx)	Volatile Organic Compounds (VOC)	Nitrogen Oxides (NOX)
2000-04 Plan02c Annual Emissions	1,299,480	841,084	323,734	226,487	92,906	1,164,968	253,096
2018 Base18b Annual Emissions	1,419,040	847,767	31,161	208,067	115,831	1,498,215	302,436
Change in 2018	119,560	6,684	<del>-292,573</del>	-18,420	22,925	333,247	49,340
Percent Change	9.2%	0.8%	<del>-90.4%</del>	-8.1%	24.7%	28.6%	19.5%

\* Fine PM includes: Elemental Carbon (PEC) + Particulate Nitrate (NO3) + Particulate Sulfate (SO4) + Organic Carbon (POA)

\*\* Sulfur Oxides Includes: Sulfur Dioxide (SO2) + Sulfuric Acid (SULF)

- 2018 Changes based on ERG Projections using Growth & Control Assumptions using EPA's EGAS Model
- Changes in Emissions primarily a result of Population Growth & associated growth in activity levels
- Something Funky with the 2018 Coarse PM figures (probably not 90% decrease)

# Changes in 2018 Area Source Emissions



# On Road Mobile Sources: TPY

## Changes in the 2018 Base Case Emissions from the 2000-04 "Planning" Emission Inventory

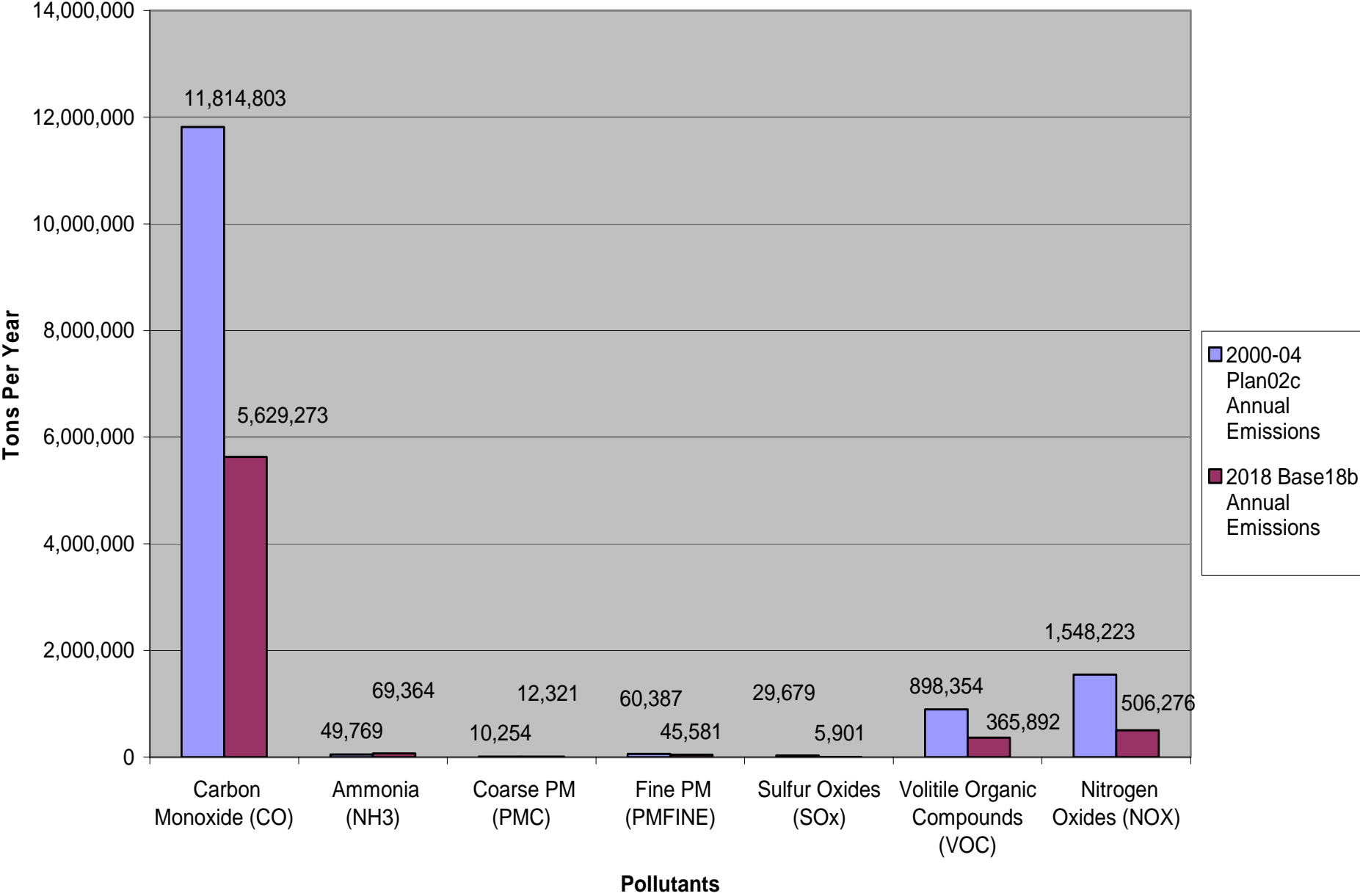
Source Category	Carbon Monoxide (CO)	Ammonia (NH3)	Coarse PM (PMC)	Fine PM* (PMFINE)	Sulfur Oxides** (SOx)	Volatile Organic Compounds (VOC)	Nitrogen Oxides (NOX)
2000-04 Plan02c Annual Emissions	11,814,803	49,769	10,254	60,387	29,679	898,354	1,548,223
2018 Base18b Annual Emissions	5,629,273	69,364	12,321	45,581	5,901	365,892	506,276
Change in 2018	-6,185,531	19,595	2,066	-14,807	-23,778	-532,462	-1,041,947
Percent Change	-52.4%	39.4%	20.2%	-24.5%	-80.1%	-59.3%	-67.3%

\* Fine PM includes: Elemental Carbon (PEC) + Particulate Nitrate (NO3) + Particulate Sulfate (SO4) + Organic Carbon (POA)

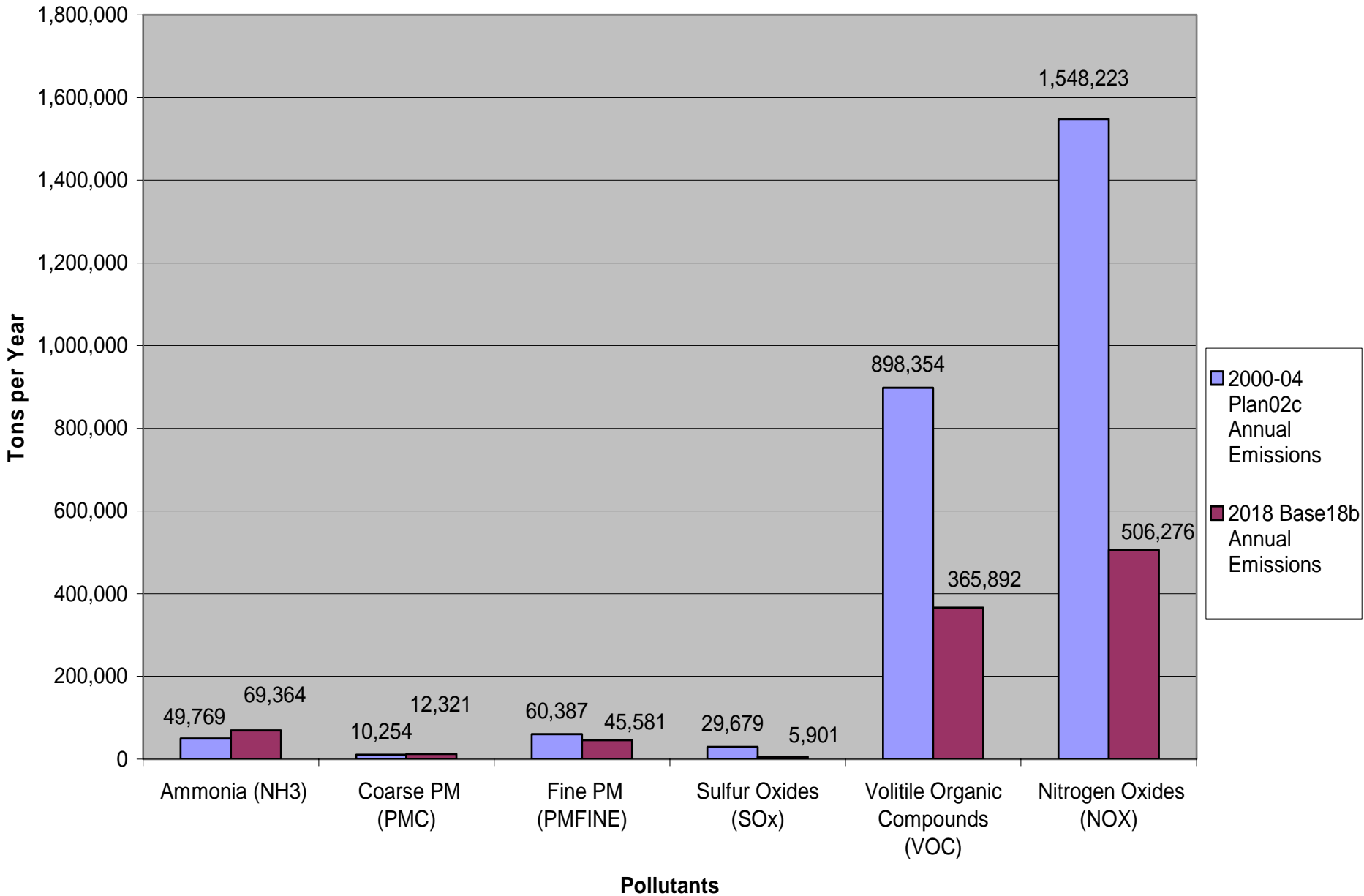
\*\* Sulfur Oxides Includes: Sulfur Dioxide (SO2) + Sulfuric Acid (SULF)

- 2018 SOx Changes primarily a result of the On Road Gasoline (300 -> 30 ppm S) and On Road Diesel (500 ->15 ppm S) rules
- 2018 NOx/CO/PM/VOC improvement due to Tier II (and above) engine standards
- All emission reductions offset by increase VMT in 2018

