AREA SOURCE EMISSIONS FOR CALENDAR YEAR 2023
METHODOLOGY DOCUMENTATION
DOMESTIC AMMONIA

DESCRIPTION OF CATEGORY

This category estimates area source emissions of Ammonia (NH3) from domestic activities. These activities include human emissions (sweat and breath), untreated human waste from both homeless and other people, cigarette smoking, household ammonia use, excretion from pet and dogs, and residential fertilizer use. Emission estimates are derived from updated emission factors and activity data such as population metrics.

CES	EIC	Description
90480	699-995-2002-0000	Domestic Activity - Ammonia

METHODOLOGY AND ASSUMPTIONS

Activity Data

Population data for the air basin in 2023 was obtained from SCAG (Southern California Association of Governments) 2024RTP (Regional Transportation Plans) sub-county level 2023 population and the State of homelessness Report 2024. The adult population was calculated by multiplying the total population by the adult percentage of the total population, with the percentage derived from the 2021 state census data.

Pet population data was calculated based on the number of pet-owning households, multiplied by the mean number of pets per household. The number of pet-owning households is calculated by multiplying the total number of households by the percentage of households that owned pets. In California, 40.1% of households own an average of 1.6 dogs and 22.9% of households own an average of 1.7 cats (World Population Review). Activity-specific details are as follows:

- **Human Emissions, Untreated Human Waste (Other), Household Ammonia Use, and Household Fertilizer Use:** Activity is based on the total human population.
- **Untreated Human Waste (Homeless):** Activity is based on the homeless population.
- **Cigarette Smoking:** Activity corresponds to the adult population.
- **Cats and Dogs:** Activity is determined by the respective pet populations.

Table 1 and Table 2 list the population in each region in detail. SCAB refers to the South Coast Air Basin, SSAB to the Salton Sea Air Basin, and MDAB to the Mojave Desert Air Basin.

Table 1. Population distribution in 2023 (in thousands).

Region	Total Population	Total Households	Adult Population	Unsheltered Homeless Population	Sheltered Homeless Population
SCAB Los Angeles	9,605	3,400	7,636	52.89	19.42
SCAB Orange	3,200	1,102	2,532	3.06	2.99
SCAB Riverside	2,009	619	1,515	1.95	1.03
SCAB San Bernardino	1,647	517	1,231	2.23	0.91
SCAB (Total)	16,462	5,638	12,913	60.13	24.36
SSAB Coachella-Riverside	470	183	354	0.46	0.24
MDAB Riverside	22	6	17	0.02	0.01

Table 2. Pet population in 2023 (in thousands).

Region	Dogs	Cats
SCAB	3617	2195
SSAB Coachella-Riverside	117	71
MDAB Riverside	4	2

Emission Factors

Emission factors for residential ammonia are sourced from the South Coast AQMD Air Quality Management Plan 2022 (South Coast Air Quality Management District. 2022), U.S. EPA Ammonia Emission Factors (Roe, S., et al. 2004) as well as recent publications.

Human emissions primarily include ammonia released through perspiration and respiration. Nitrogen (N) enters the human body through food consumption and is later excreted via various pathways, including urine, sweat, feces. Most nitrogen from urine and feces is directed into the sewer system and is not included in this category. However, a small fraction that does not enter the sewer system is accounted for under untreated human waste.

Ammonia emission factors for human emissions (perspiration and respiration) vary significantly across different sources. The last emission factor used by the 2022 AQMP was 0.5535 lbs/person/year (0.55 for perspiration and 0.0035 for respiration) and sourced from the Cass et al. (1982). In contrast, the U.S. EPA's emission factor (Roe, S., et al. 2004) had a very different value of 0.037 lbs/person/year, which was based on Sutton et al. (2000). In this report, ammonia emissions of sweating were estimated to range between 0.0046-0.17 lbs/person/year, while those from breathing ranged from 0.0022-0.017 lbs/person/year. As can be seen from Figure 1, even at the higher end, the total emission factor of 0.18 lbs/person/year remains lower than the value used in the 2022 AQMP.

More recent chamber studies by Li et al. (2020) and Yang et al. (2024) reported emission factors ranging from 0.0077-0.087 and 0.052-0.16 lbs/person/year, respectively, depending on factors like human

physiology, age, temperature, and skin exposure. For this emission inventory, we adopt an emission factor of 0.07 lbs/person/year, which aligns with recent studies and falls between the values used in the 2022 AQMP and the EPA's 2004 estimate.

