# Residual Risk Assessment for the Pulp & Paper Source Category

**by**
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## Index of Acronyms

| | |
|---|---|
| AERMOD | American Meteorological Society/EPA Regulatory Model |
| AEGL | Acute exposure guideline level |
| ASTDR | US Agency for Toxic Substances and Disease Registry |
| CalEPA | California Environmental Agency |
| CTE | Central Tendency Estimate |
| ERPG | Emergency Response Planning Guideline |
| HAP | Hazardous Air Pollutant |
| HEM | Human Exposure Model |
| HI | Hazard index |
| HQ | Hazard quotient |
| IRIS | Integrated Risk Information System |
| MACT | Maximum Achievable Control Technology |
| MIR | Maximum Individual Risk |
| MOA | Mode of action |
| NAC | National Advisory Committee |
| NAAQS | National Ambient Air Quality Standard |
| NATA | National Air Toxics Assessment |
| NEI | National Emissions Inventory |
| NPRM | Notice of Proposed Rulemaking |
| PB-HAP | Persistent and Bioaccumulative - HAP |
| POM | Polycyclic organic matter |
| REL | Reference exposure level |
| RfC | Reference concentration |
| RfD | Reference dose |
| RME | Reasonable Maximum Exposure |
| RTR | Risk and Technology |
| TOSHI | Target-organ-specific hazard index |
| URE | Unit risk estimate |

# 1 Introduction

Section 112 of the Clean Air Act (CAA) establishes a two-stage regulatory process for addressing emissions of hazardous air pollutants (HAPs) from stationary sources. In the first stage, section 112(d) requires the Environmental Protection Agency (EPA, or the Agency) to develop technology-based standards for categories of sources (e.g., petroleum refineries, pulp and paper mills, etc.) [*1*]. Under section 112(d)(6), EPA must review each of these technology-based standards at least every eight years and revise a standard, as necessary, "taking into account developments in practices, processes and control technologies." In the second stage, EPA is required under section 112(f)(2) to assess the health and environmental risks that remain after implementation of the MACT standards. If additional risk reductions are necessary to protect public health with an ample margin of safety or to prevent an adverse environmental effect, EPA must develop standards to address these remaining risks. This second stage of the regulatory process is known as the residual risk stage. For each source category for which EPA issued MACT standards, the residual risk stage must be completed within eight years of promulgation of the initial technology-based standard.

In December of 2006 we consulted with a panel from the EPA's Science Advisory Board (SAB) on the "Risk and Technology Review (RTR) Assessment Plan" and in June of 2007, we received a letter with the results of that consultation. Subsequent to the consultation, in June of 2009 a meeting was held with an SAB panel for a formal peer review of the "Risk and Technology Review (RTR) Assessment Methodologies" [*2*]. We received the final SAB report on this review in May of 2010 [*3*]. Where appropriate, we have responded to the key messages from this review in developing our current risk assessments and we will be continuing our efforts to improve our assessments by incorporating updates based on the SAB recommendations as they are developed and become available. Our responses to the key recommendations of the SAB are outlined in a memo entitled, "EPA's Actions in Response to Key Recommendations from the SAB Review of RTR Risk Assessment Methodologies" [*4*].

This document contains the methods and the results of baseline risk assessments (i.e., after the implementation of the respective MACT standards) performed for the pulp and paper source category. The methods discussion includes descriptions of the methods used to develop refined estimates of chronic inhalation exposures and human health risks for cancer and noncancer endpoints, as well as descriptions of the methods used to screen for acute health risks, chronic non-inhalation health risks, and adverse environmental effects. Since the screening assessments indicated low potential for chronic non-inhalation health effects or environmental impacts, including effects to threatened and endangered species, no further refinement of these assessments was performed.

# 2 Methods

## 2.1 Emissions and source data

Data from a CAA section 114 information collection request (ICR) were used for this assessment. In February 2011, we issued an ICR to all U.S. pulp and paper manufacturers to gather information needed to conduct the technology review and residual risk requirements of the CAA. The ICR requested available information regarding process equipment, control devices, pulp and paper production, bleaching, inventory data for all pulp and paper point and fugitive emission, practices used to control fugitive emissions, and other aspects of facility operations, including stack parameters and locations. Next, EPA engineers who have extensive knowledge of the characteristics of this industry performed an engineering review and thorough QA/QC of the data to identify limitations and issues. Finally, EPA engineers contacted facility and industry representatives to clarify details and resolve issues with their ICR data submissions. Details on the development of the emissions and source data for this source category are discussed in a memorandum entitled, *Inputs to the Pulp and Paper Industry October 2011 Residual Risk Modeling*, available in the docket for this rule making. Section 3 below provides a summary of the emissions.

## 2.2 Dispersion modeling for inhalation exposure assessment

Both long- and short-term inhalation exposure concentrations and associated health risk from each facility in the source category of interest were estimated using the Human Exposure Model in combination with the American Meteorological Society/EPA Regulatory Model (AERMOD) dispersion modeling system (HEM3). The approach used in applying this modeling system is outlined below, and further details are provided in Appendix 1. The HEM3 performs three main operations: atmospheric dispersion modeling, estimation of individual human exposures and health risks, and estimation of population risks. This section focuses on the dispersion modeling component. The exposure and risk characterization components are discussed in other subsections of Sections 2 and 3.

The dispersion model in the HEM3 system, AERMOD version 11103, is a state-of-the-science Gaussian plume dispersion model that is preferred by EPA for modeling point, area, and volume sources of continuous air emissions from facility applications [*5*]. Further details on AERMOD can be found in the AERMOD Users Guide [*6*]. The model is used to develop annual average ambient concentrations through the simulation of hour-by-hour dispersion from the emission sources into the surrounding atmosphere. Hourly emission rates used for this simulation are generated by evenly dividing the total annual emission rate from the inventory into the 8,760 hours of the year.

The first step in the application of the HEM3 modeling system is to predict ambient concentrations at locations of interest. The AERMOD model options employed are summarized in Table 2.2-1 and are discussed further below.

**Table 2.2-1 AERMOD version 09292 model options for RTR modeling**

| *Modeling Option* | *Selected Parameter for chronic exposure* |
|---|---|
| Type of calculations | Hourly Ambient Concentration |
| Source type | Point, area represented as pseudo point source |
| Receptor orientation | Polar (13 rings and 16 radials)<br>Discrete (census block centroids) and user-supplied receptors |
| Terrain characterization | Actual from USGS 1-degree DEM data |
| Building downwash | Not Included |
| Plume deposition/depletion | Not Included |
| Urban source option | No |
| Meteorology | 1 year representative NWS from nearest site (over 200 stations) |

In HEM3, meteorological data are ordinarily selected from a list of over 200 National Weather Service (NWS) surface observation stations across the continental United States, Alaska, Hawaii, and Puerto Rico. In most cases the nearest station is selected as representative of the conditions at the subject facility. Ideally, when considering off-site meteorological data most site-specific dispersion modeling efforts will employ up to five years of data to capture variability in weather patterns from year to year. However, because we had an insufficient number of appropriately formatted model input files derived from available meteorological data, we modeled only a single year, typically 1991. While the selection of a single year may result in under-prediction of long-term ambient levels at some locations, likewise it may result in over-prediction at others. For each facility identified by its characteristic latitude and longitude coordinates, the closest meteorological station was used in the dispersion modeling. The average distance between a modeled facility and the applicable meteorological station was 40 miles (72 km). Appendix 2 (*Meteorological Data Processing Using AERMET for HEM3*) provides a complete listing of stations and assumptions along with further details used in processing the data through AERMET. The sensitivity of model results to the selection of the nearest weather station and the use of one year of meteorological data is discussed in “Risk and Technology Review (RTR) Risk Assessment Methodologies” [*2*].

The HEM3 system estimates ambient concentrations at the geographic centroids of census blocks (using the 2000 Census), and at other receptor locations that can be specified by the user. The model accounts for the effects of multiple facilities when estimating concentration impacts at each block centroid. Typically we combined only the impacts of facilities within the same source category, and assessed chronic exposure and risk only for census blocks with at least one resident (i.e., locations where people may reasonably be assumed to reside rather than receptor points at the fenceline of a facility). Chronic ambient concentrations were calculated as the annual average of all estimated short-term (one-hour) concentrations at each block centroid. Possible future residential use of currently uninhabited areas was not considered. Census blocks, the finest resolution available in the census data, are typically comprised of approximately 40 people or about ten households. For each facility in this source category census block locations were carefully evaluated for proximity to each facility's property line (see Appendix 7).

In contrast to the development of ambient concentrations for evaluating long-term exposures, which was performed only for occupied census blocks, worst-case short-term (one-hour) concentrations were estimated both at the census block centroids and at points nearer the facility that represent locations where people may be present for short periods, but generally no nearer than 100 meters from the center of the facility (note that for large facilities, this 100-meter ring could still contain locations inside the facility property). Since short-term emission rates were needed to screen for the potential for hazard via acute exposures, and since the ICR contains only annual emission totals, we generally apply the assumption to all source categories that the maximum one-hour emission rate from any source is ten times the average annual hourly emission rate for that source.

The average hourly emissions rate is defined as the total emissions for a year divided by the total number of operating hours in the year. The choice of a factor of ten for acute screening was originally based on engineering judgment. To develop a more robust peak-to-mean emissions factor, and in response to one of the key messages from the SAB consultation on our RTR Assessment Plan, we performed an analysis using a short-term emissions dataset from a number of sources located in Texas (originally reported on by Allen *et al.* 2004)[*7*]. In that report, the Texas Environmental Research Consortium Project compared hourly and annual emissions data for volatile organic compounds for all facilities in a heavily-industrialized 4-county area (Harris, Galveston, Chambers, and Brazoria Counties, TX) over an eleven-month time period in 2001. We obtained the dataset and performed our own analysis, focusing that analysis on sources which reported emitting high quantities of HAP over short periods of time (see Appendix 3, *Analysis of data on short-term emission rates relative to long-term emission rates*). Most peak emission events were less than twice the annual average, the highest was a factor of 74 times the annual average, and the 99th percentile ratio of peak hourly emission rate to the annual hourly emission rate was 9. Based on these results, we typically chose a factor of ten for the initial screening. However, for the pulp and paper source category we have maximum hourly emissions estimates for each process group that indicate that a factor of 2 is more appropriate for this source category. These factors are intended to cover all possible hourly peaks associated with routinely-variable emissions. While there have been some documented emission excursions above this level, our analysis of the data from the Texas Environmental Research Consortium suggests that this factor should cover more than 99 percent of the short-term peak gaseous or volatile HAP emissions from typical industrial sources. We have no data relating specifically to peak short-term emissions of particulate HAP. In the absence of source category-specific data, we use this same default approach for particulate emissions as well.

Census block elevations for HEM3 modeling were determined nationally from the US Geological Service 1-degree digital elevation model (DEM) data files, which have a spatial resolution of about 90 meters. Elevations of polar grid points used in estimating short- and long-term ambient concentrations were assumed to be equal to the highest elevation of any census block falling within the polar grid sector corresponding to the grid point. If a sector does not contain any blocks, the model defaults the elevation to that of the nearest block. If an elevation is not provided for the emission source, the model uses the average elevation of all sectors within the innermost model ring.

In addition to using receptor elevation to determine plume height, AERMOD adjusts the plume's flow if nearby elevated hills are expected to influence the wind patterns. For details on how hill heights were estimated and used in the AERMOD modeling see Appendix 1.

## 2.3 Estimating human inhalation exposure

We used the estimated annual average ambient air concentration of each HAP at each census block centroid as a surrogate for the lifetime inhalation exposure concentration of all the people who reside in the census block. That is, the risk analysis did not consider either the short-term or long-term behavior (mobility) of the exposed populations and its potential influence on their exposure.

We did not address short-term human activity for two reasons. First, our experience with the NATA assessments (which modeled daily activity using EPA's HAPEM model) suggests that, given our current understanding of microenvironment concentrations and daily activities, modeling short-term activity would, on average, reduce risk estimates about 25 percent for particulate HAP; it will also reduce risk estimates for gaseous HAP, but typically by much less. Second, basing exposure estimates on average ambient concentrations at census block centroids may underestimate or overestimate actual exposure concentrations at some residences. Further reducing exposure estimates for the most highly exposed residents by modeling their short-term behavior could add a systematic low bias to these results.

We did not address long-term migration nor population growth or decrease over 70 years, instead basing the assessment on the assumption that each person's predicted exposure is constant over the course of their lifetime which is assumed to be 70 years. In assessing cancer risk, we generally estimated three metrics; the maximum individual risk (MIR), which is defined as the risk associated with a lifetime of exposure at the highest concentration; the population risk distribution; and the cancer incidence. The assumption of not considering short or long-term population mobility does not bias the estimate of the theoretical MIR nor does it affect the estimate of cancer incidence since the total population number remains the same. It does, however, affect the shape of the distribution of individual risks across the affected population, shifting it toward higher estimated individual risks at the upper end and reducing the number of people estimated to be at lower risks, thereby increasing the estimated number of people at specific risk levels.

When screening for potentially significant acute exposures, we used an estimate of the highest hourly ambient concentration at any off-site location as the surrogate for the maximum potential acute exposure concentration for any individual.

## 2.4 Acute Risk Screening and Refined Assessments

In establishing a scientifically defensible approach for the assessment of potential health risks due to acute exposures to HAP, we followed the same general approach that has been used for developing chronic health risk assessments under the residual risk program. That is, we developed a tiered, iterative approach. This approach to risk assessment was endorsed by the National Academy of Sciences in its 1993 publication "Science and Judgment in Risk Assessment" and subsequently was adopted in the EPA's "Residual Risk Report to Congress" in 1999.

The assessment methodology is designed to eliminate from further consideration those facilities for which we have confidence that no acute adverse health effects of concern will occur. To do so, we use what is called a tiered, iterative approach to the assessment. This means that we begin with a screening assessment, which relies on readily available data and uses conservative assumptions that in combination approximate a worst-case exposure. The result of this screening process is that either the facility being assessed poses no potential acute health risks (i.e., it "screens out"), or that it requires further, more refined assessment. A refined assessment could use industry- or site-specific data on the temporal pattern of emissions, the layout of emission points at the facility, the boundaries of the facility, and/or the local meteorology. In some cases, all of these site-specific data would be needed to refine the assessment; in others, lesser amounts of site-specific data can be used to determine that acute exposures are not a concern, and significant additional data collection is not necessary.

Acute health risk screening was performed for each facility as the first step. We used conservative assumptions for emission rates, meteorology, and exposure location. We used the following worst-case assumptions in our screening approach:

- Peak 1-hour emissions were assumed to equal 10 times the average 1-hour emission rates.
- For facilities with multiple emission points, peak 1-hour emissions were assumed to occur at all emission points at the same time.
- For facilities with multiple emission points, 1-hour concentrations at each receptor were assumed to be the sum of the maximum concentrations due to each emission point, regardless of whether those maximum concentrations occurred during the same hour.
- Worst-case meteorology (from one year of local meteorology) was assumed to occur at the same time the peak emission rates occur. The recommended EPA local-scale dispersion model, AERMOD, is used for simulating atmospheric dispersion.
- A person was assumed to be located downwind at the point of maximum impact during this same worst-case 1-hour period, but no nearer to the source than 100 meters.
- The maximum impact was compared to multiple short-term health benchmarks for the HAP being assessed to determine if a possible acute health risk might exist. These benchmarks are described in section 2.6 of this report.

As mentioned above, when we identify acute impacts which exceed their relevant benchmarks, we pursue refining our acute screening estimates to the extent possible. In some cases, this includes the use of a refined emissions multiplier to estimate the peak hourly emission rates from the average rates (rather than the default factor of 10). In other cases, this entails determining the actual physical layout and boundaries of a facility to more accurately gauge where people might reasonable be exposed for an hour. For the pulp and paper source category, maximum hourly emissions estimates were available by emission process group, so we did not use the default emissions multiplier of 10. The memorandum entitled, *Inputs to the Pulp and Paper Industry October 2011 Residual Risk Modeling* includes a detailed description of how the maximum hourly emissions were developed for this source category and can be found in the docket for this rule making. We also conducted a review of the layout of emission points at the facilities with the facility boundaries to determine the maximum off-site acute impact for the facilities that did not screen out during the initial model run. Refer to Appendices 5 and 6 for the detailed results for these sites.

## 2.5 Multipathway and environmental risk screening

The potential for significant human health risks due to exposures via routes other than inhalation (i.e., multipathway exposures) was screened by first determining whether any sources emitted any hazardous air pollutants known to be persistent and bioaccumulative in the environment (PB-HAP)[1]. The PB-HAP compounds or compound classes are identified for the screening from the EPA's Air Toxics Risk Assessment Library [*8*]. Examples of PB-HAP are cadmium compounds, chlordane, chlorinated dibenzodioxins and furans, DDE, heptachlor, hexachlorobenzene, hexachlorocyclohexane, lead compounds, mercury compounds, methoxychlor, polychlorinated biphenyls, polycyclic organic matter (POM), toxaphene, and trifluralin. Emissions of cadmium, lead, mercury, and POM were identified in the emissions inventories for the pulp and paper source category.

With respect to PB-HAP emissions other than lead, emissions were evaluated for potential non-inhalation risks and adverse environmental impacts using our screening scenario which was developed for use with the TRIM.FaTE[2] model. This screening scenario uses environmental media outputs from the peer-reviewed TRIM.FaTE to estimate the maximum potential ingestion risks for any specified emission scenario by using a generic farming/fishing exposure scenario that simulates a subsistence environment. The screening scenario retains many of the ingestion and scenario inputs developed for EPA's Human Health Risk Assessment Protocols (HHRAP) for hazardous waste combustion facilities.[3] In the development of the screening scenario a sensitivity analysis was conducted to ensure that its key design parameters were established such that environmental media concentrations were not underestimated, and to also minimize the occurrence of false positives for human health endpoints. See Appendix 4 for a complete discussion of the development and testing of the screening scenario, as well as for the values of facility-level emission rates developed for screening potentially significant multi-pathway impacts. For the purpose of developing emission rates for our multi-pathway screening, we derived emission levels for each PB-HAP (other than lead) at which the maximum human health risk would be 1 in a million for lifetime cancer risk or a hazard quotient of 1.0 for noncancer impacts.

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[1] Although the two-letter chemical symbol for lead is Pb, in this assessment PB-HAP refers to the many air pollutants known to be persistent and bioaccumulative in the environment. In instances where the report is specifically referring to lead, it is spelled out (i.e., the two-letter chemical symbol for lead is not used in this document*)*.

[2] EPA's Total Risk Integrated Methodology (General Information) http://epa.gov/ttn/fera/trim_gen.html

[3] EPA's Human Health Risk Assessment Protocol (HHRAP) for Hazardous Waste Combustion Facilities; http://www.epa.gov/epaoswer/hazwaste/combust/riskvol.htm#volume1

In evaluating the potential multi-pathway risks from emissions of lead compounds, rather than developing a screening emission rate for them, we compared maximum estimated chronic atmospheric concentrations with the current National Ambient Air Quality Standard (NAAQS) for lead. Values below the NAAQS were considered to have a low potential for multi-pathway risks.

The NAAQS value, a public health policy judgment, incorporated the Agency's most recent health evaluation of air effects of lead exposure for the purposes of setting a national ambient air quality standard. In setting this value, the Administrator promulgated a standard that was requisite to protect public health with an adequate margin of safety. We consider values below the level of the primary NAAQS to protect against multipathway risks because as mentioned above, the primary NAAQS is set as to protect public health with an adequate margin of safety. However, ambient air lead concentrations above the NAAQS are considered to pose the potential for increased risk to public health. We consider this NAAQS assessment to be a refined analysis given: 1) the numerous health studies, detailed risk and exposure analyses, and level of external peer and public review that went into the development of the primary NAAQS for lead, combined with: 2) the site-specific dispersion modeling used in this assessment to estimated ambient lead concentrations due to ferroalloys emissions. It should be noted, however, that this comparison does not account for possible population exposures to lead from sources other than the one being modeled; for example, via consumption of water from untreated local sources or ingestion of locally grown food. Nevertheless, the Administrator judged that such a standard would protect, with an adequate margin of safety, the health of children and other at-risk populations against an array of adverse health effects, most notably including neurological effects, particularly neurobehavioral and neurocognitive effects, in children (73 FR 67007). The Administrator, in setting the standard, also recognized that no evidence-or risk based bright line indicated a single appropriate level. Instead a collection of scientific evidence and other information was used to select the standard from a range of reasonable values (73 FR 67006).

We further note that comparing ambient lead concentrations to the NAAQS for lead, considering the level, averaging time, form and indicator, also informs whether there is the potential for adverse environmental effects. This is because the secondary lead NAAQS, set to protect against adverse welfare effects (including adverse environmental effects), has the same averaging time, form, and level as the primary standard. Thus, ambient lead concentrations above the NAAQS for lead also indicate the potential for adverse environmental effects.

Additionally, we evaluated the potential for significant ecological exposures to non PB-HAP from exceedances of chronic human health inhalation thresholds in the ambient air near these facilities. For this source category, the EPA considered effects to the environment separate from human health risk in order to determine whether it is necessary to set a more stringent standard to prevent an adverse environmental effect.

In considering effects to the environment, the EPA first determined that some HAPs of potential concern with respect to the environment are emitted from sources in this category.

These ecological HAPs are hydrogen chloride (HCl), chlorine, polycyclic organic matter (POM), mercury (Hg), and cadmium (Cd). We included these HAP in our environment analysis because we determined that they have the potential to cause adverse environmental effects. For example, POM, Hg and Cd, are persistent and bioaccumulative. Also, acid gases are very reactive and acidic and therefore have the potential to cause adverse effect to ecological receptors by direct contact. The agency also determined that there was at least some potential for exposures to environmental receptors, because the presence of such receptors around the sources in this category cannot be ruled out. The EPA then considered emissions of the ecological HAP, including the highest-emitting facility of each HAP and the total emissions of each HAP from the source category. The results are below.

**Table 2.5-1 Summary of Ecological HAP Emissions from the Pulp & Paper Source Category**

| HAP | Emissions (tpy) | Number of Facilities in Category Reporting Emissions | Emissions for the Facility with Highest Emissions | |
|---|---|---|---|---|
| | | | (TPY) | lbs |
| Hydrogen chloride | 259 | 55 | 31.95 | 63,900 |
| Chlorine | 24 | 53 | 2.5 | 5,000 |
| Polycyclic Organic Matter | 0.008 | 29 | 0.0008 | 2 |
| Cadmium | 0.01 | 28 | 0.006 | 12 |
| Mercury | 0.002 | 27 | 0.0007 | 1 |

Based on the emission estimates shown above, the EPA determined that the emission levels of these pollutants are low. For instance, compared to the 2008 National Emissions Inventory for point sources, estimates of nationwide HCl emissions from this source category are about 0.18 percent of the total. For Hg, emissions from this source category account for about 0.0036 percent of the nationwide total. For Cd, POM, and chlorine, this source category accounts for approximately 0.043 percent, 0.0042 percent, and 1.5 percent, respectively, of the nationwide emission totals. Based on the low emissions from this source category, the agency would not expect an environmental effect to occur[4].

