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PREPARATION OF EMISSION INVENTORIES OF TOXIC AIR CONTAMINANTS FOR THE BAY AREA

FINAL REPORT 2
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TABLE OF CONTENTS

Section **Page**

LIST OF FIGURES v
GLOSSARY OF ACRONYMS.. vii

1. INTRODUCTION.. 1-1

2. SUMMARY OF EXISTING INVENTORIES 2-1
   - 2.1 Emissions from Area and Non-road Mobile Sources 2-1
   - 2.2 Emissions from On-road Mobile Sources... 2-5
   - 2.3 Emissions from Point Sources 2-7

3. DEVELOPMENT OF TOXIC AIR CONTAMINANT INVENTORIES 3-1

4. DEVELOPMENT OF TOXICITY-WEIGHTED TOXIC INVENTORIES 4-1

5. DEMOGRAPHIC AND HEALTH STATISTICS DATA.. 5-1

6. CONCLUSIONS AND RECOMMENDATIONS.. 6-1
   - 6.1 Recommendations for Continuing Development of the Toxic Air Contaminant Emission Inventories 6-2
   - 6.2 Recommendations for Reviewing the Criteria Pollutant Inventories 6-3

7. REFERENCES... 7-1

APPENDIX A: BAAQMD MODELING GRID DEFINITION A-1

APPENDIX B: SPECIATION OF TOG AND PM EMISSIONS FROM AREA AND NON-ROAD SOURCES AND FROM ON-ROAD MOBILE SOURCES B-1

APPENDIX C: SPATIAL ALLOCATION OF EMISSIONS FROM AREA AND NON-ROAD MOBILE SOURCES C-1

APPENDIX D: SELECTION AND APPLICATION OF CANCER UNIT RISK FACTORS AND NON-CANCER REFERENCE CONCENTRATIONS......................... D-1

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LIST OF FIGURES

Figure		Page
2-1.	2000 TOG and PM_{10} emissions by major source type for the BAAQMD	2-1
2-2.	Emission density plot of PM_{10} emissions from residential wood burning	2-2
2-3.	Area and non-road mobile source TOG emissions by source category	2-3
2-4.	Area and non-road mobile source PM emissions by source category	2-3
2-5.	Emission density plot of area and non-road mobile source TOG emissions	2-4
2-6.	On-road mobile source TOG emissions by source category	2-6
2-7.	On-road mobile source PM emissions by source category	2-6
2-8.	Emission density plot of on-road mobile source TOG emissions	2-7
2-9.	Point source ROG emissions by facility	2-8
2-10.	Point source PM_{10} emissions by facility	2-8
2-11.	Emission density plot of benzene emissions from point sources	2-10
3-1.	Average daily TAC emissions by species	3-2
3-2.	Average daily TAC emissions by detailed source category	3-2
4-1.	Cancer toxicity-weighted emissions by pollutant	4-2
4-2.	Cancer toxicity-weighted emissions by source category	4-3
4-3.	Chronic toxicity-weighted emissions by pollutant	4-3
4-4.	Chronic toxicity-weighted emissions by source type	4-4
4-5.	Acute toxicity-weighted emissions by pollutant	4-4
4-6.	Acute toxicity-weighted emissions by source category	4-5
4-7.	Emission density plot of 1,3-butadiene emissions	4-6
4-8.	Emission density plot of diesel particulate emissions	4-7
4-9.	Emission density plot of acrolein emissions	4-8
4-10.	Emission density plot of benzene emissions	4-9

LIST OF FIGURES (continued)

Figure **Page**

4-11. Emission density plot of hexane emissions 4-10

4-12. Emission density plot of MTBE emissions 4-11

4-13. Emission density plot of formaldehyde emissions 4-12

4-14. Emission density plot of toluene emissions 4-13

4-15. Emission density plot of cancer toxicity-weighted emissions 4-14

4-16. Emission density plot of chronic toxicity-weighted emissions 4-15

4-17. Emission density plot of acute toxicity-weighted emissions 4-16

5-1. Population density of persons under age 18 in the BAAQMD 5-2

5-2. Population density of persons over age 64 in the BAAQMD 5-3

5-3. Population density of persons with a personal income of less than 185% of federal poverty level in the BAAQMD 5-4

5-4. Asthma hospitalization rates for children age 14 and under in the BAAQMD 5-5

GLOSSARY OF ACRONYMS

ABAG	Association of Bay Area Governments
ARB	California Air Resources Board
BAAQMD	Bay Area Air Quality Management District
CARE	Community Air Risk Evaluation
CCOS	Central California Ozone Study
Caltrans	California Department of Transportation
DPM	diesel particulate matter
DRI	Desert Research Institute
DTIM4	Direct Travel Impact Model Version 4
EPA	U.S. Environmental Protection Agency
EIC	emission inventory code
GIS	geographic information system
IRIS	Integrated Risk Information System
MEDS	Modeling Emissions Data System
MTC	Metropolitan Transportation Commission
MTBE	methyl tertiary butyl ether
NLCD	National Land Cover Dataset
OEHHA	Office of Environmental Health Hazard Assessment
OSHPD	Office of Statewide Health Planning and Development
$PM_{2.5}$	particulate matter less than 2.5 microns
PM_{10}	particulate matter less than 10 microns
QA	quality assurance
QC	quality control
ROG	reactive organic gas
RfC	[non-cancer] reference concentrations
SCC	source classification code
SFBA	San Francisco Bay Area
STI	Sonoma Technology, Inc.
TACs	toxic air contaminants
TOG	total organic gas
tpy	tons per year
UR	[cancer] unit risk
VBA	Visual Basic

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1. INTRODUCTION

The Bay Area Air Quality Management District (BAAQMD) is carrying out the Community Air Risk Evaluation (CARE) program to characterize and reduce health risks from toxic air contaminants (TACs) emitted in the San Francisco Bay Area (SFBA). In support of the CARE program's goals, screening-level gridded emission inventories of TACs were prepared (including diesel exhaust). These screening-level inventories were assembled top-down from readily available information and represent an early step from which subsequent CARE program activities may be carried forward. They are intended to aid in the identification and prioritization of further inventory development activities, to support initial exposure modeling runs, and to facilitate selection of a study community in the SFBA. Although the screening-level inventories represent many of the TACs and emissions sources that are important in the SFBA, they should be considered "working versions under development"—i.e., inventories that are useful, but should be augmented and improved in consideration of reviewers' feedback or as additional inventory data are developed bottom-up through CARE program activities.

Mass-based and risk-weighted annual emission inventories of TACs were prepared by acquiring and processing existing and available information sources, including year-2000 emissions data previously prepared by BAAQMD. BAAQMD staff provided Sonoma Technology, Inc. (STI) with a county-level area and non-road mobile source inventory of emissions of total organic gases (TOG) and particulate matter less than 10 microns (PM_{10}). These emissions were back-cast to year 2000 from a base year of 2002. In addition, BAAQMD staff generated year-2000 on-road motor vehicle emissions using the California Air Resources Board's (ARB) EMFAC2002 model (version 2.2). These emissions were allocated to the BAAQMD's 2-km $\times$ 2-km modeling grid using the California Department of Transportation's (Caltrans) Direct Travel Impact Model Version 4 (DTIM4) and year-2000 SFBA travel network data provided by the Metropolitan Transportation Commission (MTC). BAAQMD produced summer and winter average weekday inventories for on-road mobile sources, and these two inventories were averaged by grid cell to produce an annualized on-road emissions inventory. Finally, BAAQMD provided STI with a year-2000 inventory of TAC emissions from point sources in the BAAQMD, data that were compiled from emissions reported by individual facilities.[1] (STI also obtained a year-2000 inventory of point source TOG and PM_{10} emissions in the Bay Area from the ARB for purposes of comparison.)

Other information sources used to prepare TAC emission inventories included (1) chemical speciation profiles published by the U.S. Environmental Protection Agency (EPA), ARB, and Desert Research Institute (DRI); (2) geographic information systems (GIS) databases acquired from the Association of Bay Area Governments (ABAG) and other sources; (3) ratios of particulate matter less than 2.5 microns ($PM_{2.5}$):PM_{10} calculated from information published

[1] Facility emission reports were provided during calendar year 2000 and, in most cases, represent the most recent 12-month period. Therefore, because the reporting dates for various facilities are staggered throughout the year, some reported emissions include those from the previous calendar year. However, these reported emissions were judged to be sufficiently representative of year-2000 for purposes of this project.

by the ARB; and (4) inhalation unit risk factors and reference concentrations available from the ARB and EPA. The resultant inventories should be considered suitable for initial exposure modeling and data analysis with a view toward prioritizing TACs and emissions source categories of concern for future research efforts. Conclusions and recommendations for further improvements to the inventories are presented in Section 6.

2. SUMMARY OF EXISTING INVENTORIES

The BAAQMD's pre-existing inventories of TOG, PM_{10}, and TACs were used as the basis for compiling annualized, screening-level TAC emission inventories for the CARE program. **Figure 2-1** illustrates the distribution of total TOG and PM_{10} emissions by major source category (point, on-road mobile, and area/non-road). Section 2 discusses each major source category in greater detail and outlines the techniques used to geographically allocate emissions to the BAAQMD's 2-km × 2-km modeling grid (see Appendix A).

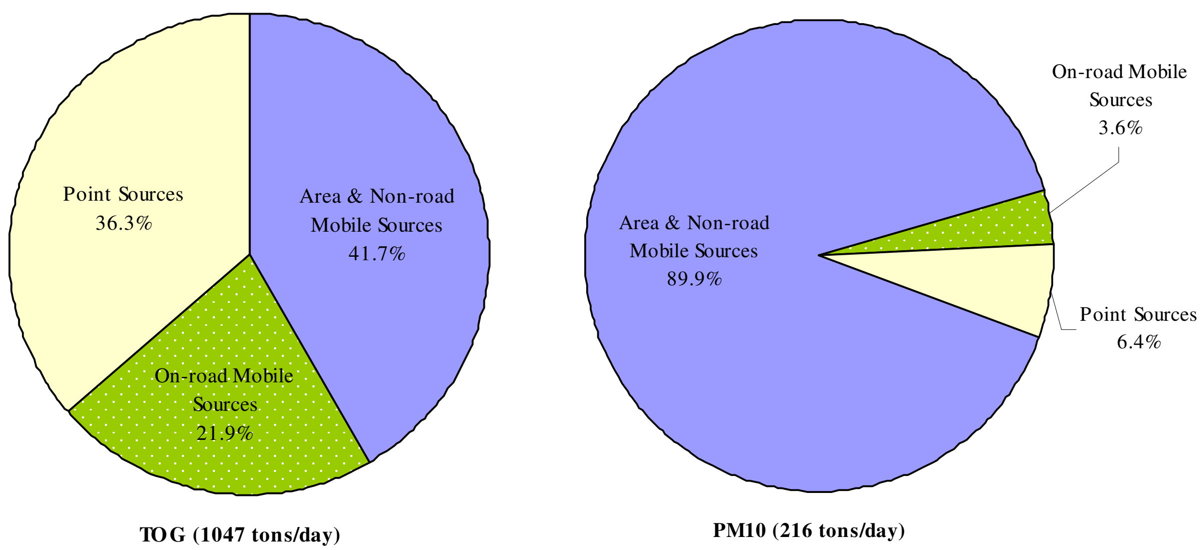

Figure 2-1. 2000 TOG and PM_{10} emissions by major source type for the BAAQMD.

2.1 EMISSIONS FROM AREA AND NON-ROAD MOBILE SOURCES

The BAAQMD provided STI with county-level area and non-road mobile source inventories of year-2000 TOG and PM_{10} emissions for 356 emission inventory codes (EICs). These inventories incorporated the latest emission estimates prepared by the BAAQMD, including the recent improvements to the area and non-road mobile source inventories listed below:

- Ship emission estimates were updated to include emissions occurring within 100 miles of county shorelines (previous estimates only included emissions occurring within 3 miles of county shorelines).
- Emission estimates for prepared for cargo handling equipment at the Port of Oakland.
- Improvements were made to the distribution of residential wood burning emissions among SFBA counties based on the results of a wood burning survey (True North Research, 2005). **Figure 2-2** shows an emission density plot of current PM_{10} emissions from residential wood burning.
- County-level estimates of emissions from livestock waste were updated.

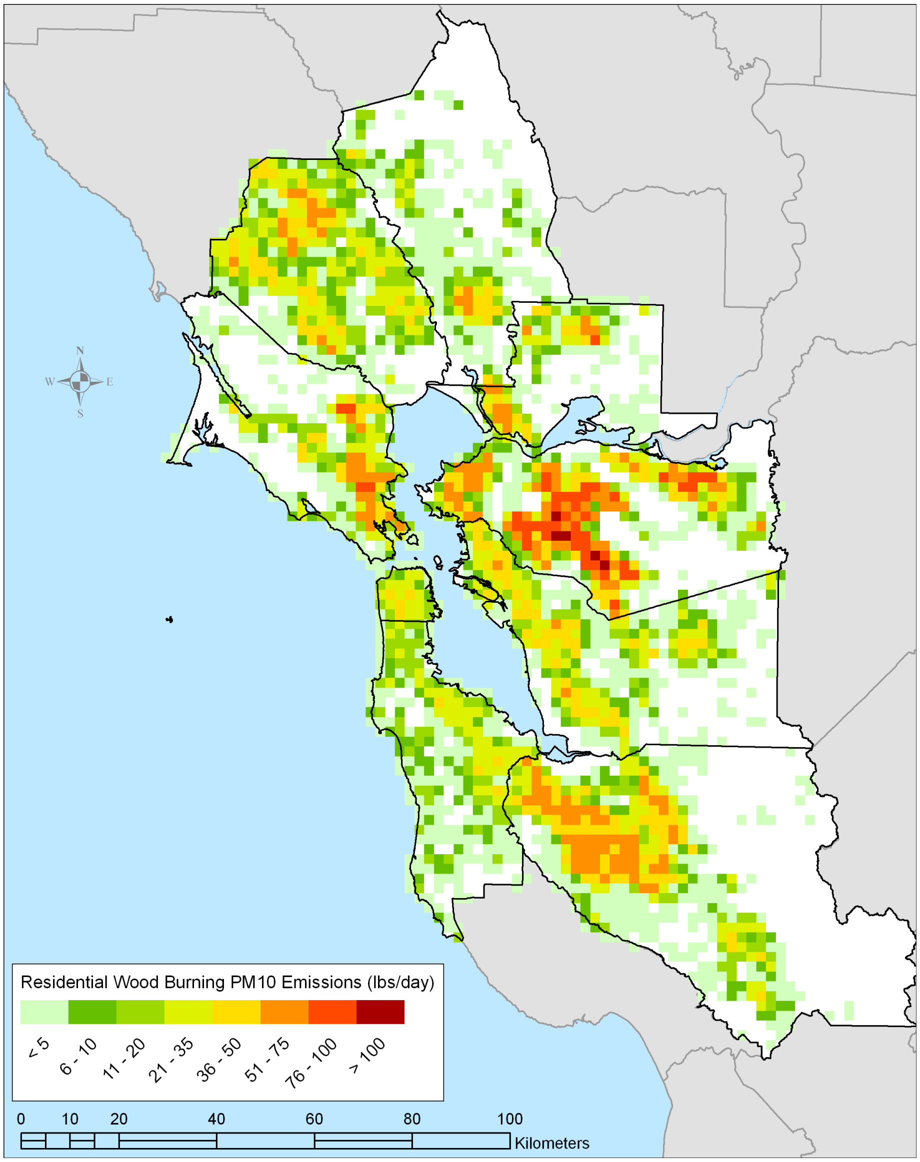

Figure 2-2. Emission density plot of PM_{10} emissions from residential wood burning.

Emission estimates for $PM_{2.5}$ were developed by applying $PM_{2.5}$-to-PM_{10} size fractions recommended by the ARB for each EIC code (see Appendix B). **Figures 2-3 and 2-4** summarize area and non-road mobile source TOG, PM_{10}, and $PM_{2.5}$ emissions by detailed source categories, and **Figure 2-5** shows an emission density plot of area and non-road mobile source TOG emissions (note that BAAQMD boundaries include only the western portion of Solano County and the southern portion of Sonoma County). Important sources of TOG include evaporative sources (e.g., petroleum marketing and consumer products) and combustion sources (e.g., off-road equipment and residential fuel combustion). Sources of TOG associated with the decomposition of organic matter (e.g., livestock waste and landfills) emit most TOG in the form of methane—a non-toxic gas. Important sources of PM include combustion sources (e.g., residential fuel combustion and off-road equipment). Sources of fugitive dust emit most PM in the form of non-toxic geologic material.

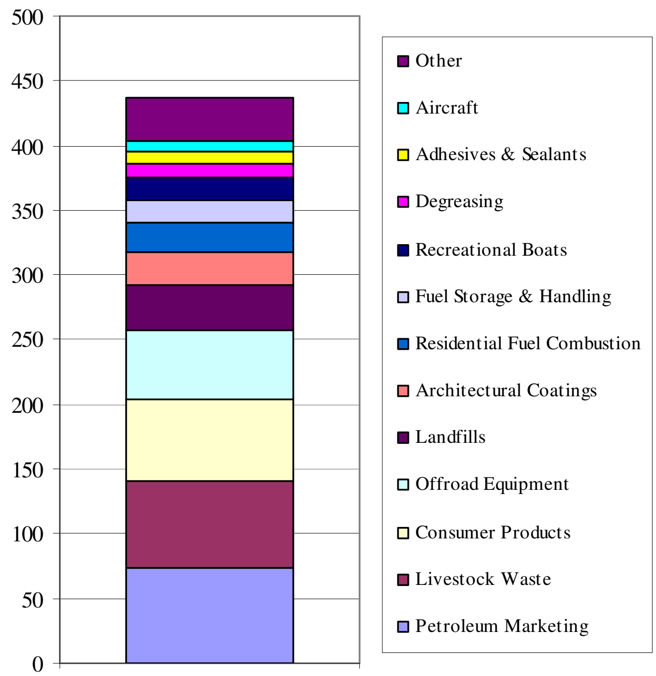

Figure 2-3. Area and non-road mobile source TOG emissions (tons/day) by source category.

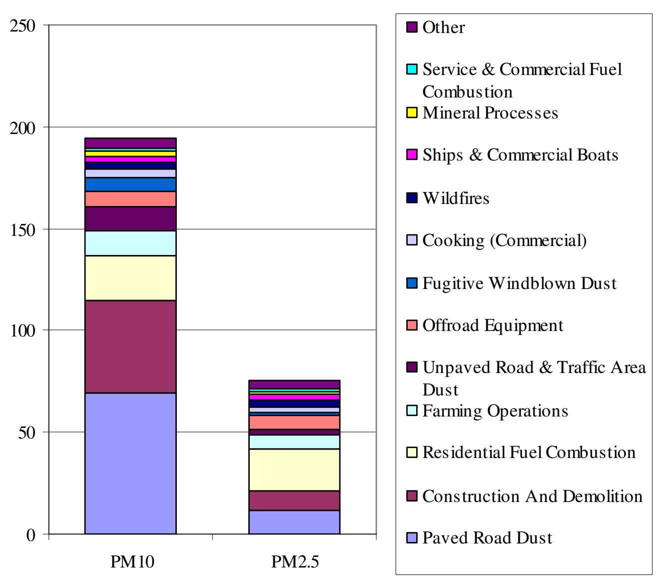

Figure 2-4. Area and non-road mobile source PM emissions (tons/day) by source category.

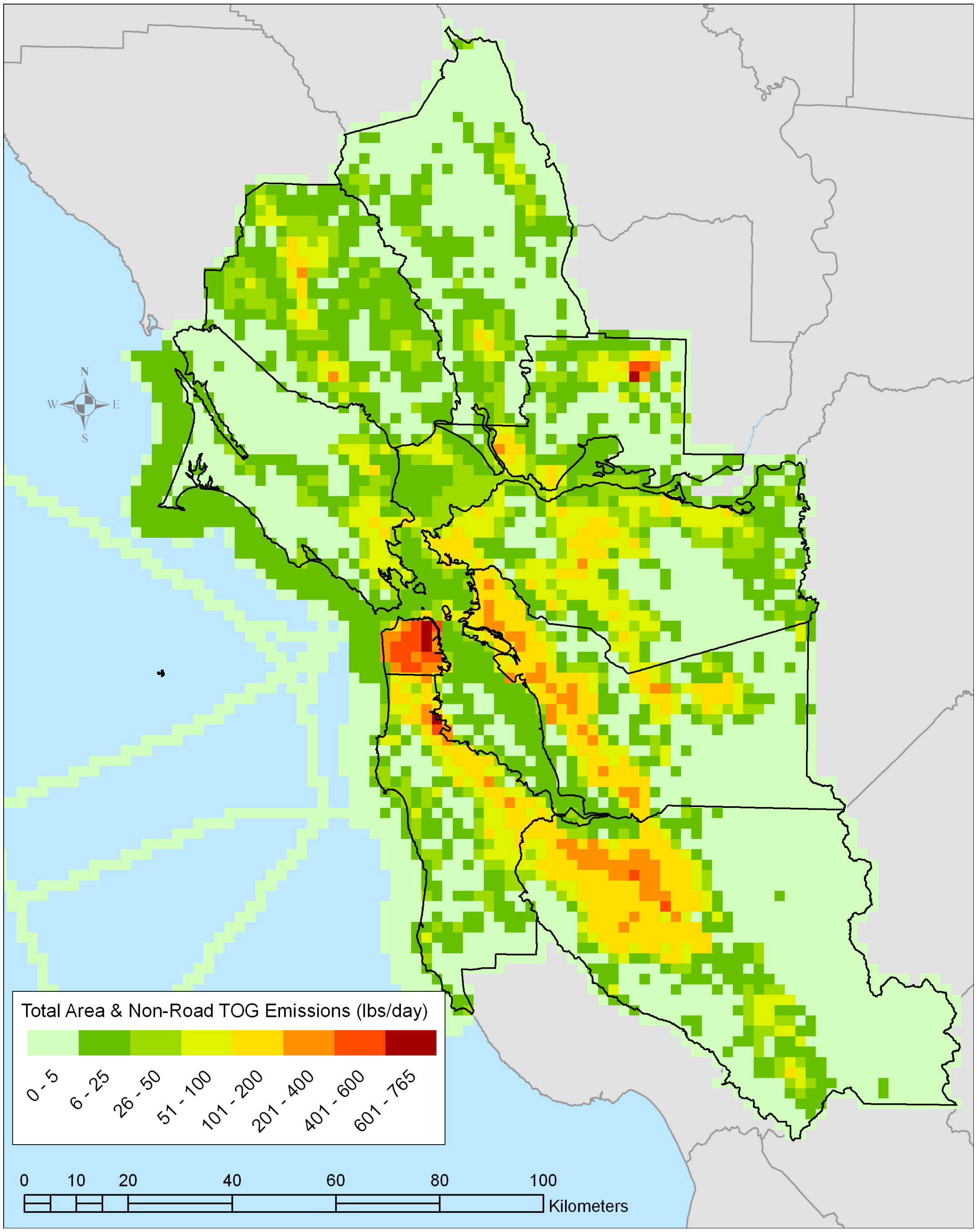

Figure 2-5. Emission density plot of area and non-road mobile source TOG emissions.

County-level area and non-road mobile emissions were geographically distributed using GIS databases. GIS databases with suitable spatial resolutions were selected as surrogates for the locations of emissions sources. Countywide emissions were allocated to individual grid cells proportionally according to the spatial patterns of the surrogate GIS data. Examples of some GIS databases employed for the process include land use area (e.g., industrial land use), line length (e.g., railroad track length), line density (e.g., roadway traffic activity), and point count (e.g., number of dry cleaning locations). Allocation factors were developed for individual grid cells by processing GIS data within a customized ArcGIS Visual Basic (VBA) program that outputs allocation factors by grid cell to Microsoft Access database tables. Four basic types of spatial allocation calculations were used to develop the spatial surrogates applied to the inventory, based on the type of GIS data (i.e., polygon, line, or point).

A variety of GIS data sets were used to geographically distribute countywide emissions. The most often-used data set for this process was the Existing Land Use – 2000, developed by the ABAG. The ABAG land use database incorporates the U.S. Geological Survey National Land Cover Dataset (NLCD) as well as county assessors' data on land use. Another important data source was the Central California Ozone Study (CCOS) gridded surrogates project (Funk et al., 2001) that included representations of the geographic locations of businesses derived from records of business addresses. Addresses for auto body shops, dry cleaners, and variety of other types of businesses were geocoded to estimate geographic locations, which Funk et al. (2001) used in turn to calculate gridded spatial allocation factors. In total, 46 surrogates were developed for spatially allocating the area and non-road sources. The details about GIS data sources and methods used for spatial allocation are provided in Appendix C.

2.2 EMISSIONS FROM ON-ROAD MOBILE SOURCES

The BAAQMD provided STI with gridded on-road mobile source inventories of TOG and PM_{10} emissions in Modeling Emissions Data System (MEDS) format. BAAQMD staff generated year-2000 on-road mobile source emission estimates using the ARB's EMFAC2002 model (version 2.2). These emissions were allocated to BAAQMD's 2-km × 2-km modeling grid using Caltrans' DTIM4 and year-2000 SFBA travel network data provided by the MTC. The final emission inventories provided to STI incorporated a number of recent improvements that BAAQMD staff made to on-road mobile source emission estimates:

- The redistribution of heavy-duty truck emissions from a portion of Route 580 to I-880.[2]
- The incorporation of new emission estimates for trucks operating within the Port of Oakland.
- A vehicle speed correction for a stretch of Highway 152 east of Gilroy that eliminated a previous overestimate of emissions for that region.
- Diesel PM emissions from heavy-duty vehicles were updated based on results from a new draft version of ARB's EMFAC model which uses truck survey results and global positioning system (GPS) techniques to estimate vehicle miles traveled (VMT). This methodology is more realistic than the one employed in the current version of EMFAC (Version 2.2), which relies primarily on registration data to estimate VMT.

BAAQMD generated summer and winter MEDS files for 2000, and these two inventories were averaged by grid cell to produce an annualized on-road emissions inventory.

[2] Heavy-duty trucks over 9,000 pounds are prohibited on Route 580 from Foothill Blvd. in San Leandro to Grand Avenue in Oakland. As a result, most of these trucks use I-880 instead, a traffic feature that was not captured in previous gridded inventories.

As with emissions from area and off-road mobile sources, emission estimates for $PM_{2.5}$ were developed from the on-road PM_{10} inventory by applying ARB $PM_{2.5}$-to-PM_{10} size fractions recommended by the ARB. **Figures 2-6 and 2-7** summarize on-road mobile source TOG, PM_{10}, and $PM_{2.5}$ emissions by source category, and **Figure 2-8** shows an emission density plot of the gridded on-road mobile source TOG inventory provided by BAAQMD. Evaporative losses are important sources of TOG and exhaust emissions are important sources of both TOG and PM.

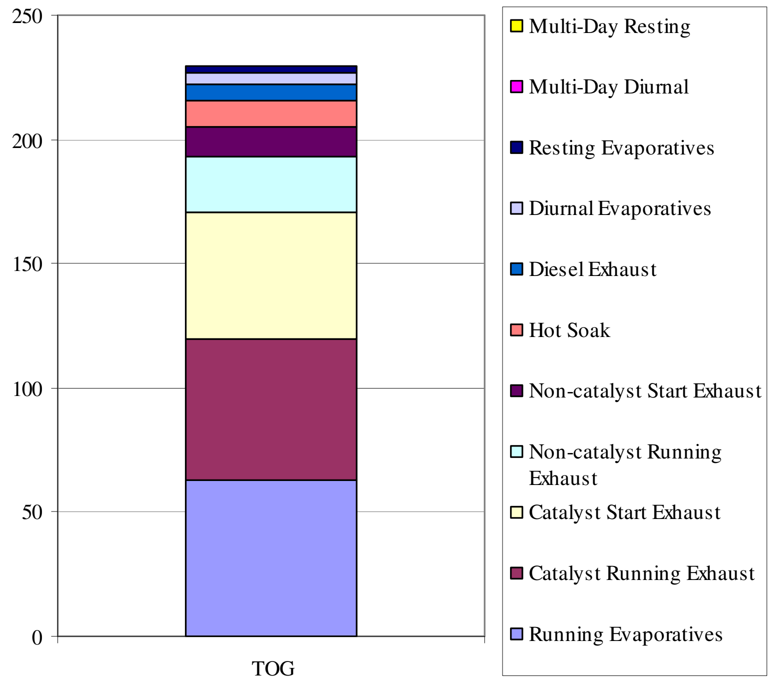

Figure 2-6. On-road mobile source TOG emissions (tons/day) by source category.

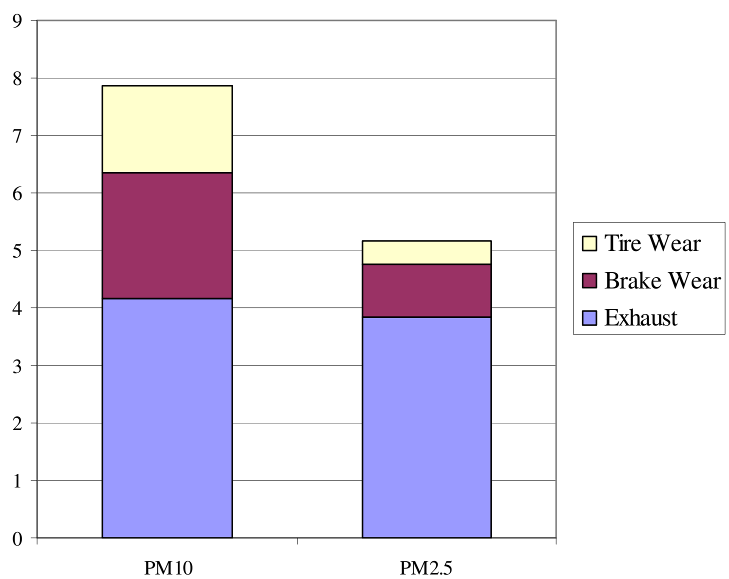

Figure 2-7. On-road mobile source PM emissions (tons/day) by source category.