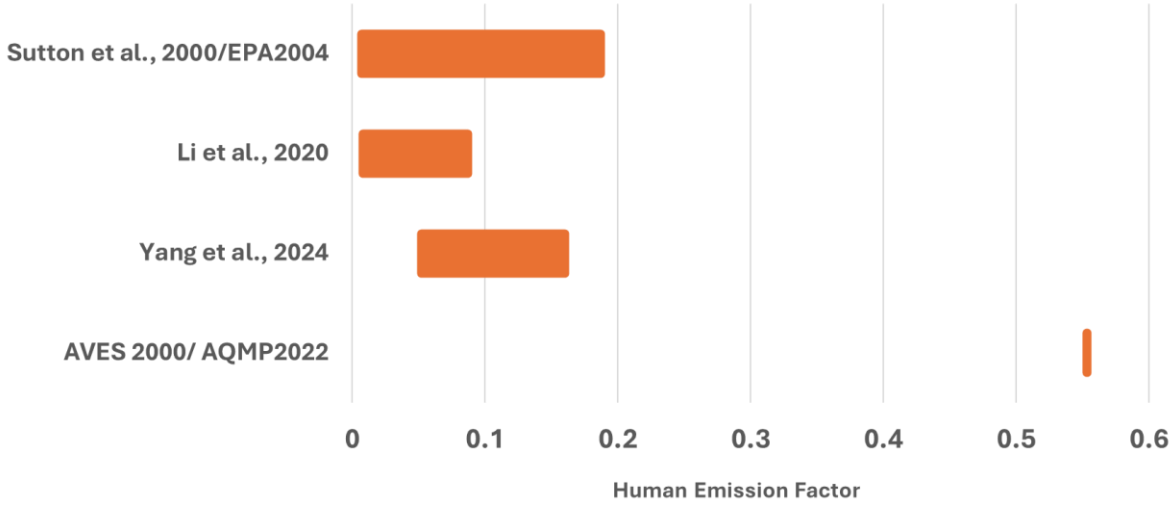

Figure 1. The emission factors (lbs/person/year) for human perspiration and respiration from different sources.

For household fertilizer use, the emission factor calculation follows the methodology outlined in the U.S. EPA report (Roe, S., et al. 2004). This report assumes a nitrogen loss rate of 2.5% for domestic fertilizer use and estimates an annual ammonia emission factor of 0.047 lbs/person for California. However, this emission factor is based on fertilizer sales many years ago and has not been updated for years.

Data for non-farm commercial fertilizer sales during 2022-2023 were obtained from the American Association of Plant Food Control Officials (AAPFCO). The reported non-farm nitrogen usage for California was 27,460 tons for January-June 2023 and 37,874 tons for July-December 2022 (California Department of Food and Agriculture. 2023), resulting in a total of 65,334 tons of non-farm nitrogen use annually. Applying the 2.5% nitrogen loss rate and factoring in the 2023 population data, an updated ammonia emission factor of 0.1 lbs/person/year was calculated. This revised emission factor is used to estimate ammonia emissions for the South Coast Air Basin and the Coachella Valley.

For cigarette smoking, the ammonia emission factor is reported as 9478 kg/milliard pieces in the report (Visschedijk, A, et al. 2018). According to the California Tobacco Facts and Figures 2024 (California Department of Public Health. 2024), 6% of California adults reported cigarette smoking. Smokers consume an average of 16 and 14 cigarettes per day for men and women, resulting in an overall average of 15 cigarettes per day per smoker. Using these inputs, an ammonia emission factor of 0.069 lbs/year per adult was calculated.

For pet ammonia emission, a recent publication (Cowan et al. 2024) provided urine nitrogen excretion rates for domesticated cats and dogs, estimating 0.60 g N/kg body mass per day for cats and 0.5 g N/kg body mass per day for dogs. Feces nitrogen excretion will be accounted for under landfill category and only urine nitrogen excretion is included here. With an average body mass of 3.75 kg per cat and 21.6 kg per dog, these values yield annual nitrogen excretion rates of 8.69 lbs N/year for dogs and 1.81 lbs N/year for cats. Assuming that 18% of cat urine nitrogen and 36% of dog urine nitrogen goes to

volatilized ammonia (N-NH3), the resulting ammonia emission factors are approximately 3.80 lbs/year per dog and 0.40 lbs/year per cat.