## 2.6 Dose-Response Assessment

### 2.6.1 Sources of chronic dose-response information

Dose-response assessment (carcinogenic and non-carcinogenic) for chronic exposure (either by inhalation or ingestion) for the HAPs reported in the emissions inventory for the pulp and paper source category were based on the EPA Office of Air Quality Planning and Standards' existing recommendations for HAPs [*9*], also used for NATA [*10*]. This information has

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[4] However, we do note that the EPA's current ability to evaluate the potential for ecological effects is limited, and we are working to improve the agency's capacity in this regard. The results of our effort to improve these capabilities will be particularly important for source categories where emissions of eco HAP are at a level that may be of concern.

been obtained from various sources and prioritized according to (1) conceptual consistency with EPA risk assessment guidelines and (2) level of peer review received. The prioritization process was aimed at incorporating into our assessments the best available science with respect to dose-response information. The recommendations are based on the following sources, in order of priority:

1) US Environmental Protection Agency (EPA). EPA has developed dose-response assessments for chronic exposure for many of the pollutants in this study. These assessments typically provide a qualitative statement regarding the strength of scientific data and specify a reference concentration (RfC, for inhalation) or reference dose (RfD, for ingestion) to protect against effects other than cancer and/or a unit risk estimate (URE, for inhalation) or slope factor (SF, for ingestion) to estimate the probability of developing cancer. The RfC is defined as an "estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime." The RfD is "an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime." The URE is defined as "the upper-bound excess cancer risk estimated to result from continuous lifetime exposure to an agent at a concentration of 1 µg/m$^3$ in air." The SF is "an upper bound, approximating a 95 percent confidence limit, on the increased cancer risk from a lifetime exposure to an agent. This estimate, [is] usually expressed in units of proportion (of a population) affected per mg/kg-day…" EPA disseminates dose-response assessment information in several forms, based on the level of review. The Integrated Risk Information System (IRIS) [*11*] is an EPA database that contains scientific health assessment information, including dose-response information. All IRIS assessments since 1996 have also undergone independent external peer review. The current IRIS process includes review by EPA scientists, interagency reviewers from other federal agencies, and the public, and peer review by independent scientists external to EPA. New IRIS values are developed and old IRIS values are updated as new health effects data become available. Refer to the "IRIS Track" website for detailed information on status and scheduling of current individual IRIS assessments and updates (http://cfpub.epa.gov/ncea/iristrac/index.cfm). EPA's science policy approach, under the current carcinogen guidelines, is to use linear low-dose extrapolation as a default option for carcinogens for which the mode of action (MOA) has not been identified. We expect future EPA dose-response assessments to identify nonlinear MOAs where appropriate, and we will use those analyses (once they are peer reviewed) in our risk assessments. At this time, however, there are no available carcinogen dose-response assessments for inhalation exposure that are based on a nonlinear MOA.

2) US Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR, which is part of the US Department of Health and Human Services, develops and publishes Minimum Risk Levels (MRLs) [*12*] for inhalation and oral exposure to many toxic substances. As stated on the ATSDR web site: "Following discussions with scientists within the Department of Health and Human Services (HHS) and the EPA, ATSDR chose to adopt a practice similar to that of the EPA's Reference Dose (RfD) and Reference Concentration

(RfC) for deriving substance specific health guidance levels for non neoplastic endpoints." The MRL is defined as "an estimate of daily human exposure to a substance that is likely to be without an appreciable risk of adverse effects (other than cancer) over a specified duration of exposure." ATSDR describes MRLs as substance-specific estimates to be used by health assessors to select environmental contaminants for further evaluation. Exposures above an MRL do not necessarily represent a threat, and MRLs are therefore not intended for use as predictors of adverse health effects or for setting cleanup levels.

3) California Environmental Protection Agency (CalEPA). The CalEPA Office of Environmental Health Hazard Assessment has developed dose-response assessments for many substances, based both on carcinogenicity and health effects other than cancer. The process for developing these assessments is similar to that used by EPA to develop IRIS values and incorporates significant external scientific peer review. As cited in the CalEPA Technical Support Document for developing their chronic assessments[5]: "The guidelines for developing chronic inhalation exposure levels incorporate many recommendations of the U.S. EPA [*13*] and NAS [*14*]." The non-cancer information includes available inhalation health risk guidance values expressed as chronic inhalation reference exposure levels (RELs) [*15*]. CalEPA defines the REL as "the concentration level at or below which no health effects are anticipated in the general human population." CalEPA's quantitative dose-response information on carcinogenicity by inhalation exposure is expressed in terms of the URE [*16*], defined similarly to EPA's URE.

In developing chronic risk estimates, we adjusted dose-response values for some HAPs based on professional judgment, as follows:

1) In the case of HAP categories such as glycol ethers and cyanide compounds, the most conservative dose-response value of the chemical category is used as a surrogate for other compounds in the group for which dose-response values are not available. This is done in order to examine, under conservative assumptions, whether these HAPs that lack dose-response values may pose an unacceptable risk and require further examination, or screen out from further assessment.

2) Where possible for emissions of unspecified mixtures of HAP categories such as metal compounds and POM, we apply category-specific chemical speciation profiles appropriate to the source category to develop a composite dose-response value for the category.

3) In 2004, the EPA determined that the Chemical Industry Institute of Toxicology (CIIT) cancer dose-response value for formaldehyde ($5.5 \times 10^{-9}$ per $\mu g/m^3$) was based on better science than the IRIS cancer dose-response value ($1.3 \times 10^{-5}$ per $\mu g/m^3$), and we switched from using the IRIS value to the CIIT value in risk assessments supporting regulatory actions. Subsequent research published by EPA suggested that the CIIT model was not appropriate and in 2010 EPA returned to using 1991 IRIS value. EPA has been working

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[5] Air Toxics Hot Spots Program, Risk Assessment Guidelines, Part III - Technical Support Document for the Determination of Non-cancer Chronic Reference Exposure Levels. Air Toxicology and Epidemiology Section, Office of Environmental Health Hazard Assessment, California Environmental Protection Agency. February 2000 (http://www.oehha.ca.gov/air/chronic_rels/pdf/relsP32k.pdf)

on revising the formaldehyde IRIS assessment and the National Academy of Sciences (NAS) completed its review of the EPA's draft assessment in April of 2011.[6] EPA will follow the NAS Report recommendations and will present results obtained by implementing the biologically-based dose-response (BBDR) model for formaldehyde. EPA will compare these estimates with those currently presented in the External Review draft of the assessment and will discuss their strengths and weaknesses. As recommended by the NAS committee, appropriated sensitivity and uncertainty analyses will be an integral component of implementing the BBDR model. In the interim, we will present findings using the 1991 IRIS value as a primary estimate and EPA may also consider other information as the science evolves.

4) In the case of nickel compounds, to provide a health-protective estimate of potential cancer risks, we used the IRIS URE value for nickel subsulfide in this assessment. Based on past scientific and technical considerations, the determination of the percent of nickel subsulfide was considered a major factor for estimating the extent and magnitude of the risks of cancer due to nickel-containing emissions. Nickel speciation information for some of the largest nickel-emitting sources (including oil combustion, coal combustion, and others) suggested that at least 35 percent of total nickel emissions may be soluble compounds and that the URE for the mixture of inhaled nickel compounds (based on nickel subsulfide, and representative of pure insoluble crystalline nickel) could be derived to reflect the assumption that 65 percent of the total mass of nickel may be carcinogenic. Based on consistent views of major scientific bodies (i.e., National Toxicology Program (NTP) in their 12th Report of the Carcinogens (ROC)[7], International Agency for Research on Cancer (IARC)[8], and other international agencies)[9] that consider all nickel compounds to be carcinogenic, we currently consider all nickel compounds to have the potential of being as carcinogenic to humans. The *12th Report of the Carcinogens* states that the "combined results of epidemiological studies, mechanistic studies, and carcinogenic studies in rodents support the concept that nickel compounds generate nickel ions in target cells at sites critical for carcinogenesis, thus allowing consideration and evaluation of these compounds as a single group." Although the precise nickel compound (or compounds) responsible for the carcinogenic effects in humans is not always clear, studies indicate that nickel sulfate and the combinations of nickel sulfides and oxides encountered in the nickel refining industries cause cancer in humans (these studies are summarized in a review by Grimsrud et al., 2010[10]). The major scientific bodies mentioned above have also recognized that there are differences in toxicity and/or carcinogenic potential across

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[6] http://www.nap.edu/catalog.php?record_id=13142

[7] National Toxicology Program (NTP), 2011. Report on carcinogens. 12th ed. Research Triangle Park, NC: US Department of Health and Human Services (DHHS), Public Health Service. Available online at http://ntp.niehs.nih.gov/ntp/roc/twelfth/roc12.pdf

[8] International Agency for Research on Cancer (IARC), 1990. IARC monographs on the evaluation of carcinogenic risks to humans. Chromium, nickel, and welding. Vol. 49. Lyons, France: International Agency for Research on Cancer, World Health Organization Vol. 49:256.

[9] World Health Organization (WHO, 1991) and the European Union's Scientific Committee on Health and Environmental Risks (SCHER, 2006).

[10] Grimsrud TK and Andersen A. Evidence of carcinogenicity in humans of water-soluble nickel salts. J Occup Med Toxicol 2010, 5:1-7. Available online at http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2868037/?tool=pubmed.

the different nickel compounds. In this inhalation risk assessment, to take a conservative approach, we have considered all nickel compounds to be as carcinogenic as nickel subsulfide and have applied the IRIS URE for nickel subsulfide without a factor to reflect the assumption that 100 percent of the total mass of nickel may be as carcinogenic as pure nickel subsulfide. In addition, given that there are two additional URE[11] values derived for exposure to mixtures of nickel compounds, as a group, that are 2-3 fold lower than the IRIS URE for nickel subsulfide, the EPA also considers it reasonable to use a value that is 50 percent of the IRIS URE for nickel subsulfide for providing an estimate of the lower end of the plausible range of cancer potency values for different mixtures of nickel compounds.

5) A substantial proportion of POM reported to EPA's National Emission Inventory (NEI) is not speciated into individual compounds. As a result, it is necessary to apply the same simplifying assumptions to assessments that are used in NATA [*17*]. The NATA approach partitions POM into eight different non-overlapping "groups" that are modeled as separate pollutants. Each POM group comprises POM species of similar carcinogenic potency, for which we can apply the same URE.

6) A chronic screening level of 163 ug/$m^3$ was developed for carbonyl sulfide (COS) from a No Observed Adverse Effects Level (NOAEL) of 200 ppm based on brain lesions and neurophysiological alterations in rodents. A more detailed discussion of the studies used to develop the COS chronic screening level is provided in Appendix 8. The screening level includes a total uncertainty factor (UF) of 3,000: 10x for extrapolation for interspecies differences, 10x for consideration of intraspecies variability, 10x for extrapolation from subchronic to chronic duration, and 3x for database insufficiencies. See section 5 of this document for a detailed discussion of exposure modeling uncertainties. The chronic screening level for COS is used only as a screening level assessment to identify areas with significant inhalation risk potential. A high COS chronic risk based on the screening level does not necessarily indicate that further action is required.

7) For 1 carcinogenic substance, (propylene dichloride) that lack inhalation assessments from the sources evaluated in this document, oral carcinogenic potency estimates were converted to inhalation UREs. The conversion from oral risk (per mg/kg/d oral intake) to inhalation risk (per $\mu$g/$m^3$ inhaled) was based on EPA's standard assumptions of a 70-kg body mass and 20 $m^3$/d inhalation rate, as follows:

$$URE\left(\frac{\mu g}{m^3}\right)^{-1} = CPS\left(\frac{mg}{kg \cdot d}\right)^{-1} \times \frac{1}{70(kg)} \times 20\left(\frac{m^3}{d}\right) \times \frac{1}{1000}\left(\frac{mg}{\mu g}\right)$$

Where: URE = Unit risk estimate for inhalation (risk per $\mu$g/$m^3$)

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[11] Two UREs (other than the current IRIS values) have been derived for nickel compounds as a group: one developed by the California Department of Health Services (http://www.arb.ca.gov/toxics/id/summary/nickel_tech_b.pdf) and the other by the Texas Commission on Environmental Quality (http://www.epa.gov/ttn/atw/nata1999/99pdfs/healtheffectsinfo.pdf).

CPS = Carcinogenic potency slope for ingestion (risk per mg oral intake per kg body mass per day)

> EPA understands that conversion of oral dose-response information to inhalation exposure may add significant uncertainty to the resulting risk estimates. However, the alternative to this would have been to omit these substances from quantitative inhalation risk estimates altogether, thereby making a *de facto* assumption of zero carcinogenic potency. For the purposes of the residual risk assessment, EPA prefers to use the approach described above to screen these carcinogens for their potential contributions to risk. If a substance is determined to be a potentially important contributor to risk, it will be prioritized for further dose-response development through EPA's IRIS process.

The emissions inventory for the pulp and paper source category includes emissions of HAP with available chronic quantitative inhalation dose-response values. Of these, 47 are classified as known, probable, or possible carcinogens, with quantitative cancer dose-response values available. These 47 HAP, their quantitative inhalation chronic cancer dose-response values, and the source of each value are listed in Table 2.6-1(a). The POM compounds with chronic oral cancer dose-response values available (for which multipathway screening assessments were performed) are listed in Table 2.6-1(b). Seventy-seven HAP have quantitative inhalation chronic noncancer threshold values available, two of these HAP (mercury and cadmium), for which a multipathway assessment was performed, also have quantitative oral chronic noncancer threshold values available. These 77 HAP, their threshold values, and the source of the value are listed in Table 2.6-2(a) and Table 2.6-2(b).

**Table 2.6-1(a) Dose-Response Values for Chronic Inhalation Exposure to Carcinogens**

URE (unit risk estimate for cancer)[12] = cancer risk per μg/m$^3$ of average lifetime exposure. Sources: IRIS = EPA Integrated Risk Information System, EPA ORD = EPA Office of Research & Development, EPA OAQPS = EPA Office of Air Quality Planning & Standards, CAL = California EPA Office of Environmental Health Hazard Assessment. HEAST = EPA Health Effects Assessment Tables, Conv. Oral = Oral unit risk converted to inhalation.

| Pollutant | CAS Number[13] | URE (1/µg/m3) | Source |
|---|---:|---:|---|
| 1,1,2,2-Tetrachloroethane | 79345 | 0.000058 | IRIS |
| 1,1,2-Trichloroethane | 79005 | 0.000016 | IRIS |
| 1,3-Butadiene | 106990 | 0.00003 | IRIS |
| 1,4-Dichlorobenzene | 106467 | 0.000011 | CAL |
| 2,4,6-Trichlorophenol | 88062 | 0.0000031 | IRIS |
| 2,4-Toluene diamine | 95807 | 0.0011 | CAL |
| 2-Nitropropane | 79469 | 0.0000056 | EPA OAQPS |
| Acetaldehyde | 75070 | 0.0000022 | IRIS |
| Acrylamide | 79061 | 0.00016 | IRIS |
| Acrylonitrile | 107131 | 0.000068 | IRIS |
| Aniline | 62533 | 0.0000016 | CAL |
| Arsenic compounds | 7440382 | 0.0043 | IRIS |
| Benzene[14] | 71432 | 0.0000078 | IRIS |
| Beryllium compounds | 7440417 | 0.0024 | IRIS |
| Bis(2-ethylhexyl)phthalate | 117817 | 0.0000024 | CAL |
| Bromoform | 75252 | 0.0000011 | IRIS |
| Cadmium compounds | 7440439 | 0.0018 | IRIS |
| Carbon tetrachloride | 56235 | 0.000006 | IRIS |
| Chlorobenzilate | 510156 | 0.000078 | HEAST |
| Chromium (VI) compounds | 18540299 | 0.012 | IRIS |
| Ethyl benzene | 100414 | 0.0000025 | CAL |
| Ethylene dibromide | 106934 | 0.0006 | IRIS |
| Ethylene dichloride | 107062 | 0.000026 | IRIS |
| Ethylene oxide | 75218 | 0.000088 | CAL |
| Ethylidene dichloride (1,1-Dichloroethane) | 75343 | 0.0000016 | CAL |
| Formaldehyde[15] | 50000 | 0.000013 | IRIS |
| Hexachloroethane | 67721 | 0.000004 | IRIS |

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[12] The URE is the upper-bound excess cancer risk estimated to result from continuous lifetime exposure to an agent at a concentration of 1 μg/m$^3$ in air. URE's are considered upper bound estimates meaning they represent a plausible upper limit to the true value.

[13] Chemical Abstract Services identification number. For groups of compounds that lack a CAS number we have used a surrogate 3-digit identifier corresponding to the group's position on the CAA list of HAPs.

[14] The EPA IRIS assessment for benzene provides a range of plausible UREs. This assessment used the highest value in that range, 7.8E-06 per ug/m$^3$. The low end of the range is 2.2E-06 per ug/m$^3$.

[15] The EPA has used the CIIT URE value, 5.5X10$^{-9}$ per mg/m$^3$, to characterize formaldehyde cancer risk in some instances.

## Table 2.6-1(a) Dose-Response Values for Chronic Inhalation Exposure to Carcinogens

URE (unit risk estimate for cancer)[12] = cancer risk per µg/m$^3$ of average lifetime exposure. Sources: IRIS = EPA Integrated Risk Information System, EPA ORD = EPA Office of Research & Development, EPA OAQPS = EPA Office of Air Quality Planning & Standards, CAL = California EPA Office of Environmental Health Hazard Assessment. HEAST = EPA Health Effects Assessment Tables, Conv. Oral = Oral unit risk converted to inhalation.

| Pollutant | CAS Number[13] | URE (1/µg/m3) | Source |
|---|---|---|---|
| Methylene chloride | 75092 | 0.00000047 | IRIS |
| Naphthalene | 91203 | 0.000034 | CAL |
| Nickel compounds | 7440020 | 0.00048 | EPA OAQPS[16] |
| Nitrobenzene | 98953 | 0.00004 | IRIS |
| Pentachlorophenol | 87865 | 0.0000051 | CAL |
| Polycyclic Organic Matter[17] (POM) | | | |
| 7,12-Dimethylbenz(a)anthracene | 57976 | 0.1136 | CAL |
| 3-Methylcholanthrene | 56495 | 0.01008 | CAL |
| Benz(a)anthracene | 56553 | 0.000176 | CAL |
| Benzo(a)pyrene | 50328 | 0.00176 | CAL |
| Benzo(b)fluoranthene | 205992 | 0.000176 | CAL |
| Benzo(k)fluoranthene | 207089 | 0.000176 | CAL |
| Chrysene | 218019 | 0.0000176 | CAL |
| Dibenzo(a,h)anthracene | 53703 | 0.0019184 | CAL |
| Indeno(1,2,3-c,d)pyrene | 193395 | 0.000176 | CAL |
| POM 71002 | 187 | 0.000088 | CAL |
| POM 72002 | 187 | 0.000088 | CAL |
| Propylene dichloride[18] | 78875 | 0.000019 | Conv. Oral |
| Tetrachloroethene | 127184 | 0.0000059 | CAL |
| Trichloroethylene | 79016 | 0.000002 | CAL |
| Vinyl chloride | 75014 | 0.0000088 | IRIS |

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[16] The EPA IRIS assessments for nickel compounds provide a range of plausible UREs. This assessment used the highest value in that range which is equal to the URE for nickel subsulfide, 4.8E-04 per ug/m$^3$. The low end of the range is equal to 50% of the URE for nickel subsulfide, 2.4E-04 per ug/m$^3$.

[17] POM without a chemical-specific URE are assigned a URE associated with a mixture of POM compounds having similar characteristics. Details of this method, also used in the 2002 National Air Toxics Assessment, are available at http://www.epa.gov/ttn/atw/nata2002/02pdfs/pom_approach.pdf.

[18] No inhalation unit risk estimates were available for this compound. Therefore we converted from a oral potency slope of 0.068 per mg/kg/d. UREs that are converted from the oral route to the inhalation route of exposure are considered highly uncertain, and are only used in cases where no other URE is available.

## Table 2.6-1(b) Dose-Response Values for Chronic Oral Exposure to Carcinogens

SF (oral slope factor for cancer) = cancer risk per mg/kg/d of average lifetime exposure. Sources: IRIS = EPA Integrated Risk Information System, CAL = California EPA Office of Environmental Health Hazard Assessment, EPA/OAQPS = interim value recommended by the EPA Office of Air Quality Planning and Standards, EPA ORD = EPA Office of Research and Development, HEAST = EPA Health Effects Assessment Tables

| Pollutant | CAS Number | SF (1/mg/kg/d) | Source |
|---|---|---|---|
| Polycyclic organic matter (POM) | | | |
| Benzo(a)anthracene | 56553 | 1.2 | CAL |
| Benzo(a)pyrene | 50328 | 7.3 | IRIS |
| Benzo(b)fluoranthene | 205992 | 1.2 | CAL |
| Benzo(k)fluoranthene | 207089 | 1.2 | CAL |
| Chrysene | 218019 | 0.12 | CAL |
| Dibenz(a,h)anthracene | 53703 | 4.1 | CAL |
| 7,12-Dimethylbenz(a)anthracene | 57976 | 250 | CAL |
| Indeno(1,2,3-cd)pyrene | 193395 | 1.2 | CAL |
| 3-Methlycholanthrene | 56495 | 22 | CAL |

## Table 2.6-2(a) Dose-Response Values for Chronic Inhalation Exposure to Noncarcinogens

RfC (reference inhalation concentration) = an estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. Sources: IRIS = EPA Integrated Risk Information System, CAL = California EPA Office of Environmental Human Health Assessment, ATSDR = US Agency for Toxic Substances Disease Registry, HEAST = EPA Health Effects Assessment Tables, EPA OAQPS = EPA Office of Air Quality Planning & Standards, EPA ORD = EPA Office of Research and Development

| Pollutant | CAS Number[12] | RfC ($mg/m^3$) | Source[19] |
|---|---|---|---|
| 1,1,1-Trichloroethane (methyl chloroform) | 71556 | 5 | IRIS - M |
| 1,1,2-Trichloroethane | 79005 | 0.4 | CAL |
| 1,2,4-Trichlorobenzene | 120821 | 0.2 | HEAST |
| 1,3-Butadiene | 106990 | 0.002 | IRIS - M |
| 1,4-Dichlorobenzene | 106467 | 0.8 | IRIS - M |
| 2-Nitropropane | 79469 | 0.02 | IRIS - L |
| Acetaldehyde | 75070 | 0.009 | IRIS - L |
| Acetonitrile | 75058 | 0.06 | IRIS - M |
| Acrylamide | 79061 | 0.006 | IRIS - M |
| Acrylonitrile | 107131 | 0.002 | IRIS - M |

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[19] The descriptors L (low), M (medium), and H (high) have been added for IRIS RfC values to indicate the overall level of confidence in the RfC value, as reported in IRIS.