# Changes in 2018 On Road Mobile Emissions



# Changes in 2018 On-Road Emissions (w/o CO)



# Non-Road Mobile Sources: TPY

## Changes in the 2018 Base Case Emissions from the 2000-04 "Planning" Emission Inventory

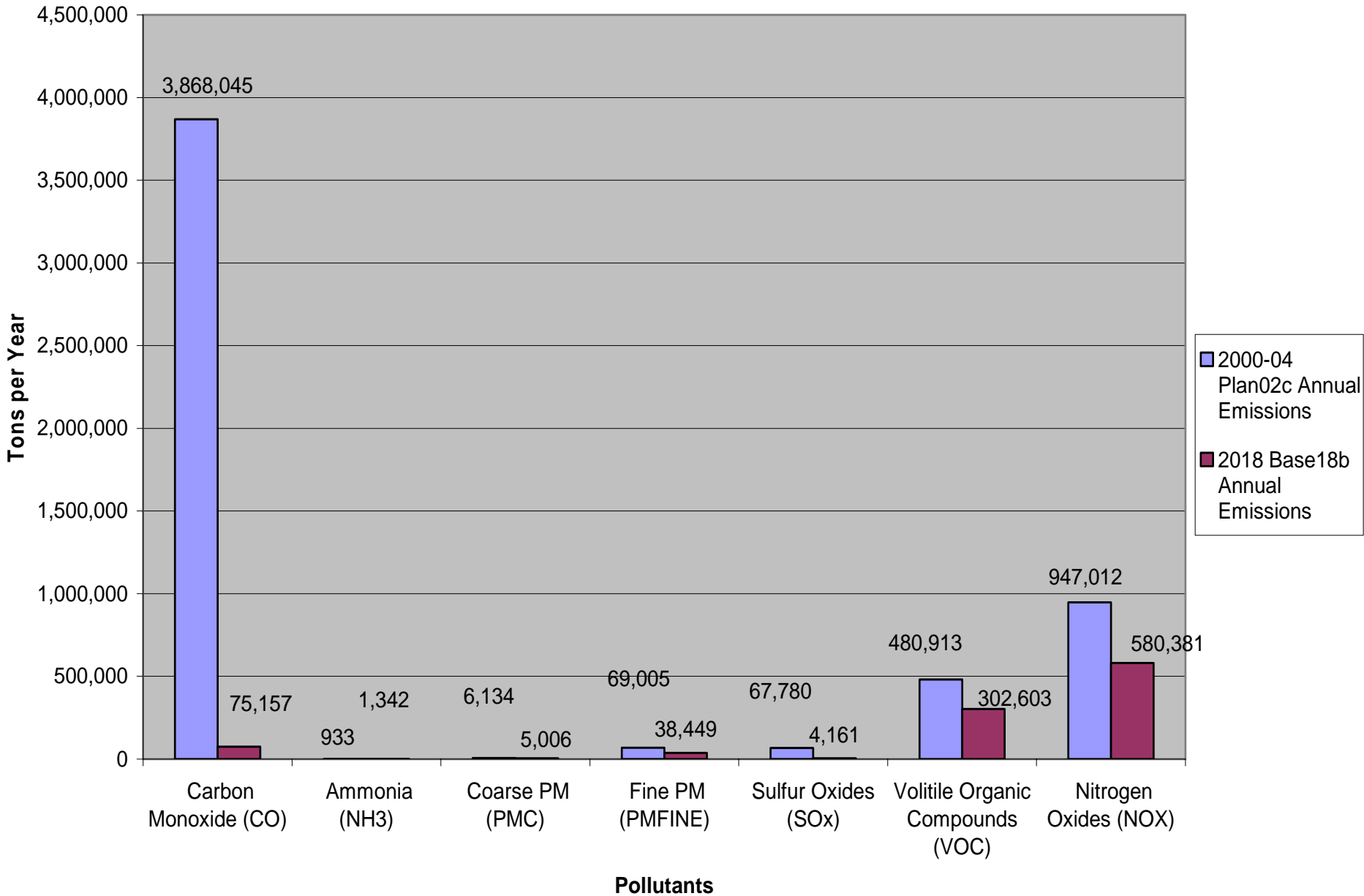
Source Category	Carbon Monoxide (CO)	Ammonia (NH3)	Coarse PM (PMC)	Fine PM* (PMFINE)	Sulfur Oxides** (SOx)	Volatile Organic Compounds (VOC)	Nitrogen Oxides (NOX)
2000-04 Plan02c Annual Emissions	3,868,045	933	6,134	69,005	67,780	480,913	947,012
2018 Base18b Annual Emissions	75,157	1,342	5,006	38,449	4,161	302,603	580,381
Change in 2018	-3,792,888	409	-1,129	-30,556	-63,619	-178,310	-366,630
Percent Change	-98.1%	43.9%	-18.4%	-44.3%	-93.9%	-37.1%	-38.7%

\* Fine PM includes: Elemental Carbon (PEC) + Particulate Nitrate (NO3) + Particulate Sulfate (SO4) + Organic Carbon (POA)

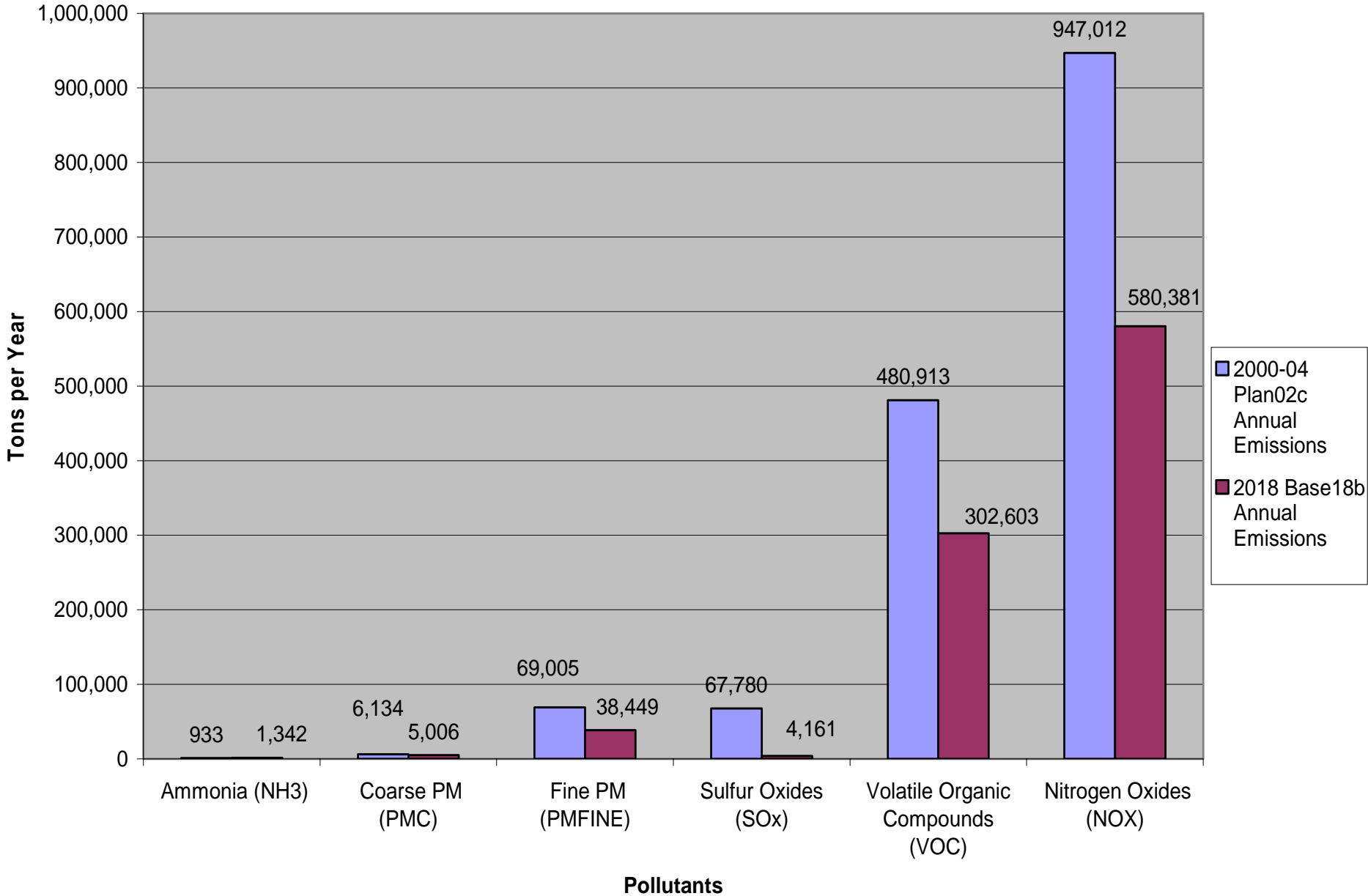
\*\* Sulfur Oxides Includes: Sulfur Dioxide (SO2) + Sulfuric Acid (SULF)

- 2018 SOx Changes primarily a result of the Non-Road Diesel Rules (up to 4,000 down to 500 ppm S in 2006; 15 ppm in 2012)
- 2018 NOx/CO/PM/VOC improvement due to Tier II (and above) engine standards