In the 2022 AQMP, infant diapered waste was included with emission factors of 6.9 and 0.36 lbs/unit/year for cloth and disposable diapers, respectively. However, since these emissions are largely accounted for under landfill and wastewater categories, this source category has been removed from the current emission inventories.

Table 3. Emission factors (EF in lbs/unit/year) and activity data used in area source emission update.

Categories	EF (AQMP2022)	EF (Prospective SIP/AQMP)	Air Basin Activity (million)	Coachella Valley Activity (million)	MDAB Riverside Activity (million)	Source of EFs
Human Emission (Perspiration/Respiration)	0.55	0.07	16.5	0.47	0.02	Ref. 7,8
Untreated Human Waste, Other	0.05	0.05	16.5	0.47	0.02	Ref. 1
Untreated Human Waste, Unsheltered Homeless	11	11	0.06	0.0005	0.00	Ref. 1
Untreated Human Waste, Sheltered Homeless	11	5.5	0.02	0.0002	0.00	Ref. 1
Cigarette Smoking	0.0002	0.007	12.9	0.35	0.02	Ref. 4,5
Household Ammonia Use	0.05	0.05	16.5	0.47	0.02	Ref. 1
Cloth Diapers	6.9	N/A	N/A	N/A	N/A	Ref. 1
Disposable Diapers	0.36					Ref. 1
Cats	0.35	0.40	2.2	0.07	0.002	Ref. 6
Dogs	2.17	3.80	3.6	0.12	0.004	Ref. 6
Household Fertilizer Use	N/A	0.1	16.5	0.47	0.02	Ref. 2,3,11

Emission Calculation Assumptions

$$Emission = Activity\ Data \times Emission\ Factors$$

Key Assumptions

- Activity data are aligned with reported population figures.
- The current methodology assumes that all activities across the state share the same emission factors, irrespective of regional differences.
- It is assumed that the emission factor of untreated human waste for the sheltered homeless is half of that for the unsheltered homeless, which results in 5.5 lbs/unit/year.
- Domestic fertilizer use is assumed to have a nitrogen loss rate of 2.5%. Based on Yara Fertilizer Industry Handbook 2022, ammonia volatilization losses can vary between 2%-15% for mineral fertilizer.

SUMMARY AND UPDATED EMISSIONS

Table 3 compares the emission factors used in the 2022 and prospective SIP/AQMP, along with the activity data applied for each category in the prospective SIP/AQMP. Categories that have been removed are indicated as N/A. The prospective SIP/AQMP update features a substantial reduction in the emission factor for human emissions and an increase for pet waste. Table 4 provides a category-specific comparison of residential ammonia emissions between the 2022 and prospective SIP/AQMP. County-level emissions were estimated using the SCAG 2024RTP sub-county level 2023 population data as a surrogate. The resulting emission estimates are summarized in Table 5.

Table 4. Emissions for Year 2023 in tons per day. South Coast Air Basin is represented by SCAB.

Categories	2022 AQMP (SCAB)	Prospective SIP/ AQMP (SCAB)	Prospective SIP/AQMP (SSAB Riverside)	Prospective SIP/AQMP (MDAB Riverside)
Human Emission (Perspiration/Respiration)	13.7	1.58	0.05	0.002
Untreated Human Waste, Other	1.24	1.13	0.03	0.002
Untreated Human Waste, Unsheltered Homeless	2.42	0.91	0.01	0.0003
Untreated Human Waste, Sheltered Homeless		0.18	0.002	0
Cigarette Smoking	0.006	0.12	0.003	0.0002
Household Ammonia Use	1.24	1.13	0.03	0.002
Cloth Diapers	0.95	N/A	N/A	N/A
Disposable Diapers	0.45			
Cats	0.76	1.21	0.04	0.001
Dogs	7.75	18.74	0.61	0.02
Household Fertilizer Use	N/A	2.26	0.06	0.003
Total	28.52	27.26	0.83	0.03

Table 5. County-level residential ammonia emissions for Year 2023 in tons per day. It is generated using the SCAG 2024RTP sub-county level 2023 population data as the surrogate.

Name-County	SCAB Total	SCAB Los Angeles	SCAB Orange	SCAB Riverside	SCAB San Bernardino	SSAB Riverside	MDAB Riverside
Total Emission	27.26	15.90	5.30	3.33	2.73	0.83	0.03

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