**Table 2.6-2(a) Dose-Response Values for Chronic Inhalation Exposure to Noncarcinogens**

RfC (reference inhalation concentration) = an estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. Sources: IRIS = EPA Integrated Risk Information System, CAL = California EPA Office of Environmental Human Health Assessment, ATSDR = US Agency for Toxic Substances Disease Registry, HEAST = EPA Health Effects Assessment Tables, EPA OAQPS = EPA Office of Air Quality Planning & Standards, EPA ORD = EPA Office of Research and Development

| Pollutant | CAS Number[12] | RfC ($mg/m^3$) | Source[19] |
|---|---|---|---|
| Aniline | 62533 | 0.001 | IRIS - L |
| Antimony compounds | 7440360 | 0.0002 | IRIS - L |
| Arsenic compounds | 7440382 | 0.000015 | CAL |
| Benzene | 71432 | 0.03 | IRIS - M |
| Beryllium compounds | 7440417 | 0.00002 | IRIS - M |
| Bis(2-ethylhexyl)phthalate | 117817 | 0.01 | CAL |
| Cadmium compounds | 7440439 | 0.00001 | ATSDR |
| Carbon disulfide | 75150 | 0.7 | IRIS - M |
| Carbon tetrachloride | 56235 | 0.1 | IRIS - M |
| Carbonyl sulfide | 463581 | 0.163 | EPA ORD[20] |
| Chlorine | 7782505 | 0.00015 | ATSDR |
| Chlorobenzene | 108907 | 1 | CAL |
| Chloroform | 67663 | 0.098 | ATSDR |
| Chromium (VI) compounds | 18540299 | 0.0001 | IRIS - M |
| Cobalt compounds | 7440484 | 0.0001 | ATSDR |
| Cresols (mixed) | 1319773 | 0.6 | CAL |
| m-Cresol | 108394 | 0.6 | CAL |
| o-Cresol | 95487 | 0.6 | CAL |
| p-Cresol | 106445 | 0.6 | CAL |
| Cumene | 98828 | 0.4 | IRIS - M |
| Cyanide & Cyanide Compounds[21] | | | |
| Cyanide compounds | 57125 | 0.0008 | IRIS – L/M |
| Hydrogen cyanide | 74908 | 0.0008 | IRIS – L/M |
| Diethanolamine | 111422 | 0.003 | CAL |
| Ethyl benzene | 100414 | 1 | IRIS - L |
| Ethylene dibromide | 106934 | 0.009 | IRIS - M |
| Ethylene dichloride | 107062 | 2.4 | ATSDR |
| Ethylene glycol | 107211 | 0.4 | CAL |
| Ethylene oxide | 75218 | 0.03 | CAL |
| Ethylidene dichloride (1,1-Dichloroethane) | 75343 | 0.5 | HEAST |
| Formaldehyde | 50000 | 0.0098 | ATSDR |

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[20] A chronic screening level of 0.163 $mg/m^3$ was developed for carbonyl sulfide by EPA ORD from a No Observed Adverse Effects Level of 200 ppm based on brain lesions and neurophysiological alteration in rodents.

[21] The value for hydrogen cyanide was used as a surrogate for all cyanide compounds without an RfC.

### Table 2.6-2(a) Dose-Response Values for Chronic Inhalation Exposure to Noncarcinogens

RfC (reference inhalation concentration) = an estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. Sources: IRIS = EPA Integrated Risk Information System, CAL = California EPA Office of Environmental Human Health Assessment, ATSDR = US Agency for Toxic Substances Disease Registry, HEAST = EPA Health Effects Assessment Tables, EPA OAQPS = EPA Office of Air Quality Planning & Standards, EPA ORD = EPA Office of Research and Development

| Pollutant | CAS Number[12] | RfC ($mg/m^3$) | Source[19] |
|---|---|---|---|
| Glycol Ethers[22] | | | |
| 1,2-Dimethoxyethane | 110714 | 0.02 | IRIS - M |
| Butyl carbitol acetate | 124174 | 0.02 | IRIS - M |
| Ethylene glycol ethyl ether | 110805 | 0.2 | IRIS - M |
| Methyl cellosolve acrylate | 3121617 | 0.02 | IRIS - M |
| Hexachlorocyclopentadiene | 77474 | 0.0002 | IRIS – M/H |
| Hexachloroethane | 67721 | 0.08 | CAL |
| Hexane | 110543 | 0.7 | IRIS - M |
| Hydrochloric acid (hydrogen chloride) | 7647010 | 0.02 | IRIS - L |
| Lead compounds | 7439921 | 0.00015 | EPA OAQPS |
| Manganese compounds | 7439965 | 0.00005 | IRIS - M |
| Mercury and Mercury Compounds | | | |
| Mercuric chloride | 7487947 | 0.0003 | IRIS - M |
| Mercury (elemental) | 7439976 | 0.0003 | IRIS - M |
| Methanol | 67561 | 4 | CAL |
| Methyl bromide | 74839 | 0.005 | IRIS - H |
| Methyl chloride | 74873 | 0.09 | IRIS - M |
| Methyl isobutyl ketone | 108101 | 3 | IRIS - L/M |
| Methylene chloride | 75092 | 1 | ATSDR |
| Naphthalene | 91203 | 0.003 | IRIS - M |
| Nickel compounds | 7440020 | 0.00009 | ATSDR |
| Nitrobenzene | 98953 | 0.009 | IRIS - M |
| Pentachlorophenol | 87865 | 0.1 | CAL |
| Phenol | 108952 | 0.2 | CAL |
| Propionaldehyde | 123386 | 0.008 | IRIS – L/M |
| Propylene dichloride | 78875 | 0.004 | IRIS - M |
| Selenium compounds | 7782492 | 0.02 | CAL |
| Styrene | 100425 | 1 | IRIS - M |
| Tetrachloroethene | 127184 | 0.27 | ATSDR |
| Toluene | 108883 | 5 | IRIS - H |
| Trichloroethylene | 79016 | 0.6 | CAL |
| Triethylamine | 121448 | 0.007 | IRIS - L |
| Vinyl acetate | 108054 | 0.2 | IRIS - H |

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[22] The RfC value for ethylene glycol methyl ether (0.02 $mg/m^3$) was used as a surrogate for all glycol ethers without an RfC.

**Table 2.6-2(a) Dose-Response Values for Chronic Inhalation Exposure to Noncarcinogens**

RfC (reference inhalation concentration) = an estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. Sources: IRIS = EPA Integrated Risk Information System, CAL = California EPA Office of Environmental Human Health Assessment, ATSDR = US Agency for Toxic Substances Disease Registry, HEAST = EPA Health Effects Assessment Tables, EPA OAQPS = EPA Office of Air Quality Planning & Standards, EPA ORD = EPA Office of Research and Development

| **Pollutant** | **CAS Number**[12] | **RfC ($mg/m^3$)** | **Source**[19] |
|---|---|---|---|
| Vinyl chloride | 75014 | 0.1 | IRIS - M |
| Vinylidene chloride | 75354 | 0.2 | IRIS – H/M |
| Xylenes (mixed) | 1330207 | 0.1 | IRIS - M |
| m-Xylene[23] | 108383 | 0.1 | IRIS - M |
| o-Xylene[23] | 95476 | 0.1 | IRIS - M |
| p-Xylene[23] | 106423 | 0.1 | IRIS - M |

**Table 2.6-2(b) Dose-Response Values for Chronic Oral Exposure to Noncarcinogens**

RfD (reference dose) = an estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.
Sources: IRIS = EPA Integrated Risk Information System

| **Pollutant** | **CAS Number** | **RfD (mg/kg/d)** | **Source** [24] |
|---|---|---|---|
| Mercuric chloride[25] | 7439976 | 0.0003 | IRIS - H |
| Cadmium compounds | 7440439 | 0.0005 | IRIS - H |

## 2.6.2 Sources of acute dose-response information

Hazard identification and dose-response assessment information for preliminary acute inhalation exposure assessments are based on the existing recommendations of OAQPS for HAPs [*18*]. Depending on availability, the results from screening acute assessments are compared to both "no effects" reference levels for the general public, such as the California Reference Exposure Levels (RELs), as well as emergency response levels, such as Acute Exposure Guideline Levels (AEGLs) and Emergency Response Planning Guidelines (ERPGs), with the recognition that the ultimate interpretation of any potential risks associated with an estimated exceedance of a particular reference level depends on the definition of that

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[23] The RfC for mixed xylene was used as a surrogate.

[24] The descriptors L (low), M (medium), and H (high) have been added for IRIS RfC values to indicate the overall level of confidence in the RfC value, as reported in the IRIS file.

[25] The multipathway exposure assessment for mercury included fate and transport analysis, that included separate oral exposure estimates for divalent mercury and methylmercury.

level and any limitations expressed therein. Comparisons among different available inhalation health effect reference values (both acute and chronic) for selected HAPs can be found in a newly released EPA document [*19*].

***California Acute Reference Exposure Levels (RELs).*** The California Environmental Protection Agency (CalEPA) has developed acute dose-response reference values for many substances, expressing the results as acute inhalation Reference Exposure Levels (RELs).

> The acute REL (http://www.oehha.ca.gov/air/pdf/acuterel.pdf) is defined by CalEPA as "the concentration level at or below which no adverse health effects are anticipated for a specified exposure duration. [*20*]. RELs are based on the most sensitive, relevant, adverse health effect reported in the medical and toxicological literature. RELs are designed to protect the most sensitive individuals in the population by the inclusion of margins of safety. Since margins of safety are incorporated to address data gaps and uncertainties, exceeding the REL does not automatically indicate an adverse health impact." Acute RELs are developed for 1-hour (and 8-hour) exposures. The values incorporate uncertainty factors similar to those used in deriving EPA's Inhalation Reference Concentrations (RfCs) for chronic exposures (and, in fact, California also has developed chronic RELs).

***Acute Exposure Guideline Levels (AEGLs)****.* AEGLs are developed by the National Advisory Committee (NAC) on Acute Exposure Guideline Levels (NAC/AEGL) for Hazardous Substances, and then reviewed and published by the National Research Council As described in the Committee's "Standing Operating Procedures (SOP)" (http://www.epa.gov/opptintr/aegl/pubs/sop.pdf), AEGLs "represent threshold exposure limits for the general public and are applicable to emergency exposures ranging from 10 min to 8 h." Their intended application is "for conducting risk assessments to aid in the development of emergency preparedness and prevention plans, as well as real time emergency response actions, for accidental chemical releases at fixed facilities and from transport carriers." The document states that "the primary purpose of the AEGL program and the NAC/AEGL Committee is to develop guideline levels for once-in-a-lifetime, short-term exposures to airborne concentrations of acutely toxic, high-priority chemicals." In detailing the intended application of AEGL values, the document states that, "It is anticipated that the AEGL values will be used for regulatory and nonregulatory purposes by U.S. Federal and State agencies, and possibly the international community in conjunction with chemical emergency response, planning, and prevention programs. More specifically, the AEGL values will be used for conducting various risk assessments to aid in the development of emergency preparedness and prevention plans, as well as real-time emergency response actions, for accidental chemical releases at fixed facilities and from transport carriers."

The NAC/AEGL defines AEGL-1 and AEGL-2 as:

> "AEGL-1 is the airborne concentration (expressed as ppm or mg/m$^3$) of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic nonsensory effects. However, the effects are not disabling and are transient and reversible upon cessation of

> exposure."
>
> "AEGL-2 is the airborne concentration (expressed as ppm or mg/m$^3$) of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape."
>
> "Airborne concentrations below AEGL-1 represent exposure levels that can produce mild and progressively increasing but transient and nondisabling odor, taste, and sensory irritation or certain asymptomatic, nonsensory effects. With increasing airborne concentrations above each AEGL, there is a progressive increase in the likelihood of occurrence and the severity of effects described for each corresponding AEGL. Although the AEGL values represent threshold levels for the general public, including susceptible subpopulations, such as infants, children, the elderly, persons with asthma, and those with other illnesses, it is recognized that individuals, subject to unique or idiosyncratic responses, could experience the effects described at concentrations below the corresponding AEGL."

***Emergency Response Planning Guidelines (ERPGs).*** The American Industrial Hygiene Association (AIHA) has developed Emergency Response Planning Guidelines (ERPGs) [*21*] for acute exposures at three different levels of severity. These guidelines represent concentrations for exposure of the general population (but not particularly sensitive persons) for up to 1 hour associated with effects expected to be mild or transient (ERPG-1), irreversible or serious (ERPG-2), and potentially life-threatening (ERPG-3).

ERPG values (http://www.aiha.org/insideaiha/guidelinedevelopment/erpg/Pages/default.aspx) are described in their supporting documentation as follows: "ERPGs are air concentration guidelines for single exposures to agents and are intended for use as tools to assess the adequacy of accident prevention and emergency response plans, including transportation emergency planning, community emergency response plans and incident prevention and mitigation."

ERPG-1 and ERPG-2 values are defined by AIHA as follows:

> "ERPG-1 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing other than mild transient adverse health effects or without perceiving a clearly defined, objectionable odor."
>
> "ERPG-2 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action."

The emissions inventory for the pulp and paper source category includes emissions of 50 HAP with relevant and available quantitative acute dose-response threshold values. These HAP, their acute threshold values, and the source of the value are listed below in Table 2.6-3.

**Table 2.6-3 Dose-Response Values for Acute Exposure**

| Pollutant | CAS Number | AEGL-1 (1-hr) (mg/m$^3$) | AEGL-2 (1-hr) (mg/m$^3$) | ERPG-1 (mg/m$^3$) | ERPG-2 (mg/m$^3$) | REL |
|---|---|---|---|---|---|---|
| 1,1,1-Trichloroethane (methyl chloroform) | 71556 | 1300 | 3300 | 1900 | 3800 | 68 |
| 1,3-Butadiene | 106990 | 1500 | 12000 | 22 | 440 | |
| Acetaldehyde | 75070 | 81 | 490 | 18 | 360 | 0.47 |
| Acetonitrile | 75058 | 22 | 540 | | | |
| Acrylonitrile | 107131 | 10 | 130 | 22 | 77 | |
| Aniline | 62533 | 30 | 46 | | | |
| Arsenic compounds | 7440382 | | | | | 0.0002 |
| Benzene | 71432 | 170 | 2600 | 160 | 480 | 1.3 |
| Beryllium compounds | 7440417 | | | | 0.025 | |
| Biphenyl | 92524 | | 61 | | | |
| Carbon disulfide | 75150 | 40 | 500 | 3.1 | 160 | 6.2 |
| Carbon tetrachloride | 56235 | 280 | 1200 | 130 | 630 | 1.9 |
| Carbonyl sulfide | 463581 | | 140 | | | |
| Chlorine | 7782505 | 1.5 | 5.8 | 2.9 | 8.7 | 0.21 |
| Chloroacetic acid | 79118 | | 26 | | | |
| Chlorobenzene | 108907 | 46 | 690 | | | |
| Chloroform | 67663 | | 310 | | 240 | 0.15 |
| Cumene | 98828 | 250 | 1500 | | | |
| Hydrogen cyanide | 74908 | 2.2 | 7.8 | | 11 | 0.34 |
| Ethyl benzene | 100414 | 140 | 4800 | | | |
| Ethylene dibromide | 106934 | 130 | 180 | | | |
| Ethylene dichloride | 107062 | | | 200 | 810 | |
| Ethylene oxide | 75218 | | 81 | | 90 | |
| Formaldehyde | 50000 | 1.1 | 17 | 1.2 | 12 | 0.055 |
| Glycol Ethers[26] | | | | | | |
| 1,2-Dimethoxyethane | 110714 | | | | | 0.093 |
| Butyl carbitol acetate | 124174 | | | | | 0.093 |
| Ethylene glycol ethyl ether | 110805 | | | | | 0.37 |
| Methyl cellosolve acrylate | 3121617 | | | | | 0.093 |
| Hexane | 110543 | | 12000 | | | |
| Hydrochloric acid | 7647010 | 2.7 | 33 | 4.5 | 30 | 2.1 |

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[26] The acute REL for ethylene glycol methyl ether was used as a surrogate for glycol ether compounds without an acute REL.

**Table 2.6-3 Dose-Response Values for Acute Exposure**

| Pollutant | CAS Number | AEGL-1 (1-hr) (mg/m$^3$) | AEGL-2 (1-hr) (mg/m$^3$) | ERPG-1 (mg/m$^3$) | ERPG-2 (mg/m$^3$) | REL |
|---|---|---|---|---|---|---|
| Mercury (elemental) | 7439976 | | 1.7 | | 2 | 0.0006 |
| Methanol | 67561 | 690 | 2700 | 260 | 1300 | 28 |
| Methyl bromide | 74839 | | 820 | | 190 | 3.9 |
| Methyl chloride | 74873 | | 1900 | | 830 | |
| Methyl iodide | 74884 | | | 150 | 290 | |
| Methylene chloride | 75092 | 690 | 1900 | 1000 | 2600 | 14 |
| Nickel compounds | 7440020 | | | | | 0.006 |
| Phenol | 108952 | 58 | 89 | 38 | 190 | 5.8 |
| Propionaldehyde | 123386 | 110 | 620 | | | |
| Styrene | 100425 | 85 | 550 | 210 | 1100 | 21 |
| Tetrachloroethene | 127184 | 240 | 1600 | 680 | 1400 | 20 |
| Toluene | 108883 | 750 | 4500 | 190 | 1100 | 37 |
| Trichloroethylene | 79016 | 700 | 2400 | 540 | 2700 | |
| Triethylamine | 121448 | | | | | 2.8 |
| Vinyl acetate | 108054 | 24 | 630 | 18 | 260 | |
| Vinyl chloride | 75014 | 640 | 3100 | 1300 | 13000 | 180 |
| Xylenes (mixed) | 1330207 | 560 | 4000 | | | 22 |
| m-Xylene[27] | 108383 | | | | | 22 |
| o-Xylene[27] | 95476 | | | | | 22 |
| p-Xylene[27] | 106423 | | | | | 22 |

## 2.7 Risk Characterization

### 2.7.1 General

The final product of the risk assessment is the risk characterization, in which the information from the previous steps is integrated and an overall conclusion about risk is synthesized that is complete, informative, and useful for decision makers. In general, the nature of this risk characterization depends on the information available, the application of the risk information and the resources available. In all cases, major issues associated with determining the nature and extent of the risk are identified and discussed. Further, the EPA Administrator's March 1995 *Policy for Risk Characterization* [*22*] specifies that a risk characterization "be prepared in a manner that is clear, transparent, reasonable, and consistent with other risk characterizations of similar scope prepared across programs in the Agency." These principles of transparency and consistency have been reinforced by the *Agency's Risk Characterization Handbook* [*23*], in 2002 by the Agency's information quality guidelines [*24*], and in the

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[27] The REL for mixed xylenes was used as a surrogate.

OMB/OSTP September 2007 Memorandum on Updated Principles for Risk Analysis[28], and are incorporated in these assessments.

Estimates of health risk are presented in the context of uncertainties and limitations in the data and methodology. Through our tiered, iterative analytical approach, we have attempted to reduce both uncertainty and bias to the greatest degree possible in these assessments, within the limitations of available time and resources. We provide summaries of risk metrics (including maximum individual cancer risks and noncancer hazards, as well as cancer incidence estimates) along with a discussion of the major uncertainties associated with their derivation to provide decision makers with the fullest picture of the assessment and its limitations.

For each carcinogenic HAP included in the assessment that has a potency estimate available, individual and population cancer risks were calculated by multiplying the corresponding lifetime average exposure estimate by the appropriate URE. This calculated cancer risk is defined as the upper-bound probability of developing cancer over a 70-yr period (i.e., the assumed human lifespan) at that exposure. Because UREs for most HAPs are upper-bound estimates, actual risks at a given exposure level may be lower than predicted, and could be zero.

For EPA's list of carcinogenic HAPs that act by a mutagenic mode-of-action [*25*], we applied EPA's *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens* [*26*]. This guidance has the effect of adjusting the URE by factors of 10 (for children aged 0-1), 3 (for children aged 2-15), or 1.6 (for 70 years of exposure beginning at birth), as needed in risk assessments. In this case, this has the effect of increasing the estimated life time risks for these pollutants by a factor of 1.6. In addition, although only a small fraction of the total POM emissions may be reported as individual compounds, EPA expresses carcinogenic potency for compounds in this group in terms of benzo[a]pyrene equivalence, based on evidence that carcinogenic POM have the same mutagenic mechanism of action as does benzo[a]pyrene. For this reason, EPA implementation policy [*27*] recommends applying the *Supplemental Guidance* to all carcinogenic PAHs for which risk estimates are based on relative potency. Accordingly, we applied the Supplemental Guidance to all unspeciated POM mixtures.

Increased cancer incidence for the entire receptor population within the area of analysis was estimated by multiplying the estimated lifetime cancer risk for each census block by the number of people residing in that block, then summing the results for the entire modeled domain. This lifetime population incidence estimate was divided by 70 years to obtain an estimate of the number of cancer cases per year.

In the case of benzene, the high end of the reported cancer URE range was used in our

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[28] Memorandum for the Heads of Executive Departments and Agencies - Updated Principles for Risk Analysis (September 19, 2007), From Susan E. Dudley, Administrator, Office of Information and Regulatory Affairs, Office of Management and Budget; and Sharon L. Hays, Associate Director and Deputy Director for Science, Office of Science and Technology Policy (http://www.whitehouse.gov/sites/default/files/omb/assets/omb/memoranda/fy2007/m07-24.pdf)

assessments to provide a conservative estimate of potential cancer risks. Use of the high end of the range provides risk estimates that are approximately 3.5 times higher than use of the equally plausible low end value. If the estimated benzene–associated risks exceed 1 in a million, we also evaluated the impact of using the low end of the URE range on our risk results.

Unlike linear dose-response assessments for cancer, noncancer health hazards generally are not expressed as a probability of an adverse occurrence. Instead, "risk" for noncancer effects is expressed by comparing an exposure to a reference level as a ratio. The "hazard quotient" (HQ) is the estimated exposure divided by a reference level (e.g., the RfC). For a given HAP, exposures at or below the reference level ($HQ \leq 1$) are not likely to cause adverse health effects. As exposures increase above the reference level (HQs increasingly greater than 1), the potential for adverse effects increases. For exposures predicted to be above the RfC, the risk characterization includes the degree of confidence ascribed to the RfC values for the compound(s) of concern (i.e., high, medium, or low confidence) and discusses the impact of this on possible health interpretations.

The risk characterization for chronic effects other than cancer is expressed in terms of the HQ for inhalation, calculated for each HAP at each census block centroid. As discussed above, RfCs incorporate generally conservative uncertainty factors in the face of uncertain extrapolations, such that an HQ greater than one does not necessarily suggest the onset of adverse effects. The HQ cannot be translated to a probability that adverse effects will occur, and is unlikely to be proportional to adverse health effect outcomes in a population.

Screening for potentially significant acute inhalation exposures also followed the HQ approach. We divided the maximum estimated acute exposure by each available short-term threshold value to develop an array of HQ values relative to the various acute endpoints and thresholds. In general, when none of these HQ values are greater than one, there is no potential for acute risk. In those cases where HQ values above one are seen, additional information is used to determine if there is a potential for significant acute risks.