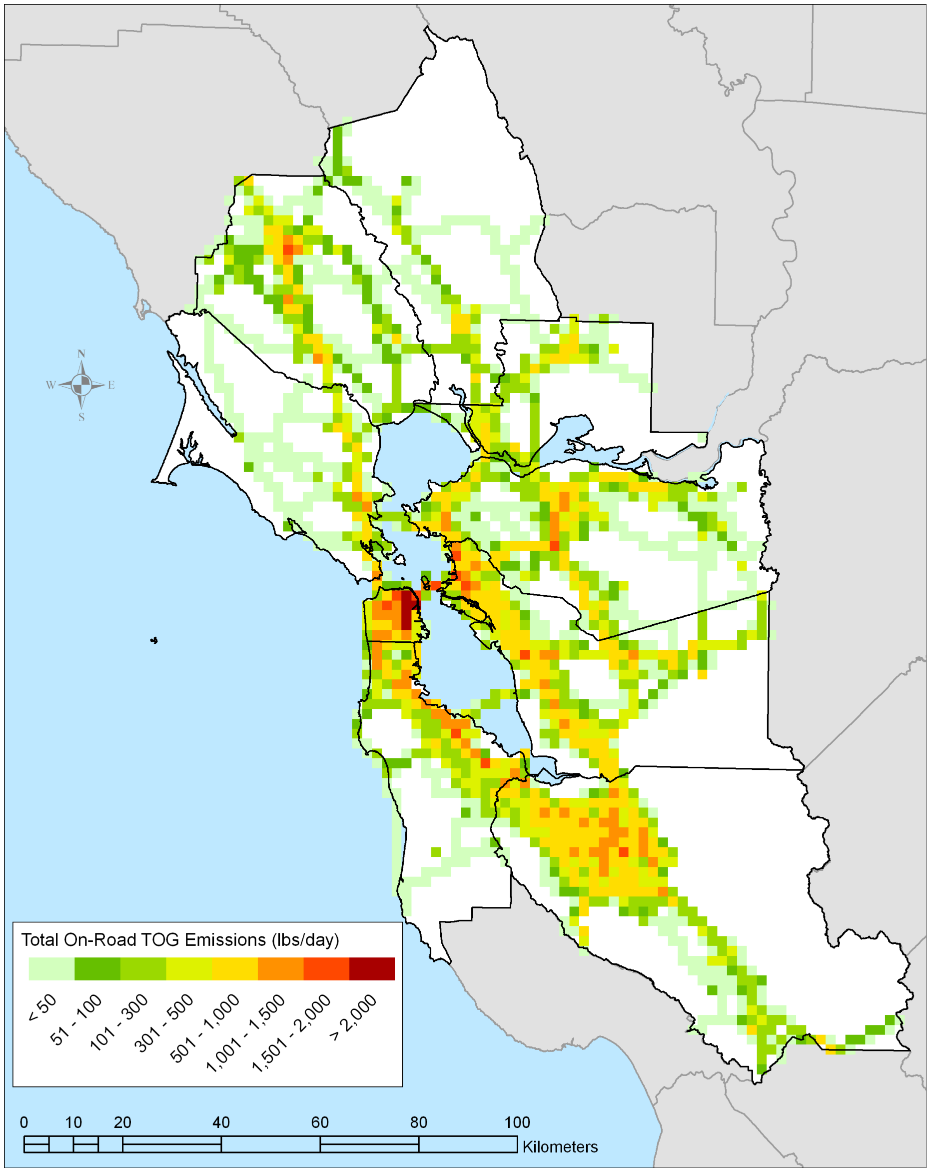

Figure 2-8. Emission density plot of on-road mobile source TOG emissions.

2.3 EMISSIONS FROM POINT SOURCES

BAAQMD provided STI with a year-2000 inventory of TAC emissions from point sources within the district, data that were compiled from emissions reported by individual facilities. However, for purposes of direct comparison to the criteria-pollutant data summarized in Sections 2.1 and 2.2, STI downloaded year-2000 TOG, reactive organic gases (ROG) and PM_{10} point-source emissions from ARB's Facility Search Engine. **Figures 2-9 and 2-10** summarize point source ROG and PM_{10} emissions by facility. (ROG emissions are displayed because the TOG inventory is dominated by landfills, which emit most TOG in the form of methane—a non-toxic gas). Petroleum refineries are important sources of ROG and PM_{10}, and electrical generation facilities and landfills are also important sources of PM_{10}.

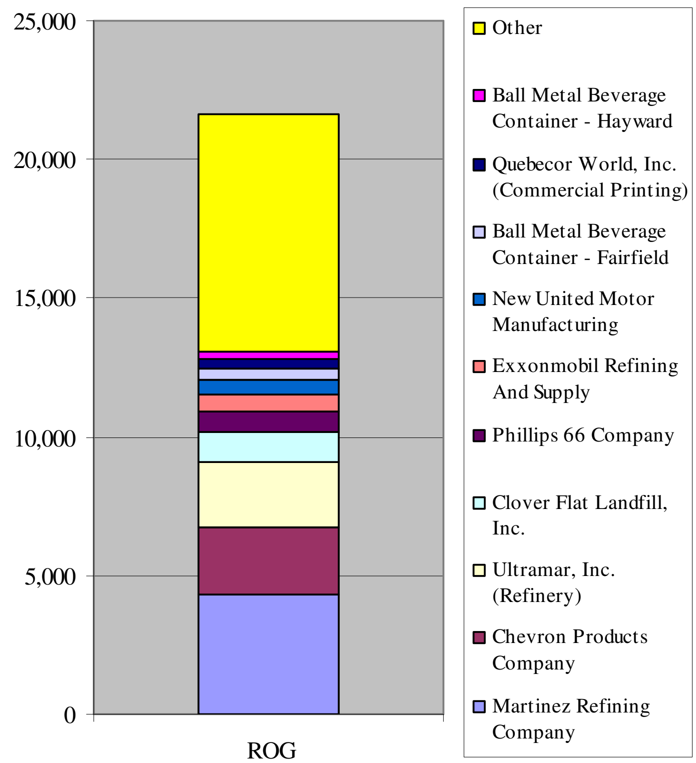

Figure 2-9. Point source ROG emissions (tons/year) by facility.

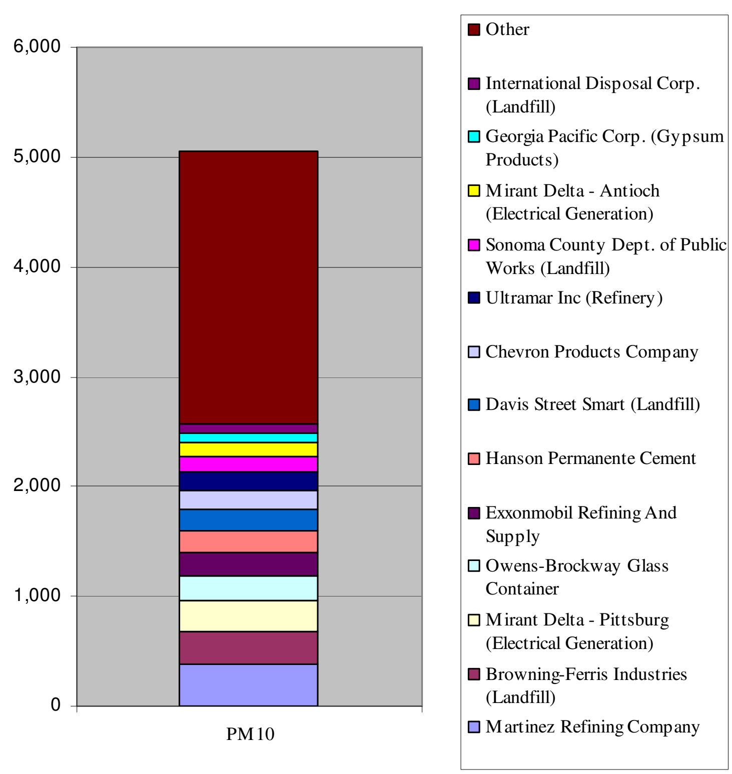

Figure 2-10. Point source PM_{10} emissions (tons/year) by facility.

In order to assign a geographical location to individual point sources, facility addresses reported in the BAAQMD's point source inventory were geocoded. The geocoding was achieved using the TeleAtlas EZ-Locate software. The TeleAtlas' geocoding process relies on a combination of postal standardization software, positionally accurate maps, and advanced geocoding techniques to generate the most accurate geocode coordinates available. Each point source in the BAAQMD's inventory file was assigned a geographic location and a geocode match type field. The match type is determined according to the accuracy of the geocoded address. A match type of "1" is the best match type possible—the geographic location is accurate to an exact house number within a single side of a single street block. A match type of "4" is accurate only to the 5-digit ZIP Code centroid. Of 3,359 unique addresses in the BAAQMD's point source inventory file, 4% (137 addresses) received a match type "4" and 96% (3,222 addresses) received a match type "1".

Following STI's geographic location assignments, BAAQMD staff reviewed spatial information for 90 of the BAAQMD's most significant point sources. Sites selected for review included all Title V facilities[3] and the 20 sites with the highest toxicity-weighted emissions for either cancer, chronic or acute health risks. The BAAQMD provided STI with correct UTM coordinates for 56 of these sites and correct grid cell locations for 34 of these sites. This review also included 21 sites that STI designated a match type of "4", and it should be noted that the estimated locations of remaining point sources with a match type "4" are inexact and should be corrected or taken into consideration during exposure modeling and risk assessment efforts. **Figure 2-11** illustrates the geographic distribution of benzene emissions from point sources. Details about the point source inventory geocoding match type results are documented in Appendix C.

[3] These facilities are required to obtain a Title V operating permit in accordance with federal Clean Air Act Amendments of 1990 based on their potential to produce certain thresholds of air pollution.

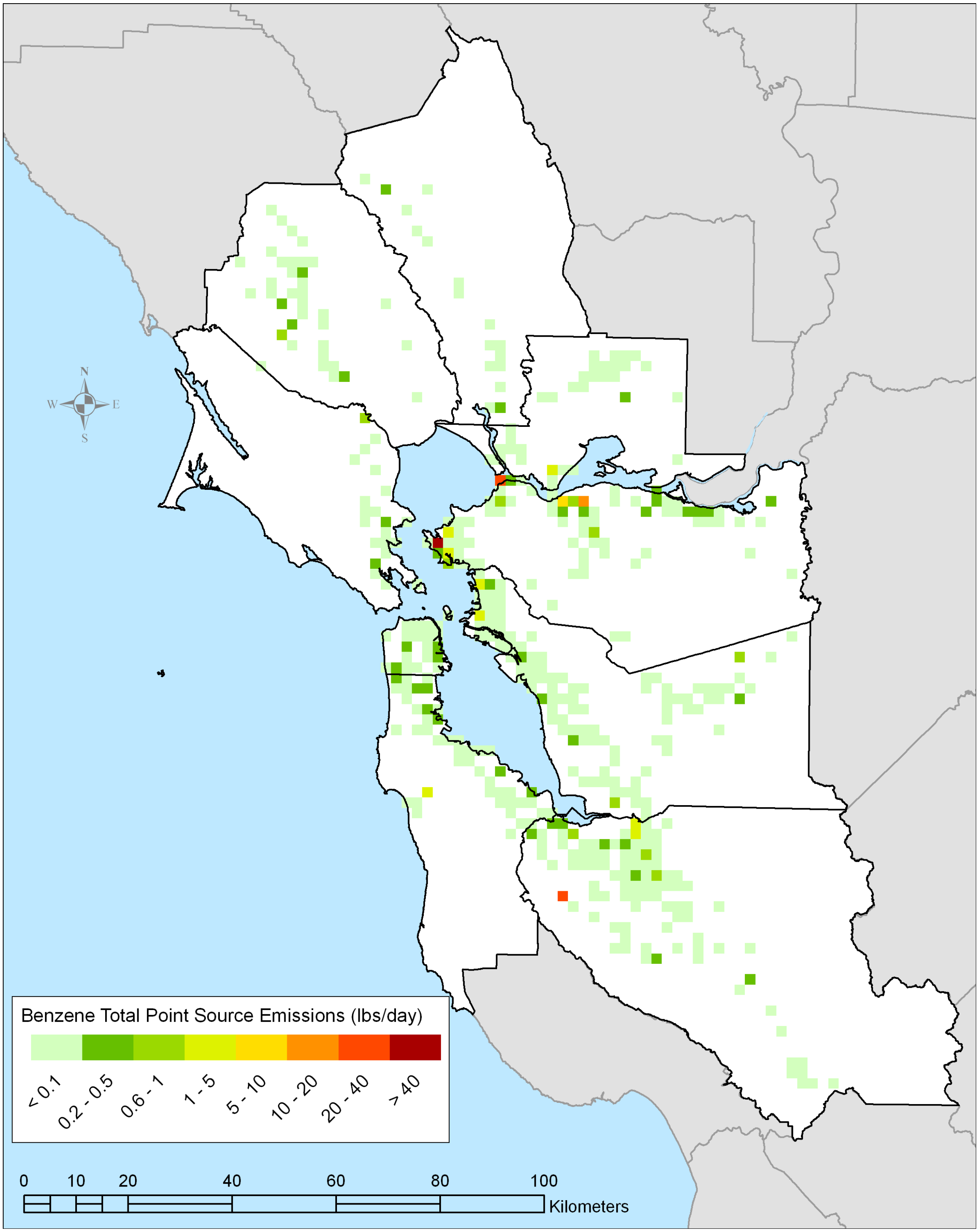

Figure 2-11. Emission density plot of benzene emissions from point sources.

3. DEVELOPMENT OF TOXIC AIR CONTAMINANT INVENTORIES

Several data processing steps were followed to prepare the inventories for chemical speciation. STI assigned speciation profiles to each EIC or source classification code (SCC) in the area, non-road mobile, and on-road mobile source TOG and PM inventories. The ARB has developed a database of TOG and PM speciation profiles, as well as a cross-reference file that indicates which TOG or PM profile is assigned to each EIC code. In most cases, speciation profile-to-EIC code assignments recommended by the ARB were followed. However, where no speciation profile (or a composite profile) was recommended for a given source category by the ARB, appropriate profiles from DRI or the EPA Speciate 3.2 database were utilized. (Appendix C contains a listing of the speciation profiles used in this study and a cross-reference table matching these profiles to each EIC/SCC code in the inventories).

Several speciation profiles contained weight fractions for chromium, a compound that is highly toxic when it exists in its hexavalent state. Data on ambient concentrations of hexavalent chromium in California indicate that hexavalent chromium comprises 3% to 8% of total ambient chromium (California Air Resources Board, 1985). Therefore, in consultation with BAAQMD staff, STI assumed that 5% of the chromium fractions in the speciation profiles used in this project was made up of hexavalent chromium; the speciation profiles were adjusted accordingly. No other revisions were made to the selected speciation profiles. It should also be noted that the BAAQMD provided STI with a year-2000 inventory of TACs from point sources in the SFBA; therefore, no processing steps were required to accomplish chemical speciation of the point source inventories.

In addition, because particulate emissions from diesel-fueled engines have been defined as a toxic air contaminant by the ARB, all sources of diesel particulate matter (DPM) were identified prior to the application of speciation profiles. This identification was made by flagging all sources assigned to a diesel exhaust speciation profile and—based on guidance from BAAQMD staff—all ship emissions.[4] PM_{10} and $PM_{2.5}$ emissions from these sources were treated as DPM and included in the final TAC inventories.

Selected speciation profiles were used to transform TOG and PM emissions into individual chemical species so that TAC emissions from area, non-road mobile, and on-road mobile sources could be estimated. These estimates were combined with the inventory of TAC emissions from point sources provided by the BAAQMD to form a complete inventory of TACs. TAC emissions by pollutant and source category can be seen in **Figures 3-1 and 3-2**. Note that Figures 3-1 and 3-2 show emissions on a mass basis; however, the toxicity and the geographic distribution of each TAC must be considered in order to evaluate its potential for posing human health risks. Section 4 discusses measures of toxicity and plots the geographic distributions of several potentially important TACs.

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[4] Some commercial marine vessels burn residual fuel and are assigned to ARB's "Marine Vessels – Liquid Fuel" PM speciation profile. However, BAAQMD staff determined that previous ARB studies at the Ports of Los Angeles and Long Beach treated particulate emissions from residual-fueled ships as DPM. This was done for two reasons: (1) residual-fueled ships burn a fossil fuel in diesel (compression) engines; and (2) health studies for determining risk factors were based on older diesel fuels which closely resemble the "residual fuels" of today.

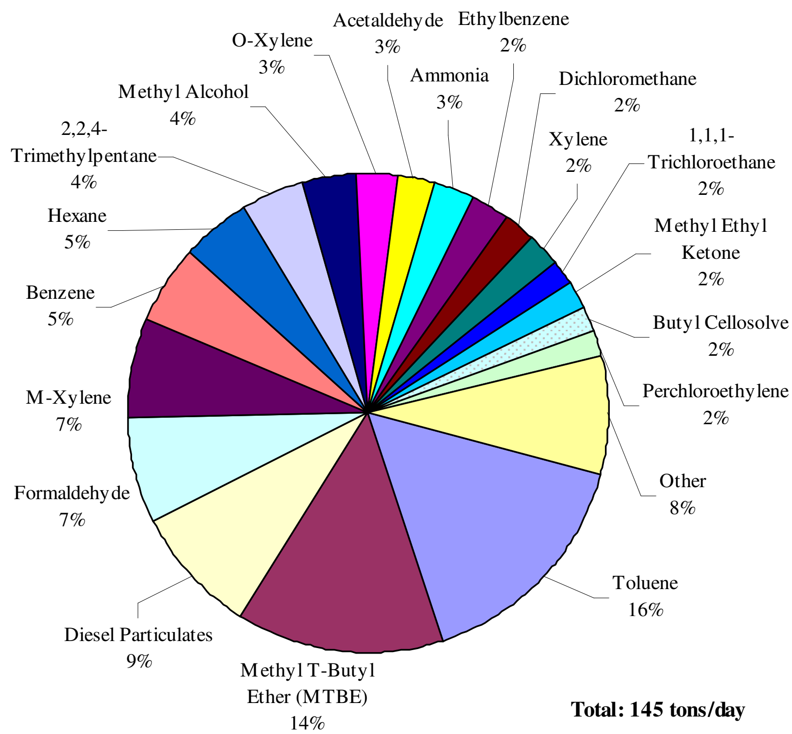

Figure 3-1. Average daily TAC emissions by species.

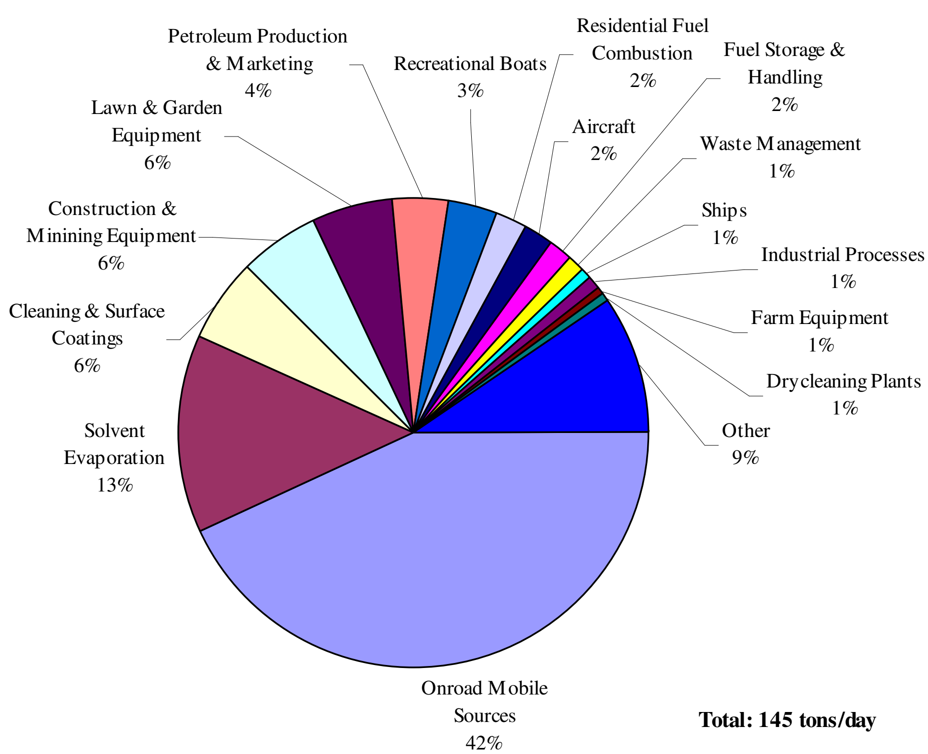

Figure 3-2. Average daily TAC emissions by detailed source category.

4. DEVELOPMENT OF TOXICITY-WEIGHTED TOXIC INVENTORIES

To develop toxicity-weighted emission inventories, STI applied available cancer unit risk (UR) factors and non-cancer reference concentrations (RfC) for the inhalation exposure pathway. UR factors estimate the expected change in the rate of observed adverse effects per unit change in dose (or air concentration). An RfC is a regulatory definition that indicates the dose at which no adverse effects are expected plus a safety margin allowing for measurement uncertainty plus another safety margin based on professional toxicologists' judgment. UR factors and RfCs were compiled from the following information sources in declining order of preference: ARB in conjunction with EPA's Office of Environmental Health Hazard Assessment (OEHHA), the EPA's Integrated Risk Information System (IRIS), and the EPA's Technology Transfer Network. Secondary sources were used to estimate factors for important TACs not available in the preferred references. When URs or RfCs were reported as a range (e.g., Benzene, CAS# 71432, IRIS), the high end of the range was used to prepare the toxicity-weighted emission inventory, and range-related uncertainties were calculated and documented. Details about the selection, application, and calculation of quantifiable uncertainties are documented in Appendix D.

Mass-based emissions for all TACs were converted to toxicity-weighted emissions for cancer, chronic, and acute risks. Toxicity-weighted emissions are reported in units of "mass equivalents per unit time". For risks of cancer due to inhalation, the mass equivalent of a specific TAC is the estimated mass of hypothetical compound "X" that poses a cancer risk equal to that of the emitted mass of the TAC of interest (where "X" is defined as having a UR factor equal to 1 $(\mu g/m^3)^{-1}$). Thus, toxicity-weighted emissions for cancer due to inhalation exposure are calculated according to Equation 4-1.

$$\text{Emissions} \times UR_i \div UR_X = \text{Toxicity-Weighted Emissions} \qquad \textbf{(4-1)}$$

where:

Emissions = Mass-based emissions of a TAC species *i*; **lbs/day**

UR_i = UR factor for TAC species *i*, or the estimated probability of a person contracting cancer as a result of constant exposure to an ambient concentration one microgram per cubic meter of species *i* over a 70-year lifetime; $\mathbf{(\mu g/m^3)^{-1}}$

UR_X = UR factor for a hypothetical compound "X" ≡ 1 $(\mu g/m^3)^{-1}$

Toxicity-Weighted Emissions = Equivalent emissions of hypothetical compound "X", which would be expected to pose a risk equal to that of the emissions of the TAC species *i*; **equivalent lbs/day**

For non-cancer risks due to inhalation (whether acute or chronic), the mass equivalent of a specific TAC is the estimated mass of hypothetical compound "Y", which would be expected to pose a risk equal to that of the emitted mass of the TAC of interest (where "Y" is defined as having an RfC equal to unity). Thus, toxicity-weighted emissions for acute or chronic effects due to inhalation exposure are calculated according to Equation 4-2.

$$\text{Emissions} \div RfC_i \times RfC_Y = \text{Toxicity-Weighted Emissions} \quad \textbf{(4-2)}$$

where:

Emissions = Mass-based emissions of a TAC species i; **lbs/day**

RfC_i = RfC for TAC species i; **$\mu g/m^3$**

RfC_Y = RfC for hypothetical compound "Y" ≡ 1 $\mu g/m^3$

Toxicity-Weighted Emissions = Equivalent emissions of hypothetical compound "Y", which would be expected to pose a risk equal to that of the emissions of the TAC species i; **equivalent lbs/day**

Figures 4-1 through 4-6 show toxicity-weighted emissions by pollutant and source category for cancer-related, chronic, and acute effects caused by inhalation exposure. Diesel particulate matter (DPM) comprises 81% of cancer toxicity-weighted emissions. Construction-related activities, industrial and commercial equipment, and on-road mobile sources contribute almost three-fourths of the cancer toxicity-weighted emissions. Acrolein and formaldehyde appear significant when considering toxicity-weighted emissions for chronic and acute effects. On-road mobile sources and aircraft are the two most important source categories for non-cancer risks, comprising 57% of all chronic toxicity-weighted emissions and almost 80% of acute toxicity-weighted emissions.

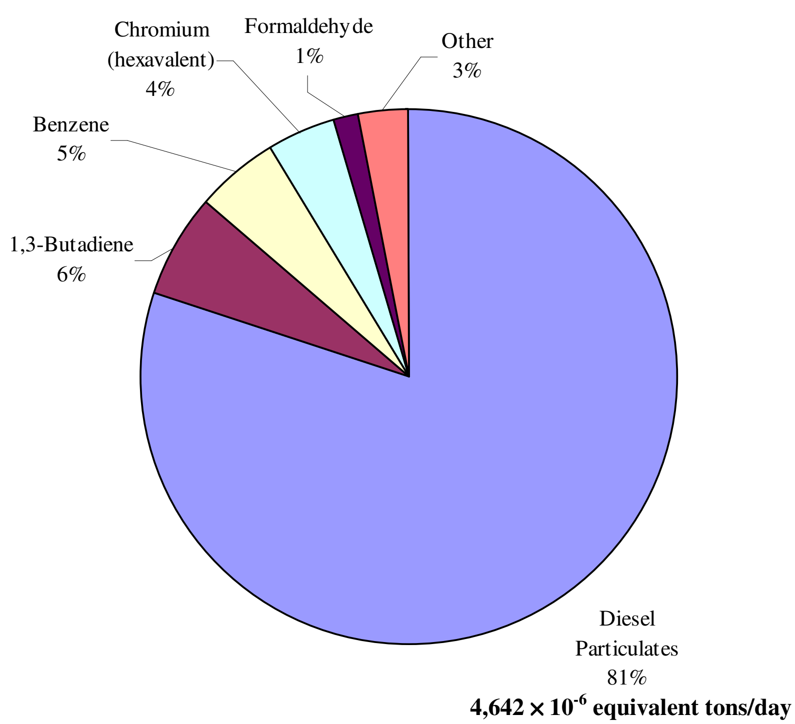

Figure 4-1. Cancer toxicity-weighted emissions by pollutant.

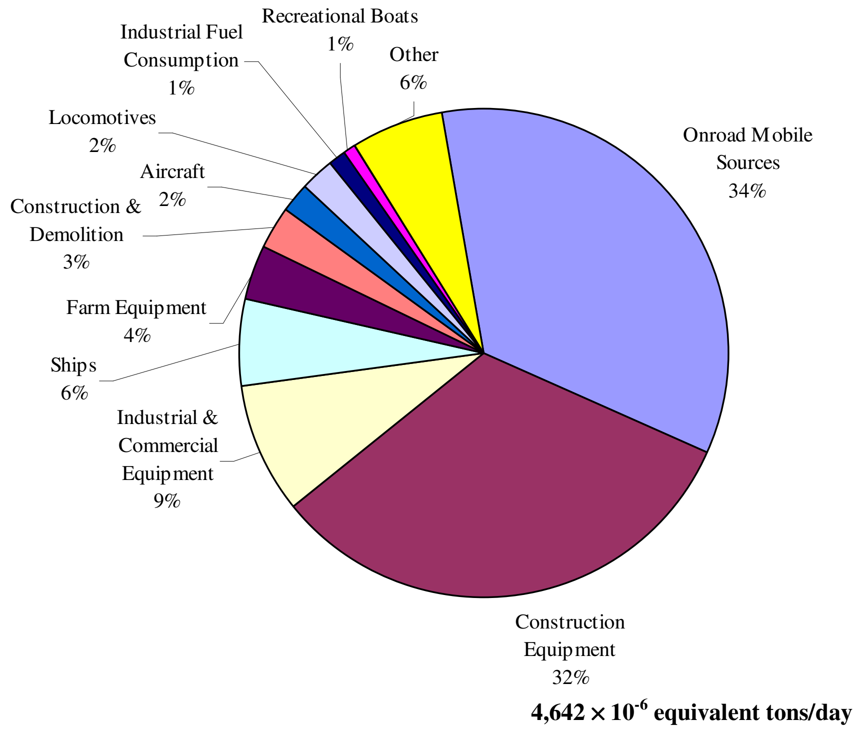

Figure 4-2. Cancer toxicity-weighted emissions by source category.

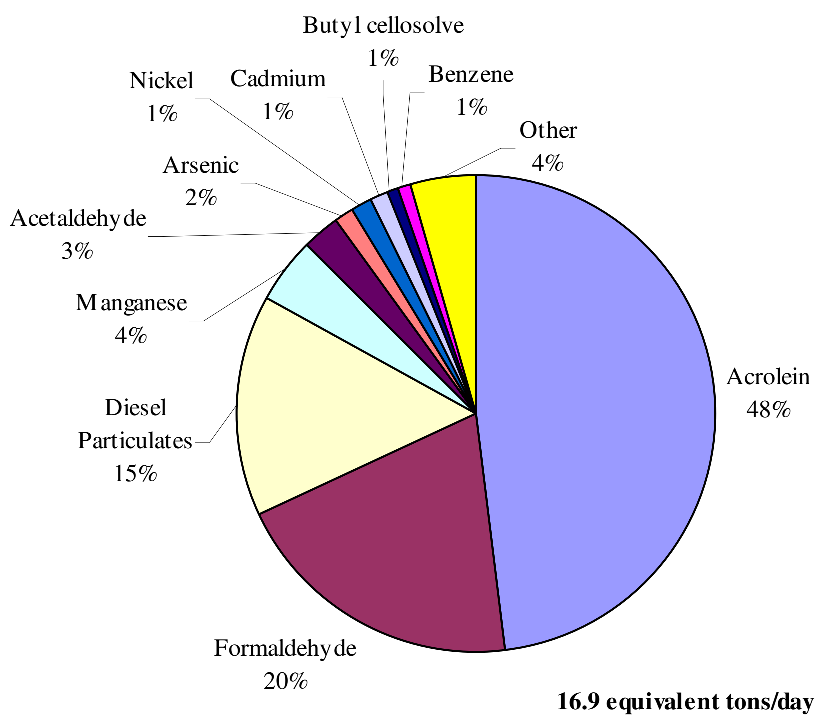

Figure 4-3. Chronic toxicity-weighted emissions by pollutant.