# Changes in 2018 Non-Road Emissions



# Changes in 2018 Non-Road Emissions (w/o CO)



# Off Shore Shipping: TPY

## Changes in the 2018 Base Case Emissions from the 2000-04 "Planning" Emission Inventory

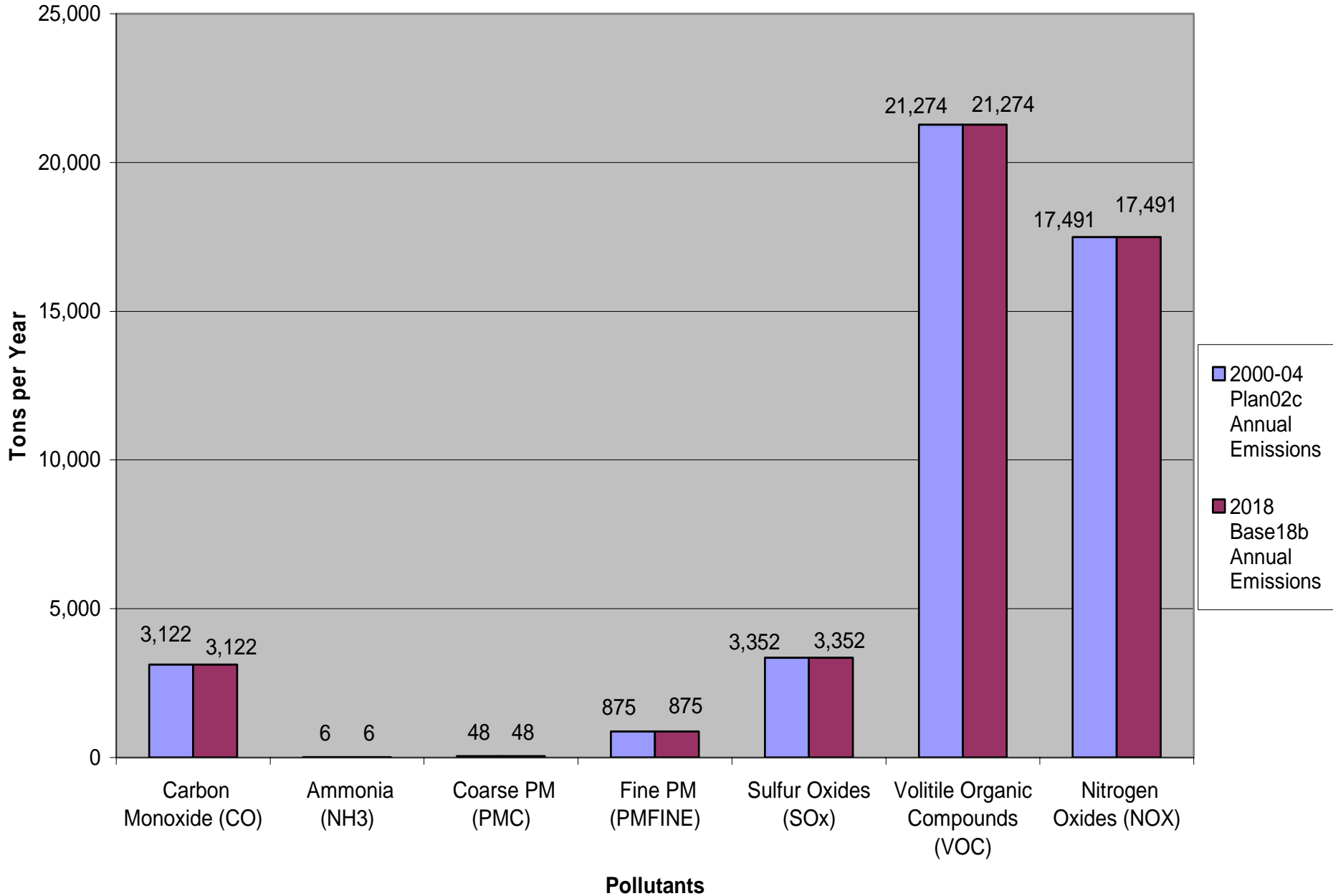
Source Category	Carbon Monoxide (CO)	Ammonia (NH3)	Coarse PM (PMC)	Fine PM* (PMFINE)	Sulfur Oxides** (SOx)	Volatile Organic Compounds (VOC)	Nitrogen Oxides (NOX)
2000-04 Plan02c Annual Emissions	3,122	6	48	875	3,352	21,274	17,491
2018 Base18b Annual Emissions	3,122	6	48	875	3,352	21,274	17,491
Change in 2018	0	0	0	0	0	0	0
Percent Change	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

\* Fine PM includes: Elemental Carbon (PEC) + Particulate Nitrate (NO3) + Particulate Sulfate (SO4) + Organic Carbon (POA)

\*\* Sulfur Oxides Includes: Sulfur Dioxide (SO2) + Sulfuric Acid (SULF)

- No adjustments were made in the 2018 Base Case for changes in off shore shipping emissions. These emissions are outside State control and subject only to Federal (or International) Rules.
- There is likely some mix up in the magnitude of these emissions – expected larger! WRAP is rechecking this sector to assure that the magnitude of these emissions is accurate.

# Changes in 2018 Off Shore Shipping Emissions



# Oil & Gas Field Operations: TPY

## Changes in the 2018 Base Case Emissions from the 2000-04 "Planning" Emission Inventory

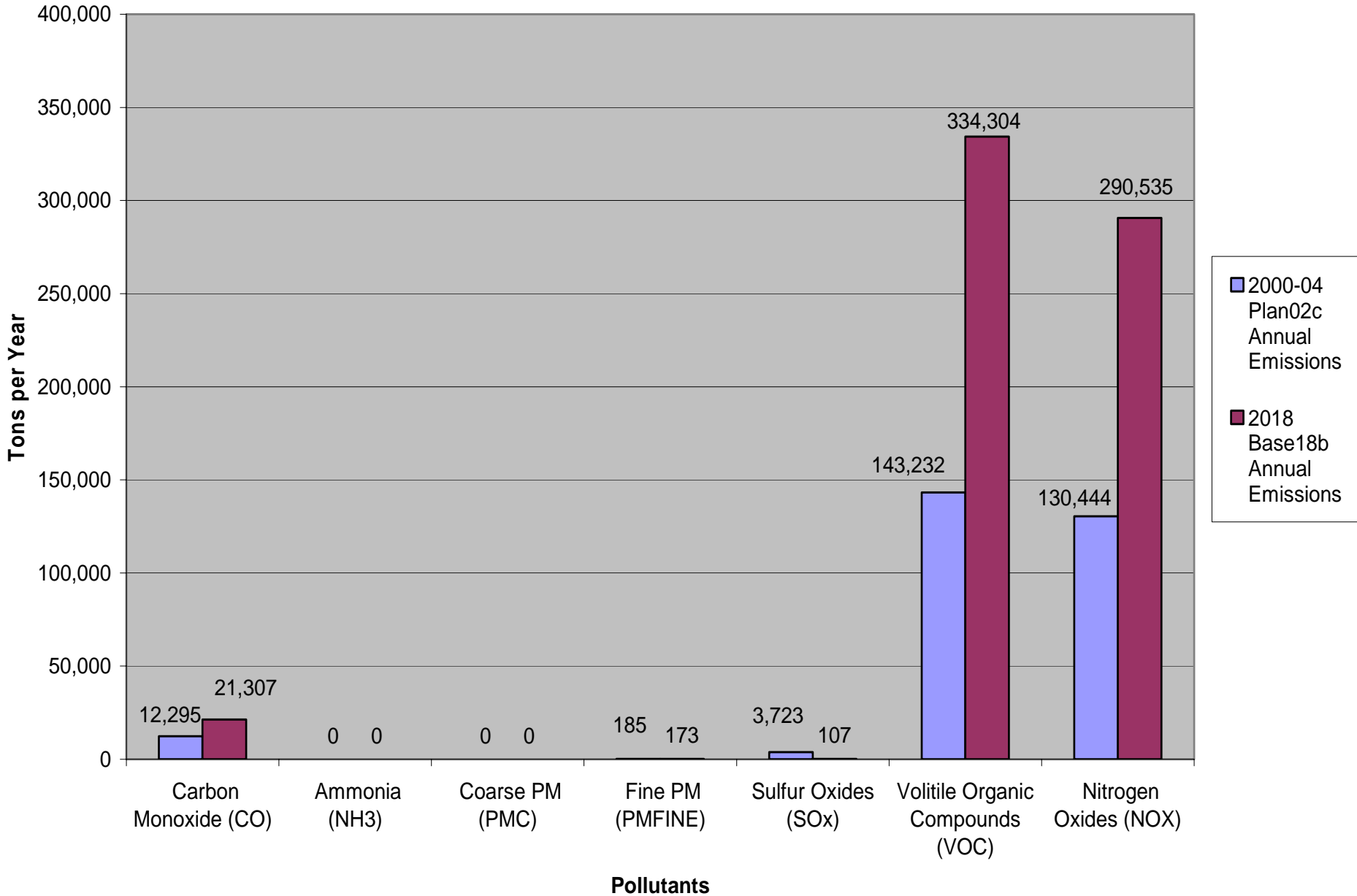
Source Category	Carbon Monoxide (CO)	Ammonia (NH3)	Coarse PM (PMC)	Fine PM* (PMFINE)	Sulfur Oxides** (SOx)	Volatile Organic Compounds (VOC)	Nitrogen Oxides (NOX)
2000-04 Plan02c Annual Emissions	12,295	0	0	185	3,723	143,232	130,444
2018 Base18b Annual Emissions	21,307	0	0	173	107	334,304	290,535
Change in 2018	9,013	0	0	-11	-3,616	191,072	160,091
Percent Change	73.3%	0.0%	0.0%	-6.2%	-97.1%	133.4%	122.7%

\* Fine PM includes: Elemental Carbon (PEC) + Particulate Nitrate (NO3) + Particulate Sulfate (SO4) + Organic Carbon (POA)

\*\* Sulfur Oxides Includes: Sulfur Dioxide (SO2) + Sulfuric Acid (SULF)

- This is a “first cut” at defining O&G field operation emissions, with a revision on-going as we speak in a Phase II Environ O&G review. There appear to be significant increases (VOC’s, NOx) in the some states w/ O&G long term projected operations as reflected in BLM Resource Management Plans (CO, MT, NM, UT, WY). [Note the exception as diesel sulfur reductions reduce drill rig SO2]