### 2.7.2 Mixtures

Since most or all receptors in these assessments receive exposures to multiple pollutants rather than a single pollutant, we estimated the aggregate health risks associated with all the exposures from a particular source category combined.

To combine risks across multiple carcinogens, our assessments use the mixtures guidelines' [*28*,*29*] default assumption of additivity of effects, and combine risks by summing them using the independence formula in the mixtures guidelines.

In assessing noncancer hazard from chronic exposures, in cases where different pollutants cause adverse health effects via completely different modes of action, it may be inappropriate to aggregate HQs. In consideration of these mode-of-action differences, the mixtures guidelines support aggregating effects of different substances in specific and limited ways. To conform to these guidelines, we aggregated non-cancer HQs of HAPs that act by similar toxic modes of action, or (where this information is absent) that affect the same target organ. This process creates, for each target organ, a target-organ-specific hazard index (TOSHI), defined as the sum of hazard quotients for individual HAPs that affect the same organ or organ system. All TOSHI calculations presented here were based exclusively on effects occurring at the "critical dose" (i.e., the lowest dose that produces adverse health effects). Although HQs associated with some pollutants have been aggregated into more than one TOSHI, this has been done only in cases where the critical dose affects more than one target organ. Because impacts on organs or systems that occur above the critical dose have not been included in the TOSHI calculations, some TOSHIs may have been underestimated. As with the HQ, the TOSHI should not be interpreted as a probability of adverse effects, or as strict delineation of "safe" and "unsafe" levels. Rather, the TOSHI is another measure of the potential for adverse health outcomes associated with pollutant exposure, and needs to be interpreted carefully by health scientists and risk managers.

Because of the conservative nature of the acute inhalation screening and the variable nature of emissions and potential exposures, acute impacts were screened on an individual pollutant basis, not using the TOSHI approach.

### 2.7.3 Facility-wide Risks

To help place the source category risks in context, we examined "facility-wide" risks using ICR data and modeling as described in Section 2.2. For the facilities in the pulp and paper source category, we estimated the maximum inhalation cancer and chronic noncancer risks associated with all HAP emissions sources at the facility, including emissions sources that are not part of the source categories but are located within a contiguous area and are under common control. We analyzed risks due to the inhalation of HAP for the populations residing within 50 kilometers of each facility. The results of the facility-wide assessment are summarized below in the Risk characterization section of this document. The complete results of the facility-wide assessment are provided in Appendix 5.

### 2.7.4 MACT-Allowable Risk

The emissions data in the data set for the pulp and paper source category are estimates of actual emissions on an annual basis. The risk results presented in the following sections are based on these actual emissions. To estimate emissions at the MACT-allowable level, a ratio of MACT-allowable to actual emissions for each source type was developed. This ratio was based on the level of control required by the MACT standard compared to the level of reported actual emissions and available information from the ICR on the level of control achieved by the emissions controls in use. The memorandum entitled, *Inputs to the Pulp and Paper Industry October 2011 Residual Risk Modeling* includes a detailed discussion on the development of the MACT-allowable emissions (available in the docket for this rule making).

# 3 Risk Results for the Pulp & Paper Source Category

## 3.1 Source Category Description and Results

The pulp and paper source category includes any facility engaged in the production of pulp and/or paper. This category includes, but is not limited to, integrated mills (where pulp and paper or paperboard are manufactured on-site), non-integrated mills (where paper/paperboard or pulp are manufactured, but not both), and secondary fiber mills (where waste paper is used as the primary raw material. The pulp and paper production process include operations such as pulping, bleaching, chemical recovery, and papermaking. Pulping methods include chemical processes such as kraft, soda, sulfite, and semi-chemical, and mechanical, secondary fiber, or non-wood processes. The MACT standards for the pulp and paper production source category were developed in three parts. This source-category-level risk assessment address the emissions sources covered by the MACT I and MACT III standards[29]. Emission sources regulated under the pulp and paper MACT I standard include all HAP emissions in the kraft, soda, sulfite, and stand-alone semi-chemical pulping processes using wood and all HAP emission points in the bleaching systems. Mills that mechanically pulp wood, pulp secondary fiber or non-wood fibers, and any mills that make paper, paper board, or related products from pulp are entities covered by the MACT III standard. HAP sources covered by the MACT III standard include emission points along the bleaching process. Specifically, bleaching emissions points include storage tanks, tower vents, washer bents, filtrate tank vents, and scrubber outlets. HAP sources covered by the MACT III standard also include paper manufacturing machines and their components (e.g., vacuum pump, storage tank, exhaust). A separate MACT standard[30] applicable to chemical recovery processes at kraft, soda, sulfite, and stand-alone semi-chemical pulp mills was promulgated at a later date. The emissions from the sources covered by this later standard are included in the facility-wide risk analysis. A complete description of the pulp and paper production source category can be found in the text of the NPRM.

We currently estimate that there are 171 pulp and paper facilities operating in the U.S. The ICR data set contains all 171 facilities identified with a pulp and paper production MACT code in the 2005 NEI (updated with the 2010 ICR data). All 171 of these facilities are identified as major sources in the NEI.

The emissions for the pulp and paper source category data set (of 171 facilities) are summarized in Table 3.1-1. The total HAP emissions for the source category are approximately 45,000 tons per year. Based on these data, the HAP emitted in the largest quantities are methanol and acetaldehyde. Emissions of these two HAPs make up 91 percent

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[29] 40 CFR 63, subpart S: National Emission Standards for Hazardous Air Pollutants from the Pulp and Paper Industry.

[30] 40 CFR Part 63, Subpart MM: National Emission Standards for Hazardous Air Pollutants for Chemical Recovery Combustion Sources at Kraft, Soda, Sulfite, and Stand-Alone Semichemical Pulp Mills

of the total emissions by mass. Persistent and bioaccumulative HAP (PB-HAP) [31] reported as emissions from these facilities include lead, cadmium, mercury, and POM.

**Table 3.1-1 Summary of Emissions from the Pulp & Paper Source Category Used in the Residual Risk Assessment and Availability of Dose-Response Values**

| HAP[a] | Emissions (tpy) | Number of Facilities Reporting HAP (171 facilities in data set) | Prioritized Inhalation Dose-Response Value Identified by OAQPS[b] | | | PB-HAP? |
|---|---|---|---|---|---|---|
| | | | Unit Risk Estimate for Cancer? | Reference Concentration for Noncancer? | Health Benchmark Values for Acute Noncancer? | |
| Methanol | 38,650 | 165 | | Y | Y | |
| Acetaldehyde | 2,029 | 160 | Y | Y | Y | |
| Phenol | 454 | 127 | | Y | Y | |
| Cresols (mixed) | 439 | 84 | | Y | | |
| Chloroform | 356 | 128 | | Y | Y | |
| o-Cresol | 315 | 41 | | Y | | |
| Formaldehyde | 274 | 151 | Y | Y | Y | |
| Hydrochloric acid (hydrogen chloride) | 259 | 55 | | Y | Y | |
| Biphenyl | 218 | 92 | | | Y | |
| Hexachloroethane | 207 | 34 | Y | Y | | |
| Propionaldehyde | 135 | 106 | | Y | Y | |
| 1,2,4-Trichlorobenzene | 129 | 94 | | Y | | |
| Methylene chloride | 120 | 112 | Y | Y | Y | |
| Xylenes (mixed) | 98 | 107 | | Y | Y | |
| Carbon disulfide | 90 | 96 | | Y | Y | |
| Cumene | 83 | 95 | | Y | Y | |
| Toluene | 82 | 126 | | Y | Y | |
| Styrene | 77 | 112 | | Y | Y | |
| Tetrachloroethene | 75 | 98 | Y | Y | Y | |
| Methyl isobutyl ketone | 61 | 104 | | Y | | |
| Acetophenone | 60 | 39 | | | | |
| Hexane | 56 | 111 | | Y | Y | |
| Carbon tetrachloride | 40 | 92 | Y | Y | Y | |
| Trichloroethylene | 37 | 93 | Y | Y | Y | |
| o-Xylene | 36 | 64 | | Y | Y | |
| Benzene | 25 | 128 | Y | Y | Y | |
| Naphthalene | 24 | 105 | Y | Y | | |
| Chlorine | 24 | 53 | | Y | Y | |
| 1,1,2-Trichloroethane | 23 | 88 | Y | Y | | |
| 1,1,1-Trichloroethane (methyl chloroform) | 22 | 85 | | Y | Y | |
| Ethyl benzene | 18 | 76 | Y | Y | Y | |

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[31] Persistent and bioaccumulative HAP are defined in the EPA's *Air Toxics Risk Assessment Library*, Volume 1, EPA-453K-04-001A, as referenced in the ANPRM and provided on the EPA's Technology Transfer Network website for Fate, Exposure, and Risk Assessment at http://www.epa.gov/ttn/fera/risk_atra_vol1.html.

### Table 3.1-1 Summary of Emissions from the Pulp & Paper Source Category Used in the Residual Risk Assessment and Availability of Dose-Response Values

| HAP[a] | Emissions (tpy) | Number of Facilities Reporting HAP (171 facilities in data set) | Prioritized Inhalation Dose-Response Value Identified by OAQPS[b] | | | PB-HAP? |
|---|---|---|---|---|---|---|
| | | | Unit Risk Estimate for Cancer? | Reference Concentration for Noncancer? | Health Benchmark Values for Acute Noncancer? | |
| Vinyl acetate | 16 | 6 | | Y | Y | |
| Chlorobenzene | 15 | 82 | | Y | Y | |
| Methyl chloride | 14 | 63 | | Y | Y | |
| Hexachlorocyclopentadiene | 10 | 6 | | Y | | |
| Vinylidene chloride | 8 | 3 | | Y | | |
| Glycol Ethers | | | | | | |
| 1,2-Dimethoxyethane | 7 | 31 | | Y | Y | |
| Ethylene glycol ethyl ether | 0.01 | 2 | | Y | Y | |
| Methly cellosolve acrylate | 0.001 | 1 | | Y | Y | |
| Butyl carbitol acetate | 0.0002 | 1 | | Y | Y | |
| Acetonitrile | 5 | 2 | | Y | Y | |
| Ethylene dichloride | 4 | 75 | Y | Y | Y | |
| Vinyl chloride | 4 | 34 | Y | Y | Y | |
| Triethylamine | 3 | 2 | | Y | Y | |
| m-Cresol | 3 | 4 | | Y | | |
| Carbonyl sulfide | 3 | 18 | | Y[d] | Y | |
| Acrylonitrile | 3 | 4 | Y | Y | Y | |
| m-Xylene | 2 | 11 | | Y | Y | |
| Chloroacetic acid | 2 | 2 | | | Y | |
| p-Xylene | 1 | 7 | | Y | Y | |
| Pentachlorophenol | 1 | 2 | Y | Y | | |
| Ethylene glycol | 0.8 | 9 | | Y | | |
| Diethanolamine | 0.8 | 4 | | Y | | |
| Hydrogen cyanide | 0.6 | 1 | | Y | Y | |
| 1,3-Butadiene | 0.5 | 59 | Y | Y | Y | |
| 2,4,5-Trichlorophenol | 0.4 | 1 | | | | |
| p-Cresol | 0.3 | 3 | | Y | | |
| Methyl bromide | 0.3 | 25 | | Y | Y | |
| Nickel compounds | 0.2 | 29 | Y | Y | Y | |
| Acrylamide | 0.2 | 2 | Y | Y | | |
| Ethylene dibromide | 0.1 | 20 | Y | Y | Y | |
| Cyanide compounds | 0.1 | 1 | | Y | | |
| Nitrobenzene | 0.09 | 2 | Y | Y | | |
| Antimony compounds | 0.08 | 1 | | Y | | |
| Lead compounds | 0.05 | 28 | | Y | | Y |
| Propylene dichloride | 0.05 | 3 | Y | Y | | |
| 2-Nitropropane | 0.05 | 2 | Y | Y | | |
| 2,4-Toluene diamine | 0.02 | 3 | Y | | | |
| Methyl iodide | 0.02 | 3 | | | Y | |

## Table 3.1-1 Summary of Emissions from the Pulp & Paper Source Category Used in the Residual Risk Assessment and Availability of Dose-Response Values

| HAP[a] | Emissions (tpy) | Number of Facilities Reporting HAP (171 facilities in data set) | Prioritized Inhalation Dose-Response Value Identified by OAQPS[b] | | | PB-HAP? |
|---|---|---|---|---|---|---|
| | | | Unit Risk Estimate for Cancer? | Reference Concentration for Noncancer? | Health Benchmark Values for Acute Noncancer? | |
| Chromium Compounds | | | | | | |
| Chromium (III) compounds | 0.02 | 27 | | | | |
| Chromium (VI) compounds | 0.0007 | 25 | Y | Y | | |
| Ethylidene dichloride (1,1-Dichloroethane) | 0.01 | 3 | Y | Y | | |
| Bromoform | 0.01 | 2 | Y | | | |
| Cadmium compounds | 0.01 | 28 | Y | Y | | Y |
| Beryllium compounds | 0.01 | 8 | Y | Y | Y | |
| 2,4,6-Trichlorophenol | 0.009 | 2 | Y | | | |
| Polycyclic Organic Matter (POM) | | | | | | |
| POM 72002 | 0.008 | 29 | Y | | | Y |
| Dibenzo(a,h)anthracene | 0.0007 | 7 | Y | | | Y |
| Indeno(1,2,3-c,d)pyrene | 0.000003 | 7 | Y | | | Y |
| 7,12-Dimethylbenz(a)anthracene | 0.000002 | 3 | Y | | | Y |
| Benzo(b)fluoranthene | 0.0000006 | 7 | Y | | | Y |
| Chrysene | 0.0000003 | 5 | Y | | | Y |
| Benz(a)anthracene | 0.0000002 | 6 | Y | | | Y |
| Benzo(k)fluoranthene | 0.0000002 | 5 | Y | | | Y |
| POM 71002 | 0.0000002 | 1 | Y | | | Y |
| 3-Methylcholanthrene | 0.0000002 | 3 | Y | | | Y |
| Benzo(a)pyrene | 0.0000002 | 6 | Y | | | Y |
| Manganese compounds | 0.006 | 29 | | Y | | |
| Catechol | 0.006 | 5 | | | | |
| n,n-Dimethylaniline | 0.005 | 1 | | | | |
| Arsenic compounds | 0.004 | 28 | Y | Y | Y | |
| Selenium compounds | 0.004 | 9 | | Y | | |
| Dibutylphthalate | 0.003 | 5 | | | | |
| 1,4-Dichlorobenzene | 0.003 | 7 | Y | Y | | |
| Chlorobenzilate | 0.002 | 1 | Y | | | |
| Cobalt compounds | 0.002 | 24 | | Y | | |
| Mercury Compounds | | | | | | |
| Mercury (elemental) | 0.002 | 27 | | Y | Y | Y |
| Mercuric chloride | 0.002 | 27 | | Y | | Y |
| Bis(2-ethylhexyl)phthalate | 0.001 | 2 | Y | Y | | |
| 1,1,2,2-Tetrachloroethane | 0.0007 | 1 | Y | | | |
| Ethylene oxide | 0.0003 | 1 | Y | Y | Y | |
| Aniline | 0.00001 | 3 | Y | Y | Y | |

[a] Notes for how HAP were speciated for risk assessment:

- For most metals, emissions reported as the elemental metal are combined with metal compound emissions (e.g., "cadmium" emissions modeled as "cadmium & compounds"). In the absence of speciation information, we assume the reported mass is 100 percent metal.
- For emissions reported generically as "chromium" or "chromium & compound," emissions are speciated "chromium (III) compounds" and "chromium (VI) compounds" according to the individual emitting process speciation profile for this source category. Chromium speciation profiles can be found on the EPA's Technology Transfer Network website for emissions inventories at http://www.epa.gov/ttn/chief/net/2005inventory.html. Further information on the development of the chromium speciation profiles used in this assessment can be found in the memorandum entitled, *Inputs to the Pulp and Paper Industry October 2011 Residual Risk Modeling*, found in the docket.
- For emissions reported generically as "mercury" or "mercury & compounds," emissions are speciated for this category as "mercury (elemental)" and "mercuric chloride." Mercury speciation profiles can be found on the EPA's Technology Transfer Network website for emissions inventories at http://www.epa.gov/ttn/chief/net/2005inventory.html.
- For emissions of any chemicals or chemical groups classified as POM, emissions were grouped into POM subgroups as found on EPA's Technology Transfer Network website for the 2005 National-Scale Air Toxics Assessment at http://www.epa.gov/ttn/atw/nata2005/methods.html#pom (*Approach to Modeling POM)*.
- For emissions reported generically as "Glycol Ethers" or specific glycol ethers not found on EPA's Technology Transfer Network for air toxics (see footnote b), emissions were treated as ethylene glycol methyl ether.

[b] Specific dose-response values for each chemical are identified on EPA's Technology Transfer Network website for air toxics at http://www.epa.gov/ttn/atw/toxsource/summary.html.

[c] There is no reference concentration for lead. In considering noncancer hazards for lead in this assessment, we compared rolling three-month average exposure estimates to the National Ambient Air Quality Standard (NAAQS) for lead (0.15 $\mu g/m^3$). These NAAQS for lead were recently reviewed with revisions adopted in October 2008 (http://www.epa.gov/air/lead/actions.html). The primary (health-based) standard is a maximum or not-to-be-exceeded, rolling three-month average, measured as total suspended particles (TSP). The secondary (welfare-based) standard is identical to the primary standard.

[d] A chronic screening level of 0.163 $mg/m^3$ was developed for carbonyl sulfide by EPA ORD from a No Observed Adverse Effects Level of 200 ppm based on brain lesions and neurophysiological alteration in rodents.

## 3.2 Risk Characterization

This section presents the results of the risk assessment for the pulp and paper source category. The basic chronic inhalation risk estimates presented here are the maximum individual lifetime cancer risk, the maximum chronic hazard index, and the cancer incidence. We also present results from our acute inhalation impact screening assessment in the form of maximum hazard quotients, as well as the results of our preliminary screen for potential non-inhalation risks from PB-HAP. Also presented are the HAP "drivers," which are the HAP that collectively contribute 90 percent of the maximum cancer risk or maximum hazard at the highest exposure location, as well as a summary of the results of our facility-wide assessments and our analysis of risks associated with the maximum allowed emissions under the current MACT standards. A detailed summary of the facility-specific risk assessment results is available in Appendix 5.

Tables 3.2-1 and 3.2-2 summarize the chronic and acute inhalation risk results for the pulp and paper source category. The results indicate that maximum lifetime individual cancer risks could be up to 10 in a million. The major contributors to this risk are hexachloroethane and naphthalene from kraft processes such as pulp storage, wastewater, and bleaching. The total estimated cancer incidence from this source category is 0.01 excess cancer cases per year, or one excess case in every 100 years. Approximately 40 people are estimated to have cancer risks at or above 10 in a million, and approximately 76,000 people are estimated to have cancer risks at or above 1 in a million as a result of the emissions from 68 facilities. The maximum chronic noncancer target organ specific hazard index (TOSHI) value for the source category could be up to 0.4 associated with emissions of acetaldehyde, indicating no significant potential for chronic noncancer impacts.

Analysis of potential differences between actual emissions levels and the maximum emissions allowable under the MACT standards were also calculated for stack emissions for this source category. Risk estimates based on the maximum emissions allowable under the MACT standards were calculated from stack emissions obtained from the ICR. Risk results from the inhalation risk assessment indicate that the maximum lifetime individual cancer risk could be up to 10 in a million, and that the maximum chronic noncancer TOSHI value could be up to 0.6 at the MACT-allowable emissions level.

Worst-case acute hazard quotients (HQs) were calculated for every HAP that has an acute benchmark. For cases where the screening acute HQ was greater than 1, we further refined the estimates by determining the highest HQ value that is outside facility boundaries. The highest refined worst-case acute HQ value is 20 (based on the acute REL for acetaldehyde) as shown in Table 3.2-1. The HQ of 20 represents an upper-bound risk estimate and is located in a rural location in which public access is limited or may represent an off-site area that is owned by the facility. An acute noncancer HQ of 3 for this facility would represent an area in which the public has access via a public road. The next highest acute noncancer HQ for this source category would be 6 for chloroform. Nine facilities have estimated acute noncancer HQ values greater than 1, but less than or equal to 6. Based on maximum hourly emission estimates available by emission process group, an emissions multiplier of 2 was used to estimate the peak hourly emission rates for source category. See the memorandum entitled, *Inputs to the Pulp and Paper Industry October 2011 Residual Risk Modeling* for detailed description of how the maximum hourly emissions were developed for this source category (found in the docket for this rule making). Table 3.2-2 provides more information on the refined acute risk estimates for HAP that had an acute HQ greater than 1 for any benchmark.

To better characterize the potential health risks associated with estimated worst-case acute exposures to HAP, and in response to a key recommendation from the Science Advisory Board's peer review of EPA's RTR risk assessment methodologies[32], we examine a wider range of available acute health metrics than we do for our chronic risk assessments. This is in response to the acknowledgement that there are generally more data gaps and inconsistencies in acute reference values than there are in chronic reference values. By definition, the acute CA-REL represents a health-protective level of exposure, with no risk anticipated below those levels, even for repeated exposures; however, the health risk from higher-level exposures is unknown. Therefore, when a CA-REL is exceeded and an AEGL-1 or ERPG-1 level is available (i.e., levels at which mild effects are anticipated in the general public for a single exposure), we have used them as a second comparative measure. Historically, comparisons of the estimated maximum off-site one-hour exposure levels have not been typically made to

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[32] The SAB peer review of RTR Risk Assessment Methodologies is available at: http://yosemite.epa.gov/sab/sabproduct.nsf/4AB3966E263D943A8525771F00668381/$File/EPA-SAB-10-007-unsigned.pdf

occupational levels for the purpose of characterizing public health risks in RTR assessments. This is because occupational ceiling values are not generally considered protective for the general public since they are designed to protect the worker population (presumed healthy adults) for short duration (<15 minute) increases in exposure[33]. As a result, for most chemicals, the 15-minute occupational ceiling values are set at levels higher than a one-hour AEGL-1, making comparisons to them irrelevant unless the AEGL-1 or ERPG-1 levels are exceeded. Such is not the case when comparing the available acute inhalation health effect reference values for formaldehyde.

The worst-case maximum estimated 1-hour exposure to formaldehyde outside the facility fence line for the pulp and paper source category is 0.25 mg/m$^3$. This estimated worst-case exposure exceeds the 1-hour REL by a factor of 5 ($HQ_{REL}$ = 5) and is below the 1-hour AEGL-1 ($HQ_{AEGL-1}$ = 0.2). This exposure estimate is below the AEGL-1, and exceed the workplace ceiling level guideline for the formaldehyde value developed by National Institutes for Occupational Safety and Health (NIOSH)[34] "for any 15 minute period in a work day" (NIOSH REL-ceiling value of 0.12 mg/m$^3$; $HQ_{NIOSH}$ = 2). The estimate is at the value developed by the American Conference of Governmental Industrial Hygienists (ACGIH)[35] as "not to be exceeded at any time" (ACGIH TLV-ceiling value of 0.37 mg/m$^3$; $HQ_{ACGIH}$ = 1). Additionally, the estimated maximum acute exposure exceeds the Air Quality Guideline value that was developed by the World Health Organization[36] for 30-minute exposures (0.1 mg/m$^3$; $HQ_{WHO}$ = 2.5).