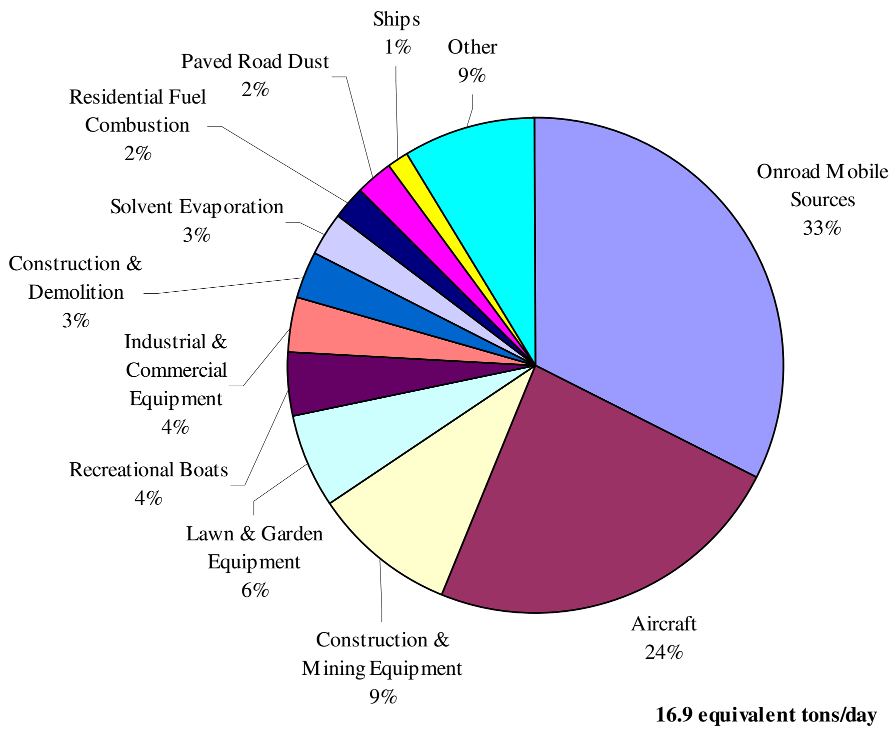

Figure 4-4. Chronic toxicity-weighted emissions by source type.

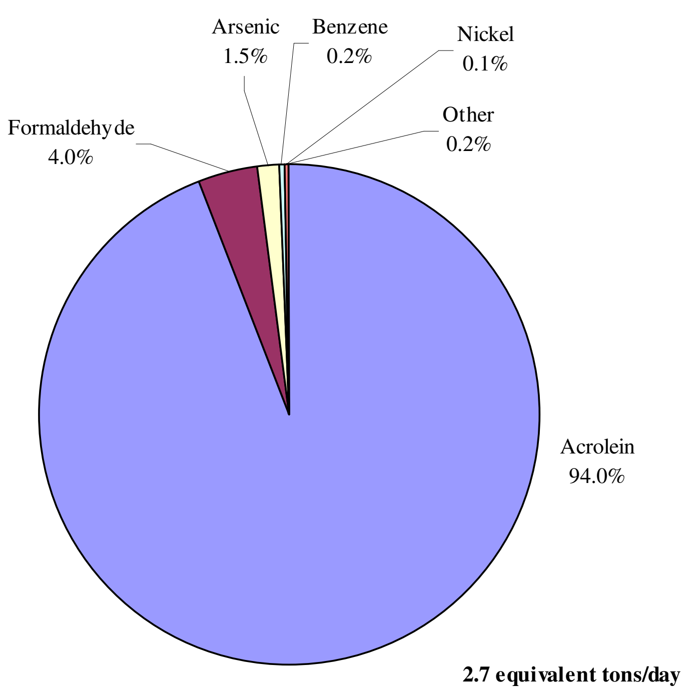

Figure 4-5. Acute toxicity-weighted emissions by pollutant.

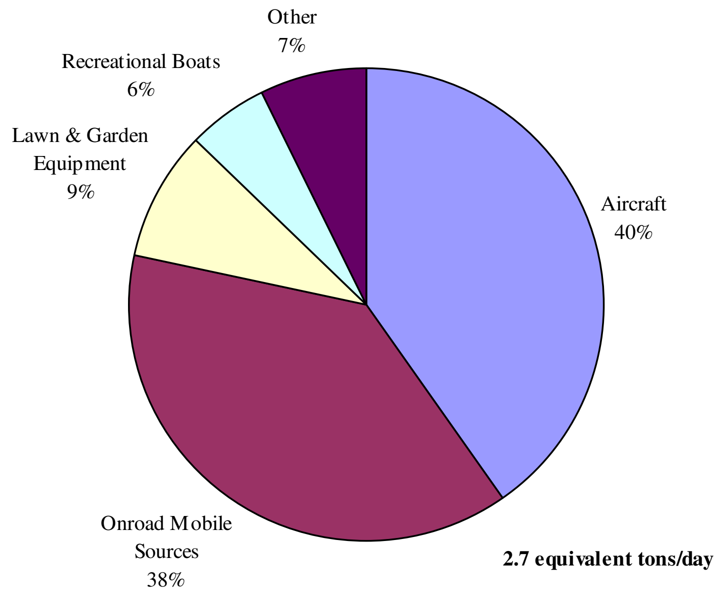

Figure 4-6. Acute toxicity-weighted emissions by source category.

Geographic distributions of emissions for several of the TACs prominent in Figures 4-1 through 4-6 are illustrated in **Figures 4-7 through 4-14**, including 1,3-butadiene, DPM, acrolein, benzene, hexane, MTBE, formaldehyde, and toluene. In addition, geographic distributions of cancer toxicity-weighted, chronic toxicity-weighted, and acute toxicity-weighted emissions are shown in **Figures 4-15 through 4-17**.

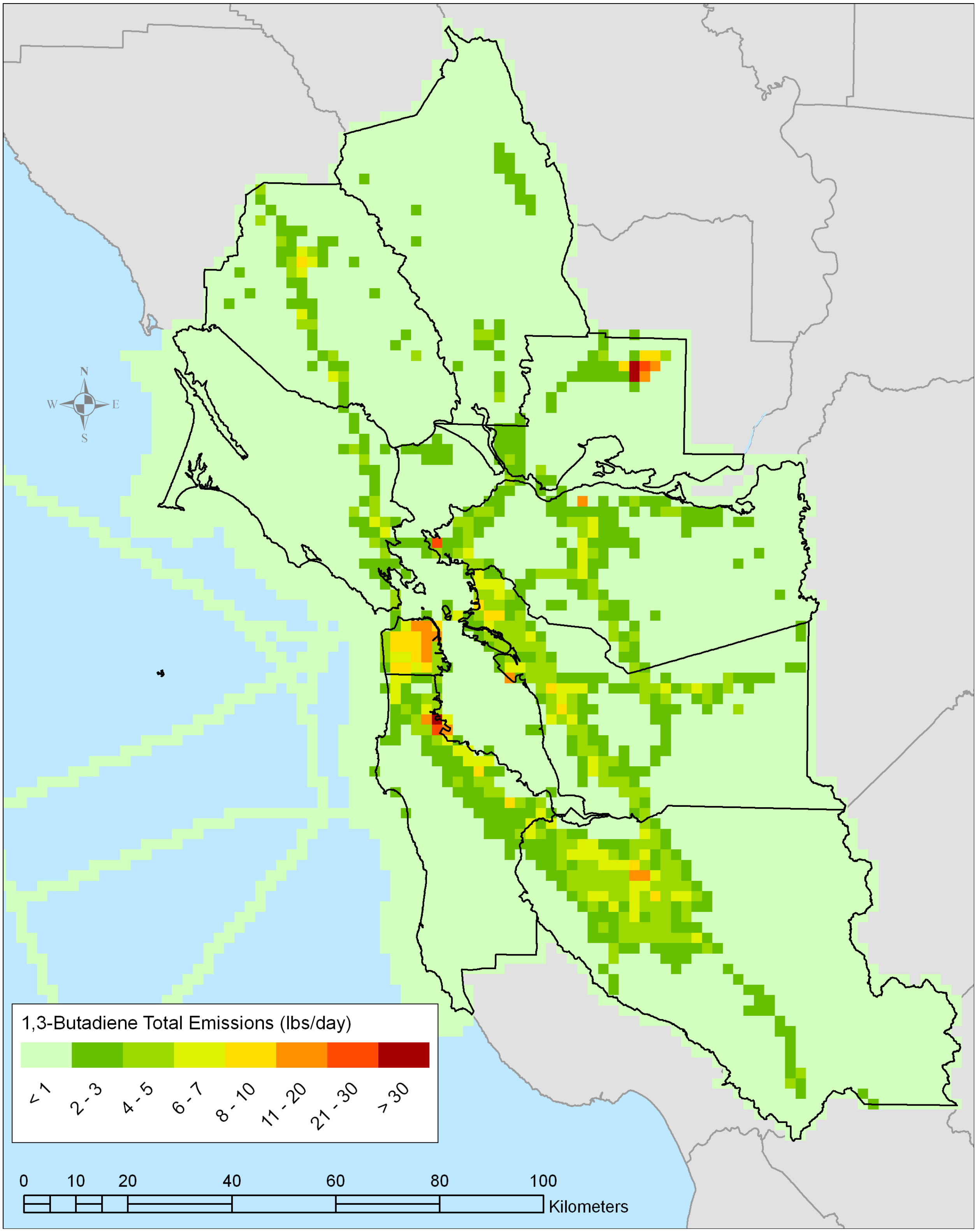

Figure 4-7. Emission density plot of 1,3-butadiene emissions.

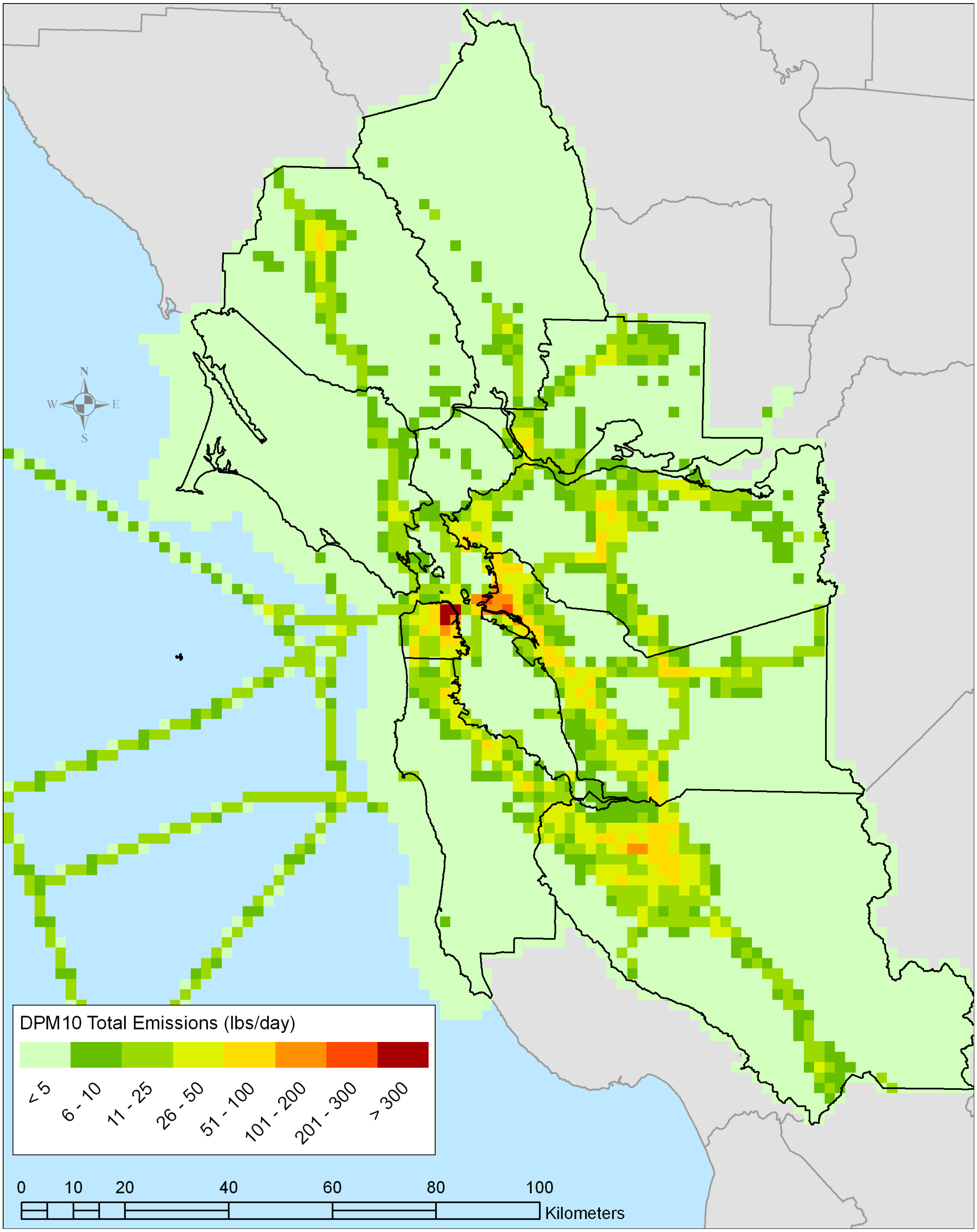

Figure 4-8. Emission density plot of diesel particulate emissions.

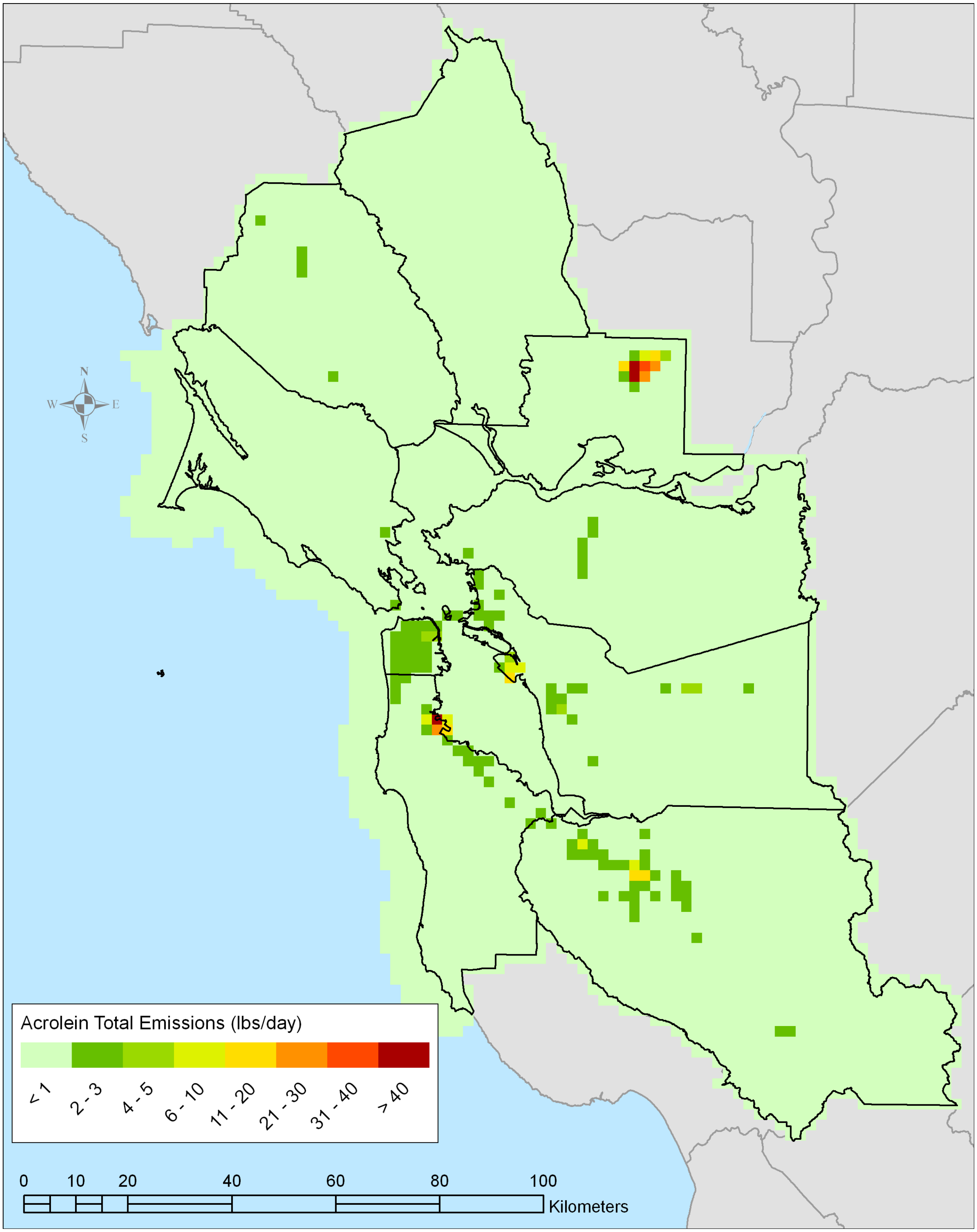

Figure 4-9. Emission density plot of acrolein emissions.

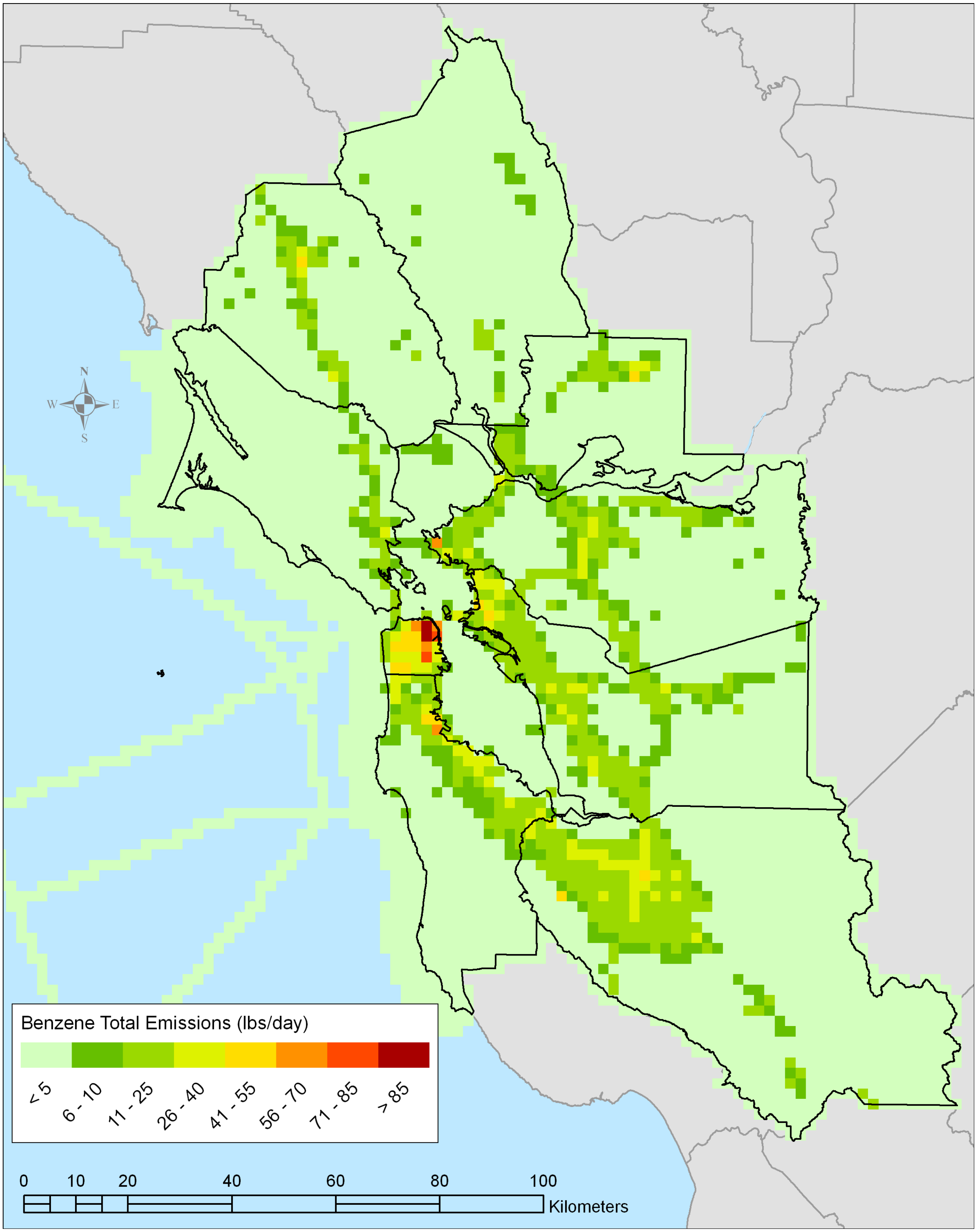

Figure 4-10. Emission density plot of benzene emissions.

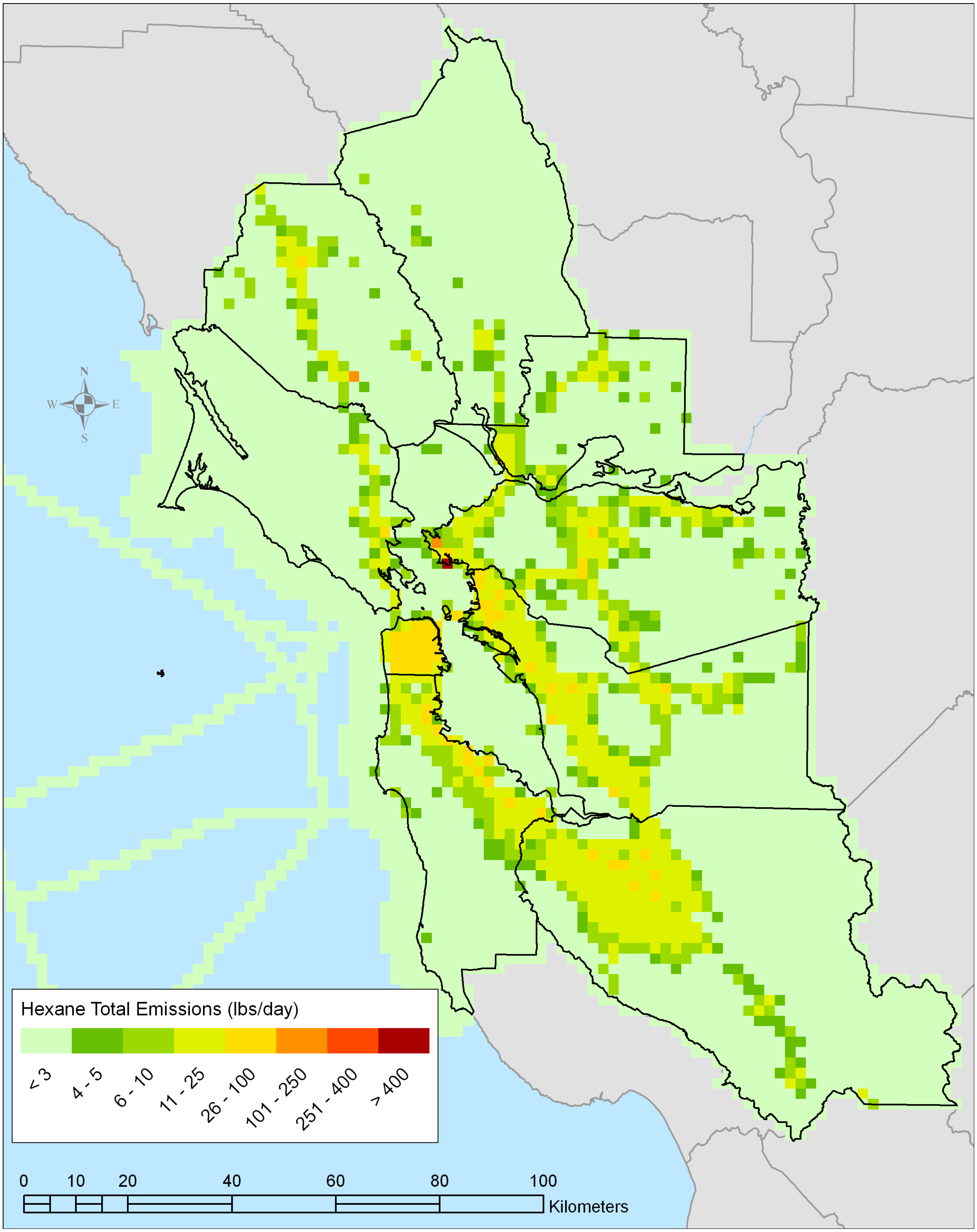

Figure 4-11. Emission density plot of hexane emissions.

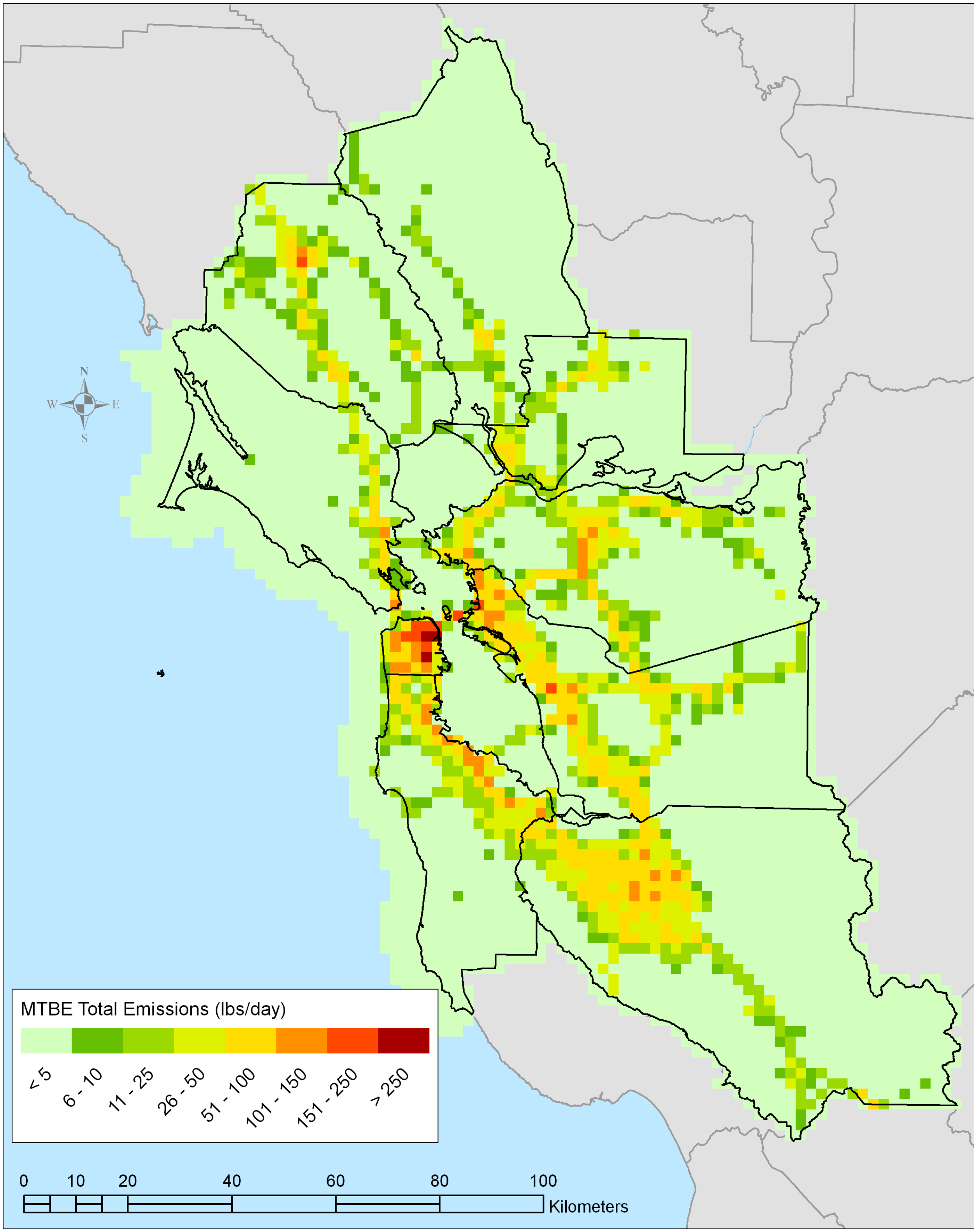

Figure 4-12. Emission density plot of MTBE emissions.

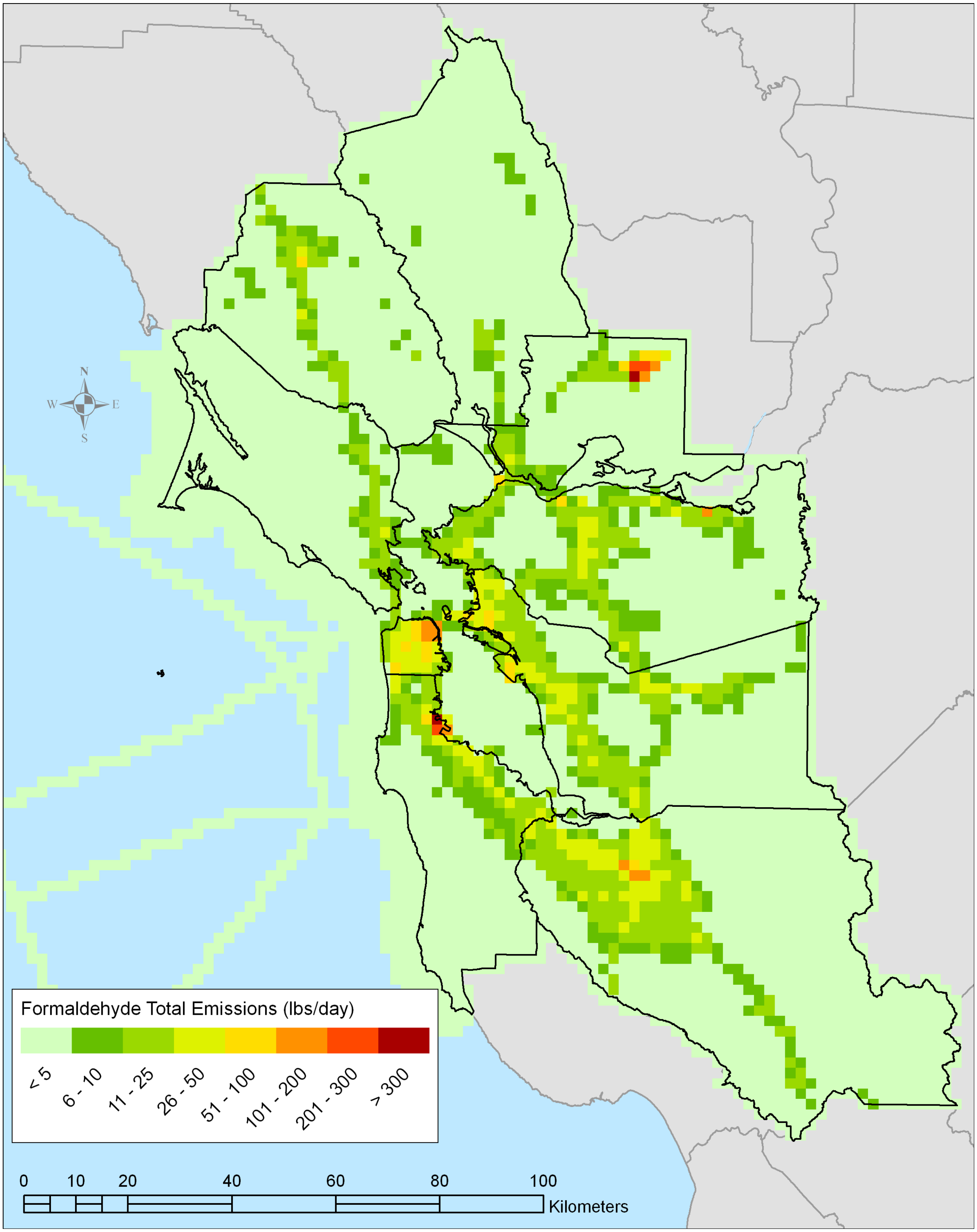

Figure 4-13. Emission density plot of formaldehyde emissions.