# Changes in 2018 Oil & Gas Field Emissions



# Road Dust: Annual Tons

## Changes in the 2018 Base Case Emissions from the 2000-04 "Planning" Emission Inventory

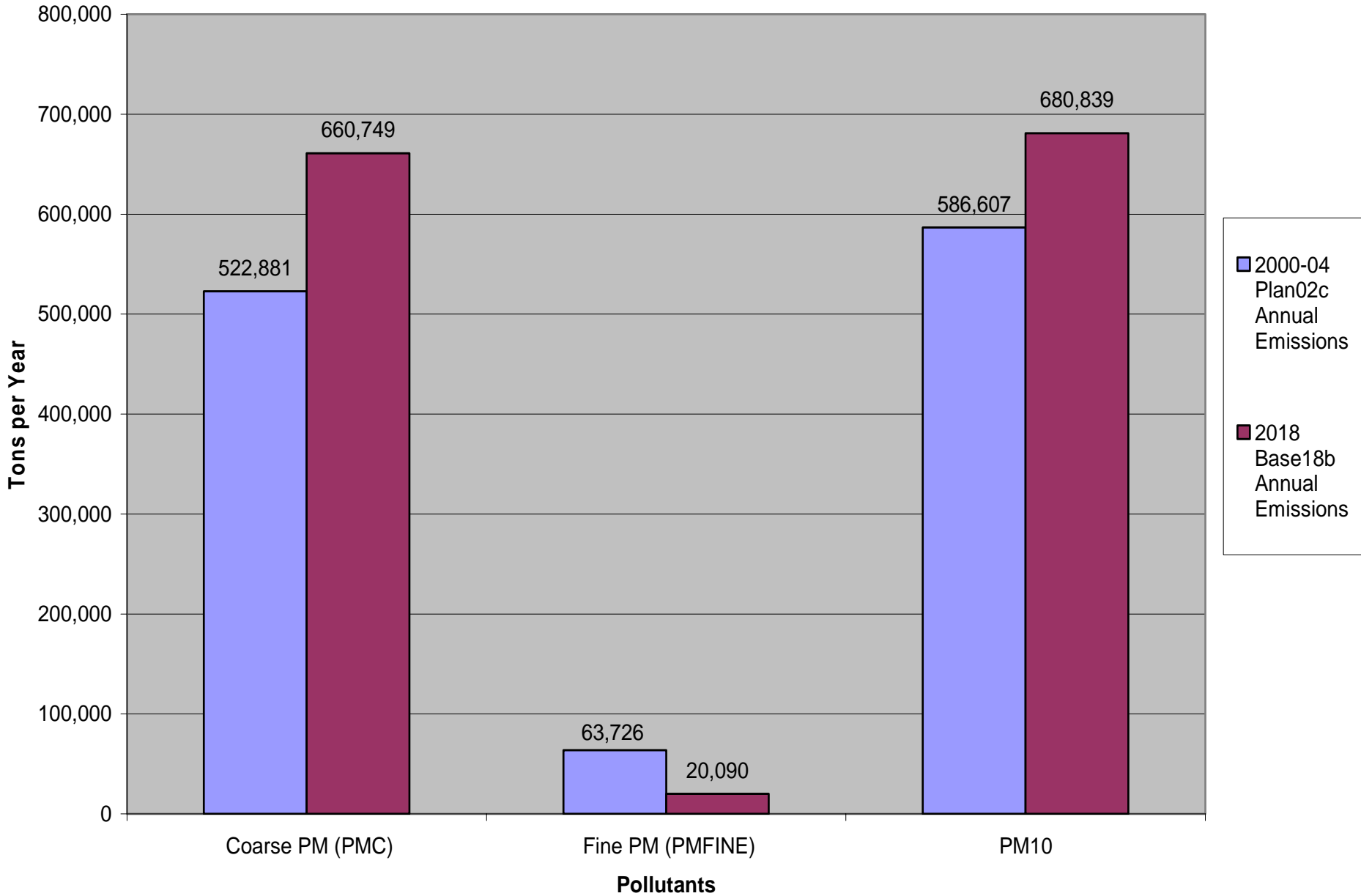
Source Category	Coarse PM (PMC)	Fine PM* (PMFINE)	PM10 **
2000-04 Plan02c Annual Emissions	522,881	63,726	586,607
2018 Base18b Annual Emissions	660,749	20,090	680,839
Change in 2018	137,867	-43,636	94,232
Percent Change	26.4%	-68.5%	16.1%

\* Fine PM includes: Elemental Carbon (PEC) + Particulate Nitrate (NO3) + Particulate Sulfate (SO4) + Organic Carbon (POA)

\*\* PM10 = PMC + PMFINE

- Applied the revised fine/coarse ratios developed by the Dust Forum – acts to “reduce” the fine PM
- Overall, dust emissions rise 16% due to increased VMT in 2018

# Changes in 2018 PM from Road Dust



# Fugitive Dust: Annual Tons

## Changes in the 2018 Base Case Emissions from the 2000-04 "Planning" Emission Inventory

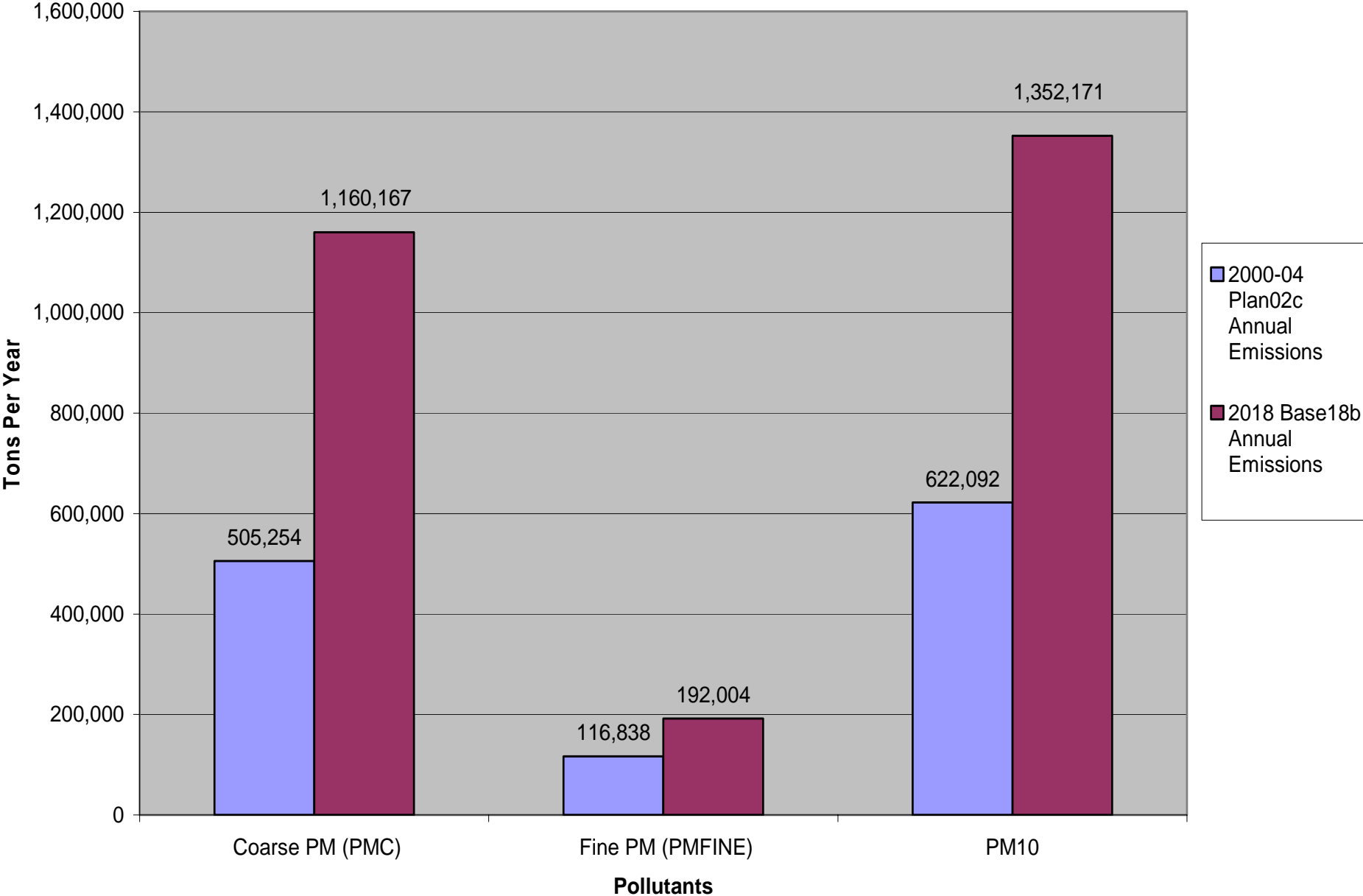
Source Category	Coarse PM (PMC)	Fine PM* (PMFINE)	PM10 **
2000-04 Plan02c Annual Emissions	505,254	116,838	622,092
2018 Base18b Annual Emissions	1,160,167	192,004	1,352,171
Change in 2018	654,914	75,166	730,080
Percent Change	129.6%	64.3%	117.4%

\* Fine PM includes: Elemental Carbon (PEC) + Particulate Nitrate (NO<sub>3</sub>) + Particulate Sulfate (SO<sub>4</sub>) + Organic Carbon (POA)

\*\* PM10 = PMC + PMFINE

- Applied the revised fine/coarse ratios developed by the Dust Forum – acts to “reduce” the fine PM
- Overall, fugitive dust area source emissions rise 117% due to the EGAS projection increases in 2018. Changes in Emissions primarily a result of Population Growth & associated growth in activity levels