To identify potential multipathway health risks from PB-HAP other than lead, we first performed a screening analysis that compared emissions of PB-HAP emitted from the pulp and paper source category to screening emission rates (see section 2.5). The PB-HAP emitted by facilities in this category include cadmium, mercury, and POM (as benzo(a)pyrene toxicity equivalents). Thirty-eight facilities in the source category reported emissions of one or more of these PB-HAP. At the time of proposal for this rulemaking, for all 38 facilities the emissions rate for each PB-HAP was below the screening thresholds, with the exception of one facility's emission rate of POM which exceeded the screening threshold by 2 times. For POM, exceeding the screening emission rate corresponds to a potential for creating a cancer risk in excess of 1 in a million. Since proposal, EPA has refined the emission screening thresholds in the multipathway analysis to use improved toxicity rating and scaling methods for POM and dioxin congeners as well as improved fate, transport, and uptake behavior

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[33] U.S. EPA. (2009) Chapter 2.9 Chemical Specific Reference Values for Formaldehyde in Graphical Arrays of Chemical-Specific Health Effect Reference Values for Inhalation Exposures (Final Report). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-09/061, and available on-line at http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=211003

[34] National Institutes for Occupational Safety and Health (NIOSH). Occupational Safety and Health Guideline for Formaldehyde; http://www.cdc.gov/niosh/docs/81-123/pdfs/0293.pdf

[35] ACGIH (2001) Formaldehyde. In Documentation of the TLVs® and BEIs® with Other Worldwide Occupational Exposure Values. ACGIH, 1300 Kemper Meadow Drive, Cincinnati, OH 45240 (ISBN: 978-1-882417-74-2) and available on-line at http://www.acgih.org.

[36] WHO (2000). Chapter 5.8 Formaldehyde, in Air Quality Guidelines for Europe, second edition. World Health Organization Regional Publications, European Series, No. 91. Copenhagen, Denmark. Available on-line at http://www.euro.who.int/__data/assets/pdf_file/0005/74732/E71922.pdf.

through the aquatic food chain. (See Appendix 4 for a detailed discussion of the changes to the multipathway screening scenario.) Based on the above changes, the facility-level emissions of POM from this source category are now below the screening threshold by a factor of 9.

In evaluating the potential for multipathway effects from emissions of lead, modeled maximum annual lead concentrations were compared to the NAAQS value for lead (0.15 $\mu g/m^3$), which takes into account multipathway exposures, so a separate multipathway screening value was not developed. Since none of our maximum estimated annual lead concentrations were even close to the NAAQS, we do not expect any significant multipathway exposure and risk due to lead emissions from these facilities.

**Table 3.2-1 Summary of Source Category Level Inhalation Risks for Pulp and Paper**

| **Result** | | **HAP "Drivers"** |
|---|---|---|
| **Facilities in Source Category** | | |
| Number of Facilities Estimated to be in Source Category | 171 | n/a |
| Number of Facilities Identified in the NEI and Modeled in Preliminary Risk Assessment | 171 | n/a |
| **Cancer Risks** | | |
| Maximum Individual Lifetime Cancer Risk (in 1 million) | 10 | hexachloroethane, naphthalene |
| *Number of Facilities with Maximum Individual Lifetime Cancer Risk:* | | |
| Greater than or equal to 100 in 1 million | 0 | n/a |
| Greater than or equal to 10 in 1 million | 2 | hexachloroethane |
| Greater than or equal to 1 in 1 million | 6 | hexachloroethane, naphthalene |
| **Chronic Noncancer Risks** | | |
| Maximum Respiratory Hazard Index | 0.4 | acetaldehyde |
| *Number of Facilities with Maximum Respiratory Hazard Index:* | | |
| Greater than 100 | 0 | n/a |
| Greater than 10 | 0 | n/a |
| Greater than 1 | 0 | n/a |
| **Acute Noncancer Refined Results** | | |
| Maximum Acute Hazard Quotient | 20<br>6<br>5<br>2 | acetaldehyde (REL)<br>chloroform (REL)<br>formaldehyde (REL)<br>methanol (REL) |
| Number of Facilities With Potential for Acute Effects | 9 | acetaldehyde, chloroform, formaldehyde, methanol |
| **Population Exposure** | | |
| Number of People Living Within 50 Kilometers of Facilities Modeled | 50,000,000 | n/a |
| *Number of People Exposed to Cancer Risk:* | | |
| Greater than or equal to 100 in 1 million | 0 | n/a |
| Greater than or equal to 10 in 1 million | 40 | n/a |
| Greater than or equal to 1 in 1 million | 76,000 | n/a |
| *Number of People Exposed to Noncancer Respiratory Hazard Index:* | | |

## Table 3.2-1 Summary of Source Category Level Inhalation Risks for Pulp and Paper

| **Result** | | **HAP "Drivers"** |
|---|---|---|
| Greater than 100 | 0 | n/a |
| Greater than 10 | 0 | n/a |
| Greater than 1 | 0 | n/a |
| Estimated Cancer Incidence (excess cancer cases per year) | 0.01[37] | n/a |
| *Contribution of HAP to Cancer Incidence:* | | |
| acetaldehyde | 38% | n/a |
| formaldehyde | 36% | n/a |
| hexachloroethane | 9% | n/a |
| naphthalene | 4% | n/a |
| tetrachloroethene | 3% | n/a |
| 1,1,2-trichloroethane | 2% | n/a |

## Table 3.2-2 Summary of Refined Acute Results for Pulp & Paper Facilities

| **Refined Results** | | **MAXIMUM ACUTE HAZARD QUOTIENTS** | | | **ACUTE DOSE-RESPONSE VALUES** | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | **Based on REL** | **Based on AEGL-1/ ERPG-1** | **Based on AEGL-2/ ERPG-2** | **REL (mg/m$^3$)** | **AEGL-1 (1-hr) (mg/m$^3$)** | **ERPG-1 (mg/m$^3$)** | **AEGL-2 (1-hr) (mg/m$^3$)** | **ERPG-2 (mg/m$^3$)** |
| **HAP** | **Max. 1-hr. Air Conc. (mg/m$^3$)** | | | | | | | | |
| acetaldehyde | 7.1 | 20 | 0.09/0.4 | 0.01/0.02 | 0.47 | 81 | 18 | 490 | 360 |
| chloroform | 0.9 | 6 | | 0.003/0.004 | 0.15 | | | 310 | 240 |
| formaldehyde | 0.25 | 5 | 0.2/0.2 | 0.01/0.02 | 0.055 | 1.1 | 1.2 | 17 | 12 |
| methanol | 64 | 2 | 0.09/0.2 | 0.02/0.05 | 28 | 690 | 260 | 2700 | 1300 |

Notes on Refined Process:

1) The screening was performed for all emitted HAP with available acute dose-response values. Only those pollutants whose screening HQs were greater than 1 for at least one acute threshold value are shown in the table.
2) HAP with available acute dose-response values which are not in the table do not carry any potential for posing acute health risks, based on an analysis of currently available emissions data.

Notes on Acute Dose-Response Values:

REL – California EPA reference exposure level for no adverse effects. Most, but not all, RELs are for 1-hour exposures.

AEGL – Acute exposure guideline levels represent emergency exposure (1-hour) limits for the general public.

AEGL-1 is the exposure level above which it is predicted that the general population, including susceptible individuals, could experience effects that are notable discomfort, but which are transient and reversible upon cessation of exposure.

AEGL-2 is the exposure level above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects of an impaired ability to escape.

EPRG – Emergency Removal Program guidelines represent emergency exposure (1-hour) limits for the general public.

ERPG-1 is the maximum level below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing other than mild, transient adverse health effects.

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[37] We note that the MIR for this source category would not change if the CIIT URE for formaldehyde had been used in the assessment; however, the total cancer incidence would decrease by about 36%. There is an ongoing IRIS reassessment for formaldehyde, and future RTR risk assessments will use the cancer potency for formaldehyde that results from that reassessment. As a result, the current results many not match those of future assessments.

ERPG-2 is the maximum exposure below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action.

The facility-wide MIR and TOSHI, available in Appendix 5, are based on emissions, as collected in the ICR, from all emissions sources at the identified facilities. The results of the facility-wide assessment are summarized in Table 3.2-3. The results indicate that 100 facilities with pulp and paper production processes have facility-wide cancer MIR greater than or equal to 1 in a million. The maximum facility-wide MIR is 30 in a million, with pulp and paper source category contributing 27 percent of the risk. The remaining 63 percent is driven by emissions of arsenic and chromium (VI) from hazardous waste incineration. The maximum facility-wide TOSHI is 2, driven by emissions of antimony compounds from smelt dissolving tank kraft process units. The source category contributes approximately 11 percent to the facility-wide TOSHI.

**Table 3.2-3 Source Category Contribution to Facility-Wide Cancer Risks**

| **Pulp & Paper Production** | **Number of Facilities Binned by Facility-Wide MIR (in 1 million)** | | | | |
|---|---|---|---|---|---|
| **Source Category MIR Contribution to Facility-Wide MIR** | <1 | 1≤ MIR<10 | 10≤ MIR<100 | ≥ 100 | **Total** |
| > 90% | 19 | 14 | 1 | 0 | 34 |
| 50-90% | 21 | 42 | 1 | 0 | 64 |
| 10-50% | 27 | 31 | 3 | 0 | 61 |
| < 10% | 4 | 5 | 3 | 0 | 12 |
| **Total** | 71 | 92 | 8 | 0 | 171 |

# 4 General Discussion of Uncertainties and How They Have Been Addressed

## 4.1 Exposure Modeling Uncertainties

Although every effort has been made to identify all the relevant facilities and emission points, as well as to develop accurate estimates of the annual emission rates for all relevant HAP, the uncertainties in our emission inventory likely dominate the uncertainties in our exposure estimates. The chronic ambient modeling uncertainties are considered relatively small in comparison, since we are using EPA's refined local dispersion model with site-specific parameters and reasonably representative meteorology. If anything, the population exposure estimates are biased high by not accounting for short- or long-term population mobility, and by neglecting processes like deposition, plume depletion, and atmospheric degradation. Additionally, estimates of the maximum individual risk (MIR) contain uncertainty, because they are derived at census block centroid locations rather than actual residences. This uncertainty is known to create potential underestimates and overestimates of the actual MIR values for individual facilities, but, overall, it is not thought to have a significant impact on the estimated MIR for a source category. Finally, we did not factor in the possibility of a source closure occurring during the 70-year chronic exposure period, leading to a potential upward bias in both the MIR and population risk estimates; nor did we factor in the possibility of population growth during the 70-year chronic exposure period, leading to a potential downward bias in both the MIR and population risk estimates.

A sensitivity analysis performed for the 1999 NATA found that the selection of the meteorology dataset location could result in a range of chronic ambient concentrations which varied from as much as 17 percent below the predicted value to as much as 84 percent higher than the predicted value. This variability translates directly to the predicted exposures and risks in our assessment, indicating that the actual risks could vary from 17 percent lower to 84 percent higher than the predicted values.

We have purposely biased the acute screening results high, considering that they depend upon the joint occurrence of independent factors, such as hourly emissions rates, meteorology and human activity patterns. Furthermore, in cases where multiple acute threshold values are considered scientifically acceptable we have chosen the most conservative of these threshold values, erring on the side of overestimating potential health risks from acute exposures. In the cases where these results indicated the potential for exceeding short-term health thresholds, we have refined our assessment by developing a better understanding of the geography of the facility relative to potential exposure locations and the true variability of short-term emission rates.

## 4.2 Uncertainties in the Dose-Response Relationships

In the sections that follow, separate discussions are provided on uncertainty associated with cancer potency factors and for noncancer reference values. Cancer potency values are derived for chronic (lifetime) exposures. Noncancer reference values are generally derived for chronic exposures (up to a lifetime), but may also be derived for acute (<24 hours), short-term (>24 hours up to 30 days), and subchronic (>30 days up to 10 percent of lifetime) exposure durations, all of which are derived based on an assumption of continuous exposure throughout the duration specified. For the purposes of assessing all potential health risks associated with the emissions included in an assessment, we rely on both chronic (cancer and noncancer) and acute (noncancer) benchmarks, which are described in more detail below.

Although every effort is made to identify peer-reviewed dose-response values for all HAPs emitted by the source category included in an assessment, some HAP have no peer-reviewed cancer potency values or reference values for chronic non-cancer or acute effects (inhalation or ingestion). Since exposures to these pollutants cannot be included in a quantitative risk estimate, an understatement of risk for these pollutants at environmental exposure levels is possible.

Additionally, chronic dose-response values for certain compounds included in the assessment may be under EPA IRIS review and revised assessments may determine that these pollutants are more or less potent than currently thought. We will re-evaluate risks if, as a result of these reviews, a dose-response metric changes enough to indicate that the risk assessment may significantly mischaracterize human health risk

## Cancer assessment

The discussion of dose-response uncertainties in the estimation of cancer risk below focuses on the uncertainties associated with the specific approach currently used by the EPA to develop cancer potency factors. In general, these same uncertainties attend the development of cancer potency factors by CalEPA, the source of peer-reviewed cancer potency factors used where EPA-developed values are not yet available. To place this discussion in context, we provide a quote from the EPA's *Guidelines for Carcinogen Risk Assessment* [*30*] (herein referred to as *Cancer Guidelines*). "The primary goal of EPA actions is protection of human health; accordingly, as an Agency policy, risk assessment procedures, including default options that are used in the absence of scientific data to the contrary, should be health protective." The approach adopted in this document is consistent with this approach as described in the *Cancer Guidelines*.

For cancer endpoints EPA usually derives an oral slope factor for ingestion and a unit risk value for inhalation exposures. These values allow estimation of a lifetime probability of developing cancer given long-term exposures to the pollutant. Depending on the pollutant being evaluated, EPA relies on both animal bioassay and epidemiological studies to characterize cancer risk. As a science policy approach, consistent with the *Cancer Guidelines*, EPA uses animal cancer bioassays as indicators of potential human health risk when other human cancer risk data are unavailable.

Extrapolation of study data to estimate potential risks to human populations is based upon EPA's assessment of the scientific database for a pollutant using EPA's guidance documents and other peer-reviewed methodologies. The EPA *Cancer Guidelines* describes the Agency's recommendations for methodologies for cancer risk assessment. EPA believes that cancer risk estimates developed following the procedures described in the *Cancer Guidelines* and outlined below generally provide an upper bound estimate of risk. That is, EPA's upper bound estimates represent a "plausible upper limit to the true value of a quantity" (although this is usually not a true statistical confidence limit).[38] In some circumstances, the true risk could be as low as zero; however, in other circumstances the risk could also be greater.[39] When developing an upper bound estimate of risk and to provide risk values that do not underestimate risk, EPA generally relies on conservative default approaches.[40] EPA also

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[38] IRIS glossary (www.epa.gov/NCEA/iris/help_gloss.htm).

[39] The exception to this is the URE for benzene, which is considered to cover a range of values, each end of which is considered to be equally plausible, and which is based on maximum likelihood estimates.

[40] According to the NRC report Science and Judgment in Risk Assessment (NRC, 1994) "[Default] options are generic approaches, based on general scientific knowledge and policy judgment, that are applied to various elements of the risk-assessment process when the correct scientific model is unknown or uncertain." The 1983 NRC report Risk Assessment in the Federal Government: Managing the Process defined default option as "the option chosen on the basis of risk assessment policy that appears to be the best choice in the absence of data to the contrary" (NRC, 1983a, p. 63). Therefore, default options are not rules that bind the agency; rather, the agency may depart from them in evaluating the risks posed by a specific substance when it believes this to be appropriate. In keeping with EPA's goal of protecting public health and the environment, default assumptions

uses the upper bound (rather than lower bound or central) estimates in its assessments, although it is noted that this approach can have limitations for some uses (e.g. priority setting, expected benefits analysis).

Such health risk assessments have associated uncertainties, some which may be considered quantitatively, and others which generally are expressed qualitatively. Uncertainties may vary substantially among cancer risk assessments associated with exposures to different pollutants, since the assessments employ different databases with different strengths and limitations and the procedures employed may differ in how well they represent actual biological processes for the assessed substance. EPA's *Risk Characterization Handbook* also recommends that risk characterizations present estimates demonstrating the impact on the assessment of alternative choices, data, models and assumptions [*31*]. Some of the major sources of uncertainty and variability in deriving cancer risk values are described more fully below.

(1) The qualitative similarities or differences between tumor responses observed in experimental animal bioassays and those which would occur in humans are a source of uncertainty in cancer risk assessment. In general, EPA does not assume that tumor sites observed in an experimental animal bioassay are necessarily predictive of the sites at which tumors would occur in humans.[41] However, unless scientific support is available to show otherwise, EPA assumes that tumors in animals are relevant in humans, regardless of target organ concordance. For a specific pollutant, qualitative differences in species responses can lead to either under-estimation or over-estimation of human cancer risks.

(2) Uncertainties regarding the most appropriate dose metric for an assessment can also lead to differences in risk predictions. For example, the measure of dose is commonly expressed in units of mg/kg/d ingested or the inhaled concentration of the pollutant. However, data may support development of a pharmacokinetic model for the absorption, distribution, metabolism and excretion of an agent, which may result in improved dose metrics (e.g., average blood concentration of the pollutant or the quantity of agent metabolized in the body). Quantitative uncertainties result when the appropriate choice of a dose metric is uncertain or when dose metric estimates are themselves uncertain (e.g., as can occur when alternative pharmacokinetic models are available for a compound). Uncertainty in dose estimates may lead to either over or underestimation of risk.

(3) For the quantitative extrapolation of cancer risk estimates from experimental animals to humans, EPA uses scaling methodologies (relating expected response to differences in physical size of the species), which introduce another source of uncertainty. These methodologies are based on both biological data on differences in rates of process according to species size and empirical comparisons of toxicity between experimental animals and humans. For a particular pollutant, the quantitative difference in cancer potency between

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are used to ensure that risk to chemicals is not underestimated (although defaults are not intended to overtly overestimate risk). See EPA 2004 An Examination of EPA Risk Assessment Principles and Practices, EPA/100/B-04/001 available at: http://www.epa.gov/osa/pdfs/ratf-final.pdf.

[41] Per the EPA Cancer Guidelines: "The default option is that positive effects in animal cancer studies indicate that the agent under study can have carcinogenic potential in humans." and "Target organ concordance is not a prerequisite for evaluating the implications of animal study results for humans."

experimental animals and humans may be either greater than or less than that estimated by baseline scientific scaling predictions due to uncertainties associated with limitations in the test data and the correctness of scaled estimates.

(4) EPA cancer risk estimates, whether based on epidemiological or experimental animal data, are generally developed using a  benchmark dose (BMD) analysis to estimate a dose at which there is a specified excess risk of cancer, which is used as the point of departure (or POD) for the remainder of the calculation.  Statistical uncertainty in developing a POD using a benchmark dose (BMD) approach is generally addressed though use of the 95 percent lower confidence limit on the dose at which the specified excess risk occurs (the BMDL), decreasing the likelihood of understating risk.  EPA has generally utilized the multistage model for estimation of the BMDL using cancer bioassay data (see further discussion below).

(5) Extrapolation from high to low doses is an important, and potentially large, source of uncertainty in cancer risk assessment.  EPA uses different approaches to low dose risk assessment (i.e., developing estimates of risk for exposures to environmental doses of an agent from observations in experimental or epidemiological studies at higher dose) depending on the available data and understanding of a pollutant's mode of action (i.e., the manner in which a pollutant causes cancer).  EPA's *Cancer Guidelines* express a preference for the use of reliable, compound-specific, biologically-based risk models when feasible; however, such models are rarely available.  The mode of action for a pollutant (i.e., the manner in which a pollutant causes cancer) is a key consideration in determining how risks should be estimated for low-dose exposure.  A reference value is calculated when the available mode of action data show the response to be nonlinear (e.g., as in a threshold response).  A linear low-dose (straight line from POD) approach is used when available mode of action data support a linear (e.g., nonthreshold response) or as the most common default approach when a compound's mode of action is unknown.  Linear extrapolation can be supported by both pollutant-specific data and broader scientific considerations.  For example, EPA's *Cancer Guidelines* generally consider a linear dose-response to be appropriate for pollutants that interact with DNA and induce mutations.  Pollutants whose effects are additive to background biological processes in cancer development can also be predicted to have low-dose linear responses, although the slope of this relationship may not be the same as the slope estimated by the straight line approach.

EPA most frequently utilizes a linear low-dose extrapolation approach as a baseline science-policy choice (a "default") when available data do not allow a compound-specific determination.  This approach is designed to not underestimate risk in the face of uncertainty and variability.  EPA believes that linear dose-response models, when appropriately applied as part of EPA's cancer risk assessment process, provide an upper bound estimate of risk and generally provide a health protective approach.  Note that another source of uncertainty is the characterization of low-dose nonlinear, non-threshold relationships.  The National Academy of Sciences has encouraged the exploration of sigmoidal type functions (e.g., log-probit models) in representing dose response relationships due to the variability in response within human populations.  Another National Research Council (NRC) report [*32*] suggests that models based on distributions of individual thresholds are likely to lead to sigmoidal-shaped dose-response functions for a population.  This report notes sources of variability in the human population: "One might expect these individual tolerances to vary extensively in humans depending on genetics, coincident exposures, nutritional status, and various other susceptibility factors..." Thus, if a distribution of thresholds approach is considered for a carcinogen risk assessment, application would depend on ability of modeling to reflect the degree of variability in response in human populations (as opposed to responses in bioassays with genetically more uniform rodents). Note also that low dose linearity in risk can arise for reasons separate from population variability: due to the nature of a mode of action and additivity of a chemical's effect on top of background chemical exposures and biological processes.

As noted above, EPA's current approach to cancer risk assessment typically utilizes a straight line approach from the BMDL. This is equivalent to using an upper confidence limit on the slope of the straight line extrapolation. The impact of the choice of the BMDL on bottom line risk estimates can be quantified by comparing risk estimates using the BMDL value to central estimate BMD values, although these differences are generally not a large contributor to uncertainty in risk assessment (Subramaniam et. al., 2006) [*33*]. It is important to note that earlier EPA assessments, including the majority of those for which risk values exist today, were generally developed using the multistage model to extrapolate down to environmental dose levels and did not involve the use of a POD. Subramaniam et. al. (2006) also provide comparisons indicating that slopes based on straight line extrapolation from a POD do not show large differences from those based on the upper confidence limit of the multistage model.