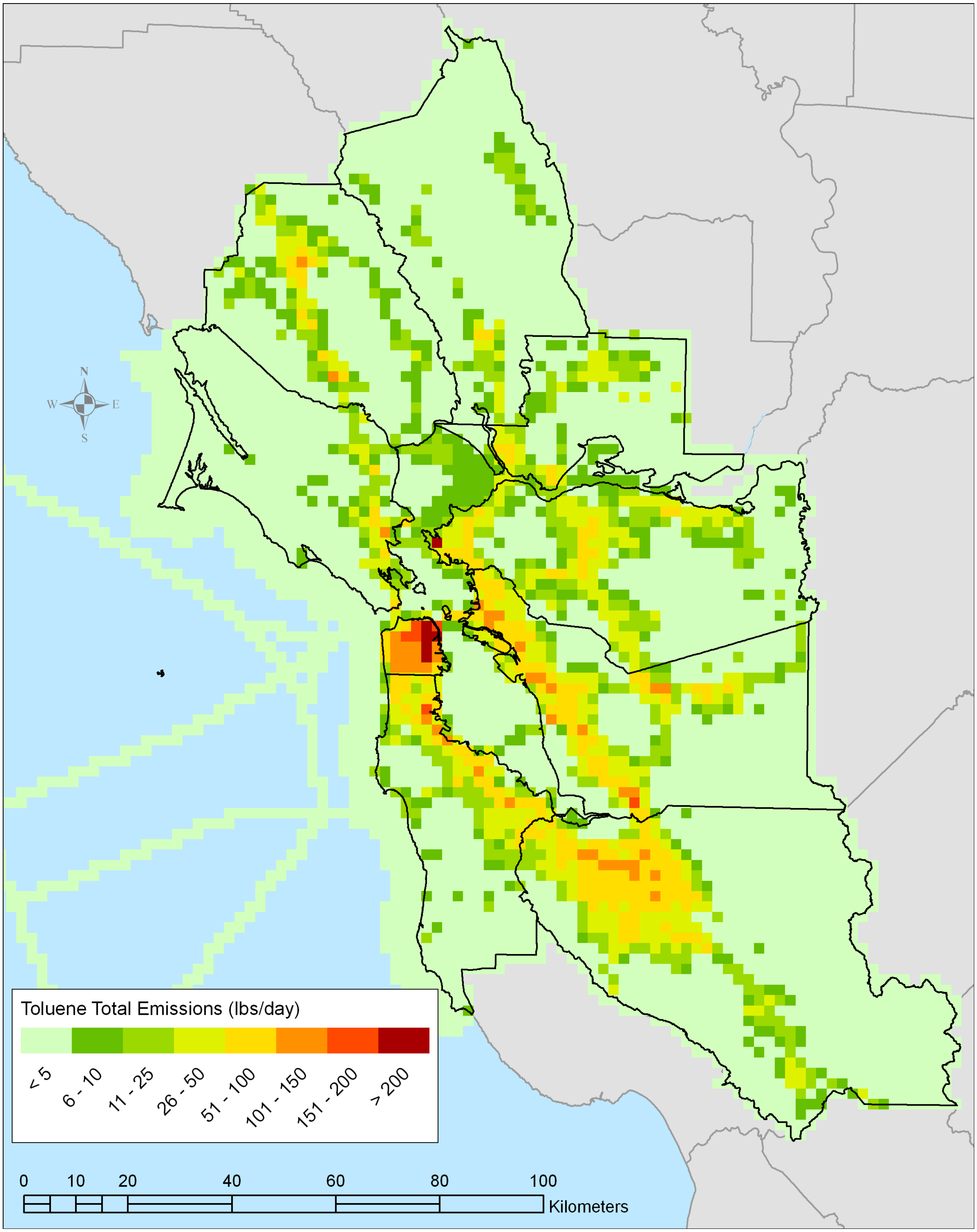

Figure 4-14. Emission density plot of toluene emissions.

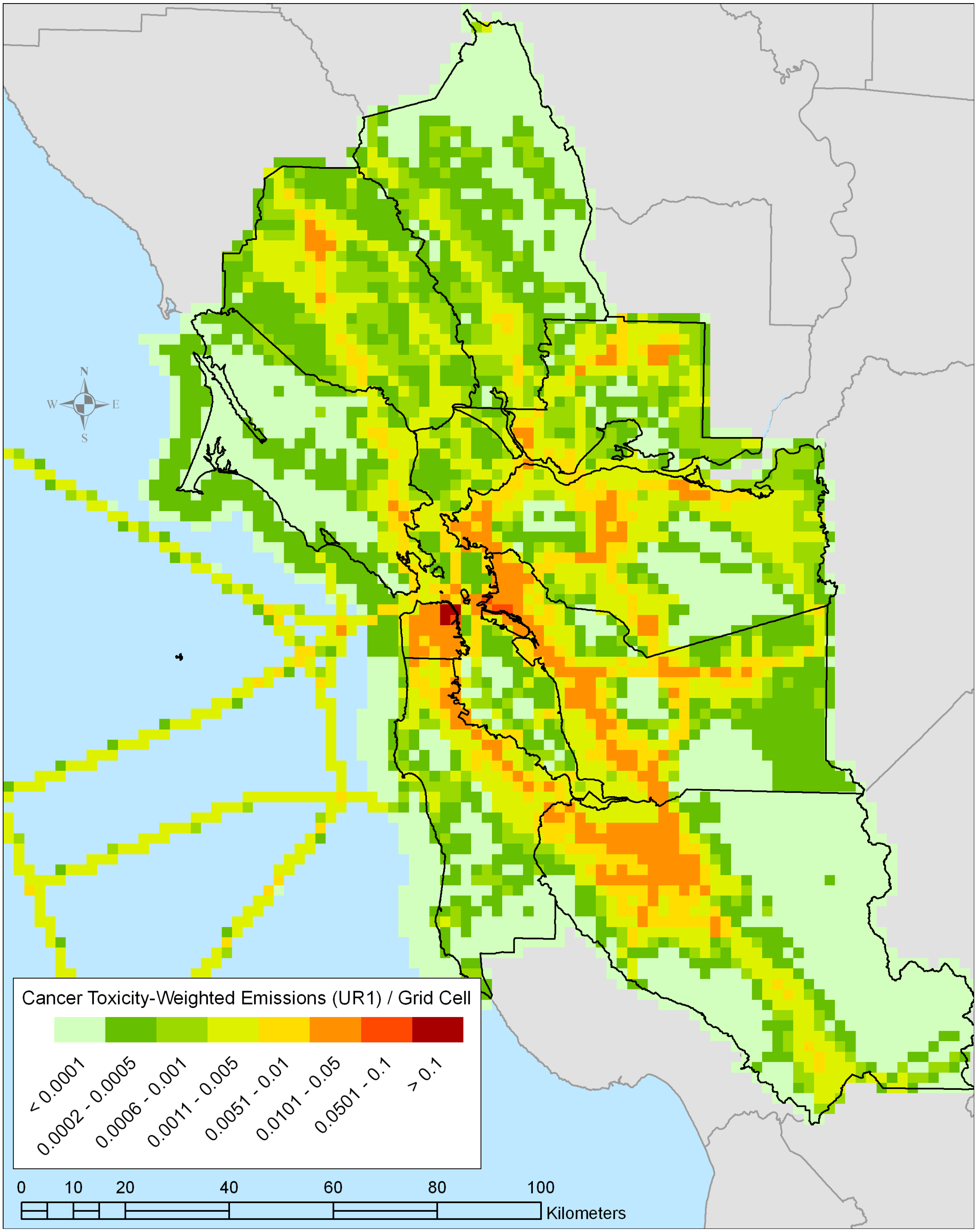

Figure 4-15. Emission density plot of cancer toxicity-weighted emissions.

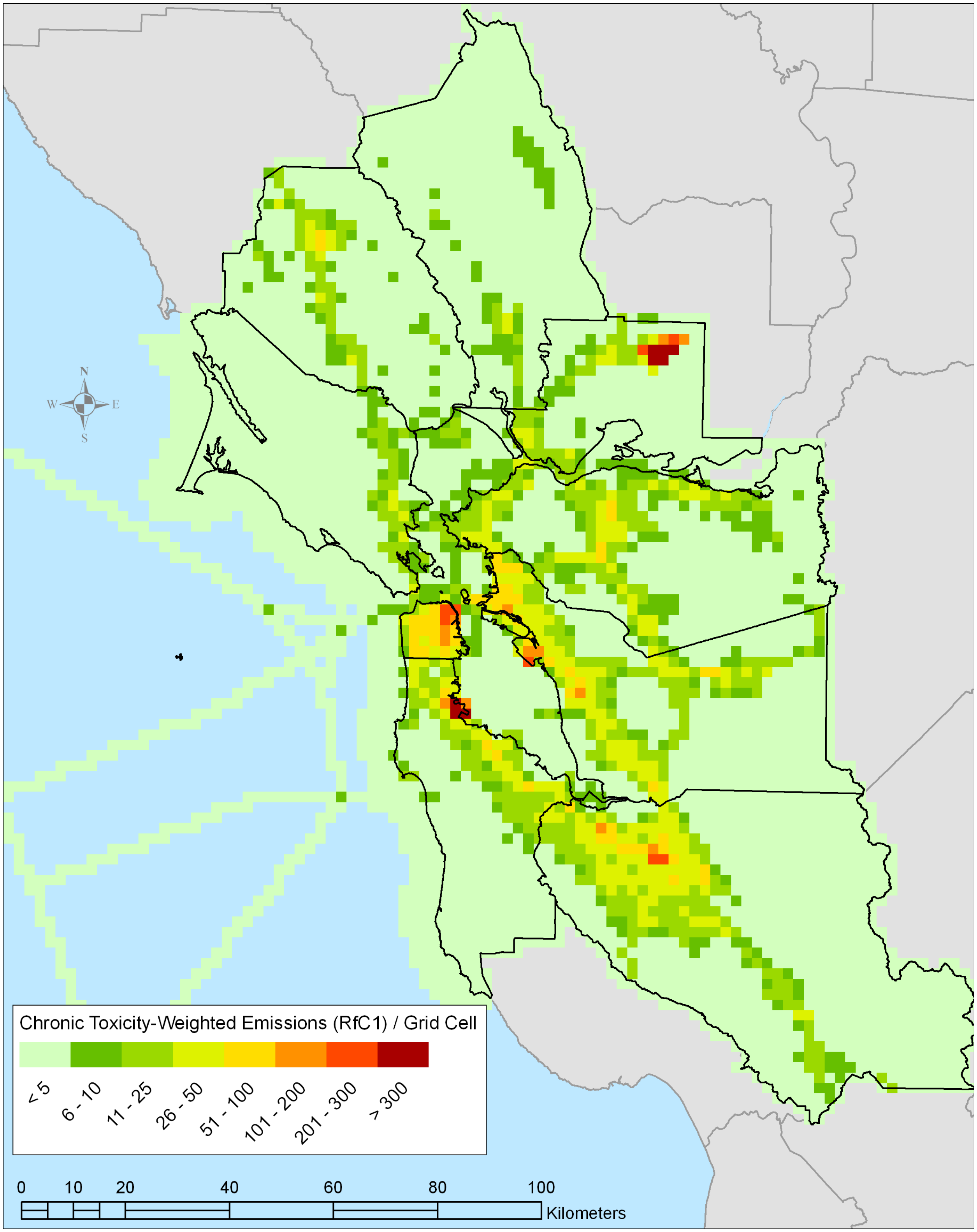

Figure 4-16. Emission density plot of chronic toxicity-weighted emissions.

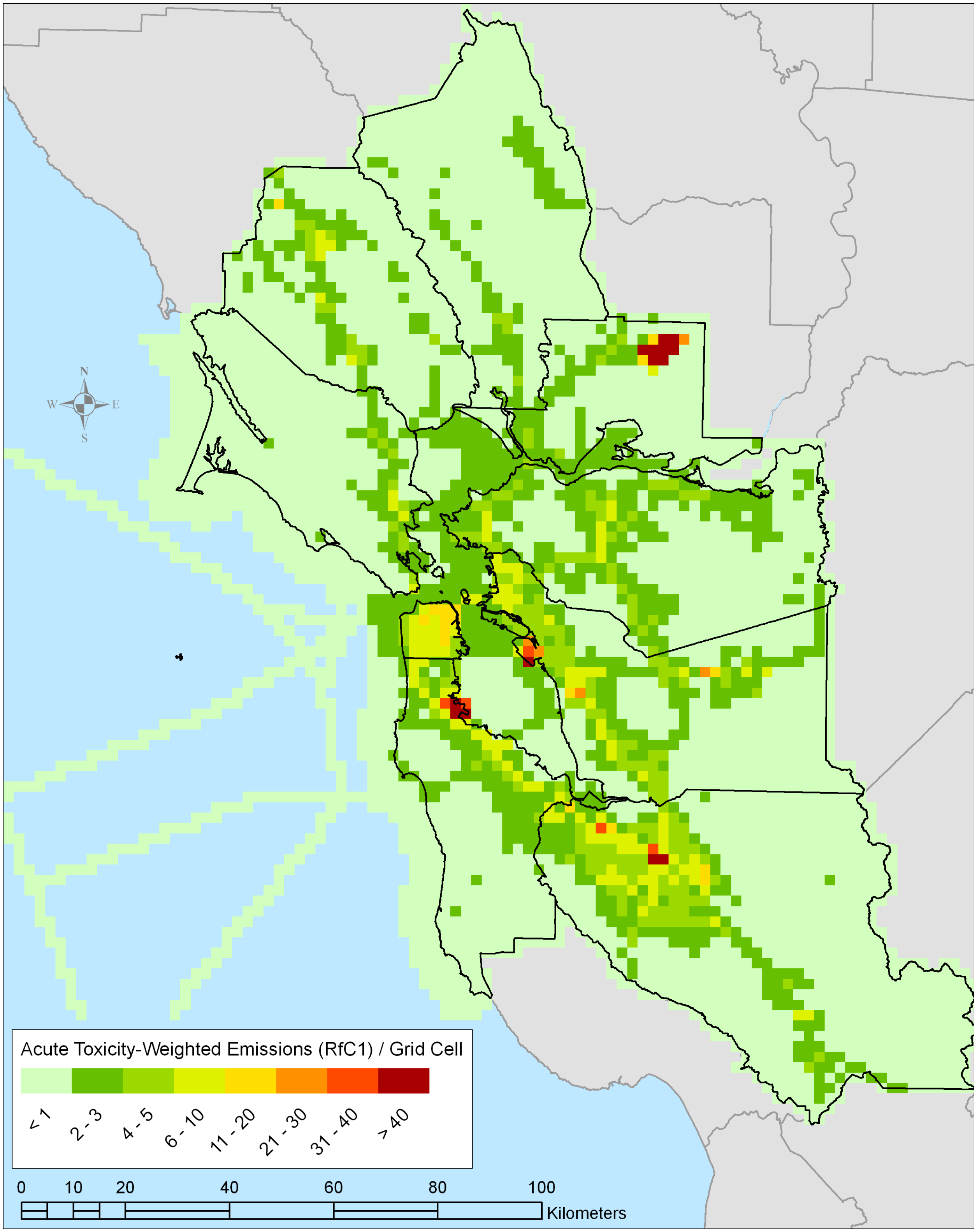

Figure 4-17. Emission density plot of acute toxicity-weighted emissions.

5. DEMOGRAPHIC AND HEALTH STATISTICS DATA

In addition to TAC emission inventory development, demographic and health statistics data were acquired and geographically distributed in an effort to identify the locations of at-risk or sensitive populations. Several demographic and health parameters were considered:

- Populations under 18 and over 64. Youthful and elderly populations are especially vulnerable to exposures to toxic pollutants. Exposures at early ages are more likely to lead eventually to cancer or other chronic effects than are exposures at later ages, and the elderly are more vulnerable than the average population to acute morbidity or mortality from exposures to toxic pollutants.
- Income less than 185% of federal poverty level. Co-analyses of the TAC emission inventories with indicators of economically disadvantaged populations may indicate areas in which environmental justice issues are a concern.
- Age-adjusted rates of asthma-related hospitalizations in children 14 years of age and below. Note that great caution should be used when interpreting hospital admissions data. Numerous confounding factors can interfere with the analyses, either masking true causal relationships or falsely highlighting arbitrary correlations.

Gridded population data were developed for the BAAQMD using census block-group levels of data from U.S. Census 2000 summary files. The block-group population data for each variable of interest were spatially allocated to the BAAQMD's 2-km × 2-km modeling grid using spatial allocation factors that were developed for individual grid cells by processing GIS-based census block-group data within a customized ArcGIS VBA program. Census block-group populations were then multiplied by the spatial allocation factors in order to acquire grid-level population values. The gridded population data are shown in **Figures 5-1 through 5-3**. These data show the population variations for each demographic variable.

In addition, the BAAQMD provided STI with age-adjusted asthma hospitalization rates by ZIP Code for children ages 0-14 obtained from the California Office of Statewide Health Planning and Development (OSHPD) (Community Action to Fight Asthma, 2004). STI spatially allocated these data to the BAAQMD's 2-km × 2-km modeling grid using the same ArcGIS program described above. **Figure 5-4** depicts the gridded, age-adjusted asthma hospitalization rates (note that not all ZIP Codes have corresponding data).

These demographic and health statistics data sets may be used to quickly identify communities of potential concern. In addition, the population data may be used as inputs for exposure-assessment modeling. However, it should again be noted that no attempt is being made to demonstrate a causative relationship between gridded TAC emissions data and the gridded asthma rates data shown in Figure 5-4.

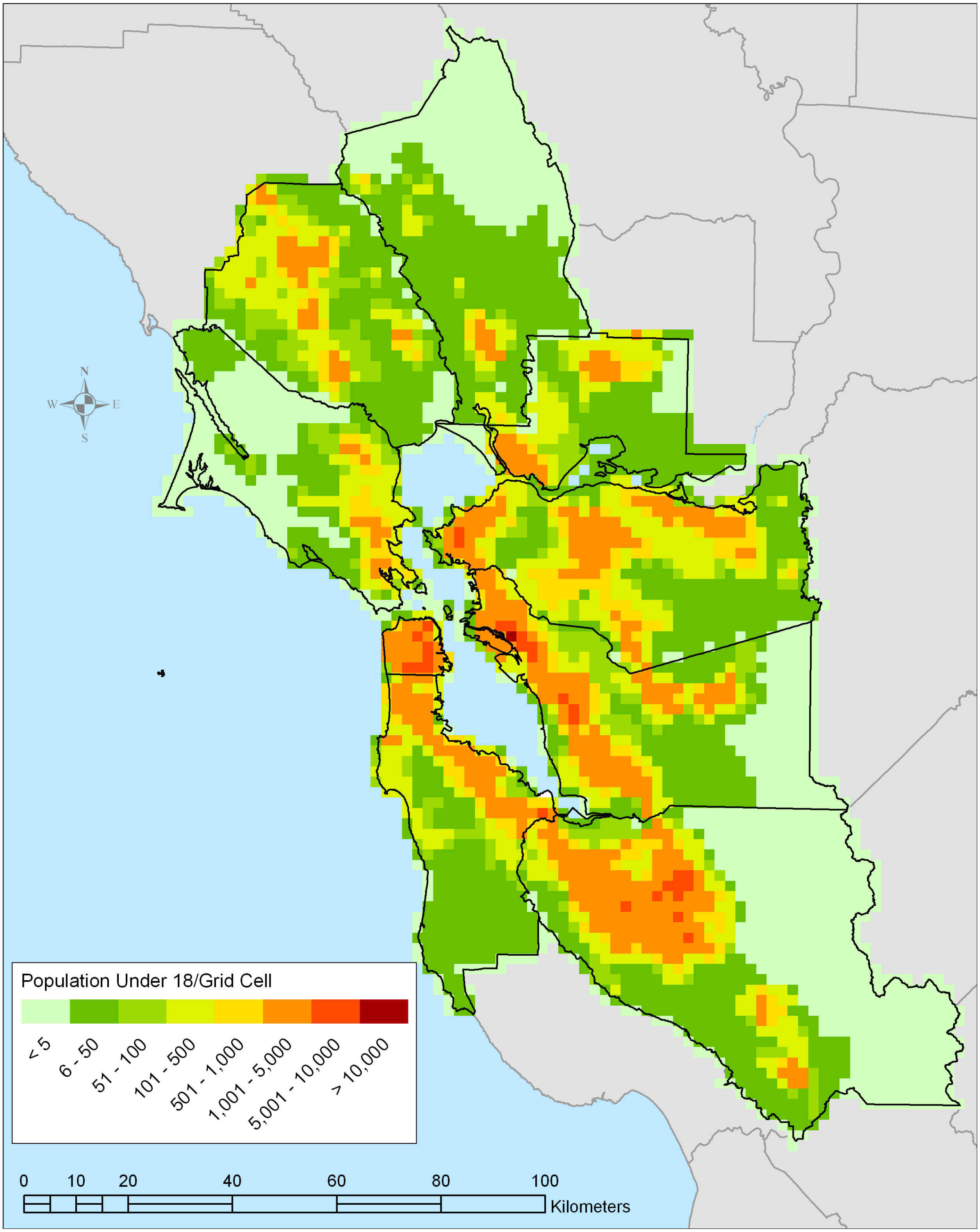

Figure 5-1. Population density of persons under age 18 in the BAAQMD.

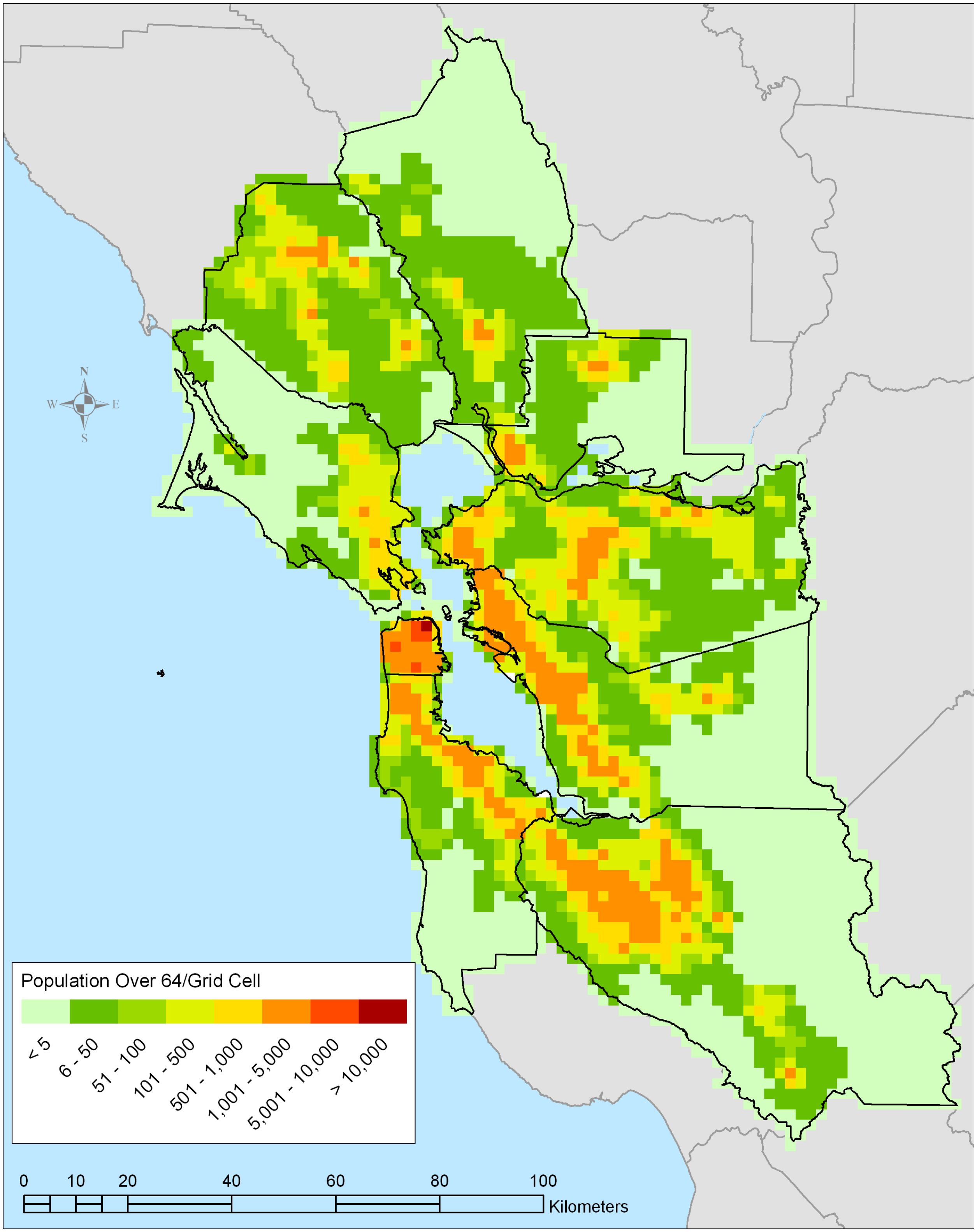

Figure 5-2. Population density of persons over age 64 in the BAAQMD.

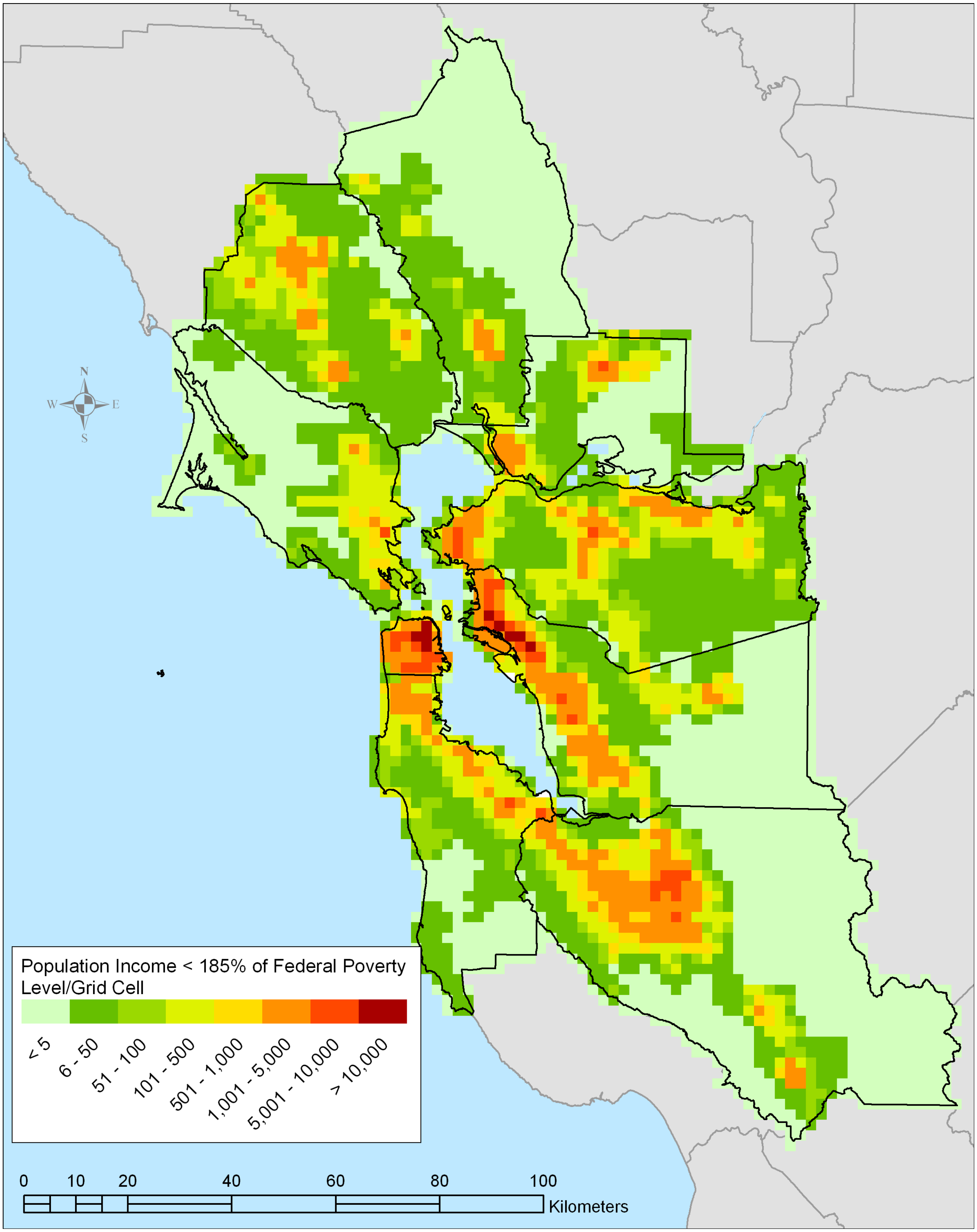

Figure 5-3. Population density of persons with a personal income of less than 185% of federal poverty level in the BAAQMD.