# Changes in 2018 PM from Fugitive Dust



# Wind Blown Dust: Annual Tons

## Changes in the 2018 Base Case Emissions from the 2000-04 "Planning" Emission Inventory

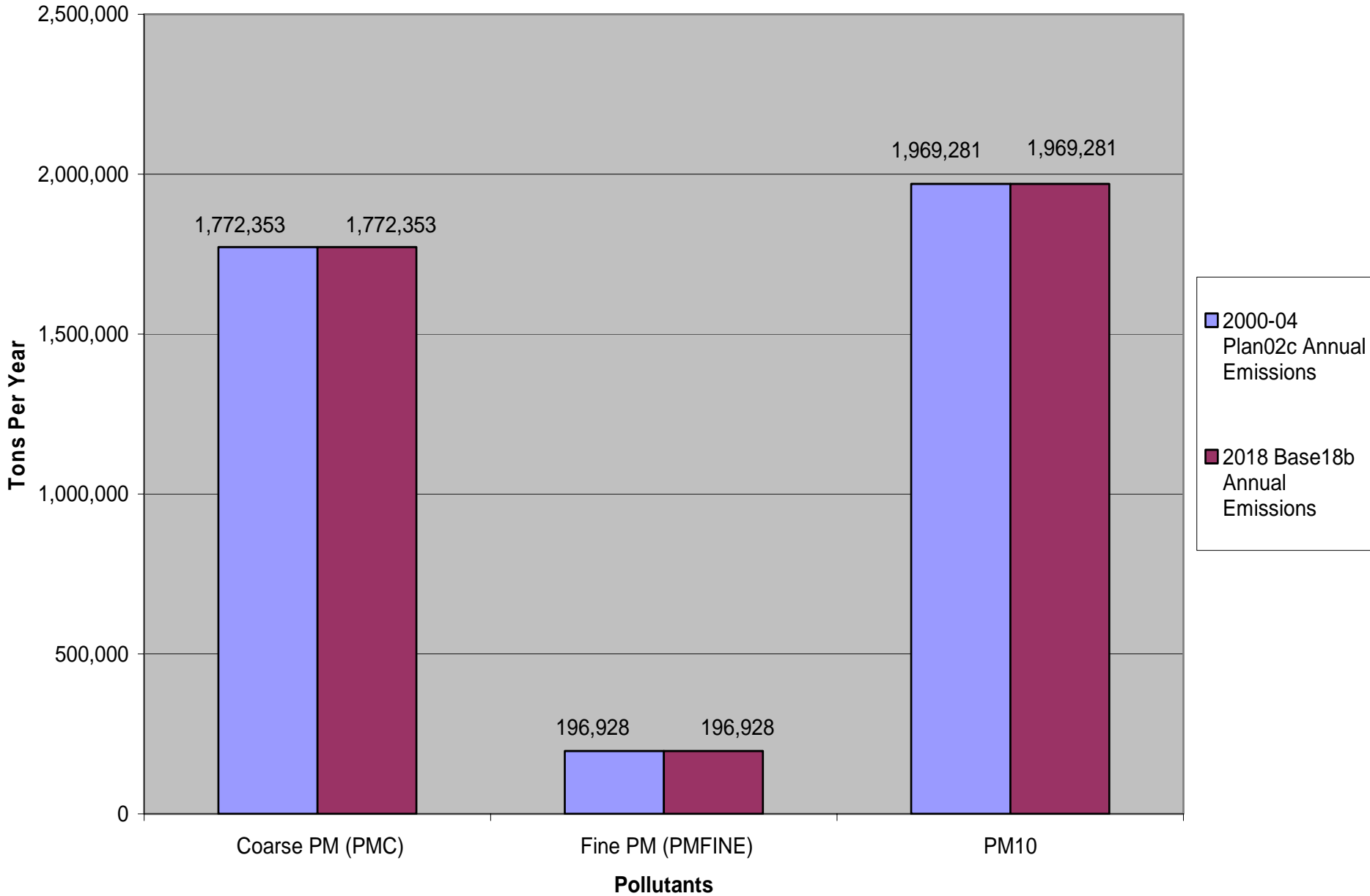
Source Category	Coarse PM (PMC)	Fine PM* (PMFINE)	PM10 **
2000-04 Plan02c Annual Emissions	1,772,353	196,928	1,969,281
2018 Base18b Annual Emissions	1,772,353	196,928	1,969,281
Change in 2018	0	0	0
Percent Change	0.0%	0.0%	0.0%

\* Fine PM includes: Elemental Carbon (PEC) + Particulate Nitrate (NO<sub>3</sub>) + Particulate Sulfate (SO<sub>4</sub>) + Organic Carbon (POA)

\*\* PM10 = PMC + PMFINE

- The Wind Blown Dust calculation is a function of meteorology and land use patterns. The WRAP has no basis for predicting new wind and precipitation events in the future, thus the Wind Blown Dust emissions are held constant in 2018.

# Changes in 2018 Emissions from Wind Blown Dust



# Anthropogenic Fire: Annual Tons

## Changes in the 2018 Base Case Emissions from the 2000-04 "Planning" Emission Inventory

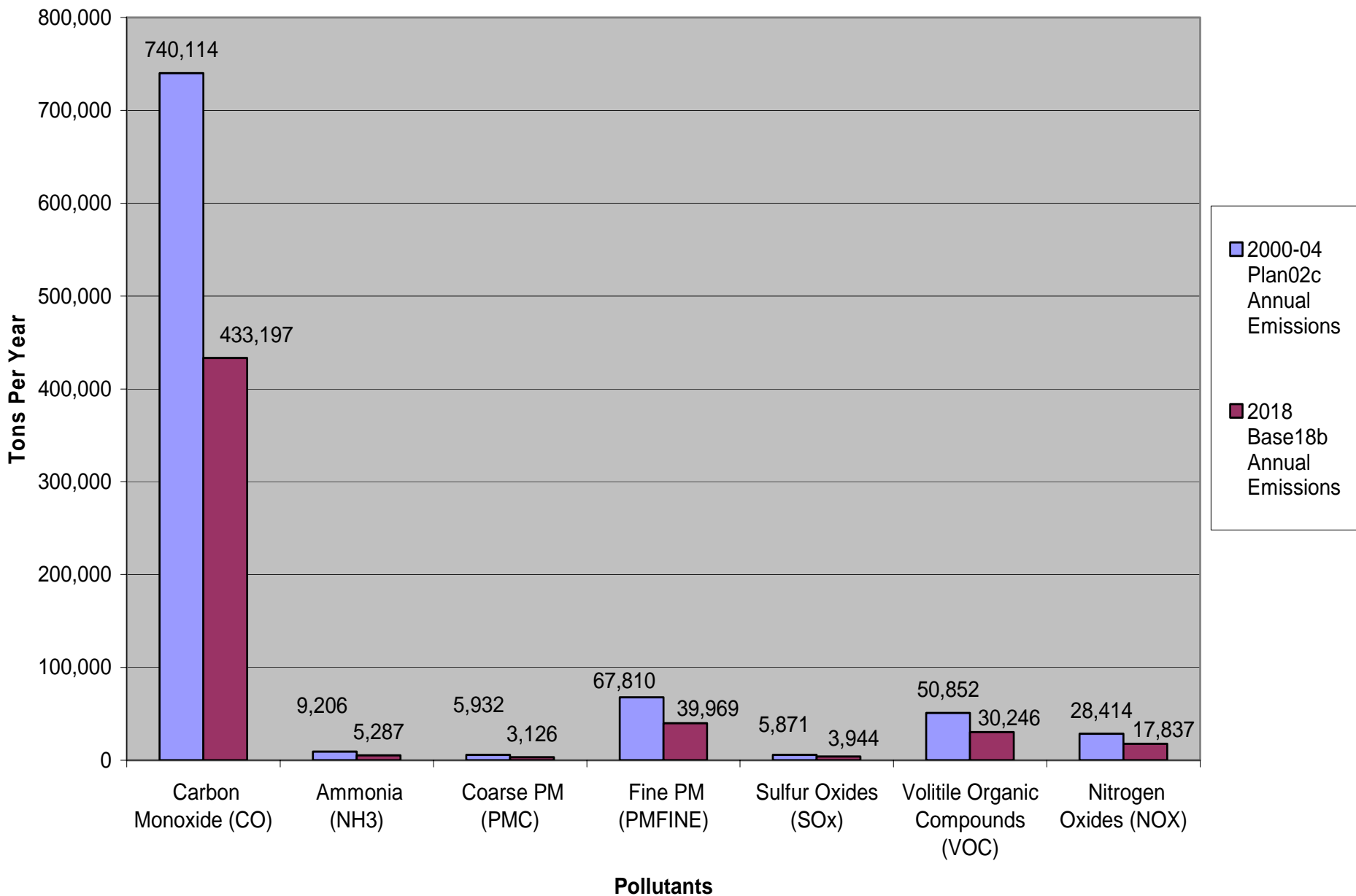
Source Category	Carbon Monoxide (CO)	Ammonia (NH3)	Coarse PM (PMC)	Fine PM* (PMFINE)	Sulfur Oxides** (SOx)	Volatile Organic Compounds (VOC)	Nitrogen Oxides (NOX)
2000-04 Plan02c Annual Emissions	740,114	9,206	5,932	67,810	5,871	50,852	28,414
2018 Base18b Annual Emissions	433,197	5,287	3,126	39,969	3,944	30,246	17,837
Change in 2018	-306,917	-3,919	-2,806	-27,841	-1,927	-20,606	-10,577
Percent Change	-41.5%	-42.6%	-47.3%	-41.1%	-32.8%	-40.5%	-37.2%

\* Fine PM includes: Elemental Carbon (PEC) + Particulate Nitrate (NO3) + Particulate Sulfate (SO4) + Organic Carbon (POA)

\*\* Sulfur Oxides Includes: Sulfur Dioxide (SO2) + Sulfuric Acid (SULF)

- With no basis for adjusting fire location and timing throughout the year, the application of Emission Reduction Techniques (ERT's) is the basis for the emission reductions shown for Anthropogenic Fire.

# Changes in 2018 Anthropogenic Fire Emissions



# Natural Fire: Annual Tons

## Changes in the 2018 Base Case Emissions from the 2000-04 "Planning" Emission Inventory

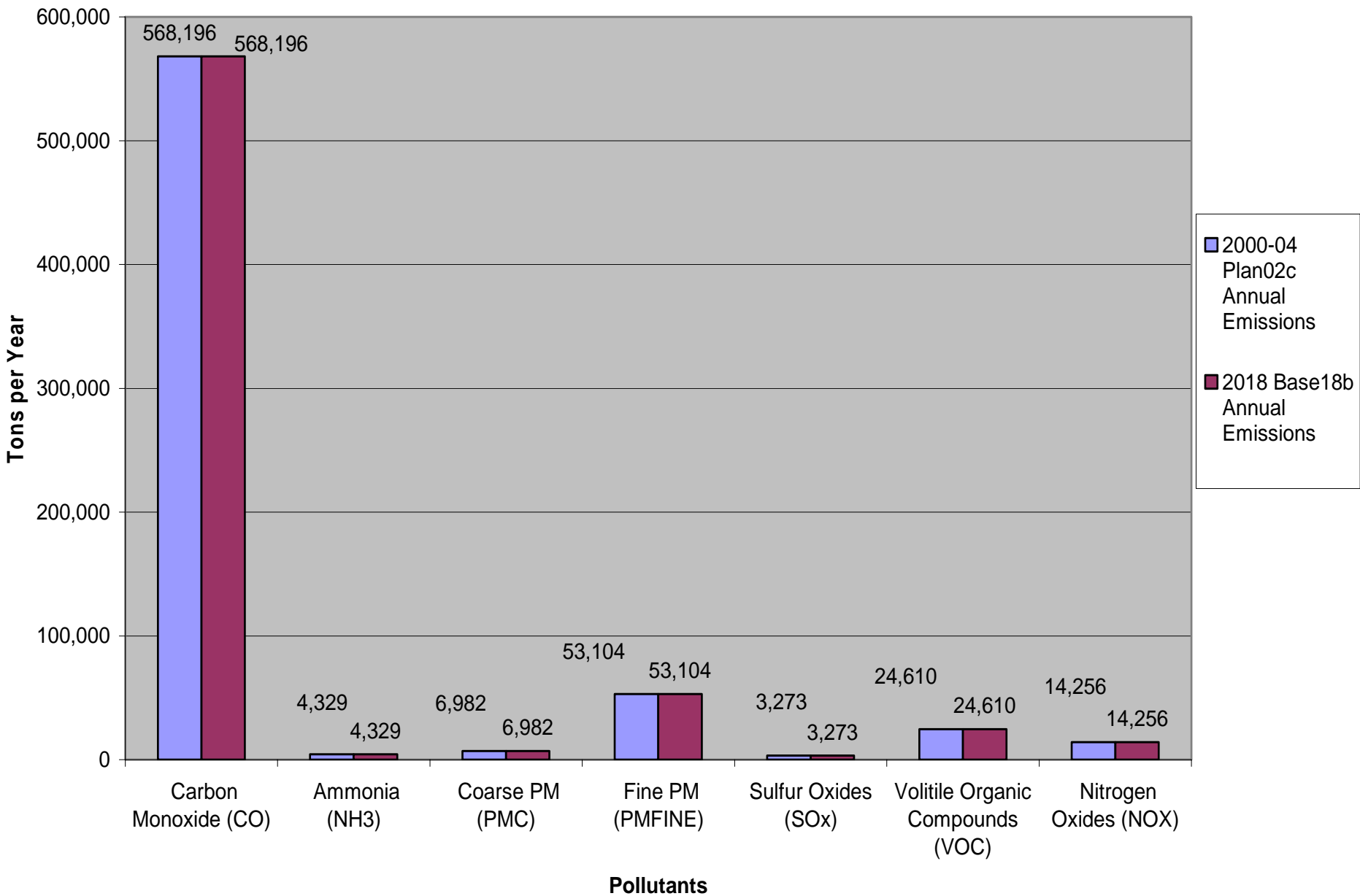
Source Category	Carbon Monoxide (CO)	Ammonia (NH3)	Coarse PM (PMC)	Fine PM* (PMFINE)	Sulfur Oxides** (SOx)	Volatile Organic Compounds (VOC)	Nitrogen Oxides (NOX)
2000-04 Plan02c Annual Emissions	568,196	4,329	6,982	53,104	3,273	24,610	14,256
2018 Base18b Annual Emissions	568,196	4,329	6,982	53,104	3,273	24,610	14,256
Change in 2018	0	0	0	0	0	0	0
Percent Change	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