(6) Cancer risk estimates do not generally make specific adjustments to reflect the variability in response within the human population — resulting in another source of uncertainty in assessments. In the diverse human population, some individuals are likely to be more sensitive to the action of a carcinogen than the typical individual, although compound-specific data to evaluate this variability are generally not available. There may also be important life stage differences in the quantitative potency of carcinogens and, with the exception of the recommendations in EPA's Supplemental Cancer Guidance for carcinogens with a mutagenic mode of action, risk assessments do not generally quantitatively address life stage differences. However, one approach used commonly in EPA assessments that may help address variability in response is to extrapolate human response from results observed in the most sensitive species and sex tested, resulting typically in the highest URE which can be supported by reliable data, thus supporting estimates that are designed not to underestimate risk in the face of uncertainty and variability.

## Chronic noncancer assessment

Chronic noncancer reference values represent chronic exposure levels that are intended to be health-protective. That is, EPA and other organizations which develop noncancer reference values (e.g., the Agency for Toxic Substances and Disease Registry – ATSDR) utilize an approach that is intended not to underestimate risk in the face of uncertainty and variability. When there are gaps in the available information, uncertainty factors (UFs) are applied to derive reference values that are intended to be protective against appreciable risk of deleterious effects. Uncertainty factors are commonly default values[42] e.g., factors of 10 or 3, used in the absence of compound-specific data; where data are available, uncertainty factors may also be developed using compound-specific information. When data are limited, more assumptions are needed and more default factors are used. Thus there may be a greater tendency to overestimate risk—in the sense that further study might support development of reference values that are higher (i.e., less potent) because fewer default assumptions are needed. However, for some pollutants it is possible that risks may be underestimated.

For non-cancer endpoints related to chronic exposures, EPA derives a Reference Dose (RfD) for exposures via ingestion, and a Reference Concentration (RfC) for inhalation exposures. These values provide an estimate (with uncertainty spanning perhaps an order of magnitude) of daily oral exposure (RfD) or of a continuous inhalation exposure (RfC) to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.[43] To derive values that are intended to be "without appreciable risk," EPA's methodology relies upon an uncertainty factor (UF) approach [*34*],[*35*] which includes consideration of both uncertainty and variability.

EPA begins by evaluating all of the available peer-reviewed literature to determine non-cancer endpoints of concern, evaluating the quality, strengths and limitations of the available studies. EPA typically chooses the relevant endpoint that occurs at the lowest dose, often using statistical modeling of the available data, and then determines the appropriate point of departure (POD) for derivation of the reference value. A POD is determined by (in order of preference): (1) a statistical estimation using the benchmark dose (BMD) approach; (2) use of the dose or concentration at which the toxic response was not significantly elevated (no observed adverse effect level— NOAEL); or (3) use of the lowest observed adverse effect level (LOAEL).

A series of downward adjustments using default UFs is then applied to the POD to estimate the reference value [*36*]. While collectively termed "UFs", these factors account for a number of different quantitative considerations when utilizing observed animal (usually rodent) or human toxicity data in a risk assessment. The UFs are intended to account for: (1) variation in susceptibility among the members of the human population (i.e., inter-individual variability); (2) uncertainty in extrapolating from experimental animal data to humans (i.e., interspecies differences); (3) uncertainty in extrapolating from data obtained in a study with

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[42] According to the NRC report *Science and Judgment in Risk Assessment* (NRC, 1994) "[Default] options are generic approaches, based on general scientific knowledge and policy judgment, that are applied to various elements of the risk-assessment process when the correct scientific model is unknown or uncertain." The 1983 NRC report, *Risk Assessment in the Federal Government: Managing the Process* defined *default option* as "the option chosen on the basis of risk assessment policy that appears to be the best choice in the absence of data to the contrary" (NRC, 1983a, p. 63). Therefore, default options are not rules that bind the agency; rather, the agency may depart from them in evaluating the risks posed by a specific substance when it believes this to be appropriate. In keeping with EPA's goal of protecting public health and the environment, default assumptions are used to ensure that risk to chemicals is not underestimated (although defaults are not intended to overtly overestimate risk). See EPA 2004 *An examination of EPA Risk Assessment Principles and Practices,* EPA/100/B-04/001 available at: http://www.epa.gov/osa/pdfs/ratf-final.pdf.

[43] See IRIS glossary

less-than-lifetime exposure (i.e., extrapolating from subchronic to chronic exposure); (4) uncertainty in extrapolating from a LOAEL in the absence of a NOAEL; and (5) uncertainty when the database is incomplete or there are problems with applicability of available studies. When scientifically sound, peer-reviewed assessment-specific data are not available, default adjustment values are selected for the individual UFs. For each type of uncertainty (when relevant to the assessment), EPA typically applies an UF value of 10 or 3 with the cumulative UF value leading to a downward adjustment of 10-3000 fold from the selected POD. An UF of 3 is used when the data do not support the use of a 10-fold factor. If an extrapolation step or adjustment is not relevant to an assessment (e.g., if applying human toxicity data and an interspecies extrapolation is not required) the associated UF is not used. The major adjustment steps are described more fully below.

1) Heterogeneity among humans is a key source of variability as well as uncertainty. Uncertainty related to human variation is considered in extrapolating doses from a subset or smaller-sized population, often of one sex or of a narrow range of life stages (typical of occupational epidemiologic studies), to a larger, more diverse population. In the absence of pollutant-specific data on human variation, a 10-fold UF is used to account for uncertainty associated with human variation. Human variation may be larger or smaller; however, data to examine the potential magnitude of human variability are often unavailable. In some situations, a smaller UF of 3 may be applied to reflect a known lack of significant variability among humans.

2) Extrapolation from results of studies in experimental animals to humans is a necessary step for the majority of chemical risk assessments. When interpreting animal data, the concentration at the POD (e.g. NOAEL, BMDL) in an animal model (e.g. rodents) is extrapolated to estimate the human response. While there is long-standing scientific support for the use of animal studies as indicators of potential toxicity to humans, there are uncertainties in such extrapolations. In the absence of data to the contrary, the typical approach is to use the most relevant endpoint from the most sensitive species and the most sensitive sex in assessing risks to the average human. Typically, compound specific data to evaluate relative sensitivity in humans versus rodents are lacking, thus leading to uncertainty in this extrapolation. Size-related differences (allometric relationships) indicate that typically humans are more sensitive than rodents when compared on a mg/kg/day basis. The default choice of 10 for the interspecies UF is consistent with these differences. For a specific chemical, differences in species responses may be greater or less than this value.

Pharmacokinetic models are useful to examine species differences in pharmacokinetic processing and associated uncertainties; however, such dosimetric adjustments are not always possible. Information may not be available to quantitatively assess toxicokinetic or toxicodynamic differences between animals and humans, and in many cases a 10-fold UF (with separate factors of 3 for toxicokinetic and toxicodynamic components) is used to account for expected species differences and associated uncertainty in extrapolating from laboratory animals to humans in the derivation of a reference value. If information on one or the other of these components is available and accounted for in the cross-species extrapolation, a UF of 3 may be used for the remaining component.

3) In the case of reference values for chronic exposures where only data from shorter durations are available (e.g., 90-day subchronic studies in rodents) or when such data are judged more appropriate for development of an RfC, an additional UF of 3 or 10-fold is typically applied unless the available scientific information supports use of a different value.

4) Toxicity data are typically limited as to the dose or exposure levels that have been tested in individual studies; in an animal study, for example, treatment groups may differ in exposure by up to an order of magnitude. The preferred approach to arrive at a POD is to use BMD analysis; however, this approach requires adequate quantitative results for a meaningful analysis, which is not always possible. Use of a NOAEL is the next preferred approach after BMD analysis in determining a POD for deriving a health effect reference value. However, many studies lack a dose or exposure level at which an adverse effect is not observed (i.e., a NOAEL is not identified). When using data limited to a LOAEL, a UF of 10 or 3-fold is often applied.

5) The database UF is intended to account for the potential for deriving an underprotective RfD/RfC due to a data gap preventing complete characterization of the chemical's toxicity. In the absence of studies for a known or suspected endpoint of concern, a UF of 10 or 3-fold is typically applied.

There is no RfD or other comparable chronic health benchmark value for lead compounds. Thus, to address multipathway human health and environmental risks associated with emissions of lead from these facilities, ambient lead concentrations were compared to the NAAQS for lead. In developing the NAAQS for lead, EPA considered human health evidence reporting adverse health effects associated with lead exposure, as well as an EPA conducted multipathway risk assessment that applied models to estimate human exposures to air-related lead and the associated risk (73FR at 66979). EPA also explicitly considered the uncertainties associated with both the human health evidence and the exposure and risk analyses when developing the NAAQS for lead. For example, EPA considered uncertainties in the relationship between ambient air lead and blood lead levels (73FR at 66974), as well as uncertainties between blood lead levels and loss of IQ points in children (73FR at 66981). In considering the evidence and risk analyses and their associated uncertainties, the EPA Administrator noted his view that there is no evidence- or risk-based bright line that indicates a single appropriate level. Instead, he noted, there is a collection of scientific evidence and judgments and other information, including information about the uncertainties inherent in many relevant factors, which needs to be considered together in making this public health policy judgment and in selecting a standard level from a range of reasonable values (73FR at 66998). In so doing, the Administrator decided that, a level for the primary lead standard of 0.15 $\mu g/m^3$, in combination with the specified choice of indicator, averaging time, and form, is requisite to protect public health, including the health of sensitive groups, with an adequate margin of safety (73FR at 67006). A thorough discussion of the health evidence, risk and exposure analyses, and their associated uncertainties can be found in EPA's final rule revising the lead NAAQS (73 FR 66970-66981, November 12, 2008).

We also note the uncertainties associated with the health-based (i.e., primary) NAAQS are likely less than the uncertainties associated with dose-response values developed for many of the other HAP, particularly those HAP for which no human health data exist. In 1988, EPA's IRIS program reviewed the health effects data regarding lead and its inorganic compounds and determined that it would be inappropriate to develop an RfD for these compounds, saying, "A great deal of information on the health effects of lead has been obtained through decades of medical observation and scientific research. This information has been assessed in the development of air and water quality criteria by the Agency's Office of Health and Environmental Assessment (OHEA) in support of regulatory decision-making by the Office of Air Quality Planning and Standards (OAQPS) and by the Office of Drinking Water (ODW). By comparison to most other environmental toxicants, the degree of uncertainty about the health effects of lead is quite low. It appears that some of these effects, particularly changes in the levels of certain blood enzymes and in aspects of children's neurobehavioral development, may occur at blood lead levels so low as to be essentially without a threshold. The Agency's RfD Work Group discussed inorganic lead (and lead compounds) at two meetings (07/08/1985 and 07/22/1985) and considered it inappropriate to develop an RfD for inorganic lead." EPA's IRIS assessment for Lead and compounds (inorganic) (CASRN 7439-92-1) is available at http://www.epa.gov/iris/subst/0277.htm.

We note further that because of the multi-pathway, multi-media impacts of lead, the risk assessment supporting the NAAQS considered direct inhalation exposures and indirect air-related multi-pathway exposures from industrial sources like primary and secondary lead smelting operations. It also considered background lead exposures from other sources (like contaminated drinking water and exposure to lead-based paints). In revising the NAAQS for lead, we note that the Administrator placed more weight on the evidence-based framework and less weight on the results from the risk assessment, although he did find the risk estimates to be roughly consistent with and generally supportive of the evidence-based framework applied in the NAAQS determination (73FR at 67004). Thus, when revising the NAAQS for lead to protect public health with an adequate margin of safety, EPA considered both the evidence-based framework and the risk assessment, albeit to different extents.

## Acute noncancer assessment

Many of the UFs used to account for variability and uncertainty in the development of acute reference values are quite similar to those developed for chronic durations, but more often using individual UF values that may be less than 10. UFs are applied based on chemical-specific or health effect-specific information (e.g., simple irritation effects do not vary appreciably between human individuals, hence a value of 3 is typically used), or based on the purpose for the reference value (see the following paragraph). The UFs applied in acute reference value derivation include: 1) heterogeneity among humans; 2) uncertainty in extrapolating from animals to humans; 3) uncertainty in LOAEL to NOAEL adjustments; and 4) uncertainty in accounting for an incomplete database on toxic effects of potential concern. Additional adjustments are often applied to account for uncertainty in extrapolation from observations at one exposure duration (e.g., 4 hours) to arrive at a POD for derivation of an acute reference value at another exposure duration (e.g., 1 hour).

Not all acute reference values are developed for the same purpose and care must be taken when interpreting the results of an acute assessment of human health effects relative to the reference value or values being exceeded. Where relevant to the estimated exposures, the lack of threshold values at different levels of severity should be factored into the risk characterization as potential uncertainties.

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# Appendix 1
# Technical Support Document for HEM-3 Modeling

# Modeling for the Residual Risk and Technology Review Using the Human Exposure Model 3 (HEM-3)

Updated 8/7/2008

Technical Support Document

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# Contents

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# 1. Introduction

This document describes the modeling approach used to estimate the risks to human populations in support of the Residual Risk and Technology Review currently being carried out by the U.S. Environmental Protection Agency (EPA). The model used in these risk assessments was the Human Exposure Model, Version 3 (HEM3). HEM3 incorporates the AERMOD, a state of the art air dispersion model developed under the direction of the American Meteorological Society / Environmental Protection Agency Regulatory Model Improvement Committee (AERMIC).

Section 2 of this report provides an overview of the HEM3 system; and Section 3 describes inputs and choices made in implementing the model for the RTR program. Quality assurance efforts undertaken in the modeling effort are discussed in Section 4, and uncertainties associated with the modeling effort are discussed in Section 5.

# 2. Overview of the HEM3–AERMOD System

HEM3 performs three main operations: dispersion modeling, estimation of population exposure, and estimation of human health risks. Two options are provided for dispersion modeling. The first is the American Meteorological Society (AMS) EPA Regulatory Model (AERMOD).[1,2] The second option is the Industrial Source Complex - Short Term, Version 3 (ISCST3) model. Both of these dispersion models handle a wide range of different source types which may be associated with an industrial source complex, including stack sources, area sources, and volume sources. AERMOD was used for the RTR modeling effort.

To prepare dispersion modeling inputs and carry out risk calculations, HEM3 draws on four data libraries, which are provided with the model. The first is a library of meteorological data for over 120 stations, which are used for dispersion calculations. A second library of Census block internal point locations and populations provides the basis of human exposure calculations (Census, 2000). This Census library also includes the elevation of each Census block, which can also be used in dispersion calculations, at the option of the model user. A third library of pollutant unit risk estimates and reference concentrations is used to calculate population risks. These unit risk estimates and reference concentrations are based on the latest values recommended by EPA for hazardous air pollutants (HAP) and other toxic air pollutants (EPA, 2007). The fourth data library is used only with AERMOD and only when the user opts to compute deposition or plume depletion. This database provides deposition parameters for gaseous pollutants.

HEM3 has been implemented in two versions: a single-plant version, and a community and sector version. The latter was used in this modeling effort. Both versions operate under the same general principles. In essence, the community and sector version provides a platform for running the single plant version multiple times. In both versions, source location and emissions data are input through a set of Excel™ spreadsheets. The main difference is in the user interface for other model inputs. The single plant includes a graphical user interface (GUI) for the selection of various dispersion modeling options. In the community and sector version of HEM3, a control file replaces many of these GUI inputs.

The model estimates cancer risks and noncancer adverse health effects due to inhalation exposure at Census block internal point locations, and at other receptor locations that can be specified by the user. Cancer risks are computed using EPA's recommended unit risk estimates for Hazardous Air Pollutants (HAP) and other toxic air pollutants. The resulting estimates reflect the excess cancer risk for an individual breathing the ambient air at a given receptor site 24-hours per day over a 70-year lifetime. The model estimates the numbers of people exposed to various cancer risk levels. In addition, HEM3 estimates the total incremental cancer risks for people living within different distances of the modeled emission sources.

Potential noncancer health effects due to chronic exposures are quantified using hazard quotients and hazard indices for various target organs. The “hazard quotient” for a given chemical and receptor site is the ratio of the ambient concentration of the chemical to the reference concentration. The “hazard index” for a given organ is the sum of hazard quotients for substances that affect that organ. HEM3 computes target-organ-specific hazard indices (TOSHI) for HAPs and other toxic air pollutants, and estimates the numbers of people exposed to different hazard index levels. In addition, maximum short term concentrations are computed for all pollutants, and concentrations are compared with threshold levels for acute health effects.

The following sections outline the methodologies used in the HEM3–AERMOD system. Section 2.1 describes the preparation of dispersion modeling inputs, Section 2.2 describes the running of AERMOD, Section 2.3 describes calculations performed by HEM3 to calculate risks and exposures, and Section 2.4 details the sources and methods used to produce HEM3’s data libraries. The HEM3 User’s Manual provides additional details on the input data and algorithms used in the model.[3] Specific model options used in the RTR are discussed in Chapter 3.

## 2.1 Preparation of Dispersion Modeling Inputs

HEM3 compiles data that will be needed for dispersion modeling, and prepares an input file suitable for running AERMOD. The dispersion modeling inputs can be divided into three main components: emission source data, information on the modeling domain and receptors for which impacts will be computed, and meteorological data.

### *2.1.1 Compiling Emission Source Data*

A series of Excel™ spreadsheet files are used to specify the emissions and configuration of the facility to be modeled. At a minimum, two files are needed: a pollutant emission file, and an emission location file. The emission file includes an emission source identification code for each emission source at the facility, the names of pollutants emitted by each source, and the emission rate for each pollutant. In addition, if the model run is to incorporate deposition or plume depletion, the emission file must also specify the percentage of each pollutant that is in the form of particulate matter. The balance is assumed to be in vapor form.

The emission location file includes the coordinates of each source, as well as information on the configuration and other characteristics of the source. HEM3 can analyze stack sources, area sources, or volume sources.[a] For stack sources, the location file must provide the stack height, stack diameter, emission velocity, and emission temperature. The file must also provide dimensions for each area or volume source, as well as the height of the source above the ground. For area sources, the angle of rotation from north can also be specified. The user can also

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[I] For definitions of stack, area, and volume sources, please see the AERMOD documentation. AERMOD provides the capability to analyze some other emission source configurations, such as storage piles, however these configurations are not supported by HEM3.

provide the terrain elevation at the base of each source, and the controlling hill height for each source. (The controlling hill height is used in AERMOD's flow calculations. Calculation of the hill height is discussed in Section 2.4.2.) If these are not provided, HEM3 will calculate terrain elevations and controlling hill heights based on elevations and hill heights for the Census blocks nearest to the facility.

If particulate deposition or plume depletion are to be considered, then HEM-3 requires a third input file to specify the particle size distribution and scavenging parameters for various particle size ranges. Another optional file can be used to specify building dimensions if building wake effects are to be modeled.

### *2.1.2 Defining the Modeling Domain and Receptors*

HEM3 defines a modeling domain for each facility that is analyzed based on parameters specified by the model user. These parameters are summarized in Table 2-1. The modeling domain is circular, and is centered on the facility, with a radius specified by the user. For the RTR analysis, the radius of the modeling domain is 50 kilometers (km). HEM3 identifies all of the Census block locations in the modeling domain from its Census database, and divides the blocks into two groups based on their distance from the facility. For the inner group of Census blocks (closest to the facility), each block location is modeled as a separate receptor in AERMOD. The cutoff distance for modeling individual Census blocks is determined by the model user. The model user can also provide an Excel™ spreadsheet specifying additional locations to be included as model receptors in AERMOD. These additional discrete receptors may include plant boundary locations, monitoring sites, individual residences, schools, or other locations of interest.

For Census blocks in the outer group, beyond this modeling cutoff distance, emissions impacts are interpolated based on modeling results for a polar receptor network. The user also specifies an "overlap" distance, within which Census block coordinates will be considered to be on plant property. The following paragraphs provide more details on the treatment of blocks near the facility, on the polar receptor network, and on the determination of receptor elevations and controlling hill heights to be used in AERMOD.

**Table 2-1. Parameters Used to Delineate the Modeling Domain in HEM3**

| Parameter | Typical value |
|---|---|
| Modeling domain size – maximum distance to be modeled [a] | 50 km |
| Cutoff distance for modeling of individual blocks [b] | 2,000 – 3,000 m |
| Overlap distance – where receptors will be considered to be on plant property [b] | 30 m |
| Polar receptor network | |
| Distance to the innermost ring [a] | 100 m |
| Number of concentric rings | 13 |
| Number of radial directions | 16 |

[a] Measured from the center of the facility.

[b] Measured from each stack at the facility, and from the edges of each area or volume source.

*Treatment of Nearby Census Blocks and Screening for Overlapping Blocks*

Census block locations near the facility are modeled as separate receptors within AERMOD. The cutoff distance for modeling of individual Census blocks is chosen by the user, and is tpically between 2000 and 3000 meters. This distance is not measured from the center of the facility, but is the minimum distance from any source at the facility. Therefore, any Census block location that is within the cutoff distance from any emission source is treated as a discrete AERMOD receptor.

HEM3 checks Census blocks that are very close to the facility in order to assess whether they overlap any area or volume emission sources. In addition, the user can specify an overlap distance, within which receptors will be considered to be on plant property. The default value for the overlap distance is 30 meters, or approximately equal to the width of a narrow buffer and a roadway. HEM3 tests each nearby receptor to determine whether it is within this distance from any stack or from the perimeter of any area or volume source. If a receptor falls within this distance, HEM-3 will not calculate risks based on the location of that receptor, but will instead assume that the risks associated with the receptor are the same as the highest predicted value for any receptor that is not overlapping. The location for calculating the default impact may be either another Census block, one of the polar grid receptors, or one of the additional discrete receptor locations provided by the model user.

### *Polar receptor network*

The polar receptor network used in HEM3 serves three functions. First, it is used to estimate default impacts if one or more Census locations are inside the overlap cutoff distance is used to represent the plant boundary. Second, it is used to evaluate potential acute effects that may occur due to short-term exposures in unpopulated locations outside the plant boundary. Third, the polar receptor network is used to interpolate long-term and short-term impacts at Census block locations that are outside the cutoff distance for modeling of individual blocks.

The user defines the inner radius for the polar receptor network, the number of concentric rings to be analyzed, and the number of radial directions. The inner radius of the polar network should the minimum distance from the facility center that is generally outside of plant property. (For complex plant shapes, it is sometimes useful to specify an inner ring that encroaches on facility property in some directions.) The default, and also the minimum inner radius for the polar network is 100 meters (m). A typical run includes 13 concentric rings and 16 radial directions. HEM3 will distribute the radial directions evenly around the plant. For the concentric rings, the model will generate logarithmic progression of distances starting at the inner ring radium and ending at the outer radius of the modeling domain. In the single plant version of HEM3, the user can change these ring distances to meet the needs of a specific study.

### *Elevations and hill heights for model receptors*

The user can specify whether HEM3 will include the effects of terrain when running AERMOD. If the terrain option is selected, HEM3 obtains elevations and controlling hill heights for Census block receptors from its internal Census location library. Section 2.4.2 describes the derivation of these elevations and hill heights.