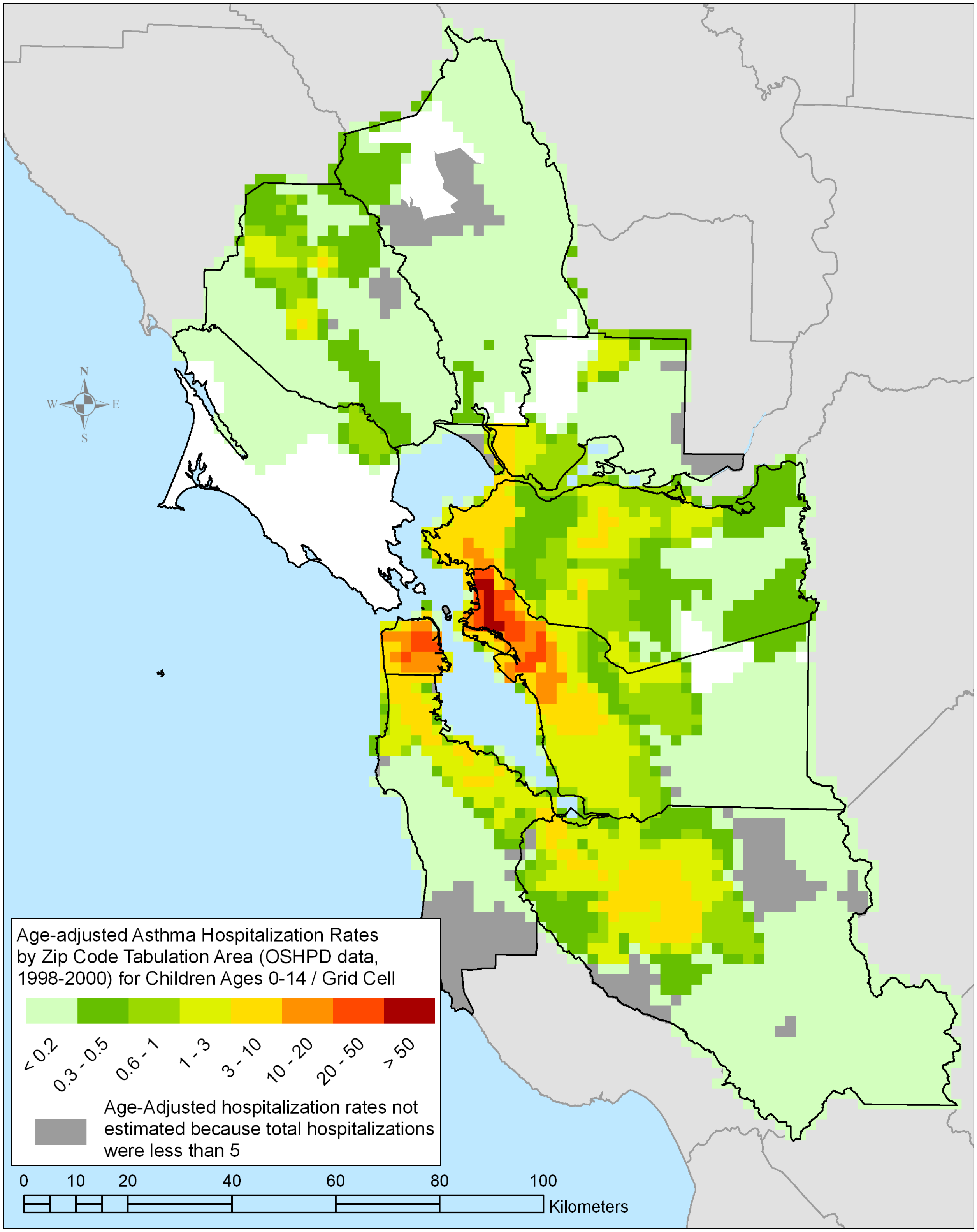

Figure 5-4. Asthma hospitalization rates for children age 14 and under in the BAAQMD.

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6. CONCLUSIONS AND RECOMMENDATIONS

The TAC inventories summarized in this document represent the first step of inventory development for the CARE program. These screening-level inventories are useful for prioritizing further inventory development activities, conducting preliminary exposure modeling runs, and selecting communities in the SFBA for further study. In addition, these inventories—in combination with demographic and health data—may be used to develop preliminary, screening-level targets for emission mitigation measures using grant and incentive funds. Although refinements to these inventories should be pursued, they represent the best available information to begin the process of targeting source types and locations for potential emission mitigation measures. This section characterizes general aspects of the TAC inventories and provides recommendations for continued inventory development.

The TAC inventories prepared to date should be treated as "working versions under development". They were prepared from readily available, pre-existing information sources—an approach that was both time- and cost-efficient. A more technically rigorous approach to inventory development—though requiring more effort and resources—is a "bottom-up" approach. Bottom-up inventory development involves gathering observations of emissions or supporting data directly from emissions sources. Examples of bottom-up methods include direct measurements of emissions at their sources; surveys of emissions-related activities by telephone, mail, or in person; or measurement of emissions-producing activities with monitoring devices, such as automated daily traffic counters or meters that measure fuel consumption.

The TAC inventories developed to date have a number of strengths, but also several potentially important weaknesses. Strengths of the inventories include

- use of the most up-to-date criteria pollutant inventories for area, non-road mobile source, and on-road mobile source emissions, inventories which incorporated the refinements described in Section 2 (such as corrections to the geographic distribution of heavy-duty truck emissions);
- TAC emissions for on-road mobile sources, which were estimated using EPA-recommended methods but were improved with California-specific chemical speciation data;
- TAC emissions for point sources that were directly reported, many of which are based on bottom-up approaches; and
- spatial allocations of emissions, which produced inventories that are accurate and spatially well-resolved relative to the resolution of the modeling grid (2 km × 2 km).

However, some TACs are likely omitted from the inventory because they are not components of TOG or PM_{10} (e.g., hydrofluoric acid) or because they are infrequently measured for chemical speciation profiles. Two examples of omitted TACs—quinoline (most often emitted by combustion sources) and hydrazine (most often released by certain industrial manufacturing processes)—are among the EPA's designated urban air toxics, a listing of 33 priority TACs (plus DPM and coke oven emissions), which are considered to pose significant health risks in urban areas of the United States. Others—which may or may not be important in the SFBA—include radionuclides (usually from natural sources and controlled medical or testing uses); titanium tetrachloride (from titanium metals manufacturing); and hydrochloric acid, hydrofluoric acid, and sulfuric acid (most often emitted by certain manufacturing processes and refining).

In addition, the chemical speciation profiles that were applied to estimate TAC emissions from pre-existing emission inventories of TOG and PM_{10} contain significant uncertainties. Due to the limitations of available chemical analysis techniques, some of the speciation profiles include large reported proportions of unknown or unidentified species—occasionally as much as 50% to 80% of the total mass—contributing to total TOG or PM emissions. Measurements of source-specific chemical speciation profiles are expensive; therefore, the number of measurements for each source category and TAC are fairly limited in number and may contain inaccuracies or large errors. We are particularly concerned about the large proportion of chromium attributed to the ARB's source profile for construction and demolition activities (as noted in Section 6.1). However, in general, these issues with speciation profiles are difficult and expensive to resolve and will likely take many years of gradual efforts to address.

Finally, there are uncertainties associated with the assumption that 5% of chromium compounds (unspecified), which are associated mostly with fugitive dust emissions, are emitted in their most highly toxic form: chromium VI (or hexavalent chromium). As described in Section 3, speciation profiles containing unspecified chromium were adjusted to reflect this assumption that 5% of the chromium fraction in each profile was made up of chromium VI. Because this assumption was based on ambient measurements taken during the 1980s, we recommend further research into the relative proportions of chromium (III) and chromium (IV) emitted in fugitive dust and other emission sources.

6.1 RECOMMENDATIONS FOR CONTINUING DEVELOPMENT OF THE TOXIC AIR CONTAMINANT EMISSION INVENTORIES

The following strategies are suggested to begin addressing some of the weaknesses in the TAC inventories:

- To the extent feasible, use bottom-up methods for emission inventory development beginning with the highest priority TACs and source types. Prioritize TACs that seem most likely to pose health risks in the SFBA for further emission inventory development. We suggest prioritizing TACs that are listed among the EPA's designated urban air toxics or that appear prominently in Figures 4-1, 4-3, and 4-5. Identify source categories likely to emit prioritized TACs, such as those shown in Figures 4-2, 4-4, and 4-6 or identified in EPA guidance documents (U.S. Environmental Protection Agency, 2005; 1998, Appendix I).
- Use readily available (or, if possible, bottom-up methods) to estimate emissions of TACs that are currently omitted from the inventories: quinoline, hydrazine, radionuclides, titanium tetrachloride, hydrochloric acid, hydrofluoric acid, and sulfuric acid.
- Complete the correction of the coordinates of point sources that were located according to ZIP Code centroids. Of the 137 facilities so located, 24 were included in BAAQMD's

review of spatial information for the most significant point sources (see Section 2.3). A list of remaining point sources located by ZIP Code centroids is provided in Appendix C.

- Use the ARB database of TAC emissions reported for its AB 2588 Air Toxics Hot Spots Program (California Air Resources Board, 2001b) as a means of checking the BAAQMD point source inventory for completeness and accuracy. In a few cases, 1996 emissions reported in the AB 2588 database of point sources in the SFBA greatly exceeded year-2000 emissions included in the BAAQMD's TAC inventory of point sources. These differences may accurately represent reduced levels of TAC emissions; however, it may be worthwhile to verify this information. The AB 2588 database reported 972 tons per year (tpy) of methylene chloride emitted from point sources in the SFBA (compared to 59 tpy reported in the BAAQMD inventory); 5 tpy of manganese (compared to 0.6 tpy); and 110 pounds per year of beryllium (compared to 1 pound per year).
- Investigate the chromium content of ARB's recommended PM_{10} speciation profiles, particularly the profile assigned to construction and demolition dust. Chromium VI is a recognized compound of concern in Portland cement (Klemm, 1994); however, the actual chromium content of construction and demolition dust SFBA counties is unknown. Further research is warranted into the relative proportions of chromium (III) and chromium (IV) emitted in construction and demolition dust and other emission sources.
- Investigate the spatial distribution of emissions from construction activities. Construction dust and construction equipment appear to be significant sources of cancer toxicity-weighted emissions and chronic risk-weighted emissions, but the locations of these emission sources are likely to change with time as construction projects are completed and new projects begin.
- Investigate the assumption that all PM emissions from residual-fueled ships should be classified as DPM, a toxic air contaminant. While this assumption appears reasonable and in keeping with previous ARB studies, further discussions with ship emissions experts may be warranted.

6.2 RECOMMENDATIONS FOR REVIEWING THE CRITERIA POLLUTANT INVENTORIES

The BAAQMD's TOG and PM_{10} emission inventories, which were the basis of the TAC inventories, previously underwent a thorough quality assurance and quality control (QA/QC) review to support of the goals and objectives of the CCOS.[5] In addition, the inventory files received from the BAAQMD were given a cursory QA/QC review prior to the development of the BAAQMD's TAC inventories. A few unusual features were noted and corrected, including a small "hot spot" (about 5 grid cells) of emissions from on-road mobile sources located along a rural stretch of Highway 152 east of Gilroy and north of Hollister. Other features of the inventories might warrant investigation:

- Emissions from on-road mobile sources along Highway 1 in San Mateo County appear to be located approximately 2 km too far west (over Pacific waters).

[5] More information about the CCOS is available at <http://www.arb.ca.gov/airways/ccaqs.htm>.

- We considered whether emissions estimated for ships and commercial boats might be too low for an area with active ports. We verified the reasonableness of the emissions by comparing the BAAQMD's emission inventories to three other inventories—those for Baton Rouge, Louisiana; Houston-Galveston, Texas; and Los Angeles, California. These three port cities were selected for the comparison because we are familiar with the underpinnings of their inventories and are highly confident about the validity of the estimated emissions for commercial marine vessels. In these three cities, commercial marine vessels were estimated to emit 10% to 24% of total $PM_{2.5}$ from all non-road mobile sources: 24% in Baton Rouge, Louisiana; 10% in Houston-Galveston, Texas; and 16% in the Los Angeles area (Reid et al., 2004; California Air Resources Board, 2001a). The BAAQMD's inventory attributes 22% of total non-road $PM_{2.5}$ emissions to commercial marine vessels, which is within the range of values estimated for the other cities.

7. REFERENCES

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APPENDIX A

BAAQMD MODELING GRID DEFINITION

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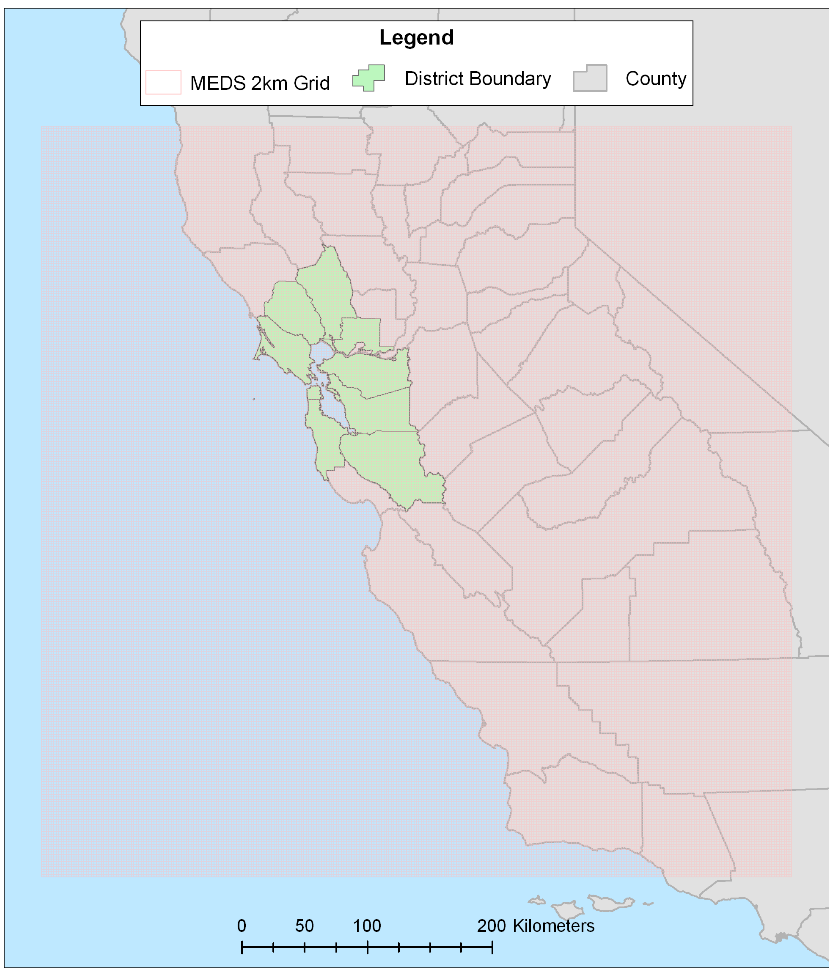
BAAQMD Modeling Grid Definition

Projection:	Lambert Conformal Conic
Central meridian:	-120.5
Standard parallel 1:	30.0
Standard parallel 2:	60.0
Latitude of origin:	37.0
Linear unit:	Meter
Datum:	Clarke 1866

Lower Left Corner (origin): Y = -385131.6m, X= -302910.3m
Grid cell size: 2km x 2km
Number of grid cells: 90,000 (300 grid cells x 300 grid cells)



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APPENDIX B

SPECIATION OF TOG AND PM EMISSIONS FROM AREA AND NON-ROAD SOURCES AND FROM ON-ROAD MOBILE SOURCES

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SPECIATION OF EMISSIONS FROM AREA AND NON-ROAD MOBILE SOURCES

The Bay Area Air Quality Management District (BAAQMD) provided STI with year-2000 county-level emission inventories of TOG and PM_{10} for area and non-road mobile sources. These inventories contain annual average emissions (tons/day) by emission inventory code (EIC). To prepare inventories of toxic air contaminants (TACs), STI assigned speciation profiles to each EIC code. Thus, TOG and PM_{10} emissions were transformed into individual chemical species which allowed specific TACs to be identified. In addition, STI prepared estimates of $PM_{2.5}$ emissions for speciation. (We anticipate that the BAAQMD will model dispersion and deposition of airborne $PM_{2.5}$ differently from that of PM_{10}.)

The California Air Resources Board (ARB) maintains TOG and PM speciation profiles and a cross-reference table, which indicates which TOG or PM profile should be assigned to each EIC code. ARB also provides PM_{10} and $PM_{2.5}$ size fractions for each PM profile. These ARB datasets were the starting points for estimating $PM_{2.5}$ emissions (based on the BAAQMD's PM_{10} inventory and $PM_{2.5}$:PM_{10} ratios) and for speciating the BAAQMD's TOG, PM_{10}, and resultant $PM_{2.5}$ inventories. In most cases, we considered the ARB's recommended speciation profile-to-EIC assignments to be appropriate for use. However, in some cases, ARB did not provide a recommended speciation profile (or composite profile). For these cases, we identified appropriate speciation profiles available from the Desert Research Institute (DRI) or listed in the EPA's Speciate 3.2 database.

Table B-1 lists the EIC codes and speciation profiles for which alternative DRI or EPA profiles were used. In addition, the accompanying Microsoft Excel file contains tables of available speciation profile-to-EIC assignments, complete listings of the TOG and PM profiles recommended for use, and ARB's $PM_{2.5}$-to-PM_{10} size ratios.

Table B-1. Non-ARB speciation profiles selected for use in speciating the BAAQMD inventories.

EIC Code	EIC Description	Profile	Source	Profile Name
TOG Speciation Profiles				
66065602000000	Structural Fires	0307	EPA	Miscellaneous Burning - Forest Fires
66065802000000	Automobile Fires	0307	EPA	Miscellaneous Burning - Forest Fires
84086411000021	Recreational Boats - 2-Stroke Evaporative	1204	EPA	Light-Duty Gasoline Vehicles - Evaporative
84086411000041	Recreational Boats - 4-Stroke Evaporative	1204	EPA	Light-Duty Gasoline Vehicles - Evaporative
86088311000021	Lawn & Garden Equipment - 2-Stroke Evaporative	1305	EPA	Industry Average (circa 1990) Gasoline Composite (Hot Soak + Diurnal) Evaporative
86088311000041	Lawn & Garden Equipment - 4-Stroke Evaporative	1305	EPA	Industry Average (circa 1990) Gasoline Composite (Hot Soak + Diurnal) Evaporative
86088411000041	Transportation Refrigeration Unit - 4-Stroke Evaporative	1305	EPA	Industry Average (circa 1990) Gasoline Composite (Hot Soak + Diurnal) Evaporative
86088511000021	Light Commercial Equipment - 2-Stroke Evaporative	1305	EPA	Industry Average (circa 1990) Gasoline Composite (Hot Soak + Diurnal) Evaporative
86088511000041	Light Commercial Equipment - 4-Stroke Evaporative	1305	EPA	Industry Average (circa 1990) Gasoline Composite (Hot Soak + Diurnal) Evaporative
86088611000021	Industrial Equipment - 2-Stroke Evaporative	1305	EPA	Industry Average (circa 1990) Gasoline Composite (Hot Soak + Diurnal) Evaporative
86088611000041	Industrial Equipment - 4-Stroke Evaporative	1305	EPA	Industry Average (circa 1990) Gasoline Composite (Hot Soak + Diurnal) Evaporative
86088711000021	Construction & Mining Equipment - 2-Stroke Evaporative	1305	EPA	Industry Average (circa 1990) Gasoline Composite (Hot Soak + Diurnal) Evaporative
86088711000041	Construction & Mining Equipment - 4-Stroke Evaporative	1305	EPA	Industry Average (circa 1990) Gasoline Composite (Hot Soak + Diurnal) Evaporative
87089311000041	Agricultural Equipment - 4-Stroke Evaporative	1305	EPA	Industry Average (circa 1990) Gasoline Composite (Hot Soak + Diurnal) Evaporative
89089511000041	Fuel Storage and Handling - Gasoline Can Evaporative	1305	EPA	Industry Average (circa 1990) Gasoline Composite (Hot Soak + Diurnal) Evaporative
PM Speciation Profiles				
62061802620000	Livestock Waste	DRI1	DRI	DRI Bay Area Soil Speciation
62061802620001	Livestock Husbandry - Dairy Cattle	DRI1	DRI	DRI Bay Area Soil Speciation
62061802620002	Livestock Husbandry - Ranch Cattle	DRI1	DRI	DRI Bay Area Soil Speciation
69068460000000	Cooking (Unspecified)	16000	EPA	Meat Cooking - Charbroiling

SPECIATION OF TOG AND PM EMISSIONS FROM ON-ROAD MOBILE SOURCES

BAAQMD provided STI with gridded on-road mobile source inventories of TOG and PM_{10} emissions in Modeling Emissions Data System (MEDS) format. MEDS files were provided for both a July weekday and a January weekday in 2000, and the emissions from these inventories were averaged by grid cell to produce an annualized on-road emissions inventory.

The on-road emission estimates provided by BAAQMD were based on emission factors generated with ARB's EMFAC model, and BAAQMD also provided STI with an input file listing the key settings and input options used to run the EMFAC model. EMFAC, unlike the EPA's MOBILE6 model, does not generate toxic emission factors; therefore, to prepare inventories of toxic air contaminants (TACs), STI assigned speciation profiles to each source category contained in the BAAQMD on-road emissions inventory. Thus, TOG and PM_{10} emissions were transformed into individual chemical species so that specific TACs could be identified. In addition, STI prepared estimates of $PM_{2.5}$ for speciation, anticipating that BAAQMD will model dispersion and deposition of airborne $PM_{2.5}$ differently from that of PM_{10}.

The ARB maintains TOG and PM speciation profiles, as well as PM_{10} and $PM_{2.5}$ size fractions for each PM profile. The ARB has also assembled a cross-reference table that indicates which TOG or PM profile should be assigned to a given Emission Inventory Code (EIC). However, the BAAQMD MEDS inventory lists emissions by a source category code (SCC) numbered from 1 to 12 rather than by EIC. Therefore, STI assigned the most appropriate ARB profile to each SCC code, and these assignments are shown in **Table B-2**.

In addition, STI ran the EPA's MOBILE6 model using input parameters derived from the EMFAC runs done by BAAQMD. Toxic speciation profiles for the six toxic pollutants covered by MOBILE6 (benzene, 1,3-butadiene, formaldehyde, acetaldehyde, acrolein, and MTBE) were derived from model outputs, and TOG fractions for these TACs were compared to TOG fractions listed in corresponding ARB profiles. **Table B-3** shows the results of this comparison, and one can see that the ARB profiles generally predict higher TOG fractions for the six TACs in MOBILE6, with differences being especially pronounced for MTBE (this is likely because of California fuels characteristics being poorly modeled by MOBILE6, a national model).

To adopt a conservative approach, STI decided to use ARB profiles and size fractions for all on-road mobile source speciation. An accompanying Microsoft Excel file contains listings of the TOG and PM profiles recommended for use in speciating the on-road inventory (see Table B-2), as well as ARB's $PM_{2.5}$-to-PM_{10} size ratios.

Table B-2. PM and TOG speciation profile assignments by SCC code.

SCC[a]	Description	Profile	Source	Profile Name
1a	Exhaust Particulate Emissions	425	ARB	Diesel Vehicle Exhaust
1b	Tire Wear Particulate Emissions	472	ARB	Tire Wear
1c	Brake Wear Particulate Emissions	473	ARB	Brake Wear
2	Catalyst Start Exhaust	877	ARB	Gasoline - catalyst - FTP Bag 1-3 STARTS - ARB IUS summer 1996
3	Catalyst Running Exhaust	438	ARB	Gasoline - catalyst - stabilized exhaust - ARB IUS summer 1999
4	Non-catalyst Start Exhaust	402	ARB	Gasoline - non-cat - FTP bag1-3 STARTS - ARB IUS summer 1996
5	Non-catalyst Running Exhaust	401	ARB	Gasoline - non-cat - stabilized exhaust - ARB IUS summer 1996
6	Hot Soak	422	ARB	CBG - hot soak - ARB IUS 1999-2000 - LDV
7	Diurnal Evaporatives	906	ARB	Gasoline - diurnal & resting evaporatives - UCBerk - headspace vapors
8	Diesel Exhaust	818	ARB	Farm equipment - diesel - light and heavy
9	Running Evaporatives	906	ARB	Gasoline - diurnal & resting evaporatives - UCBerk - headspace vapors
10	Resting Evaporatives	906	ARB	Gasoline - diurnal & resting evaporatives - UCBerk - headspace vapors
11	Multi-Day Resting	906	ARB	Gasoline - diurnal & resting evaporatives - UCBerk - headspace vapors
12	Multi-Day Diurnal	906	ARB	Gasoline - diurnal & resting evaporatives - UCBerk - headspace vapors

[a] In the BAAQMD MEDS inventory, only TOG emissions are reported in SCC2-SCC12.

Table B-3. ARB TOG speciation profiles with compared with profiles derived from MOBILE6 outputs.

CAS	CHEMICAL NAME	TOG Percentage									
		Exhaust					Hot Soak		Evaporative		
		ARB 401	ARB 402	ARB 438	ARB 877	M6 Exhaust	ARB 422	M6 Hot Soak	ARB 906	M6 Diurnal	M6 Resting
100414	ETHYLBENZENE	1.50	1.39	1.09	1.54		0.53		0.11		
100425	STYRENE	0.13	0.14	0.13	0.25		0.02				
106423	P-XYLENE								0.10		
106990	1,3-BUTADIENE	0.83	0.78	0.56	0.70	0.53	0.01				
107028	ACROLEIN (2-PROPENAL)	0.18	0.13	0.14	0.11	0.08					
108383	M & P-XYLENE	8.90	9.50	7.41	10.34		4.02		0.64		
108883	TOLUENE	6.79	7.37	5.99	7.25		3.42		1.59		
110543	N-HEXANE	1.31	1.69	1.61	1.74		1.42		1.44		
123386	PROPIONALDEHYDE	0.13	0.07	0.04	0.06						
1634044	METHYL T-BUTYL ETHER (MTBE)	1.86	3.80	1.97	3.02	0.36	12.66	3.85	16.83	3.24	3.23
50000	FORMALDEHYDE	3.12	1.46	1.73	1.31	1.92					
540841	2,2,4-TRIMETHYLPENTANE	1.99	1.58	1.75	1.92		1.07		1.21		
67561	METHANOL	1.40	1.68	0.83	2.46		0.79				
71432	BENZENE	3.44	2.75	2.68	2.47	3.52	0.84	0.43	0.36	0.40	0.40
75070	ACETALDEHYDE	0.75	0.35	0.25	0.40	0.65					
78933	METHYL ETHYL KETONE (MEK) (2-BUTANONE)	0.06	0.10	0.02	0.06						
91203	NAPHTHALENE	0.13	0.02	0.05	0.07		0.00				
95476	O-XYLENE	1.55	1.62	1.29	1.78		0.66		0.12		
98828	(1-METHYLETHYL) BENZENE	0.10	0.06	0.02	0.12		0.04		0.02		

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APPENDIX C

SPATIAL ALLOCATION OF EMISSIONS FROM AREA AND NON-ROAD MOBILE SOURCES

County-level emissions were geographically distributed to the spatial resolution of the BAAQMD modeling domain (2 km x 2 km). Because the exact locations of emissions sources are unknown at this spatial scale, GIS databases with suitable spatial resolutions were used as surrogates to represent the locations of related emissions sources. County-level emissions were allocated to individual grid cells proportionally according to the spatial patterns of the surrogate GIS data.

APPROACH

Allocation factors were developed for individual grid cells by acquiring GIS data and processing them within a customized ArcGIS Visual Basic (VBA) program that outputs allocation factors by grid cell to Microsoft Access database tables. Four basic types of spatial allocation calculations were used to develop the spatial surrogates.

1. Total Area—Calculate the fraction of total area that falls within a grid cell (e.g., industrial land use).
2. Line Length—Calculate the fraction of total line length that falls within the grid cell.
3. Line Density—Calculate the fraction of total line density that falls within the grid cell.
4. Point Count—Calculate the fraction of total point locations that falls within the grid cell.

DATA SOURCES

A variety of data sets, listed below, were acquired and used to prepare the surrogate fractions:

- Land Use—The majority of the BAAQMD surrogate development relied on Existing Land Use–2000 data set developed by the Association of Bay Area Governments (ABAG). The Existing Land Use–2000 data set incorporates the U.S. Geological Survey National Land Cover Dataset (NLCD) and county assessors' information. Land use categories are broken down into four levels of numerical subdivisions, which are used to denote the levels of detail in the map data. The categories used by ABAG are described in Existing Land Use–2000 documentation. The individual surrogates were created by determining the fractions of total area of selected land use categories that fell within individual grid cells.
- Land Cover—A satellite-derived land cover database for northern California was acquired from the NLCD in a Geo-TIFF format. Each pixel of the 30-m resolution NLCD was assigned one of the 38 land cover classes. These data were created in the early 1990s and are the most complete land cover data set readily available (U.S. Geological Survey, 2001).
- InfoUSA Business Locations—For a handful of activities (e.g., marine shops, car dealerships, carwash centers, etc.), surrogates were developed using business addresses purchased from InfoUSA (InfoUSA, 2005). Addresses were acquired for businesses within the BAAQMD domain. The addresses were geocoded and assigned to grid cells in the domain. The spatial surrogate data were created by determining the fractions of total businesses that fell within individual grid cells.
- U.S. Electronic Yellow Pages (*ProCD Select Phone*) Business Locations—For a handful of activities, surrogates were used from the Central California Ozone Study (CCOS) gridded surrogates project (Funk et al., 2001). Business addresses for such categories as auto body shops, dry cleaners, restaurants, gas stations, and wineries were acquired from the U.S. Electronic Yellow Pages. The addresses were then geocoded and assigned to grid cells in the domain. The surrogates were created by determining the fractions of

total businesses that fell within individual grid cells or combined with other surrogate types.

- Railroads—Year-2002 railroad tracks were acquired from the U.S. Bureau of Transportation Statistics in Shapefile format. Tracks are represented as linear segments. The data include terminal and rail yard lines in addition to mainline tracks. The proportions of total track length within individual grid cells were used to develop surrogates for rail-related activities.
- Oil and Gas Wells—Onshore and offshore oil and gas well locations were gathered as part of the CCOS gridded surrogates project (Funk et al., 2001). For all areas of California, including the Bay Area, abandoned wells were filtered out and all other well sites—active, completed, idle, directional, etc.—were retained. The oil and gas wells within the BAAQMD domain were queried out of the CCOS gridded surrogate database and assigned to BAAQMD grid cells.
- Landfills—Geographic coordinates of landfill locations were gathered from the Integrated Waste Management Board as part of the CCOS gridded surrogates project (Funk et al., 2001). Only sites flagged as active by the data provider were included. Landfills within the BAAQMD domain were queried out of the CCOS gridded surrogate database and assigned to BAAQMD grid cells.
- Sand and Gravel Mines—Geographic coordinates of sand and gravel mines were gathered as part of the CCOS gridded surrogates project from the National Atlas database (Funk et al., 2001). The sand and gravel mines within the BAAQMD domain were queried out of the CCOS gridded surrogate database and assigned to BAAQMD grid cells.
- Road Activity—The TeleAtlas MultiNet road network was used to create line-density surrogates for some highway and traffic-related emission sources. Because traffic count information was not provided, line density surrogates were developed based on the functional class definition (FRC code). Thus, a major freeway (FRC code = 0) has a higher weighting scheme than a local road (FRC code = 6).
- Recreational Water—Water body polygons were derived from the 2000 Census data for the entire state as part of the CCOS gridded surrogates project (Funk et al., 2001). The water body file was edited in order to eliminate dry lakes and to retain lakes and rivers with boat marinas based on information published by the California Water Resources Agency, Department of Boating and Waterways. The water bodies within the BAAQMD domain were queried out of the CCOS gridded surrogate database and assigned to BAAQMD grid cells.
- Shipping Lanes—Year-2000 shipping lanes were acquired from the U.S. Bureau of Transportation Statistics in Shapefile format. Shipping lanes are represented as linear segments. The data include shipping lanes both within the San Francisco Bay and the coastal region beyond the nine Bay Area counties. The proportions of total shipping lane length within individual grid cells were used to develop surrogates for shipping-related activities.