\* Fine PM includes: Elemental Carbon (PEC) + Particulate Nitrate (NO3) + Particulate Sulfate (SO4) + Organic Carbon (POA)

\*\* Sulfur Oxides Includes: Sulfur Dioxide (SO2) + Sulfuric Acid (SULF)

- With no basis for adjusting fire location and timing throughout the year, and no ability to predict future year meteorology, the Natural Fire inventory has been held constant.
- There does appear to be an error in quantifying Natural Fire however, as the magnitude only approximates that of Anthropogenic Fire.

# Change in 2018 Natural Fire



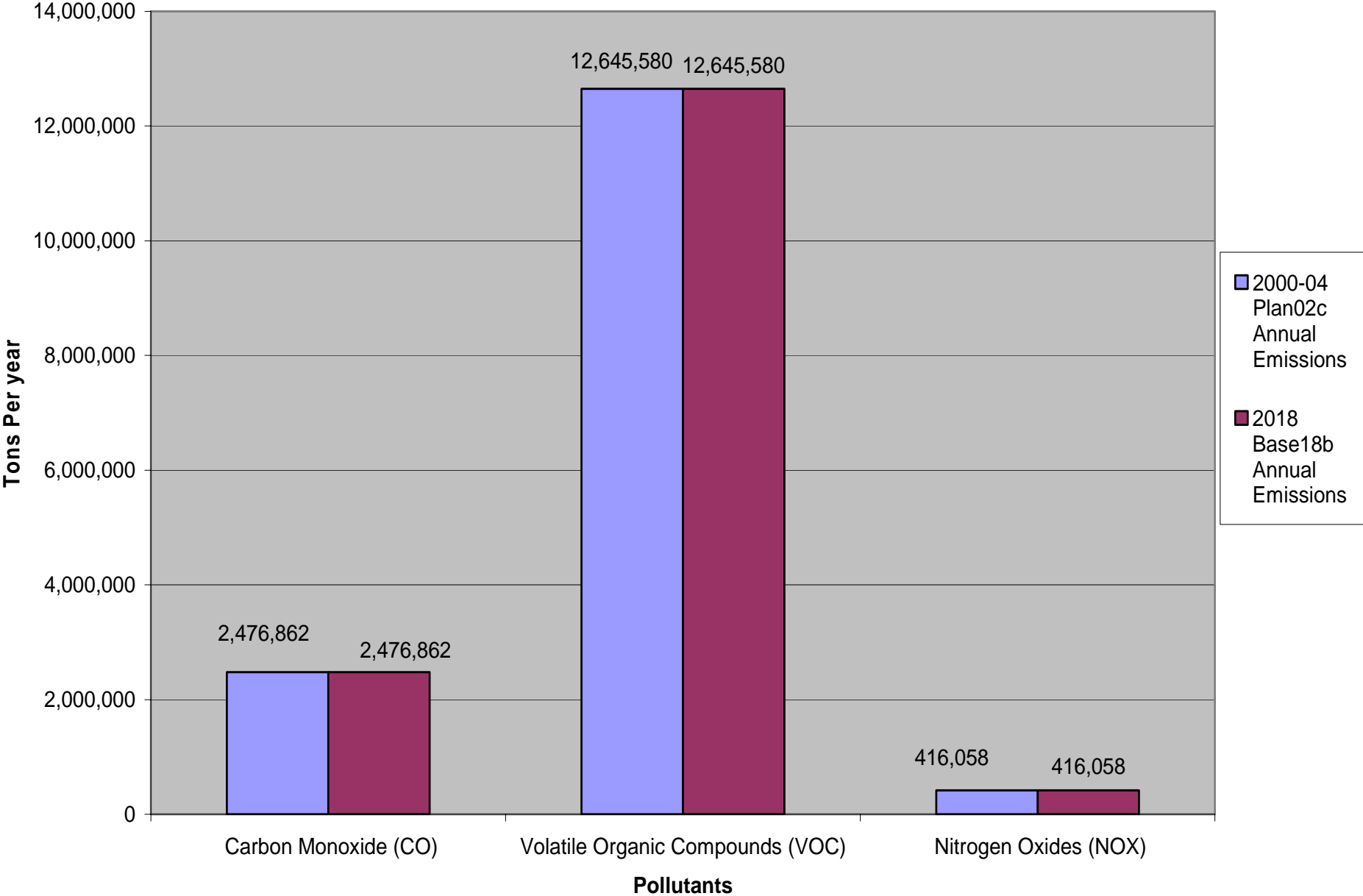
# Biogenic Emissions: Annual Tons

## Changes in the 2018 Base Case Emissions from the 2000-04 "Planning" Emission Inventory

Source Category	Carbon Monoxide (CO)	Volatile Organic Compounds (VOC)	Nitrogen Oxides (NOX)
2000-04 Plan02c Annual Emissions	2,476,862	12,645,580	416,058
2018 Base18b Annual Emissions	2,476,862	12,645,580	416,058
Change in 2018	0	0	0
Percent Change	0.0%	0.0%	0.0%

- Like Wind Blown Dust the Biogenic calculation is also function of meteorology and land use patterns. Once again the WRAP has no basis for predicting new wind and precipitation events in the future, thus the Biogenic emissions are held constant in 2018.