Elevations and controlling hill heights for the polar grid receptors are also estimated based on values from the Census library. HEM3 divides the modeling domain into sectors based on the polar receptor network, with each Census block assigned to the sector corresponding to the closest polar grid receptor. Each polar grid receptor is then assigned an elevation based on the highest elevation for any Census block in its sector. The controlling hill height is also set to the maximum hill height within the sector. If a sector does not contain any blocks, the model defaults to the elevation and controlling hill height of the nearest block outside the sector.

### *2.1.3 Selection of Meteorological Data*

In addition to source and receptor information, AERMOD requires surface and upper air meteorological observations in a prescribed format. The model user can select a meteorological station from the HEM3 meteorological data library, or add new files to the library if site-specific data are available. If the user does not specify a meteorological station, HEM3 will select the closest station to the center of the modeling domain.

## 2.2 Running of AERMOD

Based on the user input data and other data described in the previous section, HEM3 produces an input file suitable for AERMOD. HEM3 then runs AERMOD as a compiled executable program. No changes have been made from the version of AERMOD released to the public by EPA. The following sections give additional information on how AERMOD is used within HEM3.

### *2.2.1 AERMOD Dispersion Options Used by HEM3*

AERMOD provides a wide array of options for controlling dispersion modeling calculations. In general, HEM3 uses the regulatory default options when running AERMOD.[1] These options include the following:

- consideration of stack-tip downwash (except for Schulman-Scire downwash)
- use of calm processing routines
- use of missing-data processing routines
- consideration of terrain effects

However, the model user can opt to exclude the effects of terrain when running HEM3. The following additional options are available to the HEM3 user:

- calculation of wet and dry deposition rates for vapor and particulate mater
- consideration of plume depletion (due to deposition) when calculating air concentrations
- consideration of building wake effects
- calculation of short term impacts

As noted in Section 2.1, the calculation of deposition or depletion and the consideration of building wake effects require additional user inputs.

The user can opt to analyze short term impacts on a number of different time scales (e.g. 1 hour, 2 hours, etc.), however only one short term time scale can be selected per run. If the user chooses to analyze short term impacts, a multiplier must be specified to reflect the ratio between the maximum short term emission rate and the long term average emission rate. The default multiplier for short term emissions is a factor of 10. This means that in the default case the maximum short term emission rate is assumed to be 10 times the long term average emission rate. The multiplier can be set to 1.0 if emissions from the facility are known to be constant.

HEM3 uses the AERMOD TOXICS run option, which optimizes the area source integration routine to reduce model runtimes. The TOXICS Sampled Chronological Input Model (SCIM) is not used, since the HEM3 AERMOD meteorological library only includes one year of observations for each station. (The SCIM option can be used to skip a portion of the hourly observations when meteorological data are available for multiple years.)

### *2.2.2 Use of Dilution Factors*

To save computer run time when analyzing the impacts of multiple pollutants, HEM3 does not model each pollutant separately. Instead, AERMOD is used to compute a series of dilution factors, specific to each emission source and receptor. The dilution factor for a particular emission source and receptor is defined as the predicted ambient impact from the given source and at the given receptor, divided by the emission rate from the given source.

If the user chooses not to analyze deposition or plume depletion, the dilution factor does not vary from pollutant to pollutant. If either deposition or depletion is chosen with the AERMOD dispersion model option of HEM3, separate dilution coefficients must be computed for each gaseous pollutant. In addition, separate dilution factors must be computed for different components of particulate matter if the components do not have the same particle size distribution. In the current version of HEM3, this can be done by creating a separate emission record for each pollutant emitted by from each source. (Common location data and source configurations can be used for different pollutant records representing the same emission source.)

## 2.3 Postprocessing of AERMOD Results in HEM3

HEM3 estimates total excess cancer risks and potential chronic noncancer health effects for all Census block locations in the modeling domain, all user-defined receptors, and all points in the polar receptor network. Potential chronic noncancer health effects are expressed in terms of TOSHI. Based on the results for Census blocks and other receptors, HEM-3 estimates the maximum individual risk and maximum TOSHI for populated receptors, and determines the locations of these maximum impacts. The model also determines the concentrations of different pollutants at the sites of the maximum risks, and the contributions of different emission sources to these maximum estimated risks. It should be noted that the locations may differ for the maximum individual cancer risk and for the hazard indices for different target organs.

For acute impacts, HEM3 calculates the maximum short term concentrations for all pollutants emitted by the facility. These maximum short term concentrations are compared with various thresholds for acute health effects.

At the option of the model user, HEM3 will also compute the long term and short term predicted ambient concentrations of all pollutants emitted by the plant at all of the receptors in the modeling domain. In addition, pollutant contributions from each emission source at the facility are computed under this option.

Section 2.3.1. describes methods used to calculate cancer risks and hazard indices for receptors that are explicitly modeled using AERMOD. Section 2.3.2 describes the interpolation approach used to estimate cancer risks and hazard indices at Census blocks that are not explicitly modeled.

### *2.3.1 Calculation of Impacts at Modeled Receptors*

As noted in Section 2.2.2, HEM3 does not model each pollutant separately unless deposition or depletion is being analyzed. Instead, AERMOD is used to compute a series of dilution factors, specific to each emission source and receptor. HEM3 also conserves computer memory by computing cancer risks and hazard indices directly, without recording the concentration of each pollutant at each receptor. The following algorithms are used to compute cancer risks and TOSHI for chronic noncancer health effects.

For cancer risk:

$$CR_T = \Gamma_{i,j}\, CR_{i,j}$$

$$CR_{i,j} = DF_{i,j}\ \mathrm{H}\ CF\ \mathrm{H}\ \Gamma_k \left[E_{i,k}\ \mathrm{H}\ URE_k\right]$$

For TOSHI:

$$TOSHI_T = \Gamma_{i,j}\, TOSHI_{i,j}$$

$$TOSHI_{i,j} = DF_{i,j}\ \mathrm{H}\ CF\ \mathrm{H}\ \Gamma_k \left[E_{i,k}\ \text{э}\ RfC_k\right]$$

where:

$CR_T$ = total cancer risk at a given receptor (probability for one person)

$\Gamma_{i,j}$ = the sum over all sources i and pollutant types j (particulate or gas)

$CR_{i,j}$ = cancer risk at the given receptor for source i and pollutant type j

$DF_{i,j}$ = dilution factor $[(\Phi g/m^3) / (g/sec)]$ at the given receptor for source i and pollutant type j

CF = conversion factor, 0.02877 [(g/sec) / (ton/year)]

$\Gamma_k$ = sum over all pollutants k within pollutant group j (particulate or gas)

$E_{i,k}$ = emissions of pollutant k from source i and in pollutant type j

$URE_k$ = cancer unit risk estimate for pollutant k

$TOSHI_T$ = total target-organ-specific hazard index at a given receptor
$TOSHI_{i, j}$ = target-organ-specific hazard index at the given receptor for source i and pollutant type j
$RfC_k$ = noncancer health effect reference concentration for pollutant k

If the cancer unit risk estimate is not available for a given chemical, then that chemical is not included in the calculation of cancer risk. Likewise, if the noncancer reference concentration is not available for a given chemical, that chemical is not included in the calculation of hazard indices. Note also that separate reference concentrations are used for acute and chronic hazard indices.

HEM3 computes short term concentrations and records the highest short term concentration for each pollutant. In addition, the user can opt to compute and record the short term and long concentrations at each receptor. Concentrations are computed as follows.

Long term concentrations:

$$AC_{T, k} = \Gamma_i \, AC_{i, k}$$

$$AC_{i, k} = DF_{i, j} \text{ H } CF \text{ H } E_{i, k}$$

Short term concentrations:

$$AC_T = \Gamma_i \, AC_{i, k}$$

$$AC_{i, k} = DF_{i, j} \text{ H } CF \text{ H } E_{i, k} \text{ H } M$$

where:
$AC_{T, k}$ = total estimated ambient concentration for pollutant k at a given receptor
$\Gamma_i$ = the sum over all sources i (Φg/$m^3$)
$AC_{i, k}$ = estimated ambient concentration of pollutant k at the given receptor as a result of emissions from source i (Φg/$m^3$)
M = ratio between the estimated maximum short term emission rate and the long term average emission rate (dimensionless)

### *2.3.2 Interpolation of Impacts at Outer Census Blocks*

For Census blocks outside of the distance cutoff for individual block modeling, HEM-3 estimates cancer risks and hazard indices by interpolation from the polar receptor network. Impacts at the polar grid receptors are estimated using AERMOD modeling results and the algorithms described in Section 2.3.1. The impacts at each outer Census block are interpolated from the four nearest polar grid receptors. The interpolation is linear in the angular direction, and logarithmic in the radial direction, as summarized in the following equations:

$$I_{a, r} = I_{1, r} + (I_{2, r} - I_{1, r}) \text{ H } (a - A1) \text{ э } (A2 - A1)$$

$$I_{A1,\, r} = \exp\{\ln(I_{A1,R1}) + [\ln(I_{A1,R2}) - \ln(I_{A1,R1})]\ H\ [\ln r) - \ln(R1)] \ni [\ln(R2) - \ln(R1)]\}$$
$$I_{A2,\, r} = \exp\{\ln(I_{A2,R1}) + [\ln(I_{A2,R2}) - \ln(I_{A2,R1})]\ H\ [\ln r) - \ln(R1)] \ni [\ln(R2) - \ln(R1)]\}$$

where:

$I_{a,\, r}$ = the impact (cancer risk, hazard index, or concentration) at an angle, a, from north, and radius, r, from the center of the modeling domain
a = the angle of the target receptor, from north
r = the radius of the target receptor, from the center of the modeling domain
A1 = the angle of the polar network receptors immediately counterclockwise from the target receptors
A2 = the angle of the polar network receptors immediately clockwise from the target receptor
R1 = the radius of the polar network receptors immediately inside the target receptor
R2 = the radius of the polar network receptors immediately outside the target receptor

### *2.3.3 Calculation of Population Exposures and Incidence*

Using the predicted impacts for Census blocks, HEM3 estimates the numbers of people exposed to various cancer risk levels and TOSHI levels. This is done by adding up the populations for receptors that have predicted cancer risks or TOSHI above the given threshold.

The model also estimates the total annual excess cancer risk (incidence) for the entire modeling region. The following equation is used:

$$TCR = \Gamma_m\ [CR_m\ H\ P_m\ ] \ni LT$$

where:

TCR = the estimated total annual cancer risk, or incidence, (cancers/year) to the population living within the modeling domain
$\Gamma_m$ = the sum over all Census blocks m within distance the modeling domain
$CR_m$ = the total lifetime cancer risk (from all modeled pollutants and emission sources) at Census block m
$P_m$ = the population at Census block m
LT = the average lifetime used to develop the cancer unit risk factor, 70 years

### *2.3.4 Model Outputs*

The following is a summary of the outputs produced by HEM3. These are written to a collection of files in Excel™ and dBase™ format.

- Maximum long term impacts at populated locations
  - maximum lifetime individual cancer risk
  - maximum TOSHI for the following health effects
    - respiratory system effects
    - liver effects

        - neurological system effects
        - developmental effects
        - reproductive system effects
        - kidney effects
        - ocular system effects
        - endocrine system effects
        - hematological system effects
        - immunological system effects
        - skeletal system effects
        - spleen effects
        - thyroid effects
    - locations of the maximum cancer risk and TOSHI
    - Census block identification codes for the maximum cancer risk and TOSHI, and number of people in the Census block
    - contributions of different chemicals and emission sources to the maximum risk and TOSHI
- Maximum acute impacts
    - maximum short term ambient concentration for each chemical
    - threshold levels for acute health effects of each chemical (compared with the maximum short term concentrations)
    - locations of the maximum impacts for different chemicals
    - Census block identification codes at the locations of maximum concentration, and number of people in the block
    - contribution of each emission source at the facility to the maximum short term concentration of each chemical
- Outputs for all receptors
    - maximum individual cancer risk and TOSHI (all target organs) for each Census block and each user-specified discrete receptor (monitoring sites, etc.)
    - maximum individual cancer risk and TOSHI (all target organs) for each polar grid receptor
    - estimated deposition (optional)
    - predicted ambient concentration resulting from each emission source at each Census block (optional)
- Population exposures and total cancer risk, or incidence
    - estimated numbers of people exposed to different levels of lifetime individual cancer risk (1 in a million, 1 in 100,000, etc.)
    - estimated numbers of people exposed to different levels of TOSHI (1, 2, 10, etc.)
    - total cancer risk, or incidence, in estimated cancer deaths per year, over the entire modeling domain

## 2.4 Data Libraries Used in HEM3

### *2.4.1 Chemical Health Effects Information*

HEM3 includes a library of available health effects data for HAPs. For each pollutant, the library includes the following parameters, where available:

- unit risk estimate for cancer
- reference concentration for chronic noncancer health effects
- reference concentrations for acute health effects
- target organs affected by the chemical for chronic health effects

Unit risk estimates and reference concentrations included in the HEM3 chemical library have been taken from EPA's database of recommended dose-response factors for HAPs.[4]

### *2.4.2 Census Block Locations and Elevation Data*

The HEM3 Census library includes Census block identification codes, locations, populations, elevations, and controlling hill heights for all of the over 5 million Census blocks identified in the 2000 Census. The location coordinates reflect the internal point of the block, which is a point selected by the Census to be roughly in the center of the block. For complex shapes, the internal point may not be in the geographic center of the block. Locations and population data for Census blocks in the 50 states and Puerto Rico were extracted from the LandView® database.[5] Locations and populations for blocks in the Virgin Islands were obtained from the Census web site.

The elevation of each Census block in the continental U.S. and Hawaii was estimated by interpolating the elevation at the block's internal point from the U.S. Geological Service's 1:250,000 Digital Elevation Model (DEM) data.[6] These data have a resolution of 3 arc seconds, or about 90 meters. The estimation of the elevation of each Census block in Alaska and the U.S. Virgin Islands was performed with analysis tools in the ArcGis 9.1 software application. The point locations of the Census block centroids in Alaska and the Virgin Islands were overlaid with a raster layer of North American Digital Elevation Model elevations (in meters). Each Census block point was assigned an elevation value based on the closest point in the ArcGis elevation raster file.

Hill heights were determined with base on the algorithm used in AERMAP, the AERMOD terrain processor.[7] In order to save run time and resources, the HEM3 Census block elevation database was substituted for the DEM data generally used in AERMAP. As noted above, the Census block elevations were originally derived from the DEM database. To determine the controlling hill height for each Census block, a cone was projected away from the block location, representing a 10% elevation grade. The controlling hill height was selected based on the highest elevation above that 10% grade (in accordance with the AERMAP methodology). The distance cutoff for this calculation was 100 km. (This corresponds to an elevation difference, at a 10% grade, of 10,000 m, which considerably exceeds the maximum elevation difference in North America.)

### *2.4.3 Meteorological Data*

HEM3 includes an extensive library of meteorological data to support both the AERMOD and ISCST3 dispersion models. 150 meteorological stations have been preprocessed for AERMOD as part of the RTR effort. In addition, 87 stations have previously been processed for ISCST3. Section 3.3 discusses the preparation of meteorological data for the RTR.

### *2.4.4 Gaseous Deposition Parameters*

HEM3 provides options to compute the deposition of air pollutants, and to take into account the impacts of plume depletion due to deposition of gaseous and particulate pollutants. If either of these options is selected by the model user for gaseous pollutants, a number of pollutant properties are required by AERMOD. These include the diffusivity of the pollutant in air, the diffusivity of the pollutant in water, the Henry's Law constant, and a parameter reflecting the cuticular resistance to uptake of the pollutant by leaves $r_{CL}$).[8] HEM3 includes a library of these parameters for most gaseous HAPs. This library is based on an compendium of gaseous deposition parameters developed by Argonne National Laboratories.[9] It should be noted, however, that the deposition and depletion options of HEM3 and AERMOD were not used in the this component of the RTR analysis.

# 3. Modeling for the Residual Risk Technology Review

This section discusses the general approach used to implement the AERMOD version of HEM3 for the RTR modeling analysis. Separate reports have been prepared for all of the emission source categories included in the RTR analysis. These reports provide information on the emissions inputs and results for specific emission categories.

## 3.1 Emission Source Inputs

HEM3 and AERMOD require detailed data on emissions from each emission source included in the modeling analysis. These data include:

- pollutants emitted
- emission rate for each pollutant
- emission source coordinates
- stack height (or emission height for fugitive sources)
- stack diameter (or configuration of fugitive sources)
- emission velocity
- emission temperature

Emissions data for the modeling effort were taken from the 2002 National Emissions Inventory (NEI) Final Version 1.[10] These data include HAP emission rates, emission source coordinates, stack heights, stack diameters, flow rates, and exit temperatures. EPA performed an engineering review of the NEI data. In cases where new or better data were known to exist for a particular source category, that information was integrated into the data used in modeling for that category. For each source category, the emissions are summarized in the source category specific report. Detailed computer files containing all emission and release characteristics are available on the RTR website.

As noted in the previous section, industrial emission sources can be characterized in AERMOD and other dispersion models as point, area, or volume sources. The NEI includes a framework for characterizing area and volume sources; however, these fields are not filled in the 2002 Final Version 1 of the NEI. Therefore, fugitive emissions are generally characterized as low point sources with minimal exit velocities. For some categories, additional information was available on the configuration of fugitive emission sources. This information was incorporated into the emissions database as part of the engineering review. Thus, fugitive emission sources were characterized as area or volume sources when sufficient configuration information was available.

## 3.2 Pollutant Cross-Referencing

Because the NEI is developed from a number of different data sources, a single chemical may be listed in the inventory under different names (i.e. a "common name" and one or more structure-based names). In addition, pollutant groupings such as polycyclic organic matter (POM), can be listed in the NEI under the names of individual member compounds, and under different synonyms (e.g. polynuclear aromatic hydrocarbons). HEM3 requires an exact match in the chemical name in order to link emissions to the appropriate dose-response factors. The model will not process any pollutant that is not specifically listed in the chemical library (see Table 2-1). Therefore, all of the HAP names used in the NEI were linked to the appropriate chemical names in the HEM3 reference file.

The individual POM chemicals listed in the NEI were grouped into seven subclasses. Table 3-1 shows these groupings, and gives the cancer unit risk estimate used for each subclass. Emissions of metal compounds were also adjusted using algorithms developed for the Emissions Modeling System for Hazardous Air Pollutants (EMS-HAP) under the National-scale Air Toxics Assessment (NATA). A mass adjustment factor was applied to the emissions of metal compounds to account for a particular portion (e.g., the lead portion of lead sulfate) or to partition them among multiple pollutant categories (e.g. chromium arsenate into chromium VI compounds and arsenic compounds). In addition, where no specific compound information was available, metals were speciated into appropriate oxidation states (e.g. chromium compounds into chrome VI and chrome III) based on factors that have been developed for specific source categories and average factors that have been developed for the inventory as a whole. The adjustment factors and speciation factors were taken from the HAP Table module of EMS-HAP.[11],[12]

## 3.3 Meteorological Data

AERMOD meteorological data for the RTR analysis were derived from three sources: (1) AERMET processing of 122 National Weather Service (NWS) surface observation stations, (2) State agencies, and (3) industry (on-site). The 122 NWS sites were selected to provide thorough coverage of the U.S. For the RTR analysis, the average distance between a modeled facility and the applicable meteorological station was 72 km. One year of hourly data for these sites were processed through the AERMET program, and this is documented in "Meteorological Data Processing Using AERMET."[13] Four states provided AERMOD-ready meteorology files. These states were: Alabama (5 stations), Florida (4 stations), North Carolina (6 stations), and Wisconsin (22 stations). Eleven of the state supplied meteorology sites were co-located with sites in the list of 122. The data at the state supplied sites were more recent, so the state data for the 11 co-located sites were used. In addition, for the RTR petroleum refinery modeling, two refineries (Fairbanks, Alaska and the Virgin Islands) provided on-site AERMOD-ready meteorology files. These on-site meteorological data files were used with their respective refinery facilities for the HEM3 refinery modeling. Figure 3-1 shows the location of the 150 surface meteorological stations used in the RTR analysis.

As noted above, 122 NWS stations were processed through the AERMET program. To estimate the parameters needed by AERMOD, AERMET requires hourly surface weather observations and the full twice-daily upper air soundings (i.e., meteorological variables reported at all levels). The surface and upper air stations are paired to produce the required input data for AERMOD. To simplify processing and minimize the amount of quality assurance needed, the analysis was restricted to meteorological data collected prior to the installation of the Automated Surface Observation System (ASOS). The ASOS has previously been found to omit the ceiling height for a large percentage of the observations at a number of meteorological stations. Installation and operation of ASOS equipment began in 1992; therefore, data for 1991 were processed with AERMET (note; the most recent version of AERMET has corrected this issue and is now compatible with ASOS data, processing of meteorological data in the future will utilize this revised version of AERMET and more recent years of meteorology). Data were retrieved from products available from the National

**Table 3-1. Groupings Used for Polycyclic Organic Matter in the RTR Phase II Modeling Effort**

| POM subgroup | Names used in the NEI | Cancer URE used for the subgroup (m$^3$/□g) |
|---|---|---|
| POM 71002 | 16-PAH | 0.000055 |
| | PAH, total | 0.000055 |
| | Polycyclic Organic Matter | 0.000055 |
| POM72002 | 2-Chloronaphthalene | 0.000055 |
| | 2-Methylnaphthalene | 0.000055 |
| | Acenaphthene | 0.000055 |
| | Acenaphthylene | 0.000055 |
| | Anthracene | 0.000055 |
| | Benzo(c)phenanthrene | 0.000055 |
| | Benzo[e]Pyrene | 0.000055 |
| | Benzo[g,h,i,]Perylene | 0.000055 |
| | Fluoranthene | 0.000055 |
| | Fluorene | 0.000055 |
| | Perylene | 0.000055 |
| | Phenanthrene | 0.000055 |
| | Pyrene | 0.000055 |
| POM 73002 | 7,12-Dimethylbenz[a]Anthracene | 0.1 |
| POM 74002 | 3-Methylcholanthrene | 0.01 |
| POM 75002 | 5-Methylchrysene | 0.001 |
| | Benzo[a]Pyrene | 0.001 |
| | Dibenzo[a,h]Anthracene | 0.001 |
| POM 76002 | B[j]Fluoranthen | 0.0001 |
| | Benz[a]Anthracene | 0.0001 |
| | Benzo[b]Fluoranthene | 0.0001 |
| | Benzo[k]Fluoranthene | 0.0001 |
| | Indeno[1,2,3-c,d]Pyrene | 0.0001 |

| | | |
|---|---|---|
| POM 77002 | Chrysene | 0.00001 |

Climatic Data Center (NCDC). The surface data for 1991 were retrieved from the Hourly United States Weather Observation (HUSWO) CD. Upper air soundings were obtained from the Radiosonde Data of North America CDs produced by NCDC and the Forecast Systems Laboratory (FSL).