SPECIAL CASES

Computed surrogates were developed for construction activities. Because construction activities are transient (they do not take place in a fixed location), developing spatial allocation factors for these sources was more challenging. Cities tend to expand outward, and new building construction usually occurs in the suburban and rural regions surrounding the central business district, though some fill-in development does occur, as well as maintenance and remodeling on existing structures. As part of the CCOS gridded surrogates project (Funk et al., 2001), an approach to compute spatial surrogates for construction emission was developed. The resulting computed surrogates were applied to the BAAQMD domain.

Spatial allocation factors for building construction activities (both residential and non-residential) were computed by taking the difference in each grid cell for retail, non-retail, and housing data between a past year and a future year (e.g., 1995 and 2000, respectively) to obtain the differences between past-year and future-year number of units. This calculation was used to determine where new construction activity was likely to occur. In addition to determining where new construction occurred, repair and maintenance of existing structures was also considered.

According to the U.S. Census Bureau's 1997 Economic Census Construction Report (U.S. Census Bureau, 2000), approximately 30% of total residential construction expenditures in the State of California are attributed to repair and maintenance of existing residences. Because new construction activity tends to be more equipment-intensive and, consequently, produces more emissions, areas where new construction occurred (based on the difference calculation) were weighted more heavily than areas where maintenance and repair occurred. Equation C-1 shows an example calculation.

Computed Surrogate for Residential Construction between years A and B:

$$S_{rc(x)} = (TH_{A(x)} \times 0.30) + (TH_{B(x)} - TH_{A(x)}) \qquad \textbf{(C-1)}$$

where:

$S_{rc(x)}$ = residential construction surrogate for grid cell "x"
$TH_{A(x)}$ = total housing value in year A for grid cell "x"
$TH_{B(x)}$ = total housing value in year B for grid cell "x"
0.30 = percentage of total statewide residential construction expenditure spent on repair and maintenance

Table C-1 depicts the spatial surrogates used to allocate area and non-road mobile sources for the BAAQMD domain. In order to assign a geographical location and a grid cell identifier to individual point sources, facility addresses reported in the BAAQMD's point source inventory were geocoded. Each point source in the BAAQMD's inventory file was assigned a geographic location and a geocode match type field. A match type of "1" is the best match type possible, where the geographic location is accurate to an exact house number within a single side of a single street block. A match type of "4" is accurate only to the 5-digit zip code centroid. Of 3,359 unique addresses in the BAAQMD's point source inventory file, 4% received a match type "4" and 96% received a match type "1". **Table C-2** depicts the unique point source addresses that received a match type of "4" along with there corresponding TAC emissions estimates.

Table C-1. Summary of spatial surrogates used to allocate area and non-road mobile sources for the BAAQMD domain.

BAAQMD Surrogate #[a]	Surrogate Calculation Type	Source of Data	Surrogate Description
SUR01	Total Area	ABAG Land Use 2000	Land Use (11)
SUR02	Total Area	ABAG Land Use 2000	Land Use (11, 12)
SUR03	Total Area	ABAG Land Use 2000	Land Use (11, 12, 13, 14, 15, 16)
SUR04	Total Area	ABAG Land Use 2000	Land Use (11, 12, 16)
SUR05	Total Area	ABAG Land Use 2000	Land Use (13)
SUR06	Total Area	ABAG Land Use 2000	Land Use (1432, 1433, 1434, 1437, 1438)
SUR07	Total Area	ABAG Land Use 2000	Land Use (11, 121, 122, 123, 124, 126)
SUR08	Total Area	ABAG Land Use 2000	Land Use (21, 22)
SUR09	Total Area	ABAG Land Use 2000	Land Use (23)
SUR10	Total Area	ABAG Land Use 2000	Land Use (41, 42, 43)
SUR11	Total Area	CCOS, July 2001 spatial surrogate	See Special Cases
SUR12	Total Area	ABAG Land Use 2000	Land Use (11, 122, 123, 1261, 1711, 1713)
SUR13	Total Area	ABAG Land Use 2000	Land Use (12, 131, 132, 133, 135, 15, 16)
SUR14	Total Area	ABAG Land Use 2000	Land Use (121, 122, 124, 126, 127, 128, 129, 1456, 15)
SUR15	Total Area	ABAG Land Use 2000	Land Use (1256)
SUR16	Total Area	ABAG Land Use 2000	Land Use (13, 142, 143, 144, 15)

[a] See memorandum for proposed spatial approach for documentation of surrogate numerical codes.

Table C-1. Summary of spatial surrogates used to allocate area and non-road mobile sources for the BAAQMD domain.

BAAQMD Surrogate #[a]	Surrogate Calculation Type	Source of Data	Surrogate Description
SUR17	Total Area	ABAG Land Use 2000	Land Use (13, 15, 16)
SUR18	Total Area	ABAG Land Use 2000	Land Use (131, 132, 133, 135, 15)
SUR19	Total Area	ABAG Land Use 2000	Land Use (131, 132, 133, 135, 15, 16, 1411, 1414, 1422)
SUR20	Total Area	CCOS, July 2001 spatial surrogate	See Special Cases
SUR21	Line Length	Bureau of Transportation Statistics Database	Railroad Lines
SUR22	Total Area	ABAG Land Use 2000	Land Use (143, 1256)
SUR23	Total Area	ABAG Land Use 2000	Land Use (1431, 1432, 1433, 1434, 1437)
SUR24	Total Area	ABAG Land Use 2000	Land Use (1431, 1432, 1433, 1434, 1437, 1438)
SUR25	Line Length	Bureau of Transportation Statistics Database	Shipping Lanes
SUR26	Total Area	ABAG Land Use 2000	Lakes/Reservoirs/Coastline
SUR27	Total Area	ABAG Land Use 2000	Land Use (2, 3, 7)
SUR28	Total Area	ABAG Land Use 2000	Land Use (22)
SUR29	Total Area	ABAG Land Use 2000	Land Use (2, 3, 4)
SUR30	Total Area	ABAG Land Use 2000	Land Use (31, 32, 33)
SUR31	Point Count	National Atlas (1999)	Sand and Gravel Mine Locations
SUR32	Point Count	California Integrated Waste Management Board (1999)	Location of Landfills

[a] See memorandum for proposed spatial approach for documentation of surrogate numerical codes.

Table C-1. Summary of spatial surrogates used to allocate area and non-road mobile sources for the BAAQMD domain.

BAAQMD Surrogate #[a]	Surrogate Calculation Type	Source of Data	Surrogate Description
SUR33	Point Count	Electronic Yellow Pages Database	Location of Auto body/Refinishing Shops
SUR34	Total Area	Electronic Yellow Pages Database / InfoUSA / ABAG Land Use 2000	Location of Auto body/Refinishing Shops/Carwash Centers/Car Dealerships, Land Use (11)
SUR35	Point Count	ARB CEIDARS Database (1999)	Location of Bulk Terminals
SUR36	Point Count	Electronic Yellow Pages Database	Location of Dry Cleaners
SUR37	Total Area	InfoUSA Database / ABAG Land Use 2000	Location of Marine Shops/Land Use (144)
SUR38	Point Count	California Department of Oil and Gas (DO&G, 1999) / infoUSA Database	Location of Oil Wells/Refineries
SUR39	Point Count	Electronic Yellow Pages Database	Location of Restaurants/Bakeries
SUR40	Point Count	Electronic Yellow Pages Database	Location of Wineries
SUR41	Point Count	Electronic Yellow Pages Database	Locations of Gas (Service) Stations
SUR42	Line Density	Tele Atlas Mulitnet road network database, 2000.	Road link data (weighted by FCC)
SUR43	Total Area	ABAG Land Use 2000	Land Use (144)
SUR44	Total Area	National Land Cover Database, 2001	NLCD (81)
SUR45	Line Length	Caltrans Tiger Road Network	Unpaved Roads
SUR46	Total Area	ABAG Land Use 2000	Land Use (21)

[a] See memo for proposed spatial approach for documentation of surrogate numerical codes.

Table C-2. Total HAP emissions from point source (plant) addresses that geocoded to a zip code centroid match (match-type 4).

Plant Number[a]	Plant Name	SIC	Address	City	Total HAP Emissions (lbs/yr)[b]	Longitude	Latitude	# of individual point sources[c]
1534	South Bayside System Authority	4952	Radio Road, End of	Redwood City	39,111	-122.2459	37.53565	13
4116	San Francisco, City & County, PUC	4952	3500 Great Highway	San Francisco	8,521	-122.49742	37.71745	9
12089	Precision Cabinets & Trim	2434	700 Hrvst Prk Drv St	Brentwood	3,547	-121.70196	37.93333	2
11671	Gas Recovery Systems, Inc	4911	Landfill, American Canyon	Napa	3,324	-122.29874	38.32516	26
1204	Cultured Stone Corporation	3299	Highway 29 & Tower Rd	Napa	3,278	-122.28519	38.29346	3
3232	OEA Areospace Inc	3728	Explosive Tech Rd, at Highway 12	Fairfield	2,848	-122.03037	38.26551	11
653	Central Marin Sanitation Agency	4952	Anderson Drive, East end	San Rafael	2,520	-122.51632	37.9714	15
3029	Contra Costa Sanitary Landfill	4953	James Donlon Blvd	Antioch	2,067	-121.81141	37.99963	29
3256	Turk Island Solid Waste Disposal Site	4953	Union City Boulevard	Union City	1,654	-122.04476	37.59136	16
4094	San Quentin State Prison	9223	CA State Prison	San Quentin	1,432	-122.48303	37.94277	17
5264	Mc Clellan Square Cleaners	7216	10477 De Anza Blvd	Cupertino	1,349	-122.03786	37.32082	1

[a] Plant number based on point of source inventory file provided by BAAQMD.

[b] TAC emissions summed by plant address.

[c] Total number of individual point sources located at the associated plant address.

Table C-2. Total HAP emissions from point source (plant) addresses that geocoded to a zip code centroid match (match-type 4).

Plant Number[a]	Plant Name	SIC	Address	City	Total HAP Emissions (lbs/yr)[b]	Longitude	Latitude	# of individual point sources[c]
2936	Nova Group, Inc	3292	7411 Napa Vallejo Hwy	Napa	1,321	-122.26638	38.23889	5
7808	Holiday Cleaners	7216	4 Bayhill Shopping Ctr	San Bruno	1,241	-122.42399	37.62536	1
1982	County of Santa Clara	9512	Hellyer Park	San Jose	1,185	-121.82495	37.2811	16
11312	San Antonio Cleaners	7216	225 San Antonio, #8	Mountain View	1,182	-122.07714	37.40693	1
1771	City of Santa Clara	4911	Gianera Street	Santa Clara	1,176	-121.95237	37.34884	14
2053	Sausalito-Marin City Sanitary District	9511	#1 Fort Baker Road	Sausalito	1,014	-122.50149	37.86192	25
723	Lawrence Berkeley National Laboratory	8733	One Cyclotron Road	Berkeley	968	-122.25124	37.86967	12
770	Travis AFB	9711	60th Air Base Gr, 60th AMW	Travis AFB	967	-121.94161	38.27433	359
4322	Corte Madera Cleaners	7216	143 Corte Madera Twn Ctr	Corte Madera	943	-122.51011	37.92122	1
4773	Country Club Cleaners	7216	152 Robles, A 5	Vallejo	931	-122.21114	38.10168	1
5691	Sunquest Properties Inc	9999	Brisbane Landfll	Brisbane	898	-122.40051	37.68316	16
7101	Napa Sanitation District - Soscol	4952	Soscol Ferry Rd	Napa	881	-122.29874	38.32516	7
5114	Northgate Cleaners	7216	270 Northgate One	San Rafael	877	-122.5453	38.00705	1

[a] Plant number based on point of source inventory file provided by BAAQMD.
[b] TAC emissions summed by plant address.
[c] Total number of individual point sources located at the associated plant address.

Table C-2. Total HAP emissions from point source (plant) addresses that geocoded to a zip code centroid match (match-type 4).

Plant Number[a]	Plant Name	SIC	Address	City	Total HAP Emissions (lbs/yr)[b]	Longitude	Latitude	# of individual point sources[c]
7448	Sparklizing Cleaners	7216	514 San Ramon Blvd	Danville	863	-121.98584	37.81487	1
1194	Pinole-Hercules Wastewater Treatment Plant	4953	Tennant Ave, foot of	Pinole	857	-122.28879	37.99827	31
5892	Silicon Valley Auto Body	7532	327 Weddell Drive	Sunnyvale	805	-121.99974	37.40358	3
11983	Robert A Cohan	1311	Bethel Island, Contra Costa Coun	Bethel Island	596	-121.65399	38.0245	3
5104	Crest Cleaners, Inc	7216	118 Skycrest Center	San Bruno	573	-122.4258	37.62495	1
8917	Pechiney Cork & Seal of California	2754	5425 Napa & Vallejo Hwy	Vallejo	570	-122.24324	38.14148	4
3391	Americlean	7216	1545 Palos Verdes Mall	Walnut Creek	568	-122.08704	37.92201	1
4408	Mt View Sanitary District	4952	End of Arthur Road	Martinez	549	-122.10994	37.99673	11
6176	Great American Dry Cleaning	7216	215 El Cerrito Plaza	El Cerrito	541	-122.30442	37.91736	1
1071	City of Petaluma	4953	LakeVille Highway	Petaluma	532	-122.61943	38.25292	3
1784	San Francisco International Airport	4952	SFO, Intrnational Airport	San Francisco	483	-122.39608	37.63612	14
4416	NY Tailors and Cleaners	7216	129 So West Boulevard	Rohnert Park	476	-122.69604	38.34637	1

[a] Plant number based on point of source inventory file provided by BAAQMD.

[b] TAC emissions summed by plant address.

[c] Total number of individual point sources located at the associated plant address.

Table C-2. Total HAP emissions from point source (plant) addresses that geocoded to a zip code centroid match (match-type 4).

Plant Number[a]	Plant Name	SIC	Address	City	Total HAP Emissions (lbs/yr)[b]	Longitude	Latitude	# of individual point sources[c]
8390	Classic Auto Body & Painting	7532	1401 Stradella Court	Walnut Creek	447	-122.05352	37.89667	3
3471	City of Calistoga	4952	Dunaweal Lane	Calistoga	428	-122.58834	38.58192	10
10169	Skyline Cleaning Center	7216	45 Skyline Plaza	Daly City	405	-122.48611	37.68199	1
1593	Contra Costa Sanitation Distr No 5	9999	Canyon Lake Dr, End of	Port Costa	398	-122.18824	38.045	1
1820	Martinez Cogen Limited Partnership	4931	Avon Refinery	Martinez	394	-122.10994	37.99673	6
1777	City of American Canyon	4952	W American Canyon Rd, Foot of	American Canyon	346	-122.24324	38.14148	9
7535	Dana Cleaners	7216	32 Dana Plaza	Concord	331	-122.03989	37.97811	1
519	Chevron, Oakland Airport-North	5171	N Earhardt Drive	Oakland	313	-122.2049	37.73731	32
3590	City of Berkeley/Engr Div/Public Works	9199	Cesar Chavez Prk	Berkeley	273	-122.26008	37.86638	13

[a] Plant number based on point of source inventory file provided by BAAQMD.

[b] TAC emissions summed by plant address.

[c] Total number of individual point sources located at the associated plant address.

Table C-2. Total HAP emissions from point source (plant) addresses that geocoded to a zip code centroid match (match-type 4).

Plant Number[a]	Plant Name	SIC	Address	City	Total HAP Emissions (lbs/yr)[b]	Longitude	Latitude	# of individual point sources[c]
7265	International Power Technology (SJ State)	4939	San Carlos Boulevard	San Jose	265	-121.897	37.38671	13
1463	Ironhouse Sanitary District	9511	Highway 4	Oakley	260	-121.71302	37.98998	15
2604	Ramos Woodworking, Inc	2511	675 Taylor Way	Belmont	219	-122.28916	37.51849	2
1205	City of St Helena	9999	1 Thoman Lane	Saint Helena	212	-122.46077	38.50412	9
550	NASA-AMES Research Center	9711	Moffett Field NS	Mountain View	148	-122.04755	37.41836	38
2009	City of Santa Rosa Wastewater Treatment Plant	9999	6200 Stonebridge	Santa Rosa	138	-122.732	38.41035	9
761	Alves Petroleum Inc	5171	San Mateo Road	Half Moon Bay	132	-122.44227	37.47433	18
5280	Zak's Auto Body	7532	130 E So Linden, Unit #B	South San Francisco	127	-122.42627	37.65559	2
7460	Euro Design	7532	1168 San Mateo Avenue	South San Francisco	106	-122.40916	37.64122	2
813	Venoco, Inc	4922	Nichols Road	Pittsburg	105	-121.90511	38.01781	4
2814	Best Auto Painting	7532	1410 Stradella Court	Walnut Creek	102	-122.05352	37.89667	3
9904	Specialty Crushing Inc	1795	Shellmound Street	Emeryville	97	-122.2837	37.83601	10

[a] Plant number based on point of source inventory file provided by BAAQMD.

[b] TAC emissions summed by plant address.

[c] Total number of individual point sources located at the associated plant address.

Table C-2. Total HAP emissions from point source (plant) addresses that geocoded to a zip code centroid match (match-type 4).

Plant Number[a]	Plant Name	SIC	Address	City	Total HAP Emissions (lbs/yr)[b]	Longitude	Latitude	# of individual point sources[c]
7137	Delta Air Lines, Inc	9999	SF Intl Airport, Bldg 750	San Francisco	91	-122.39608	37.63612	4
1257	Genentech, Inc	2836	460 Pt San Bruno Boulevard, MS 7	South San Francisco	86	-122.42627	37.65559	16
10142	F&S Auto Body Ltd Co	7532	3100 El Camino Real, Suites I&J	Santa Clara	86	-121.98467	37.34763	3
2284	Solano Community College	8222	Suisun Valley Road	Suisun City	63	-122.00961	38.24211	9
7331	City of San Jose, Dept of Streets & Traffic	9999	Almaden & Curtner	San Jose	36	-121.89337	37.29699	1
3332	General Electric Co	8734	6705 Vallecitos Rd	Sunol	29	-121.87662	37.59795	37
6997	Pillar Point AFS	9711	End of Westpoint Ave, Princeton	Half Moon Bay	23	-122.44227	37.47433	42
11978	Napa Valley Petroleum Inc	9999	257 So Kelly Rd	Napa	23	-122.29874	38.32516	12
1299	Skylawn Memorial Park	7261	10600 Skyline Blvd	San Mateo	21	-122.32324	37.55289	34
11531	Z-Best Composting Facility	4953	Bolsa Rd & Highway 25	Gilroy	20	-121.57933	37.0178	10
11384	Raytheon Company c/o Locus Technologies	9999	NAS Moffett Fild, Bldg 117	Moffett Field	12	-122.04755	37.41836	4

[a] Plant number based on point of source inventory file provided by BAAQMD.
[b] TAC emissions summed by plant address.
[c] Total number of individual point sources located at the associated plant address.

Table C-2. Total HAP emissions from point source (plant) addresses that geocoded to a zip code centroid match (match-type 4).

Plant Number[a]	Plant Name	SIC	Address	City	Total HAP Emissions (lbs/yr)[b]	Longitude	Latitude	# of individual point sources[c]
4023	Half Moon Bay Aero	9999	Airport, Half Moon Bay	Half Moon Bay	10	-122.44227	37.47433	4
11282	XKT Engineering Inc, Railroad Ave Bldg 390	9711	Mare Island, Naval Shipyard	Vallejo	9	-122.27217	38.09547	24
1129	Homestake Mining Company	1041	Berryessa-Knxvll Rd	Napa	6	-122.29874	38.32516	14
466	MSC Pinole Point Steel Inc	3547	5000 Giant Road	Richmond	6	-122.33928	37.97309	5
173	Georgia Pacific Corporation	3275	801 Minaker Street	Antioch	5	-121.81141	37.99963	5
9477	CA Air National Guard	9999	Moffett Field NS, NAS	Mountain View	5	-122.04755	37.41836	32
1198	Hercules Wastewater Treatment Facility	9999	2000 Sewerline Road	Hercules	3	-122.26379	38.0075	10
219	Naval Weapons Station - Inland Area	9711	Port Chicago Highway	Concord	3	-122.03989	37.97811	45
7943	Berlex Laboratories, Inc	8731	2600 Hilltop Drive	Richmond	3	-122.33053	37.98251	7
10240	US Coast Guard	9621	Yerba Buena Is	San Francisco	2	-122.3727	37.824	20
1567	Sonoma County Water Agency	4952	2025 Aviation Boulevard	Santa Rosa	2	-122.7468	38.47951	1
10703	One Embarcadero Center/Pacific Properties Services	7349	1 Embarcadero Ctr, 43rd Floor	San Francisco	2	-122.39851	37.79422	4

[a] Plant number based on point of source inventory file provided by BAAQMD.

[b] TAC emissions summed by plant address.

[c] Total number of individual point sources located at the associated plant address.

Table C-2. Total HAP emissions from point source (plant) addresses that geocoded to a zip code centroid match (match-type 4).

Plant Number[a]	Plant Name	SIC	Address	City	Total HAP Emissions (lbs/yr)[b]	Longitude	Latitude	# of individual point sources[c]
7852	California Water Service Company	9999	Moore Rd, Station 5 F	Atherton	1	-122.18216	37.45103	8
10211	Mega Sand Inc	4953	Decker Island	Antioch	1	-121.81141	37.99963	10
10834	Pacific Custom Materials Inc	3299	9000 Carquinez Scenic Dr	Port Costa	1	-122.18824	38.045	2
128	Syar Industries, Inc	2951	Lake Herman Road	Vallejo	1	-122.21114	38.10168	5
3194	City of Alameda, Maint Serv Center	4953	Doolittle Drive	Alameda	1	-122.2589	37.76884	26
12181	American Airlines	4522	Spr By Hngr Cst Rd, Bldg #1060	San Francisco	1	-122.39608	37.63612	10
9327	Napa Pipe Corporation	3479	Hwy 29 & Kaiser Rd	Napa	1	-122.29874	38.32516	5
11827	Delta c/o Environmental Cost Management	9999	SF Int'l Airport, Boarding Area	San Francisco	1	-122.39608	37.63612	2
896	Hanson Aggregates	2951	Pine Hollow Road	Clayton	1	-121.9213	37.93193	4
479	Treasure Island	9711	Treasure Island	San Francisco	1	-122.3727	37.824	3
			Total HAP emissions by match-type "4" locations		811,371[d]	Total individual point sources at match-type "4" locations		3,977

[a] Plant number based on point of source inventory file provided by BAAQMD.

[b] TAC emissions summed by plant address.

[c] Total number of individual point sources located at the associated plant address.

[d] This figure corresponds to 7.5% of total mass-based TAC emissions, and 11.9% of TAC emissions from point sources.

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APPENDIX D

SELECTION AND APPLICATION OF CANCER UNIT RISK FACTORS AND NON-CANCER REFERENCE CONCENTRATIONS

Sonoma Technology, Inc. (STI) applied TAC-specific cancer unit risk factors (UR) and non-cancer Reference Concentrations (RfC) to estimated TAP emissions. UR factors and RfCs were acquired from ARB in conjunction with California EPA's Office of Environmental Health Hazard Assessment (OEHHA), EPA's Integrated Risk Information System (IRIS), and EPA's Technology Transfer Network, along with secondary sources used to estimate factors for important TAPs not reported by these sources. A table of primary and alternative factors was compiled using the following hierarchy of preference (see **Table D-1** for full citations):

1. Consolidated Table of OEHHA/ARB Approved Risk Assessment Health Values.
2. EPA OEHHA September 2004—OEHHA Cancer Potency List.
3. EPA Integrated Risk Information System (IRIS).
4. EPA Technology Transfer Network, Table 1 Prioritized Chronic Dose-Response Values for Screening Risk Assessments (2/28/05) (TTN).

The following sources were used when primary or alternative factors were not available from OEHHA/ARB, IRIS, or TTN:

1. EPA Environmental Information Management System, Trichloroethylene Health Risk Assessment: Synthesis and Characterization (External Review Draft), v1.0, EPA/600/P-01/002A, 2001.
2. Risk Assessment Information System (RAIS), Chemical-Specific Toxicity Values.

In addition, the following tables were used to cross-reference dioxin and furan descriptors for which Chemical Abstracts Service numbers (CAS) have not yet been assigned:

1. California Air Resources Board (ARB), California Air Toxics Emission Factors, Database User's Manual Version 1.2, Table 9 Listing of Field Values for the Field Substance.
2. South Coast Air Quality Management (SCAQMD), Risk Assessment Procedures for Rules 1401 and 212, Attachment C, Table – 8 Unit Risk Factor (U), Reference Exposure Level (REL) and Multi Pathway Adjustment Factors (MP).

Table D-1. Full citation, risk factors.

Citation ID	Citation Text
1	California Air Resources Board, Consolidated Table of OEHHA/ARB Approved Risk Assessment Health Values. Pdf format available on the Internet at <http://www.arb.ca.gov/toxics/healthval/healthval.htm>. Excel format received from Michele Houghton <mhoughto@arb.ca.gov> March 29, 2005.
2	EPA Integrated Risk Information System (IRIS). Available on the Internet at <http://www.epa.gov/iris/index.html>.
3	EPA Office of Environmental Health Hazard Assessment (OEHHA) September 2004 - OEHHA Cancer Potency List. Pdf format available on the Internet at <http://www.oehha.ca.gov/risk/ChemicalDB/index.asp> or <www.oehha.ca.gov/risk/pdf/092204cpf_alpha.pdf>.
4	ENSR International, Vol 2, 2004, EPA Issues an Inhalation Cancer Risk Assessment for Naphthalene. Available on the Internet at <http://www.ensr.com/newsroom/insight/insight_articles/2004_v2/v2a10.htm>.
5	EPA Technology Transfer Network, Table 1 Prioritized Chronic Dose-Response Values for Screening Risk Assessments (2/28/05). Available on the Internet at <http://www.epa.gov/ttn/atw/toxsource/summary.html>.
6	Risk Assessment Information System, Chemical-Specific Toxicity Values. Available on the Internet at <http://risk.lsd.ornl.gov/tox/tox_values.shtml>.
7	EPA Environmental Information Management System, Trichloroethylene Health Risk Assessment: Synthesis and Characterization (External Review Draft), v1.0, EPA/600/P-01/002A, 2001. Pdf format, TCEAUG2001.PDF, available on the Internet at <http://oaspub.epa.gov/eims/eimsapi.dispdetail?deid=23249>.
8	Descriptor (e.g., “Dioxin:5D”): Cross-referenced using California Air Resources Board, California Air Toxics Emission Factors, Database User’s Manual Version 1.2, Table 9 Listing of Field Values for the Field Substance. Available on the Internet at <http://www.arb.ca.gov/ei/catef/catefman.pdf >. Cancer Unit Risk: South Coast Air Quality Management, Risk Assessment Procedures for Rules 1401 and 212, Attachment C, Table – 8 Unit Risk Factor (U), Reference Exposure Level (REL) and Multi Pathway Adjustment Factors (MP). Available on the Internet at <http://www.aqmd.gov/prdas/risk%20assessment/riskassessment.html>. Chronic Inhalation: Extrapolated from Cancer Unit Risk factors using the World Health Organization's (WHO) Toxic Equivalency Factors. Citation: WHO, Executive Summary Assessment of the health risk of dioxins: re-evaluation of the Tolerable Daily Intake (TDI), May 25-29 1998. Available on the Internet at <http://www.who.int/ipcs/publications/en/exe-sum-final.pdf>.
9	Descriptor (e.g., “Dioxin:5D”): Cross-referenced using California Air Resources Board, California Air Toxics Emission Factors, Database User’s Manual Version 1.2, Table 9 Listing of Field Values for the Field Substance. Available on the Internet at <http://www.arb.ca.gov/ei/catef/catefman.pdf >. Unit Risk: EPA Integrated Risk Information System (IRIS). Available on the Internet at <http://www.epa.gov/iris/index.html>.

Selection codes 1, 2, and 3 were used to designate Selected (1) and Alternative (2 or 3) factors for each of the risk categories evaluated: Inhalation Cancer, Chronic Inhalation, and Acute Inhalation. Selection codes were assigned according to the hierarchy of preference described above. Finalized factors were used to risk-weight emission estimates. When factors were given as a range (e.g., Benzene, CAS# 71432, IRIS), selection codes were assigned to each end point of the range, with the higher selection preference given to the high end of the range. By applying the high end of the range, the risk-weighted inventories represent a worst-case, conservatively high-risk scenario. A condensed table of UR factors and RfCs is provided in **Table D-2**. **Table D-3** lists range-related and other uncertainty issues for affected TACs and tabulates associated risk-weighted emissions for each issue.

Please note the following information about substituted CAS number assignments of the TAC inventories:

- A CAS number of 111159 was used to designate emissions of “glycol ethers (other/not specified)” which were reported in the BAAQMD’s inventory of point sources. CAS 111159 normally denotes cellosolve acetate, which is a type of glycol either.

- The CAS number 1746016 normally designates 2,3,7,8-tetrachlorodibenzo-p-dioxin. It was applied as such for the TAC inventories for area, non-road mobile, and/or on-road mobile sources. In addition, this CAS number (1746016) was used to designate emissions of "undifferentiated chlorinated dioxins and furans" reported in the BAAQMD's inventory of point sources.

Table D-2. Unit risk factors and reference concentrations ("tblUnitRisk").