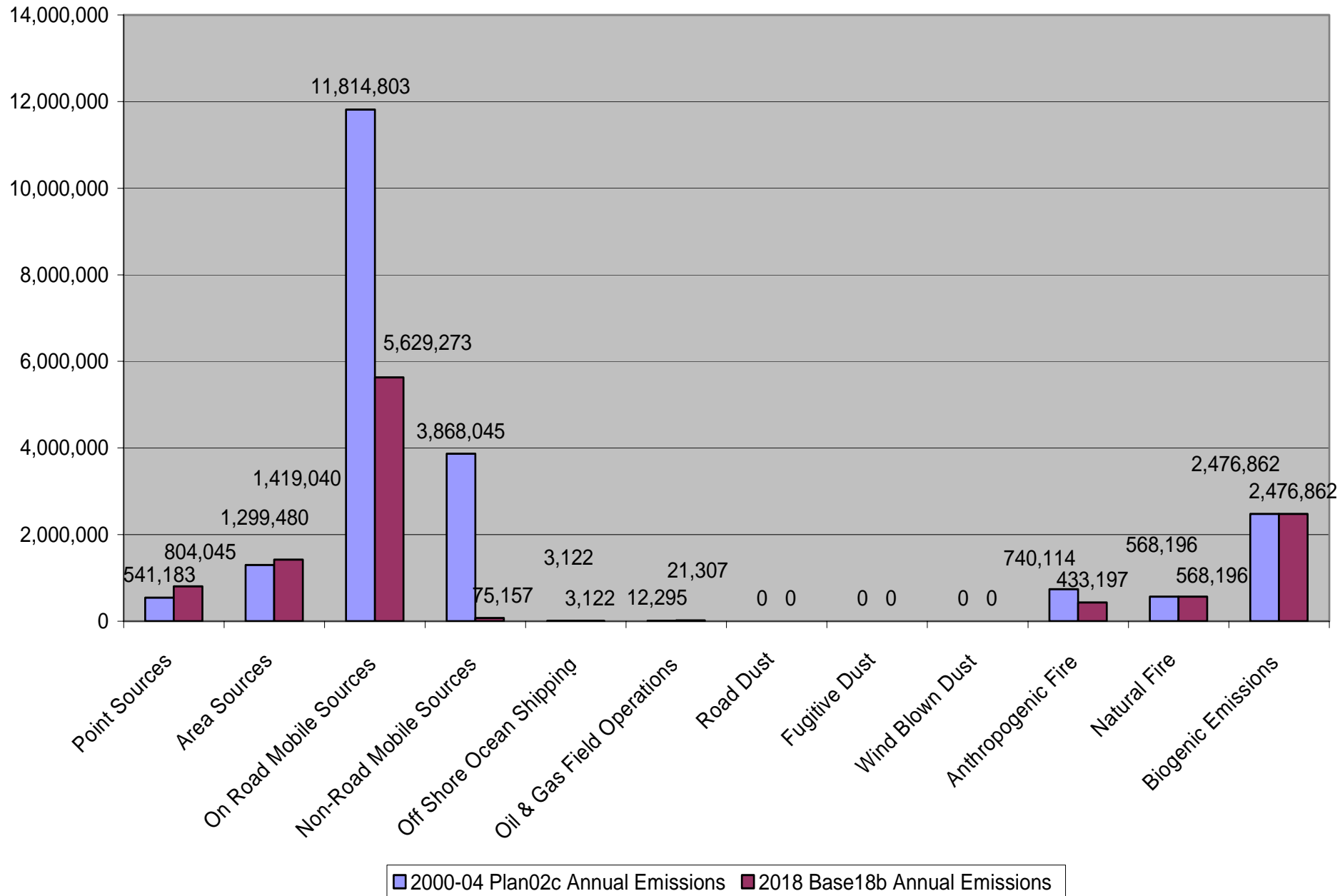
# Changes in 2018 Biogenic Emissions



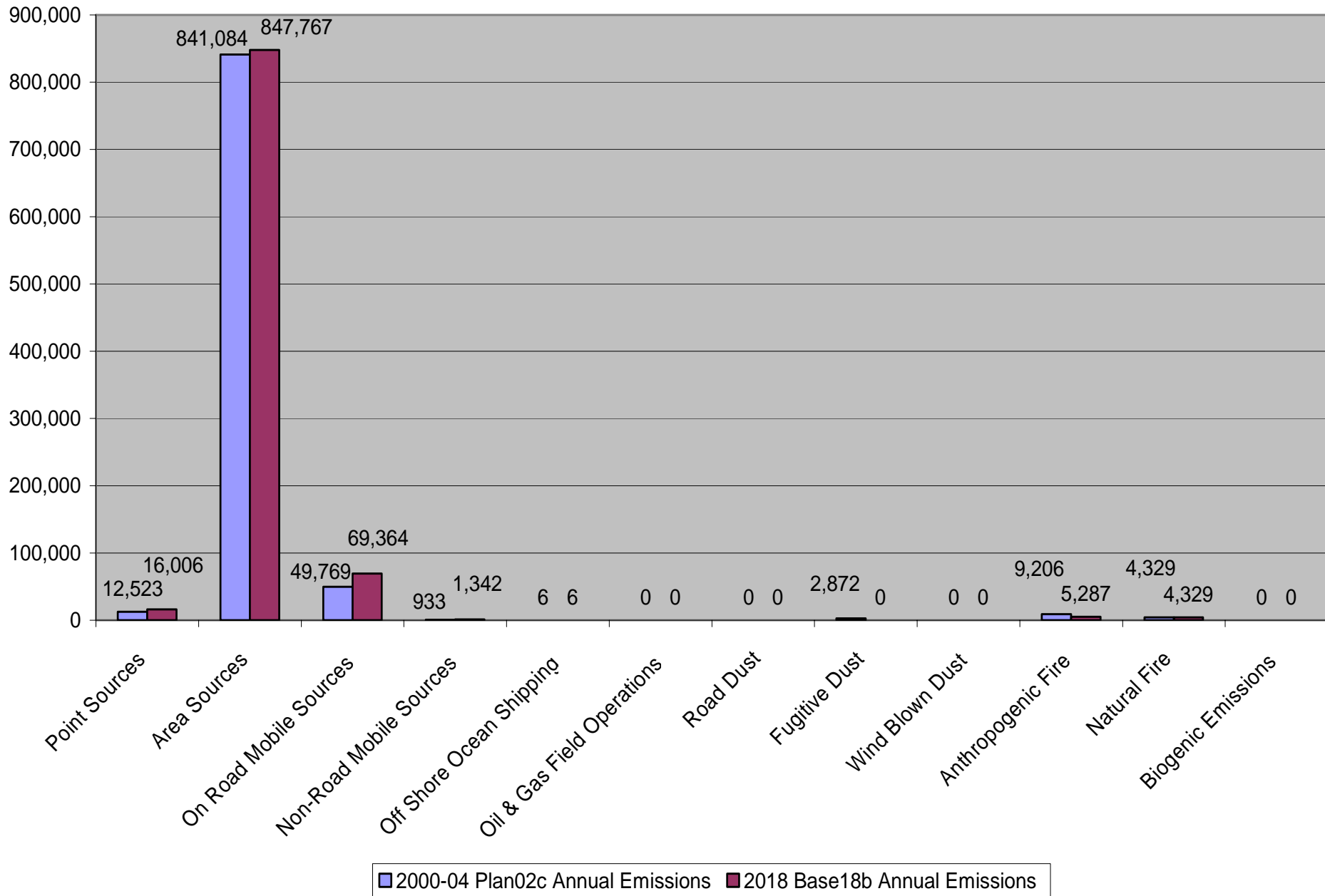
# By Pollutant

- The following charts are constructed to show how each of the 7 visibility impairing pollutants (CO, NH<sub>3</sub>, Coarse PM, Fine PM, SO<sub>x</sub>, VOC's & NO<sub>x</sub>) are affected by the changes to each of the defined source sectors:
  - Point
  - Area
  - On-Road Mobile
  - Non-Road Mobile
  - Off Shore Shipping
  - Oil & Gas Field Operations
  - Road Dust
  - Fugitive Dust
  - Wind Blown Dust
  - Anthropogenic Fire
  - Natural Fire
  - Biogenic Emissions

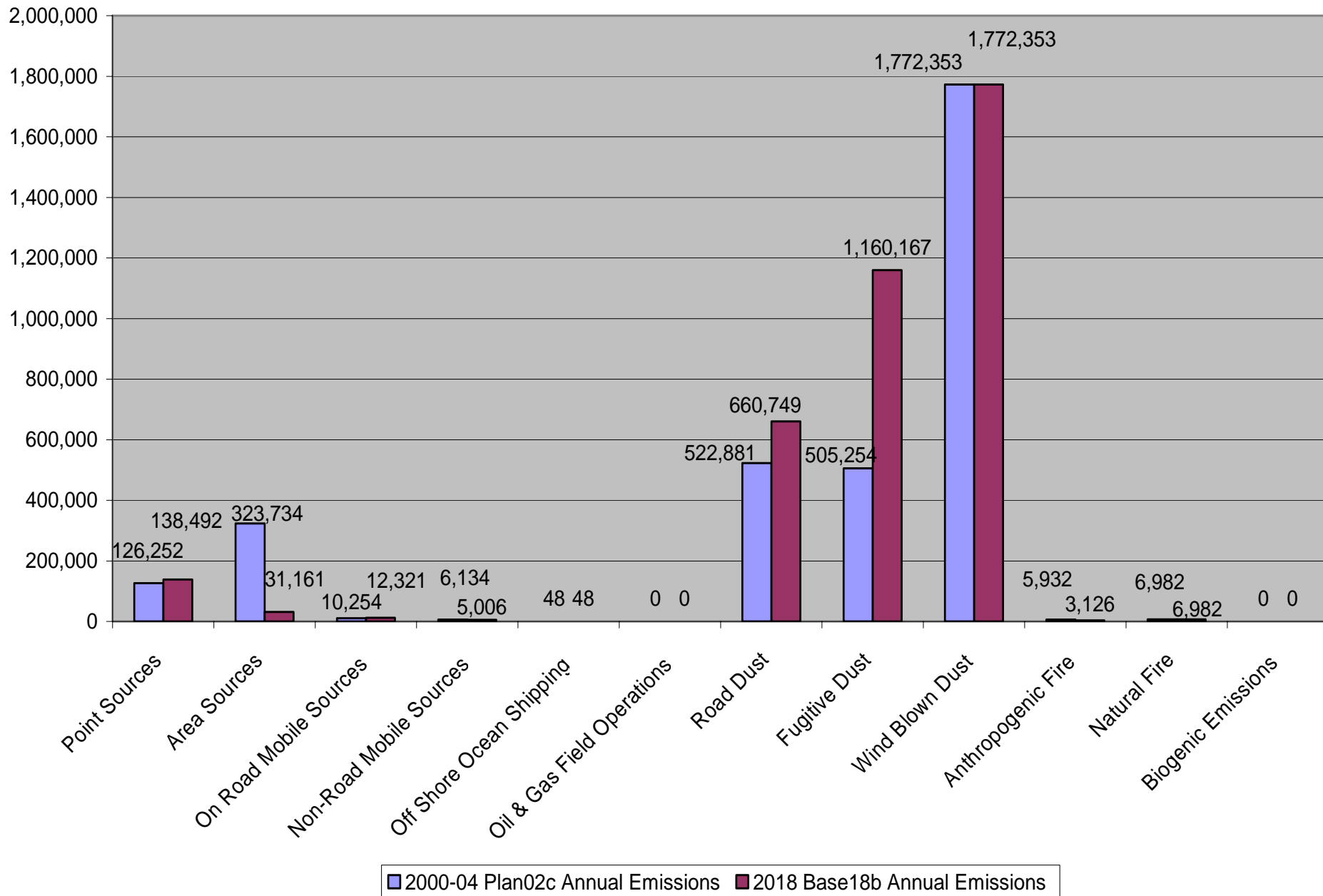
## Changes in 2018 Carbon Monoxide (CO) Emissions by Sector



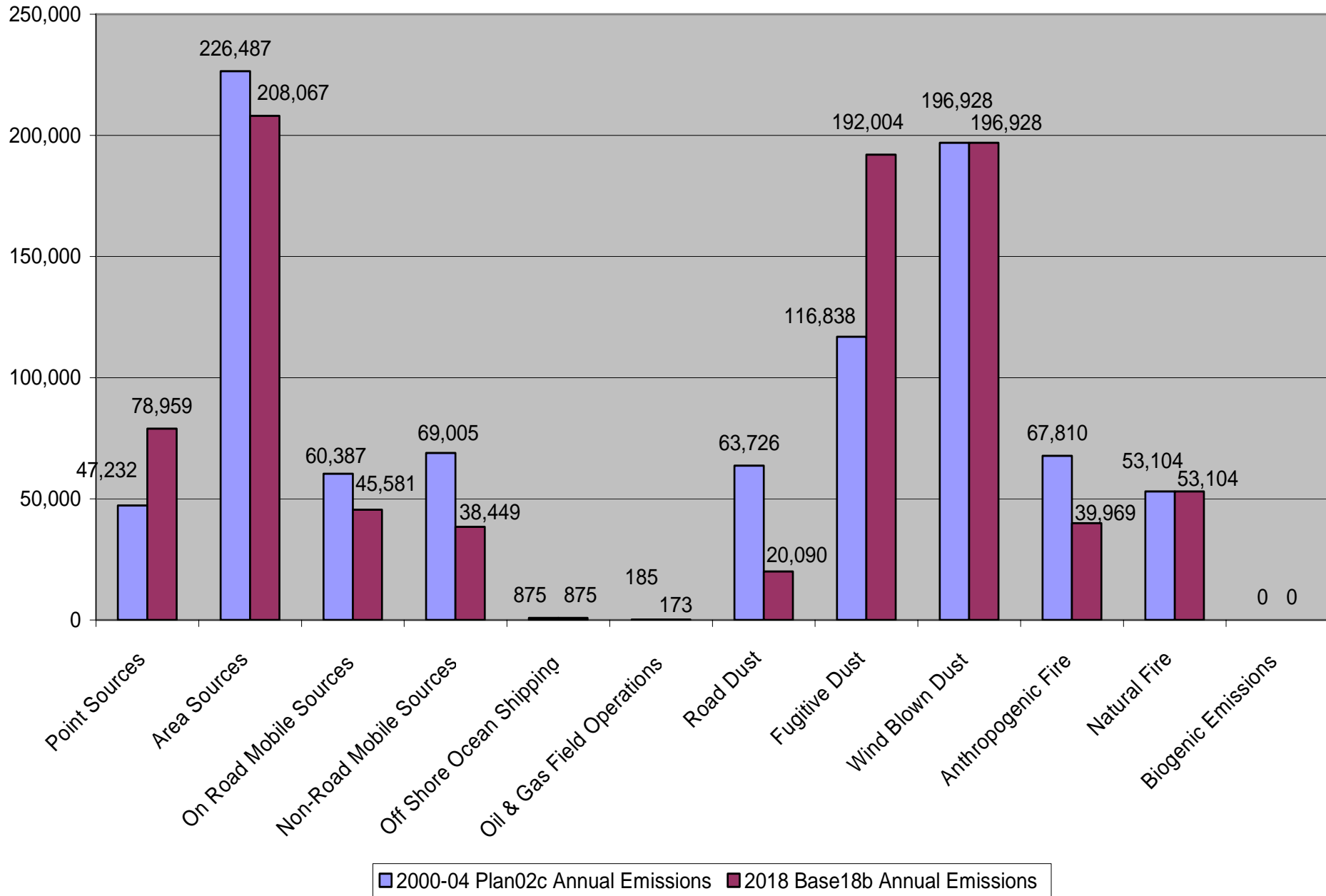
## Changes in 2018 Ammonia (NH3) Emissions by Sector



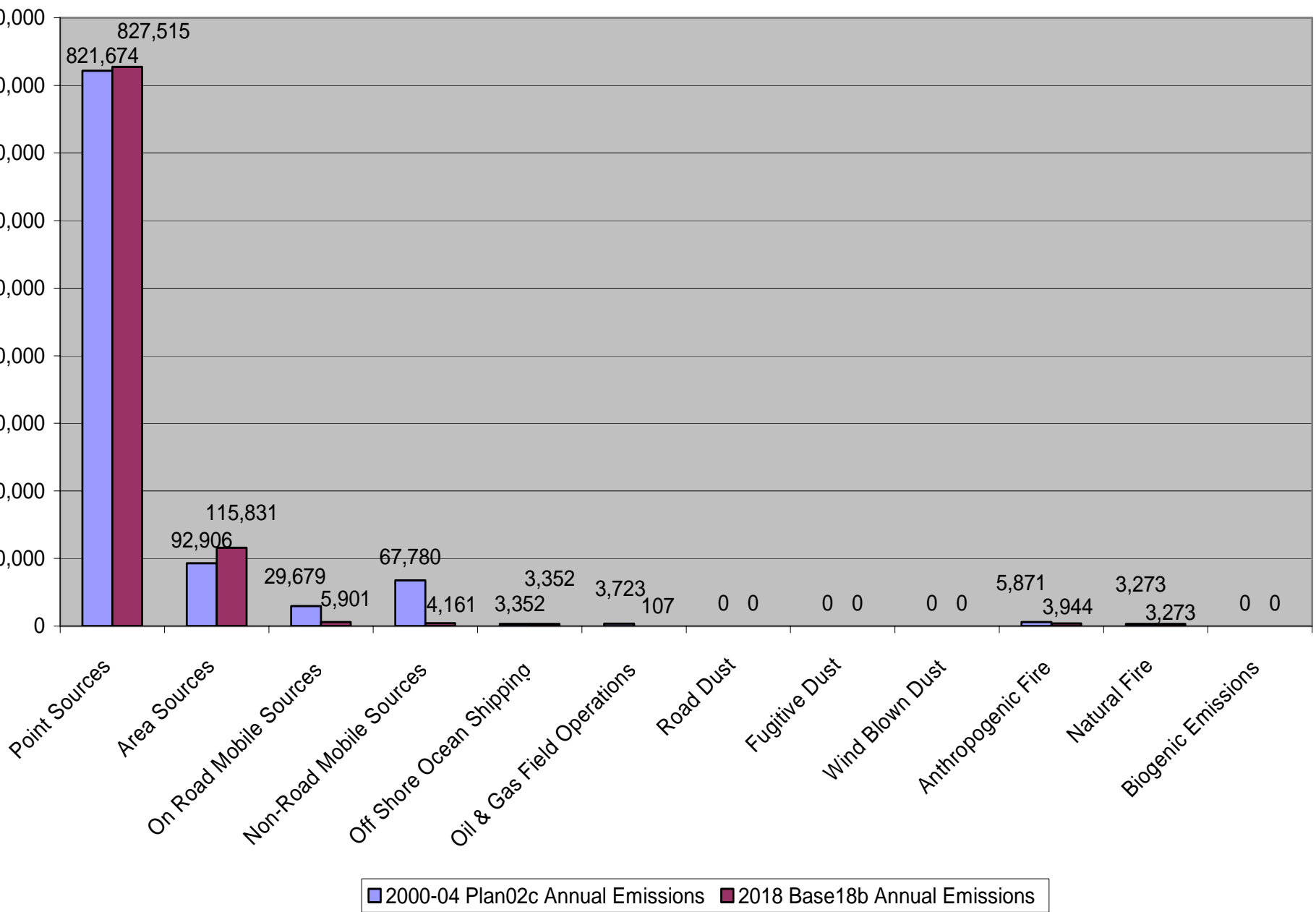
## Changes in 2018 Coarse PM (PMC) by Source Sector



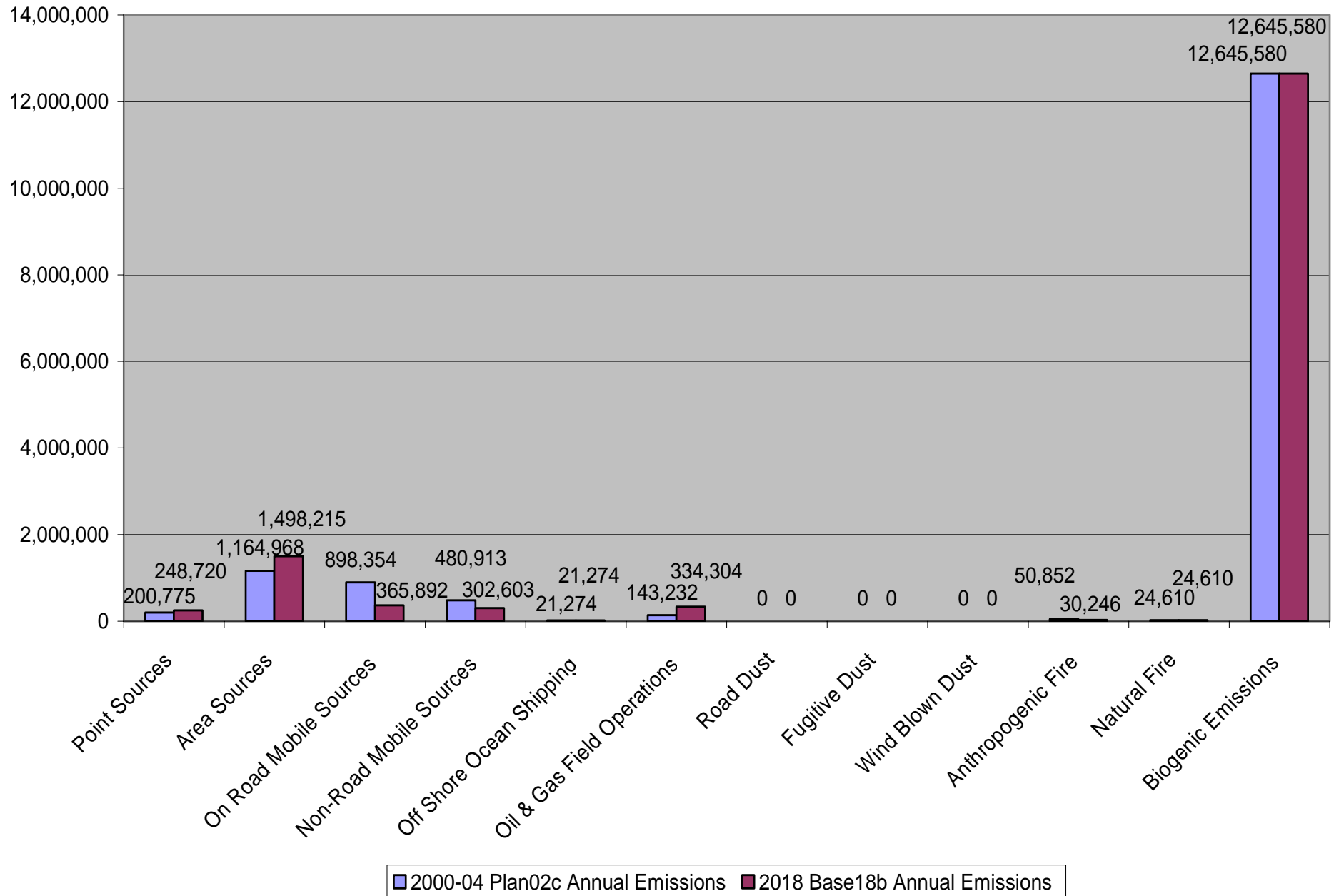
## Changes in 2018 Fine Particulate (PMFINE) Emissions by Source Sector



## Changes to 2018 Sulfur Oxide (SOx) Emissions by Source Sector



# Changes in 2018 Volatile Organic Compound (VOC) Emissions by Source Sector



## Changes in 2018 Nitrogen Oxide (NOx) Emissions by Source Sector