CAS	Chemical	Acute Inhalation[a] ($\mu g/m^3$)	Selection Code Acute Inhalation	Chronic Inhalation[b] ($\mu g/m^3$)	Selection Code Chronic Inhalation	Inhalation Cancer UnitRisk[c] $(\mu g/m^3)^{-1}$	Selection Code Inhalation CancerUR	Citation ID	Citation Date	Source
106990	1,3-Butadiene			2.0E+01	1	1.7E-04	1	1	3/29/05	OEHHA/ARB
106990	1,3-Butadiene			2.0E+00	2	3.0E-05	2	2	5/24/05	EPA IRIS
106467	1,4-Dichlorobenzene			8.0E+02	1	1.1E-05	1	1	3/29/05	OEHHA/ARB
106467	1,4-Dichlorobenzene			8.0E+02				2	5/25/05	EPA IRIS
101688	4,4'-Methylenediphenyl Diisocyanate			7.0E-01	1			1	3/29/05	OEHHA/ARB
101688	4,4'-Methylenediphenyl Diisocyanate			6.0E-01	2			2	5/25/05	EPA IRIS
75070	Acetaldehyde			9.0E+00	1	2.7E-06	1	1	3/29/05	OEHHA/ARB
75070	Acetaldehyde			9.0E+00		2.2E-06	2	2	5/25/05	EPA IRIS
107028	Acrolein	1.9E-01	1	6.0E-02	1			1	3/29/05	OEHHA/ARB
107028	Acrolein			2.0E-02	2			2	5/25/05	EPA IRIS
107131	Acrylonitrile			5.0E+00	1	2.9E-04	1	1	3/29/05	OEHHA/ARB
107131	Acrylonitrile			2.0E+00	2	6.8E-05	2	2	5/24/05	EPA IRIS
7440360	Antimony			2.0E-01	1			1	3/29/05	OEHHA/ARB
7440382	Arsenic	1.9E-01	1	3.0E-02	1	3.3E-03	1	1	3/29/05	OEHHA/ARB
7440382	Arsenic					4.3E-03	2	2	5/24/05	EPA IRIS
71432	Benzene	1.3E+03	1	6.0E+01	1	2.9E-05	1	1	3/29/05	OEHHA/ARB
71432	Benzene			3.0E+01		2.2E-06	3	2	5/24/05	EPA IRIS
71432	Benzene			3.0E+01	2	7.8E-06	2	2	5/24/05	EPA IRIS
7440417	Beryllium			7.0E-03	1	2.4E-03	1	1	3/29/05	OEHHA/ARB
7440417	Beryllium			2.0E-02	2	2.4E-03		2	5/24/05	EPA IRIS
7440439	Cadmium			2.0E-02	1	4.2E-03	1	1	3/29/05	OEHHA/ARB
7440439	Cadmium					1.8E-03	2	2	5/24/05	EPA IRIS

[a] Acute reference concentrations are generally based on a one-hour exposure.
[b] Chronic reference concentrations are based on exposures of a greater duration than 12% of a lifetime of 70 years, so human exposures of more than 8 years are considered chronic.
[c] Cancer risks are calculated based on a lifetime exposure duration (70 years)

Table D-2. Unit risk factors and reference concentrations (“tblUnitRisk”).

CAS	Chemical	Acute Inhalation (µg/m^3)	Selection Code Acute Inhalation	Chronic Inhalation (µg/m^3)	Selection Code Chronic Inhalation	Inhalation Cancer UnitRisk (µg/m^3)$^{-1}$	Selection Code Inhalation CancerUR	Citation ID	Citation Date	Source
75150	Carbon Disulfide	6.2E+03	1	8.0E+02	1			1	3/29/05	OEHHA/ARB
75150	Carbon Disulfide			7.0E+02	2			2	5/25/05	EPA IRIS
56235	Carbon Tetrachloride	1.9E+03	1	4.0E+01	1	4.2E-05	1	1	3/29/05	OEHHA/ARB
56235	Carbon Tetrachloride					1.5E-05	2	2	5/24/05	EPA IRIS
56235	Carbon Tetrachloride			1.9E+02	2	1.5E-05		5	5/26/05	EPA TTN
7782505	Chlorine	2.1E+02	1	2.0E-01	1			1	3/29/05	OEHHA/ARB
108907	Chlorobenzene			1.0E+03	1			1	3/29/05	OEHHA/ARB
67663	Chloroform	1.5E+02	1	3.0E+02	1	5.3E-06	1	1	3/29/05	OEHHA/ARB
67663	Chloroform					2.3E-05	2	2	5/24/05	EPA IRIS
67663	Chloroform			9.8E+01	2			5	5/26/05	EPA TTN
18540299	Chromium (VI)			2.0E-01	1	1.5E-01	1	1	3/29/05	OEHHA/ARB
18540299	Chromium (VI)			8.0E-03	2	1.2E-02		2	5/24/05	EPA IRIS
18540299	Chromium (VI)			1.0E-01	3	1.2E-02	2	2	5/24/05	EPA IRIS
7440484	Cobalt			1.0E-01	1			5	5/26/05	EPA TTN
7440484	Cobalt			2.0E-02	2	2.8E-03	1	6	5/26/05	RAIS
98828	Cumene			4.0E+02	1			2	5/25/05	EPA IRIS
75003	Ethyl Chloride			3.0E+04	1			1	3/29/05	OEHHA/ARB
75003	Ethyl Chloride			1.0E+04	2			2	5/25/05	EPA IRIS
100414	Ethyl Benzene			2.0E+03	1			1	3/29/05	OEHHA/ARB
100414	Ethyl Benzene			1.0E+03	2			2	5/25/05	EPA IRIS
100414	Ethyl Benzene			1.0E+03		1.1E-06	1	6	5/26/05	RAIS

[a] Acute reference concentrations are generally based on a one-hour exposure.
[b] Chronic reference concentrations are based on exposures of a greater duration than 12% of a lifetime of 70 years, so human exposures of more than 8 years are considered chronic.
[c] Cancer risks are calculated based on a lifetime exposure duration (70 years)

Table D-2. Unit risk factors and reference concentrations ("tblUnitRisk").

CAS	Chemical	Acute Inhalation (µg/m^3)	Selection Code Acute Inhalation	Chronic Inhalation (µg/m^3)	Selection Code Chronic Inhalation	Inhalation Cancer UnitRisk (µg/m^3)$^{-1}$	Selection Code Inhalation CancerUR	Citation ID	Citation Date	Source
106934	Ethylene Dibromide			8.0E-01	1	7.1E-05	1	1	3/29/05	OEHHA/ARB
106934	Ethylene Dibromide			9.0E+00		3.0E-04	3	2	5/25/05	EPA IRIS
106934	Ethylene Dibromide			9.0E+00	2	6.0E-04	2	2	5/25/05	EPA IRIS
107062	Ethylene Dichloride			4.0E+02	1	2.1E-05	1	1	3/29/05	OEHHA/ARB
107062	Ethylene Dichloride					2.6E-05	2	2	5/25/05	EPA IRIS
107062	Ethylene Dichloride			2.4E+03	2	2.6E-05		5	5/26/05	EPA TTN
107211	Ethylene Glycol			4.0E+02	1			1	3/29/05	OEHHA/ARB
75218	Ethylene Oxide			3.0E+01	1	8.8E-05	1	1	3/29/05	OEHHA/ARB
50000	Formaldehyde	9.4E+01	1	3.0E+00	1	6.0E-06	1	1	3/29/05	OEHHA/ARB
50000	Formaldehyde					1.3E-05	2	2	5/24/05	EPA IRIS
50000	Formaldehyde			9.8E+00	2	5.5E-09	3	5	5/26/05	EPA TTN
110543	Hexane			7.0E+03	1			1	3/29/05	OEHHA/ARB
110543	Hexane			2.0E+02	2			2	5/25/05	EPA IRIS
7439921	Lead					1.2E-05	1	1	3/29/05	OEHHA/ARB
7439921	Lead			1.5E+00	1			5	5/26/05	EPA TTN
7439965	Manganese			2.0E-01	1			1	3/29/05	OEHHA/ARB
7439965	Manganese			5.0E-02	2			2	5/25/05	EPA IRIS
7439976	Mercury	1.8E+00	1	9.0E-02	1			1	3/29/05	OEHHA/ARB
7439976	Mercury			3.0E-01	2			2	5/25/05	EPA IRIS
67561	Methanol	2.8E+04	1	4.0E+03	1			1	3/29/05	OEHHA/ARB
74873	Methyl Chloride			9.0E+01	1			2	5/25/05	EPA IRIS
74873	Methyl Chloride			9.0E+01		1.8E-06	1	6	6/1/05	RAIS
71556	Methyl Chloroform	6.8E+04	1	1.0E+03	1			1	3/29/05	OEHHA/ARB
78933	Methyl Ethyl Ketone	1.3E+04	1	1.0E+03	1			1	3/29/05	OEHHA/ARB

[a] Acute reference concentrations are generally based on a one-hour exposure.
[b] Chronic reference concentrations are based on exposures of a greater duration than 12% of a lifetime of 70 years, so human exposures of more than 8 years are considered chronic.
[c] Cancer risks are calculated based on a lifetime exposure duration (70 years)

Table D-2. Unit risk factors and reference concentrations (“tblUnitRisk”).

CAS	Chemical	Acute Inhalation (µg/m^3)	Selection Code Acute Inhalation	Chronic Inhalation (µg/m^3)	Selection Code Chronic Inhalation	Inhalation Cancer UnitRisk (µg/m^3)$^{-1}$	Selection Code Inhalation CancerUR	Citation ID	Citation Date	Source
78933	Methyl Ethyl Ketone			5.0E+03	2			2	5/25/05	EPA IRIS
108101	Methyl Isobutyl Ketone			3.0E+03	1			2	5/25/05	EPA IRIS
80626	Methyl Methacrylate			9.8E+02	1			1	3/29/05	OEHHA/ARB
80626	Methyl Methacrylate			7.0E+02	2			2	5/25/05	EPA IRIS
75092	Methylene Chloride	1.4E+04	1	4.0E+02	1	1.0E-06	1	1	3/29/05	OEHHA/ARB
75092	Methylene Chloride					4.7E-07	2	2	5/25/05	EPA IRIS
75092	Methylene Chloride			1.0E+03	2	4.7E-07		5	5/26/05	EPA TTN
91203	Naphthalene			9.0E+00	1	3.4E-05	1	1	3/29/05	OEHHA/ARB
91203	Naphthalene			3.0E+00	2			2	5/25/05	EPA IRIS
91203	Naphthalene					1.0E-04	2	4	5/25/05	ENSR
91203	Naphthalene			3.0E+00		3.4E-05		5	5/26/05	EPA TTN
7440020	Nickel	6.0E+00	1	5.0E-02	1	1.6E-04	1	1	3/29/05	OEHHA/ARB
7440020	Nickel			9.0E-02	2			5	5/26/05	EPA TTN
108952	Phenol	5.8E+03	1	2.0E+02	1			1	3/29/05	OEHHA/ARB
7723140	Phosphorus (white)			7.0E-02	1			1	3/29/05	OEHHA/ARB
78875	Propylene Dichloride					1.0E-05	1	3	5/24/05	OEHHA
78875	Propylene Dichloride			4.0E+00	1			2	5/25/05	EPA IRIS
78875	Propylene Dichloride			4.0E+00		1.9E-05	2	5	5/26/05	EPA TTN
7782492	Selenium			2.0E+01	1			1	3/29/05	OEHHA/ARB
100425	Styrene	2.1E+04	1	9.0E+02	1			1	3/29/05	OEHHA/ARB
100425	Styrene			1.0E+03	2			2	5/25/05	EPA IRIS
127184	Tetrachloroethylene	2.0E+04	1	3.5E+01	1	5.9E-06	1	1	3/29/05	OEHHA/ARB
127184	Tetrachloroethylene			2.7E+02	2			5	5/26/05	EPA TTN
108883	Toluene	3.7E+04	1	3.0E+02	1			1	3/29/05	OEHHA/ARB

[a] Acute reference concentrations are generally based on a one-hour exposure.
[b] Chronic reference concentrations are based on exposures of a greater duration than 12% of a lifetime of 70 years, so human exposures of more than 8 years are considered chronic.
[c] Cancer risks are calculated based on a lifetime exposure duration (70 years)

Table D-2. Unit risk factors and reference concentrations (“tblUnitRisk”).

CAS	Chemical	Acute Inhalation (µg/m^3)	Selection Code Acute Inhalation	Chronic Inhalation (µg/m^3)	Selection Code Chronic Inhalation	Inhalation Cancer UnitRisk (µg/m^3)$^{-1}$	Selection Code Inhalation CancerUR	Citation ID	Citation Date	Source
108883	Toluene			4.0E+02	2			2	5/25/05	EPA IRIS
79016	Trichloroethylene			6.0E+02	1	2.0E-06	1	1	3/29/05	OEHHA/ARB
79016	Trichloroethylene			4.0E+01	2	7.0E-05	2	7	5/26/05	EPA EIMS
79016	Trichloroethylene					1.1E-04	3	6	5/26/05	RAIS
108054	Vinyl Acetate			2.0E+02	1			1	3/29/05	OEHHA/ARB
108054	Vinyl Acetate			2.0E+02	2			2	5/25/05	EPA IRIS
75014	Vinyl Chloride	1.8E+05	1	2.6E+01	1	7.8E-05	1	1	3/29/05	OEHHA/ARB
75014	Vinyl Chloride			1.0E+02		8.8E-06	2	2	5/25/05	EPA IRIS
75014	Vinyl Chloride			1.0E+02	2	4.4E-06	3	2	5/25/05	EPA IRIS
108383	m-Xylene	2.2E+04	1	7.0E+02	1			1	3/29/05	OEHHA/ARB
108383	m-Xylene			1.0E+02	2			2	5/25/05	EPA IRIS
95476	o-Xylene	2.2E+04	1	7.0E+02	1			1	3/29/05	OEHHA/ARB
95476	o-Xylene			1.0E+02	2			2	5/25/05	EPA IRIS
106423	p-Xylene	2.2E+04	1	7.0E+02	1			1	3/29/05	OEHHA/ARB
106423	p-Xylene			1.0E+02	2			2	5/25/05	EPA IRIS
1330207	Xylenes (Mixture of o, m, and p Isomers)	2.2E+04	1	7.0E+02	1			1	3/29/05	OEHHA/ARB
1330207	Xylenes (Mixture of o, m, and p Isomers)			1.0E+02	2			2	5/25/05	EPA IRIS
DPM-10	Diesel Particulates					3.0E-04	1	3	5/24/05	OEHHA
DPM-10	Diesel Particulates			5.0E+00	1			2	5/25/05	EPA IRIS
DPM-2.5	Diesel Particulates					3.0E-04	1	3	5/24/05	OEHHA
DPM-2.5	Diesel Particulates			5.0E+00	1			2	5/25/05	EPA IRIS
79345	1,1,2,2-Tetrachloroethane					5.8E-05	1	1	5/27/05	OEHHA/ARB

[a] Acute reference concentrations are generally based on a one-hour exposure.
[b] Chronic reference concentrations are based on exposures of a greater duration than 12% of a lifetime of 70 years, so human exposures of more than 8 years are considered chronic.
[c] Cancer risks are calculated based on a lifetime exposure duration (70 years).

Table D-2. Unit risk factors and reference concentrations (“tblUnitRisk”).

CAS	Chemical	Acute Inhalation $(\mu g/m^3)$	Selection Code Acute Inhalation	Chronic Inhalation $(\mu g/m^3)$	Selection Code Chronic Inhalation	Inhalation Cancer UnitRisk $(\mu g/m^3)^{-1}$	Selection Code Inhalation CancerUR	Citation ID	Citation Date	Source
79345	1,1,2,2-Tetrachloroethane					5.8E-05		2	5/27/05	EPA IRIS
79005	1,1,2-Trichloroethane					1.6E-05	1	1	5/27/05	OEHHA/ARB
79005	1,1,2-Trichloroethane					1.6E-05		2	5/27/05	EPA IRIS
106887	1,2-Epoxybutane			2.0E+01	1			1	5/27/05	OEHHA/ARB
106887	1,2-Epoxybutane			2.0E+01				2	5/27/05	EPA IRIS
584849	2,4-Toluene Diisocyanate			7.0E-02	1	1.1E-05	1	1	5/27/05	OEHHA/ARB
584849	2,4-Toluene Diisocyanate			7.0E-02				2	5/27/05	EPA IRIS
117817	Bis(2-Ethylhexyl)Phthalate			7.0E+01	1	2.4E-06	1	1	5/27/05	OEHHA/ARB
117817	Bis(2-Ethylhexyl)Phthalate			1.0E+01	2	2.4E-06		5	5/27/05	TTN
1319773	Cresol			6.0E+02	1			1	5/27/05	OEHHA/ARB
111422	Diethanolamine			3.0E+00	1			1	5/27/05	OEHHA/ARB
1332214	Asbestos [1/(100 PCM fibers/m^3)]^-1					6.3E-02	1	3	5/27/05	OEHHA
75343	Ethylidene Dichloride (1,1-Dichloroethane)					1.6E-06	1	1	5/27/05	OEHHA/ARB
75343	Ethylidene Dichloride (1,1-Dichloroethane)			5.0E+02	1			6	5/27/05	RAIS
1634044	Methyl Tert-Butyl Ether			8.0E+03	1	2.6E-07	1	1	5/27/05	OEHHA/ARB
1634044	Methyl Tert-Butyl Ether			3.0E+03	2			2	5/27/05	EPA IRIS
111762	Butyl Cellosolve	1.4E+04	1	2.0E+01	1			1	5/27/05	OEHHA/ARB
111762	Butyl Cellosolve			1.3E+04	2			2	5/27/05	EPA IRIS
107982	Propylene Glycol Monoethyl Ether			7.0E+03	1			1	5/27/05	OEHHA/ARB
109864	Ethylene Glycol Methyl Ether	9.3E+01	1	6.0E+01	1			1	5/27/05	OEHHA/ARB

[a] Acute reference concentrations are generally based on a one-hour exposure.
[b] Chronic reference concentrations are based on exposures of a greater duration than 12% of a lifetime of 70 years, so human exposures of more than 8 years are considered chronic.
[c] Cancer risks are calculated based on a lifetime exposure duration (70 years)

Table D-2. Unit risk factors and reference concentrations ("tblUnitRisk").

CAS	Chemical	Acute Inhalation (µg/m³)	Selection Code Acute Inhalation	Chronic Inhalation (µg/m³)	Selection Code Chronic Inhalation	Inhalation Cancer UnitRisk (µg/m³)⁻¹	Selection Code Inhalation CancerUR	Citation ID	Citation Date	Source
109864	Ethylene Glycol Methyl Ether			2.0E+01	2			2	5/27/05	EPA IRIS
110496	Ethylene Glycol Monomethyl Ether Acetate			9.0E+01	1			1		OEHHA/ARB
110805	Cellosolve Solvent	3.7E+02	1	7.0E+01	1			1	5/27/05	OEHHA/ARB
110805	Cellosolve Solvent			2.0E+02	2			2	5/27/05	EPA IRIS
111159	Cellosolve Acetate	1.4E+02	1	3.0E+02	1			1	5/27/05	OEHHA/ARB
74839	Methyl Bromide	3.9E+03	1	5.0E+00	1			1	5/27/05	OEHHA/ARB
74839	Methyl Bromide			5.0E+00				2	5/27/05	EPA IRIS
68122	N,N-Dimethylformamide			8.0E+01	1			1	5/27/05	OEHHA/ARB
68122	N,N-Dimethylformamide			3.0E+01	2			2	5/27/05	EPA IRIS
123911	p-Dioxane	3.0E+03	1	3.0E+03	1	7.7E-06	1	1	5/27/05	OEHHA/ARB
123911	p-Dioxane					7.7E-06		5	5/27/05	TTN
121448	Triethylamine	2.8E+03	1	2.0E+02	1			1	5/27/05	OEHHA/ARB
121448	Triethylamine			7.0E+00	2			2	5/27/05	EPA IRIS
75354	Vinylidene Chloride			7.0E+01	1			1	5/27/05	OEHHA/ARB
75354	Vinylidene Chloride			2.0E+02	2			2	5/27/05	EPA IRIS
75354	Vinylidene Chloride					5.0E-05	1	6	6/1/05	RAIS
542756	1,3-Dichloropropene					1.6E-05	1	3	5/27/05	OEHHA
542756	1,3-Dichloropropene			2.0E+01	1	4.0E-06	2	2	6/1/05	EPA IRIS
112345	Diethylene Glycol Monobutyl Ether			2.0E+01	1			5	5/27/05	TTN
7440611	Uranium			3.0E-01	1			5	5/27/05	TTN
1582098	Trifluralin					2.2E-06	1	5	5/27/05	TTN

[a] Acute reference concentrations are generally based on a one-hour exposure.
[b] Chronic reference concentrations are based on exposures of a greater duration than 12% of a lifetime of 70 years, so human exposures of more than 8 years are considered chronic.
[c] Cancer risks are calculated based on a lifetime exposure duration (70 years)

Table D-2. Unit risk factors and reference concentrations (“tblUnitRisk”).

CAS	Chemical	Acute Inhalation (µg/m^3)	Selection Code Acute Inhalation	Chronic Inhalation (µg/m^3)	Selection Code Chronic Inhalation	Inhalation Cancer UnitRisk (µg/m^3)$^{-1}$	Selection Code Inhalation CancerUR	Citation ID	Citation Date	Source
111900	Diethylene Glycol Monoethyl Ether			3.0E+00	1			6	5/27/05	RAIS
62533	Aniline			1.0E+00	1	1.6E-06	1	1	3/29/05	OEHHA/ARB
62533	Aniline			1.0E+00				2	5/25/05	EPA IRIS
101779	4,4'-Methylenedianiline			2.0E+01	1	4.6E-04	1	1	3/29/05	OEHHA/ARB
126998	Chloroprene			1.0E+00	1			1	3/29/05	OEHHA/ARB
40321764	1,2,3,7,8-Pentachlorodibenzo-p-Dioxin			4.0E-05	1	3.8E+01	1	1	3/29/05	OEHHA/ARB
70648269	1,2,3,4,7,8-Hexachlorodibenzofuran			4.0E-04	1	3.8E+00	1	1	3/29/05	OEHHA/ARB
57117449	1,2,3,6,7,8-Hexachlorodibenzofuran			4.0E-04	1	3.8E+00	1	1	3/29/05	OEHHA/ARB
72918219	1,2,3,7,8,9-Hexachlorodibenzofuran			4.0E-04	1	3.8E+00	1	1	3/29/05	OEHHA/ARB
60851345	2,3,4,6,7,8-Hexachlorodibenzofuran			4.0E-04	1	3.8E+00	1	1	3/29/05	OEHHA/ARB
39227286	1,2,3,4,7,8-Hexachlorodibenzo-p-Dioxin			4.0E-04	1	3.8E+00	1	1	3/29/05	OEHHA/ARB
51207319	2,3,7,8-Tetrachlorodibenzofuran			4.0E-04	1	3.8E+00	1	1	3/29/05	OEHHA/ARB
67562394	1,2,3,4,6,7,8-Heptachlorodibenzofuran			4.0E-03	1	3.8E-01	1	1	3/29/05	OEHHA/ARB
35822469	1,2,3,4,6,7,8-Heptachlorodibenzo-p-Dioxin			4.0E-03	1	3.8E-01	1	1	3/29/05	OEHHA/ARB

[a] Acute reference concentrations are generally based on a one-hour exposure.
[b] Chronic reference concentrations are based on exposures of a greater duration than 12% of a lifetime of 70 years, so human exposures of more than 8 years are considered chronic.
[c] Cancer risks are calculated based on a lifetime exposure duration (70 years)

Table D-2. Unit risk factors and reference concentrations ("tblUnitRisk").

CAS	Chemical	Acute Inhalation ($\mu g/m^3$)	Selection Code Acute Inhalation	Chronic Inhalation ($\mu g/m^3$)	Selection Code Chronic Inhalation	Inhalation Cancer UnitRisk $(\mu g/m^3)^{-1}$	Selection Code Inhalation CancerUR	Citation ID	Citation Date	Source
55673897	1,2,3,4,7,8,9-Heptachlorodibenzofuran			4.0E-03	1	3.8E-01	1	1	3/29/05	OEHHA/ARB
57653857	1,2,3,6,7,8-Hexachlorodibenzo-p-Dioxin			4.0E-04	1	3.8E+00	1	1	3/29/05	OEHHA/ARB
57653857	1,2,3,6,7,8-Hexachlorodibenzo-p-Dioxin					1.3E+00	2	2	5/25/05	EPA IRIS
19408743	1,2,3,7,8,9-Hexachlorodibenzo-p-Dioxin			4.0E-04	1	3.8E+00	1	1	3/29/05	OEHHA/ARB
19408743	1,2,3,7,8,9-Hexachlorodibenzo-p-Dioxin					1.3E+00	2	2	5/25/05	EPA IRIS
1746016	2,3,7,8-Tetrachlorodibenzo-p-Dioxin			4.0E-05	1	3.8E+01	1	1	3/29/05	OEHHA/ARB
1746016	2,3,7,8-Tetrachlorodibenzo-p-Dioxin			4.0E-05		3.3E+01	2	5	5/26/05	EPA TTN
140885	Ethyl Acrylate			4.8E+01	1			1	3/29/05	OEHHA/ARB
140885	Ethyl Acrylate					1.4E-05	1	5	5/26/05	EPA TTN
7647010	Hydrochloric Acid	2.1E+03	1	9.0E+00	1			1	3/29/05	OEHHA/ARB
7647010	Hydrochloric Acid			2.0E+01	2			2	5/25/05	EPA IRIS
7664393	Hydrogen Fluoride	2.4E+02	1	1.4E+01	1			1	3/29/05	OEHHA/ARB
108316	Maleic Anhydride			7.0E-01	1			1	3/29/05	OEHHA/ARB
85449	Phthalic Anhydride			2.0E+01	1			1	3/29/05	OEHHA/ARB
50328	Benzo[a]Pyrene					1.1E-03	1	1	3/29/05	OEHHA/ARB
205992	Benzo[b]Fluoranthene					1.1E-04	1	1	3/29/05	OEHHA/ARB
207089	Benzo[k]Fluoranthene					1.1E-04	1	1	3/29/05	OEHHA/ARB
218019	Chrysene					1.1E-05	1	1	3/29/05	OEHHA/ARB

[a] Acute reference concentrations are generally based on a one-hour exposure.
[b] Chronic reference concentrations are based on exposures of a greater duration than 12% of a lifetime of 70 years, so human exposures of more than 8 years are considered chronic.
[c] Cancer risks are calculated based on a lifetime exposure duration (70 years)

Table D-2. Unit risk factors and reference concentrations ("tblUnitRisk").

CAS	Chemical	Acute Inhalation (µg/m³)	Selection Code Acute Inhalation	Chronic Inhalation (µg/m³)	Selection Code Chronic Inhalation	Inhalation Cancer UnitRisk (µg/m³)⁻¹	Selection Code Inhalation CancerUR	Citation ID	Citation Date	Source
53703	Dibenzo[a,h]Anthracene					1.2E-03	1	1	3/29/05	OEHHA/ARB
193395	Indeno[1,2,3-c,d]Pyrene					1.1E-04	1	1	3/29/05	OEHHA/ARB
75569	Propylene Oxide	3.1E+03	1	3.0E+01	1	3.7E-06	1	1	3/29/05	OEHHA/ARB
75569	Propylene Oxide			3.0E+01		3.7E-06		2	5/25/05	EPA IRIS
2	Dioxin:4D Total			4.0E-05	1	3.8E+01	1	8	5/27/05	CancerUR: South Coast AQMD; ChronicUR: TEF Extrapolation
3	Dioxin:5D Total			2.0E-05	1	1.9E+01	1	8	5/27/05	CancerUR: South Coast AQMD; ChronicUR: TEF Extrapolation
8	Furan:5F Total			2.0E-05	1	1.9E+01	1	8	5/27/05	CancerUR: South Coast AQMD; ChronicUR: TEF Extrapolation
7	Furan:4F Total			4.0E-04	1	3.8E+00	1	8	5/27/05	CancerUR: South Coast AQMD; ChronicUR: TEF Extrapolation
9	Furan:6F Total			4.0E-04	1	3.8E+00	1	8	5/27/05	CancerUR: South Coast AQMD; ChronicUR: TEF Extrapolation
4	Dioxin:6D Total					1.3E+00	1	9	5/27/05	EPA IRIS

[a] Acute reference concentrations are generally based on a one-hour exposure.
[b] Chronic reference concentrations are based on exposures of a greater duration than 12% of a lifetime of 70 years, so human exposures of more than 8 years are considered chronic.
[c] Cancer risks are calculated based on a lifetime exposure duration (70 years)

Table D-2. Unit risk factors and reference concentrations (“tblUnitRisk”).

CAS	Chemical	Acute Inhalation (µg/m^3)	Selection Code Acute Inhalation	Chronic Inhalation (µg/m^3)	Selection Code Chronic Inhalation	Inhalation Cancer UnitRisk (µg/m^3)$^{-1}$	Selection Code Inhalation CancerUR	Citation ID	Citation Date	Source
5	Dioxin:7D Total			4.0E-03	1	3.8E-01	1	8	5/27/05	CancerUR: South Coast AQMD; ChronicUR: TEF Extrapolation
10	Furan:7F Total			4.0E-03	1	3.8E-01	1	8	5/27/05	CancerUR: South Coast AQMD; ChronicUR: TEF Extrapolation
79107	Acrylic Acid	6.0E+03	1	1.0E+00	1			1	6/1/05	OEHHA/ARB
79107	Acrylic Acid			1.0E+00				2	6/1/05	EPA IRIS
107051	Allyl Chloride			1.0E+00	1	6.0E-06	1	1	6/1/05	OEHHA/ARB
107051	Allyl Chloride			1.0E+00				2	6/1/05	EPA IRIS
100447	Benzyl Chloride	2.4E+02	1	1.2E+01	1	4.9E-05	1	1	6/1/05	OEHHA/ARB
106898	1-Chloro-2,3-Epoxypropane	1.3E+03	1	3.0E+00	1	2.3E-05	1	1	6/1/05	OEHHA/ARB
106898	1-Chloro-2,3-Epoxypropane			1.0E+00	2	1.2E-06	2	2	6/1/05	EPA IRIS
118741	Hexachlorobenzene			2.8E+00	1	5.1E-04	1	1	6/1/05	OEHHA/ARB
118741	Hexachlorobenzene					4.6E-04	2	2	6/1/05	EPA IRIS
118741	Hexachlorobenzene			3.0E+00	2			5	6/1/05	EPA TTN
822060	Hexamethylene Diisocyanate			1.0E-02	1			2	6/1/05	EPA IRIS
78591	Isophorone			2.0E+03	1			1	6/1/05	OEHHA/ARB
78591	Isophorone					2.7E-07	1	5	6/1/05	EPA TTN
7803512	Phosphine			8.0E-01	1			1	6/1/05	OEHHA/ARB
7803512	Phosphine			3.0E-01	2			2	6/1/05	EPA IRIS
1336363	Polychlorinated Biphenyls			1.2E+00	1	2.0E-05	1	1	6/1/05	OEHHA/ARB
1336363	Polychlorinated Biphenyls					1.0E-04	2	2	6/1/05	EPA IRIS

[a] Acute reference concentrations are generally based on a one-hour exposure.
[b] Chronic reference concentrations are based on exposures of a greater duration than 12% of a lifetime of 70 years, so human exposures of more than 8 years are considered chronic.
[c] Cancer risks are calculated based on a lifetime exposure duration (70 years).

Table D-3. List of range-related and other risk factor uncertainties.

Range-Related Uncertainties

CAS No.	Chemical Species	Source	Description of the Source of Uncertainty	Range Endpoint (High or Low End)	UR Factor or RfC	Risk Type (units of measure)	Toxicity-Weighted Emissions (equivalent tons per day)		
							Area Sources	On-Road Mobile Sources	Point Sources
71432	Benzene	EPA IRIS	A range from 2.2×10^{-6} to 7.8×10^{-6} (rather than a single value) was reported for the UR factor.[a]	Low	2.2×10^{-6}	Cancer $(\mu g/m^3)^{-1}$	6.8×10^{-6}	9.1×10^{-6}	65×10^{-6}
				High	7.8×10^{-6}		24×10^{-6}	32×10^{-6}	235×10^{-6}
18540299	Chromium (VI)	EPA IRIS	The low value applies to nasal septum atrophy. The high value applies to lactate dehydrogenase in bronchioalveolar lavage fluid.[a]	Low	8.0×10^{-3}	Chronic $(\mu g/m^3)$	---	---	0.043
				High	1.0×10^{-1}		---	---	0.55
106934	Ethylene Dibromide (1,2-Dibromoethane)	EPA IRIS	The low value is an estimate of the central tendency of the UR factor. The high value is an estimate of the upper bound of the 95% confidence interval of the UR factor.[a]	Low	3.0×10^{-4}	Cancer $(\mu g/m^3)^{-1}$	---	---	41×10^{-6}
				High	6.0×10^{-4}		---	---	80×10^{-6}
111762	Butyl Cellosolve (Ethylene Glycol Monobutyl Ether, EGBE)	OEHHA/ ARB	An extremely large difference between alternative sources of information was noted. The RfC reported by OEHHA/ARB was 20 $\mu g/m^3$ for chronic effects. The RfC listed by EPA IRIS was 13 mg/m^3 (13,000 $\mu g/m^3$) for chronic effects. (The value reported by OEHHA/ARB was used in the TAC inventory.)	Low	2.0×10^{1}	Chronic $(\mu g/m^3)$	0.00033	---	7.5
				High	1.3×10^{4}		0.22	---	0.012
75014	Vinyl Chloride	EPA IRIS	The low value applies to continuous lifetime exposure during adulthood. The high value applies to continuous lifetime exposure from birth.[a]	Low	4.4×10^{-6}	Cancer $(\mu g/m^3)^{-1}$	0.017×10^{-6}	---	20×10^{-6}
				High	8.8×10^{-6}		0.034×10^{-6}	---	40×10^{-6}

[a] Selection codes of "2" or "3" were assigned to the listed UR factors or RfCs; therefore, the reported uncertainties do not directly affect the TAC inventories prepared for the BAAQMD. Only if selection codes are revised to apply the listed UR factors or RfCs (i.e., selection codes of "1" assigned) will the reported uncertainties directly affect the TAC inventories.

[b] "The unit risk should not be used if the air concentration exceeds 4 $\mu g/m^3$, since above this concentration the unit risk may not be appropriate." (IRIS).

[c] "The Ethylbenzene cancer toxicity values have been withdrawn by NCEA. This chemical is now being reassessed for IRIS which automatically flags further use of any provisional cancer or non-cancer assessments. However, the RAIS has retained these values and added appropriate footnotes." (RAIS).

[d] "These subchronic and chronic non-cancer toxicity values are found in Agency documents, but were calculated by alternative methods that are not currently practiced by the RfD/RfC Work Group. These values are considered to be adequate provisional values for risk assessment purposes at Superfund and RCRA sites, but are subject to be reviewed by the RfD/RfC Work Group and revised when necessary to reflect current work group practices." (RAIS).

Table D-3. Range-related and other quantifiable uncertainties.

Other Quantifiable Uncertainties

CAS No.	Chemical Species	Source	Description of the Source of Uncertainty	UR Factor or RfC	Risk Type (units of measure)	Toxicity-Weighted Emissions (equivalent tons per day)		
						Area Sources	On-Road Mobile Sources	Point Sources
7440417	Beryllium	EPA IRIS	The reported UR factor only applies up to a maximum ambient concentration of 4 $\mu g/m^3$.[b]	2.4×10^{-3}	Cancer $(\mu g/m^3)^{-1}$	---	---	1.1×10^{-6}
100414	Ethyl Benzene	RAIS	The reported UR factor is currently being reassessed.[c]	1.1×10^{-6}	Cancer $(\mu g/m^3)^{-1}$	1.6×10^{-6}	2.1×10^{-6}	17×10^{-6}
75343	Ethylidene Dichloride (1,1-Dichloroethane)	RAIS	The reported RfC is a provisional value, which was calculated by alternative methods.[d]	5.0×10^{2}	Chronic $(\mu g/m^3)$	0.0031×10^{-6}	---	---
7440473	Chromium compounds	OEHHA/ARB	No UR factors were reported. STI assumed that 5% of unspecified chromium was emitted as Chromium (VI) and applied the UR/RfC for Chromium (VI) to those emissions.	1.5×10^{-1}	Cancer $(\mu g/m^3)^{-1}$	3700×10^{-6}	420×10^{-6}	---
7440473	Chromium compounds	OEHHA/ARB	No RfC was reported. STI assumed that 5% of unspecified chromium was emitted as Chromium (VI) and applied the UR/RfC for Chromium (VI) to those emissions.	2.0×10^{-1}	Chronic $(\mu g/m^3)$	3	0.014	---

[a] Selection codes of "2" or "3" were assigned to the listed UR factors or RfCs; therefore, the reported uncertainties do not directly affect the TAC inventories prepared for the BAAQMD. Only if selection codes are revised to apply the listed UR factors or RfCs (i.e., selection codes of "1" assigned) will the reported uncertainties directly affect the TAC inventories.

[b] "The unit risk should not be used if the air concentration exceeds 4 $\mu g/m^3$, since above this concentration the unit risk may not be appropriate." (IRIS).

[c] "The Ethylbenzene cancer toxicity values have been withdrawn by NCEA. This chemical is now being reassessed for IRIS which automatically flags further use of any provisional cancer or non-cancer assessments. However, the RAIS has retained these values and added appropriate footnotes." (RAIS).

[d] "These subchronic and chronic non-cancer toxicity values are found in Agency documents, but were calculated by alternative methods that are not currently practiced by the RfD/RfC Work Group. These values are considered to be adequate provisional values for risk assessment purposes at Superfund and RCRA sites, but are subject to be reviewed by the RfD/RfC Work Group and revised when necessary to reflect current work group practices." (RAIS).

TABLE STRUCTURES, FILE DOCUMENTATION, AND PROCEDURAL STEPS

Table D-4 documents the tables structure for the compilation of cancer URs and non-cancer RfCs by citation source to form "tblUnitRisk".

Table D-4. Table structure for "tblUnitRisk".

Field	Data Type	Description
CAS	String	Chemical Abstracts Service number.
Chemical	String	Chemical Name.
HAPCategoryName	String	
PollutantType	String	HAP.
AcuteInhalation(ug/m3)	Double	Reference Concentration (RfC) for Acute Inhalation.
SelectionCodeAcuteInhalation	Long Integer	Beginning with 1 where 1 denotes preferred value.
ChronicInhalation(ug/m3)	Double	Reference Concentration (RfC) for Chronic Inhalation.
SelectionCodeChronicInhalation	Long Integer	Beginning with 1 where 1 denotes preferred value.
InhalationCancerUnitRisk(ug/m3)-1	Double	Unit risk factor for Inhalation Cancer.
SelectionCodeInhalationCancerUR	Long Integer	Beginning with 1 where 1 denotes preferred value.
CitationID	Long Integer	Full citation stored in tblCitation.
CitationDate	Date/Time	Date last accessed.
Source	String	Abbreviated citation (e.g., IRIS, OEHHA, etc.)
Notes	String	Processing or summary notes.

Selection code queries were developed individually from the above table, then rejoined to form a complete table, "CancerAndNonCancerUnitRiskFactors," for use in estimating risk-weighted emissions. Additional fields combining URs or RfCs with selection codes 1, 2, or 3 were included for use in estimating risk-weighted emissions where comparisons between primary and alternative factors are desired. For example, field "CancerUR1" contains UR factors with a selection code of 1 only, field "CancerUR1,2" contains UR factors with selection codes 1 or 2 where selection code 2 UR factors replace selection code 1 UR factors where available, etc. Selection code 1 denotes the primary factor, 2 and 3 denote alternative factors. Additional alternative factors can be added by beginning with selection code 4, etc. (additional selection code queries will need to be added along with revising summary queries).

Table D-5 documents the table structure for the complete table of primary and alternative factors for use in risk-weighting emission.

Table D-5. Table structure for "CancerAndNonCancerUnitRiskFactors".

Field	Description
CAS	Chemical Abstracts Service number.
Chemical	Chemical Name.
HAPCategoryName	
CancerUR1	Inhalation Cancer Unit Risk Factor $(ug/m3)^{-1}$ for Selection Code 1.
CancerUR1,2	Inhalation Cancer Unit Risk Factor $(ug/m3)^{-1}$ for Selection Codes 1 & 2 where Selection Code 2 URs replace Code 1 where available.
CancerUR1,3	Inhalation Cancer Unit Risk Factor $(ug/m3)^{-1}$ for Selection Codes 1 & 3 where Selection Code 3 URs replace Code 1 where available.
Chronic RfC1	Chronic Inhalation Reference Concentration (RfC) (ug/m3) for Selection Code 1.
Chronic RfC1,2	Chronic Inhalation Reference Concentration (RfC) (ug/m3) for Selection Codes 1 & 2 where Selection Code 2 RfCs replace Code 1 where available.
Chronic RfC1,3	Chronic Inhalation Reference Concentration (RfC) (ug/m3) for Selection Codes 1 & 3 where Selection Code 3 RfCs replace Code 1 where available.
Acute RfC1	Acute Inhalation Reference Concentration (RfC) (ug/m3) for Selection Code 1.
Acute RfC1,2	Acute Inhalation Reference Concentration (RfC) (ug/m3) for Selection Codes 1 & 2 where Selection Code 2 RfCs replace Code 1 where available.
Acute RfC1,3	Acute Inhalation Reference Concentration (RfC) (ug/m3) for Selection Codes 1 & 3 where Selection Code 3 RfCs replace Code 1 where available.

Table D-6 provides the complete table of primary and alternative UR factors and RfCs for use in toxicity-weighting emissions.

Toxicity-weighted emissions for cancer due to inhalation exposure are calculated according to Equation D-1.

$$\text{Emissions} \times UR_i \div UR_X = \text{Toxicity-Weighted Emissions} \qquad \textbf{(D-1)}$$

where:

Emissions = Mass-based emissions of a TAC species *i*; **lbs/day**

UR_i = UR factor for TAC species *i*, or the expected change in the number of cases of cancer per hundred thousand individuals exposed per unit change in ambient concentration; **$(\mu g/m^3)^{-1}$**

UR_X = UR factor for a hypothetical compound "X" ≡ 1 $(\mu g/m^3)^{-1}$

Toxicity-Weighted Emissions = Equivalent emissions of hypothetical compound "X", which would be expected to pose a risk equal to that of the mass of the TAC species *i*; **equivalent lbs/day**

Toxicity-weighted emissions for acute or chronic effects due to inhalation exposure are calculated according to Equation D-2.

$$\text{Emissions} \div RfC_i \times RfC_Y = \text{Toxicity-Weighted Emissions} \qquad \textbf{(D-2)}$$

where:

Emissions = Mass-based emissions of a TAC species i; **lbs/day**

RfCi = RfC for TAC species i; **$\mu g/m^3$**

RfCY = RfC for hypothetical compound "Y" ≡ 1 $\mu g/m^3$

Toxicity-Weighted Emissions = Equivalent emissions of hypothetical compound "Y", which would be expected to pose a risk equal to that of the mass of the TAC species i; **equivalent lbs/day**

Table D-6. Primary and alternative factors for use in toxicity-weighted emission comparisons (“CancerAndNonCancerUnitRiskFactors”).

CAS	Chemical	CancerUR 1	CancerUR 1,2	CancerUR 1,3	ChronicRfC 1	ChronicRfC 1,2	ChronicRfC 1,3	AcuteRf 1	AcuteRfC 1,2	AcuteRfC 1,3
1332214	Asbestos [1/(100 PCM fibers/m^3)]^-1	6.3E-02	6.3E-02	6.3E-02						
5	Dioxin:7D Total	3.8E-01	3.8E-01	3.8E-01	4.0E-03	4.0E-03	4.0E-03			
3	Dioxin:5D Total	1.9E+01	1.9E+01	1.9E+01	2.0E-05	2.0E-05	2.0E-05			
2	Dioxin:4D Total	3.8E+01	3.8E+01	3.8E+01	4.0E-05	4.0E-05	4.0E-05			
8	Furan:5F Total	1.9E+01	1.9E+01	1.9E+01	2.0E-05	2.0E-05	2.0E-05			
DPM-2.5	Diesel Particulates	3.0E-04	3.0E-04	3.0E-04	5.0E+00	5.0E+00	5.0E+00			
7	Furan:4F Total	3.8E+00	3.8E+00	3.8E+00	4.0E-04	4.0E-04	4.0E-04			
9	Furan:6F Total	3.8E+00	3.8E+00	3.8E+00	4.0E-04	4.0E-04	4.0E-04			
10	Furan:7F Total	3.8E-01	3.8E-01	3.8E-01	4.0E-03	4.0E-03	4.0E-03			
4	Dioxin:6D Total	1.3E+00	1.3E+00	1.3E+00						
DPM-10	Diesel Particulates	3.0E-04	3.0E-04	3.0E-04	5.0E+00	5.0E+00	5.0E+00			
79345	1,1,2,2-Tetrachloroethane	5.8E-05	5.8E-05	5.8E-05						
79005	1,1,2-Trichloroethane	1.6E-05	1.6E-05	1.6E-05						
106887	1,2-Epoxybutane				2.0E+01	2.0E+01	2.0E+01			
106990	1,3-Butadiene	1.7E-04	3.0E-05	1.7E-04	2.0E+01	2.0E+00	2.0E+01			
542756	1,3-Dichloropropene	1.6E-05	4.0E-06	1.6E-05	2.0E+01	2.0E+01	2.0E+01			
106467	1,4-Dichlorobenzene	1.1E-05	1.1E-05	1.1E-05	8.0E+02	8.0E+02	8.0E+02			
584849	2,4-Toluene Diisocyanate	1.1E-05	1.1E-05	1.1E-05	7.0E-02	7.0E-02	7.0E-02			
101779	4,4'-Methylenedianiline	4.6E-04	4.6E-04	4.6E-04	2.0E+01	2.0E+01	2.0E+01			
101688	4,4'-Methylenediphenyl Diisocyanate				7.0E-01	6.0E-01	7.0E-01			
75070	Acetaldehyde	2.7E-06	2.2E-06	2.7E-06	9.0E+00	9.0E+00	9.0E+00			
107028	Acrolein				6.0E-02	2.0E-02	6.0E-02	1.9E-01	1.9E-01	1.9E-01
79107	Acrylic Acid				1.0E+00	1.0E+00	1.0E+00	6.0E+03	6.0E+03	6.0E+03
107131	Acrylonitrile	2.9E-04	6.8E-05	2.9E-04	5.0E+00	2.0E+00	5.0E+00			
107051	Allyl Chloride	6.0E-06	6.0E-06	6.0E-06	1.0E+00	1.0E+00	1.0E+00			
62533	Aniline	1.6E-06	1.6E-06	1.6E-06	1.0E+00	1.0E+00	1.0E+00			
7440360	Antimony				2.0E-01	2.0E-01	2.0E-01			
7440382	Arsenic	3.3E-03	4.3E-03	3.3E-03	3.0E-02	3.0E-02	3.0E-02	1.9E-01	1.9E-01	1.9E-01

Table D-6. Primary and alternative factors for use in toxicity-weighted emission comparisons (“CancerAndNonCancerUnitRiskFactors”).

CAS	Chemical	CancerUR 1	CancerUR 1,2	CancerUR 1,3	ChronicRfC 1	ChronicRfC 1,2	ChronicRfC 1,3	AcuteRf 1	AcuteRfC 1,2	AcuteRfC 1,3
71432	Benzene	2.9E-05	7.8E-06	2.2E-06	6.0E+01	3.0E+01	6.0E+01	1.3E+03	1.3E+03	1.3E+03
71432	Benzene	2.9E-05	7.8E-06	2.2E-06	6.0E+01	3.0E+01	6.0E+01	1.3E+03	1.3E+03	1.3E+03
100447	Benzyl Chloride	4.9E-05	4.9E-05	4.9E-05	1.2E+01	1.2E+01	1.2E+01	2.4E+02	2.4E+02	2.4E+02
7440417	Beryllium	2.4E-03	2.4E-03	2.4E-03	7.0E-03	2.0E-02	7.0E-03			
117817	Bis(2-Ethylhexyl)Phthalate	2.4E-06	2.4E-06	2.4E-06	7.0E+01	1.0E+01	7.0E+01			
7440439	Cadmium	4.2E-03	1.8E-03	4.2E-03	2.0E-02	2.0E-02	2.0E-02			
75150	Carbon Disulfide				8.0E+02	7.0E+02	8.0E+02	6.2E+03	6.2E+03	6.2E+03
56235	Carbon Tetrachloride	4.2E-05	1.5E-05	4.2E-05	4.0E+01	1.9E+02	4.0E+01	1.9E+03	1.9E+03	1.9E+03
7782505	Chlorine				2.0E-01	2.0E-01	2.0E-01	2.1E+02	2.1E+02	2.1E+02
108907	Chlorobenzene				1.0E+03	1.0E+03	1.0E+03			
67663	Chloroform	5.3E-06	2.3E-05	5.3E-06	3.0E+02	9.8E+01	3.0E+02	1.5E+02	1.5E+02	1.5E+02
126998	Chloroprene				1.0E+00	1.0E+00	1.0E+00			
18540299	Chromium (VI)	1.5E-01	1.2E-02	1.5E-01	2.0E-01	8.0E-03	1.0E-01			
7440484	Cobalt	2.8E-03	2.8E-03	2.8E-03	1.0E-01	2.0E-02	1.0E-01			
1319773	Cresol				6.0E+02	6.0E+02	6.0E+02			
98828	Cumene				4.0E+02	4.0E+02	4.0E+02			
111422	Diethanolamine				3.0E+00	3.0E+00	3.0E+00			
60851345	2,3,4,6,7,8-Hexachlorodibenzofuran	3.8E+00	3.8E+00	3.8E+00	4.0E-04	4.0E-04	4.0E-04			
57653857	1,2,3,6,7,8-Hexachlorodibenzo-p-Dioxin	3.8E+00	1.3E+00	3.8E+00	4.0E-04	4.0E-04	4.0E-04			
57117449	1,2,3,6,7,8-Hexachlorodibenzofuran	3.8E+00	3.8E+00	3.8E+00	4.0E-04	4.0E-04	4.0E-04			
35822469	1,2,3,4,6,7,8-Heptachlorodibenzo-p-Dioxin	3.8E-01	3.8E-01	3.8E-01	4.0E-03	4.0E-03	4.0E-03			
1746016	2,3,7,8-Tetrachlorodibenzo-p-Dioxin	3.8E+01	3.3E+01	3.8E+01	4.0E-05	4.0E-05	4.0E-05			

Table D-6. Primary and alternative factors for use in toxicity-weighted emission comparisons ("CancerAndNonCancerUnitRiskFactors").

CAS	Chemical	CancerUR 1	CancerUR 1,2	CancerUR 1,3	ChronicRfC 1	ChronicRfC 1,2	ChronicRfC 1,3	AcuteRf 1	AcuteRfC 1,2	AcuteRfC 1,3
40321764	1,2,3,7,8-Pentachlorodibenzo-p-Dioxin	3.8E+01	3.8E+01	3.8E+01	4.0E-05	4.0E-05	4.0E-05			
19408743	1,2,3,7,8,9-Hexachlorodibenzo-p-Dioxin	3.8E+00	1.3E+00	3.8E+00	4.0E-04	4.0E-04	4.0E-04			
39227286	1,2,3,4,7,8-Hexachlorodibenzo-p-Dioxin	3.8E+00	3.8E+00	3.8E+00	4.0E-04	4.0E-04	4.0E-04			
55673897	1,2,3,4,7,8,9-Heptachlorodibenzofuran	3.8E-01	3.8E-01	3.8E-01	4.0E-03	4.0E-03	4.0E-03			
51207319	2,3,7,8-Tetrachlorodibenzofuran	3.8E+00	3.8E+00	3.8E+00	4.0E-04	4.0E-04	4.0E-04			
70648269	1,2,3,4,7,8-Hexachlorodibenzofuran	3.8E+00	3.8E+00	3.8E+00	4.0E-04	4.0E-04	4.0E-04			
72918219	1,2,3,7,8,9-Hexachlorodibenzofuran	3.8E+00	3.8E+00	3.8E+00	4.0E-04	4.0E-04	4.0E-04			
67562394	1,2,3,4,6,7,8-Heptachlorodibenzofuran	3.8E-01	3.8E-01	3.8E-01	4.0E-03	4.0E-03	4.0E-03			
106898	1-Chloro-2,3-Epoxypropane	2.3E-05	1.2E-06	2.3E-05	3.0E+00	1.0E+00	3.0E+00	1.3E+03	1.3E+03	1.3E+03
140885	Ethyl Acrylate	1.4E-05	1.4E-05	1.4E-05	4.8E+01	4.8E+01	4.8E+01			
75003	Ethyl Chloride				3.0E+04	1.0E+04	3.0E+04			
100414	Ethyl Benzene	1.1E-06	1.1E-06	1.1E-06	2.0E+03	1.0E+03	2.0E+03			
106934	Ethylene Dibromide	7.1E-05	6.0E-04	3.0E-04	8.0E-01	9.0E+00	8.0E-01			
107062	Ethylene Dichloride	2.1E-05	2.6E-05	2.1E-05	4.0E+02	2.4E+03	4.0E+02			
107211	Ethylene Glycol				4.0E+02	4.0E+02	4.0E+02			
75218	Ethylene Oxide	8.8E-05	8.8E-05	8.8E-05	3.0E+01	3.0E+01	3.0E+01			
75343	Ethylidene Dichloride (1,1-Dichloroethane)	1.6E-06	1.6E-06	1.6E-06	5.0E+02	5.0E+02	5.0E+02			

Table D-6. Primary and alternative factors for use in toxicity-weighted emission comparisons ("CancerAndNonCancerUnitRiskFactors").

CAS	Chemical	CancerUR 1	CancerUR 1,2	CancerUR 1,3	ChronicRfC 1	ChronicRfC 1,2	ChronicRfC 1,3	AcuteRf 1	AcuteRfC 1,2	AcuteRfC 1,3
50000	Formaldehyde	6.0E-06	1.3E-05	5.5E-09	3.0E+00	9.8E+00	3.0E+00	9.4E+01	9.4E+01	9.4E+01
111159	Cellosolve Acetate				3.0E+02	3.0E+02	3.0E+02	1.4E+02	1.4E+02	1.4E+02
110496	Ethylene Glycol Monomethyl Ether Acetate				9.0E+01	9.0E+01	9.0E+01			
112345	Diethylene Glycol Monobutyl Ether				2.0E+01	2.0E+01	2.0E+01			
110805	Cellosolve Solvent				7.0E+01	2.0E+02	7.0E+01	3.7E+02	3.7E+02	3.7E+02
107982	Propylene Glycol Monoethyl Ether				7.0E+03	7.0E+03	7.0E+03			
111900	Diethylene Glycol Monoethyl Ether				3.0E+00	3.0E+00	3.0E+00			
111762	Butyl Cellosolve				2.0E+01	1.3E+04	2.0E+01	1.4E+04	1.4E+04	1.4E+04
109864	Ethylene Glycol Methyl Ether				6.0E+01	2.0E+01	6.0E+01	9.3E+01	9.3E+01	9.3E+01
118741	Hexachlorobenzene	5.1E-04	4.6E-04	5.1E-04	2.8E+00	3.0E+00	2.8E+00			
822060	Hexamethylene Diisocyanate				1.0E-02	1.0E-02	1.0E-02			
110543	Hexane				7.0E+03	2.0E+02	7.0E+03			
7647010	Hydrochloric Acid				9.0E+00	2.0E+01	9.0E+00	2.1E+03	2.1E+03	2.1E+03
7664393	Hydrogen Fluoride				1.4E+01	1.4E+01	1.4E+01	2.4E+02	2.4E+02	2.4E+02
78591	Isophorone	2.7E-07	2.7E-07	2.7E-07	2.0E+03	2.0E+03	2.0E+03			
7439921	Lead	1.2E-05	1.2E-05	1.2E-05	1.5E+00	1.5E+00	1.5E+00			
108316	Maleic Anhydride				7.0E-01	7.0E-01	7.0E-01			
7439965	Manganese				2.0E-01	5.0E-02	2.0E-01			
7439976	Mercury				9.0E-02	3.0E-01	9.0E-02	1.8E+00	1.8E+00	1.8E+00
67561	Methanol				4.0E+03	4.0E+03	4.0E+03	2.8E+04	2.8E+04	2.8E+04
74839	Methyl Bromide				5.0E+00	5.0E+00	5.0E+00	3.9E+03	3.9E+03	3.9E+03
74873	Methyl Chloride	1.8E-06	1.8E-06	1.8E-06	9.0E+01	9.0E+01	9.0E+01			
71556	Methyl Chloroform				1.0E+03	1.0E+03	1.0E+03	6.8E+04	6.8E+04	6.8E+04
78933	Methyl Ethyl Ketone				1.0E+03	5.0E+03	1.0E+03	1.3E+04	1.3E+04	1.3E+04

Table D-6. Primary and alternative factors for use in toxicity-weighted emission comparisons ("CancerAndNonCancerUnitRiskFactors").

CAS	Chemical	CancerUR 1	CancerUR 1,2	CancerUR 1,3	ChronicRfC 1	ChronicRfC 1,2	ChronicRfC 1,3	AcuteRf 1	AcuteRfC 1,2	AcuteRfC 1,3
108101	Methyl Isobutyl Ketone				3.0E+03	3.0E+03	3.0E+03			
80626	Methyl Methacrylate				9.8E+02	7.0E+02	9.8E+02			
1634044	Methyl Tert-Butyl Ether	2.6E-07	2.6E-07	2.6E-07	8.0E+03	3.0E+03	8.0E+03			
75092	Methylene Chloride	1.0E-06	4.7E-07	1.0E-06	4.0E+02	1.0E+03	4.0E+02	1.4E+04	1.4E+04	1.4E+04
68122	N,N-Dimethylformamide				8.0E+01	3.0E+01	8.0E+01			
91203	Naphthalene	3.4E-05	1.0E-04	3.4E-05	9.0E+00	3.0E+00	9.0E+00			
7440020	Nickel	2.6E-04	2.6E-04	2.6E-04	5.0E-02	9.0E-02	5.0E-02	6.0E+00	6.0E+00	6.0E+00
123911	p-Dioxane	7.7E-06	7.7E-06	7.7E-06	3.0E+03	3.0E+03	3.0E+03	3.0E+03	3.0E+03	3.0E+03
108952	Phenol				2.0E+02	2.0E+02	2.0E+02	5.8E+03	5.8E+03	5.8E+03
7803512	Phosphine				8.0E-01	3.0E-01	8.0E-01			
7723140	Phosphorus				7.0E-02	7.0E-02	7.0E-02			
85449	Phthalic Anhydride				2.0E+01	2.0E+01	2.0E+01			
1336363	Polychlorinated Biphenyls	2.0E-05	1.0E-04	2.0E-05	1.2E+00	1.2E+00	1.2E+00			
218019	Chrysene	1.1E-05	1.1E-05	1.1E-05						
50328	Benzo[a]Pyrene	1.1E-03	1.1E-03	1.1E-03						
53703	Dibenzo[a,h]Anthracene	1.2E-03	1.2E-03	1.2E-03						
207089	Benzo[k]Fluoranthene	1.1E-04	1.1E-04	1.1E-04						
205992	Benzo[b]Fluoranthene	1.1E-04	1.1E-04	1.1E-04						
193395	Indeno[1,2,3-c,d]Pyrene	1.1E-04	1.1E-04	1.1E-04						
78875	Propylene Dichloride	1.0E-05	1.9E-05	1.0E-05	4.0E+00	4.0E+00	4.0E+00			
75569	Propylene Oxide	3.7E-06	3.7E-06	3.7E-06	3.0E+01	3.0E+01	3.0E+01	3.1E+03	3.1E+03	3.1E+03
7440611	Uranium				3.0E-01	3.0E-01	3.0E-01			
7782492	Selenium				2.0E+01	2.0E+01	2.0E+01			
100425	Styrene				9.0E+02	1.0E+03	9.0E+02	2.1E+04	2.1E+04	2.1E+04
127184	Tetrachloroethylene	5.9E-06	5.9E-06	5.9E-06	3.5E+01	2.7E+02	3.5E+01	2.0E+04	2.0E+04	2.0E+04
108883	Toluene				3.0E+02	4.0E+02	3.0E+02	3.7E+04	3.7E+04	3.7E+04
79016	Trichloroethylene	2.0E-06	7.0E-05	1.1E-04	6.0E+02	4.0E+01	6.0E+02			

Table D-6. Primary and alternative factors for use in toxicity-weighted emission comparisons ("CancerAndNonCancerUnitRiskFactors").

CAS	Chemical	CancerUR 1	CancerUR 1,2	CancerUR 1,3	ChronicRfC 1	ChronicRfC 1,2	ChronicRfC 1,3	AcuteRf 1	AcuteRfC 1,2	AcuteRfC 1,3
121448	Triethylamine				2.0E+02	7.0E+00	2.0E+02	2.8E+03	2.8E+03	2.8E+03
1582098	Trifluralin	2.2E-06	2.2E-06	2.2E-06						
108054	Vinyl Acetate				2.0E+02	2.0E+02	2.0E+02			
75014	Vinyl Chloride	7.8E-05	8.8E-06	4.4E-06	2.6E+01	1.0E+02	2.6E+01	1.8E+05	1.8E+05	1.8E+05
75354	Vinylidene Chloride	5.0E-05	5.0E-05	5.0E-05	7.0E+01	2.0E+02	7.0E+01			
106423	p-Xylene				7.0E+02	1.0E+02	7.0E+02	2.2E+04	2.2E+04	2.2E+04
108383	m-Xylene				7.0E+02	1.0E+02	7.0E+02	2.2E+04	2.2E+04	2.2E+04
1330207	Xylenes (Mixture of o, m, and p Isomers)				7.0E+02	1.0E+02	7.0E+02	2.2E+04	2.2E+04	2.2E+04
95476	o-Xylene				7.0E+02	1.0E+02	7.0E+02	2.2E+04	2.2E+04	2.2E+04

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