The input to and output from AERMET were examined for indications of missing input data. The 1200 Greenwich Mean Time (GMT) sounding is required for AERMET to calculate the convective boundary layer height and several associated parameters. There were many isolated days in which the 1200 GMT sounding was missing for many of the stations. However there also were several stations for which there were two or more consecutive days of missing 1200 GMT soundings. To minimize the impact on the output from AERMET, upper air data from a representative upper air station were substituted for those periods for which the 1200 GMT sounding was missing for two or more consecutive days.

One of the important requirements of applying the AERMOD model is the specification of surface characteristics for use in processing the meteorological data using AERMET. Application of AERMET requires specification of the surface roughness length, the Bowen ratio (an indicator of surface moisture), and the albedo (an indicator of surface reflectivity). These surface characteristics are used by AERMET to calculate the level of shear-induced mechanical turbulence generated by flow over the surface and for the energy balance calculations used in the determination of the Monin-Obukhov stability parameter and the convective velocity scale. For this application, the following surface characteristics were used:

- Surface roughness length = 0.25 m. At the airport meteorological site, the surface roughness Includes runways, terminal buildings and other airport structures. In addition, off-airport structures often are within 3 kilometers of the measurement site. his combination of land covers suggests a value of 0.2 – 0.3 meters is appropriate.
- Bowen ratio = 1.0. Representing an equal partition of the heat fluxes
- Albedo = 0.15. Representing conditions for all seasons, including winter without continuous snow cover.

The file STNS.TXT located on the HUSWO CD was used for the anemometer heights required by AERMET. These heights are to the nearest meter and were deemed appropriate for use in this application.

Two problems in the AERMET computer program were fixed before completing this application. The first pertained to hourly surface observations. Incorrect missing indicators in the code for wind speed and direction were output when the data were extracted from the raw input file in Stage 1, which caused the program to stop running in Stage 3. The AERMET program was changed to use correct missing indicators. The second problem was associated with the upper air soundings. AERMET would not process an entire station's data if the surface pressure for the first sounding was less than 850 millibars (mb). Surface pressures less than 850 mb are not uncommon for stations at high elevations. The AERMET program was modified to expand the allowable surface pressures.

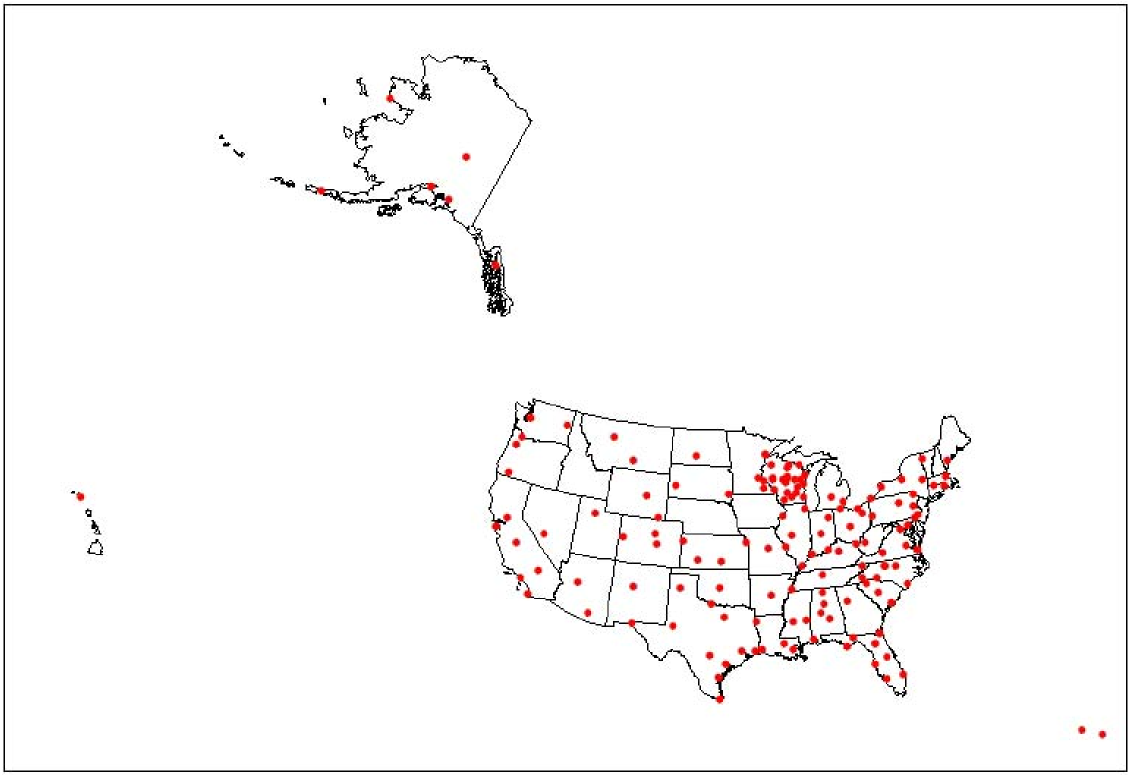


**Figure 3.1. Locations of RTR AERMOD Meteorological Stations**

In early 2007, AERMOD was modified to version 07026 which checks the header record of the surface meteorological input file to verify that its version number is 06341. As a result of this modification, the 122 NWS stations were re-processed through a newer version of AERMET (version 06431) to create meteorological data files compatible with AERMOD version 07026. The meteorology data received from the States were already at version 06341.

## 3.4 Model Options Selected

HEM3 presents a number of options for characterizing the modeling domain and data sources. As many sources were modeled in this assessment, established defaults and common practices were relied on to make these choices. The choices available to a HEM3 user and the selections that were made in this assessment are presented in Table 3-2. Some of the key selections are discussed in more detail in the paragraphs below.

Although routine emissions are not expected to vary significantly with time, nonroutine (upset) emissions can be significant relative to routine emissions. Upset emissions occur during periods of startup, shutdown, and malfunction. Upset emissions are not likely for equipment or storage tanks, but do result from malfunctioning control devices and leaks in cooling tower heat exchangers. There is some limited data on upset emissions available,[14] but no facility-specific analyses of these data were performed to characterize short-term emissions from these emission sources, and upset emissions were not modeled for the RTR risk assessments.

**Table 3-2. Modeling Domain and Model Set-Up Options in the HEM-3 Model As Used in the Residual Risk and Technology Review Assessments**

| Option | Selection |
|---|---|
| Dispersion model: AERMOD or ISCST3 | AERMOD |
| Type of analysis: chronic, acute, or both | Both |
| Averaging time for short term impacts | 1-hour |
| Multiplier for short term emissions | 10 [a] |
| Urban or rural dispersion characteristics | Rural |
| Include terrain impacts | Yes |
| Include building wake effects | No |
| Calculate deposition (wet, dry, or both) | No |
| Include impacts of plume depletion due to deposition | No |
| User-specified receptor locations (for plant boundary sites or other sites of interest) | No |
| Modeling domain size – maximum distance to be modeled | 50 km |
| Cutoff distance for modeling of individual blocks | 3 km [b] |
| Overlap distance where receptors are considered to be on plant property – measured from each source | 30 m [c] |
| Polar receptor network specifications | |
| Distance from the plant center to the innermost ring | 100 m [c] |
| Number of rings | 13 |
| Number of directions | 16 |
| Meteorology data | Closest site |

[a] For the secondary aluminum production category, the ratio of maximum short-term emissions to long-term average emissions was set to 100, based on the engineering review.

[b] The individual block modeling cutoff was increased for categories and for some facilities to ensure that the maximum individual risk values were not interpolated.

[c] The overlap distance and inner ring distance were adjusted for some facilities to avoid modeling locations that are on plant property (see section 4.2).

### *3.4.1 Urban or Rural Dispersion Characteristics*

Since 51 source categories were considered in these screening-level RTR assessments, the rural option was chosen to be most conservative (i.e., more likely to overestimate risk results).

### *3.4.2 Deposition and Plume Depletion*

This modeling analysis did not take into account the depletion of pollutant concentrations in the plume due to wet or dry deposition. In addition, reactivity and decay were not considered.

It is possible that this approach, may overestimate air concentrations and therefore risk. However, one of the main metrics used by EPA in the residual risk program is the risk to the individual most exposed (maximum risk). Because the maximum risk usually occurs at a receptor very close to the emission source, it is unlikely to be influenced by altered plume dispersion characteristics of this type. For more refined, multipathway assessments, EPA will consider deposition and depletion.

### *3.4.3 Cutoff Distance for Modeling of Individual Blocks*

The cutoff distance for modeling individual Census blocks was initially set to 3 km. This distance generally ensures that the maximum individual cancer risk and the maximum TOSHI are modeled explicitly and not interpolated. Following the modeling run, the results for each facility were checked to determine whether the maximum impacts were located inside the modeling cutoff distance. If the maximum impacts were outside the cutoff distance any of the impacts were significant, then HEM3 was rerun for the facility with an expanded modeling distance cutoff. In general, this was done if the cancer risk exceeded 1 in 10 million or any TOSHI exceeded 0.1. However, the risks for these facilities were generally very low, since the maximum impacts were generally only interpolated when the nearest Census block was more than 3 km from the facility.

### *3.4.4 Plant Boundary Assumptions*

The main input mechanisms for incorporating plant boundary information in HEM3 are the overlap distance, the distance to the innermost polar receptor ring, and user-specified receptor locations. The NEI does not provide information on plant boundaries. Therefore, the user-specified receptor file was not used in this analysis. Conservative default assumptions were used for the overlap distance and the innermost polar receptor ring. However, these were adjusted for some categories where plant sites are known to be large. In addition, satellite imagery was used to check the plant boundary assumptions for facilities with large projected impacts. These checks are discussed further in the section on Quality Assurance (Section 4).

## 3.5 Modeling of Multiple Facilities

HEM3 models one facility at a time. However, clusters of nearby facilities may impact the same people, resulting in higher risk to those people. To account for this situation, risks were summed at each Census block for all facilities affecting the Census block.

As described earlier (Section 2.3.4), HEM3 produces detailed output tables containing the risk and population for every Census block in the modeling domain. These detailed tables were combined for all facilities in a source category and the risk for each Census block was summed. Thus, the effect of multiple facilities in the same source category on the same receptor could be estimated. The resulting “combined facility” or “cluster-effect” Census block risks were used to calculate population exposure to different cancer risk levels and source category incidence.

# 4. Quality Assurance

The National Emissions Inventory is subject to an extensive program of quality assurance (QA) and quality control (QC). The QA/QC program for the point source component of the NEI is documented in a separate report, available from the NEI website.[15] This section describes QA activities carried out under the RTR modeling analysis.

## 4.1 Engineering Review

In addition to the standardized QA steps taken for the entire NEI, EPA performed an engineering review of NEI data for the emission source categories included in the RTR analysis. This engineering review included two main components. The first component addressed the list of facilities included in each source category. EPA engineers reviewed independent sources of information to identify all sources in the category that are included in the NEI. In addition, EPA reviewed the list of sources represented as part of each category in the NEI to make sure that the facilities actually manufacture products characteristic of the source category.

The second component of the engineering review focused on the appropriateness of facility emissions. EPA reviewed the list of HAPs emitted by each facility to make sure that the pollutants were appropriate to the source category. In addition, EPA engineers review the magnitude of those HAP emissions. In cases where new or better data were known to exist for a particular source category, that information was integrated into the data used in modeling for that category. In these cases, the source category specific documents provide additional details on the emissions inputs used.

## 4.2 Geographic Checks

The NEI QA process includes some basic checks on location data for point sources. The coordinates for each source are checked to ensure that they are in the county that has been specified for the source. If this is not the case, or if no geographic coordinates are available for the emission source, then the coordinates are set to a default location based on the nature of the emission source category.[15] In addition, coordinates for all emission sources at a given facility are checked to ensure that they are withing 3 km of one another.

As part of the RTR modeling analysis, additional geographical QA checks were made for some facilities. Facilities subjected to these additional checks include:

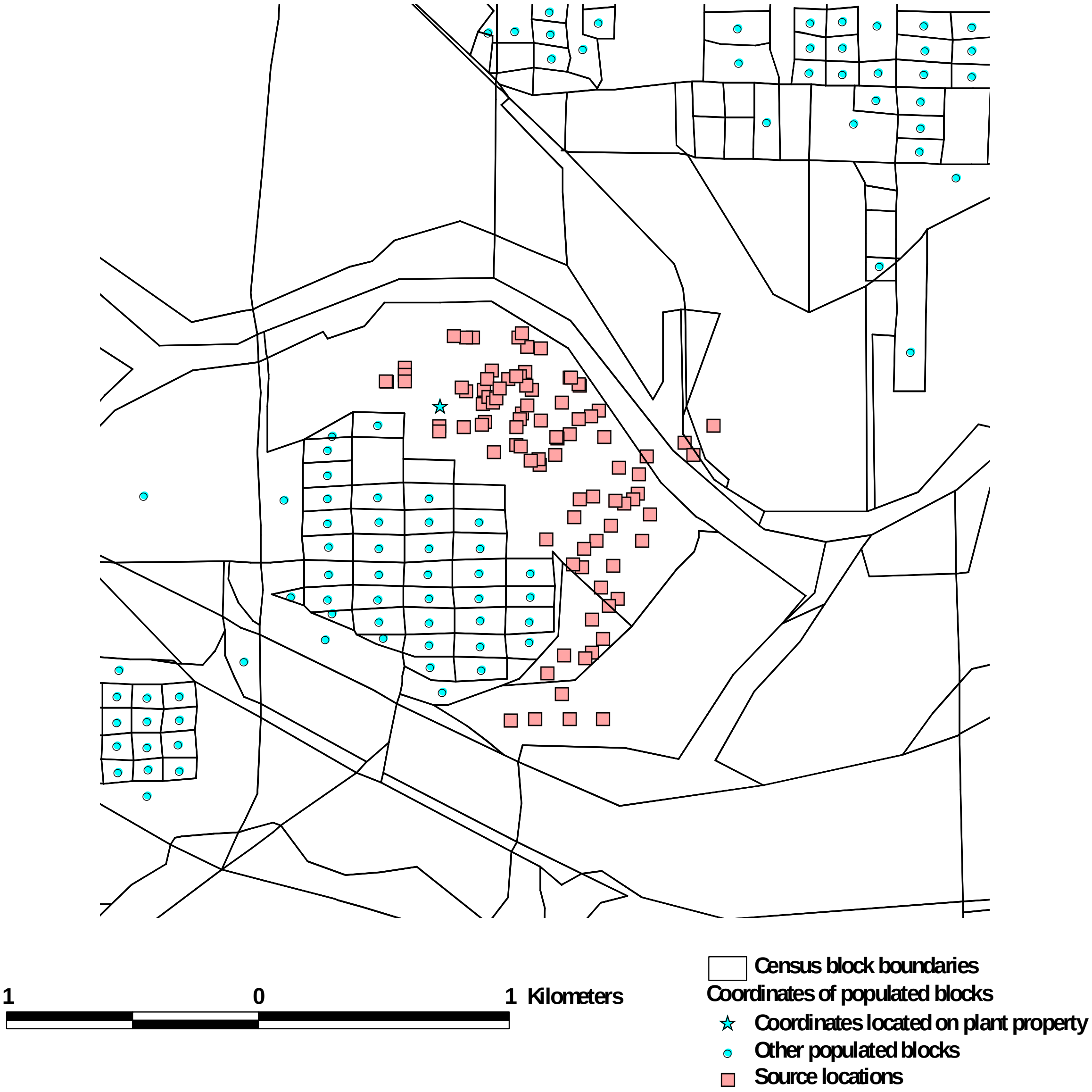
- cases where the initial estimates of maximum risks were particularly high
    - maximum individual cancer risk of over 1 in 10,000
    - any maximum TOSHI above 10
- cases where no Census blocks were identified within 3 km of the facility

The emission source coordinates were reviewed for each of these facilities, and compared with the address reported for the facility. Both the coordinates and the facility address were entered into Internet mapping sites which provide the option of viewing aerial or satellite photography. These sites include Google Earth® (earth.google.com/), Google Maps® (local.google.com/), MapQuest® (www.mapquest.com) and Microsoft Terraserver® (www.terraserver.com/). If the address and the coordinates represented the same location, then the coordinates were taken to be correct. If the locations were different, then the aerial photographs for the address and the coordinate location were reviewed to determine whether either photograph included an industrial facility. Generally, where the two locations were different, the facility address was found to be correct. In some cases, this comparison could not be made because the reported address was a Post Office box or a headquarters address. Where this occurred, the aerial photograph for the coordinate location was reviewed to determine whether an industrial facility was located at or near the location. If emission source coordinates were found to be incorrect, HEM3 was rerun using corrected coordinates. These changes are described in the source category documents.

For the high-risk facilities, the coordinates used to represent the most impacted Census blocks were also reviewed. This review drew on detailed Census block boundary maps and aerial photographs. Large industrial facilities will frequently occupy one or more entire Census blocks. However, these blocks may also include one or more residences on the periphery of the industrial land. Generally, the coordinates listed for a Census block are near the center of the block. In these cases of mixed industrial and residential blocks, the coordinates may be on plant property.

The potential for overlap between an industrial facility and a Census block coordinate is illustrated in Figure 4-1. The figure shows Census blocks divisions around a large industrial facility, with the coordinates of emission sources at the facility illustrated by red squares. Census block boundaries are shown, and the coordinates given in the Census data base for populated blocks are indicated by blue circles. As the figure shows, the facility is spread over five Census blocks. A number of populated blocks can be seen to the Southwest of the facility, and most of the blocks covering the facility are not populated. However, the block containing most of the facility's emission points also includes at least one residence (the total population given for the block is 5). The location of the residence is at the periphery of the block, near the one of the adjacent populated blocks. However, the coordinates given for the block are near its center, illustrated by the blue star, clearly between various emission sources at the facility.

In general, block coordinates were considered to be on plant property if they were located between the different emission source locations listed for the facility. In these situations, HEM3 was rerun with an expanded overlap distance, in order to exclude the Census block coordinates that appeared to be located on plant property. The distance to the innermost polar receptor ring was also adjusted to ensure that this ring was not on plant property.


1
0
1 Kilometers
Census block boundaries
Coordinates of populated blocks
Coordinates located on plant property
Other populated blocks
Source locations

# 5. Uncertainties

This analysis is subject to a number of uncertainties. For instance, model verification studies for AERMOD showed predicted maximum annual concentrations ranging from 0.3 to 1.6 times measured values, with an average of 0.9. Predicted maximum short term (1 to 24 hours) concentrations were 0.25 to 2.5 times measured values, with an average of 1.0.[16]

In addition, a number of simplifying assumptions have been made in this modeling analysis. First, the coordinates reported by the Department of Census for Census block "internal points" have been used as a surrogate for long-term population exposures. Locations of actual residences have not been modeled. In addition, the current version of HEM3 does not take into account the movement of people from one Census block to another during the course of their lives, or commuting patterns during a given day. Nor does the model take into account the attenuation of pollutant from outside emission sources in indoor air. Ideally, risks to individuals would be modeled as they move through their communities and undertake different activities. However, such modeling is time- and resource-intensive and can only capture a portion of the uncertainty associated with the full range of human activities. In general, it is expected that long-term exposures will be overstated for high-end estimates (as most individuals will not spend all their time at their highly affected residences), but may understate the total population exposed (as some individuals living outside the modeled area may regularly commute into the area for work or school).

When considering long-term or lifetime exposures, it should be noted that relatively few people in the United States reside in one place for their entire lives. For the purposes of this assessment, cancer risk estimates are based on a lifetime exposure at the 2000 Census-identified place of residence. While it is impossible to know how this assumption affects the risk experiences by a particular individual (as people can move into higher- or lower-risk areas), it is likely that this assumption will overstate the exposure to those most exposed (i.e., people already living in high exposure areas are unlikely to move to yet higher exposure areas). However, this assumption will also tend to underestimate the total number of people exposed and population risk (i.e., incidence) because population levels are generally increasing.

In the current analysis, only direct inhalation has been modeled. Other pathways such as the deposition of pollutants to drinking water, and to bioaccumulation of deposited pollutants in the food supply may be a significant source of exposure for persistent and bioaccumulative pollutants. These exposures will be modeled in subsequent analyses. Because this analysis is restricted to the inhalation pathway, the impacts of plume depletion due to deposition have not been into account. Thus, inhalation impacts may be overestimated for some pollutants, but exposures through other pathways would be underestimated.

A number of other simplifications have been made in the dispersion modeling analysis, as has been noted in Table 3-1. For instance, building wake effects have not been considered. Rural dispersion conditions have also been used for all facilities. This is viewed as a conservative assumption, since rural conditions result in less mixing close to the emission source.

In addition, meteorological observations are based on the closest station in the HEM3 meteorological library (see Figure 2-1). Alternative meteorological stations may be more appropriate for some facilities. Ideally, facility-specific meteorological observations would be used. A single year of meteorological data (1991) was selected for dispersion modeling. When considering off-site meteorological data most site specific dispersion modeling efforts will employ up to five years of data to capture variability in weather patterns from year to year. However, because of the large number of facilities in the analysis and the extent of the dispersion modeling analysis (national scale), it was not practical to model five years of data. Other national studies such as NATA have also considered only a single year of meteorological data. A sensitivity analyses performed by the NATA assessment found that variability attributable to the selection of the meteorology location/time (both temporal and spatial) resulted in a 17-84% variation in predicted concentrations at a given station[17].

Finally, risk and exposure factors are also subject to uncertainty. Not all individuals experience the same degree of exposure or internal dose of a given pollutant due to individual-specific parameters such as weight, age, and gender. While the health benchmarks used in the analysis crudely account for sensitive populations, a prototypical human (e.g., body weight, ventilation rate) is used to define the benchmark. Because of the variability of these parameters in the population, this factor will result in a degree of uncertainty in the resulting risk estimate.

Table 5-1 summarizes the general sources of uncertainty for the RTR modeling analysis. The table also gives a qualitative indication of the potential direction of bias on risk estimates. The sources of uncertainty in Table 5-1 are divided into four categories, based on the major components of the analysis:

- emissions inventory
- fate and transport modeling
- exposure assessment
- toxicity assessment

It must also be noted that individual source categories may be subject to additional uncertainties. These are discussed in separate reports which have been prepared for each emission source category included in the RTR.

### Table 5-1. Summary of General Uncertainties Associated with Risk and Technology Review Risk Assessment

| Parameter | Assumption | Uncertainty/Variability Discussion | Potential Direction of Bias on Risk Estimates |
|---|---|---|---|
| **Emissions Inventory** | | | |
| Individual HAP emissions rates and facility characteristics (stack parameters, property boundaries) | Emissions and facility characteristics from the NEI provide an accurate characterization of actual source emissions. | Our emissions inventory is based on the 2002 NEI, our internal review, and public comments received. The degree to which the data in our inventory represents actual emissions is likely to vary across sources. Nearly half of the sources in the source category submitted a review of their emissions and facility characteristics data. Some detailed data, such as property boundary information was not available for most facility. This is an important consideration in determining acute impacts. | Unbiased overall, magnitude variable |
| Multiplier for short-term emission rates | Maximum short term emission rates are estimated by applying a simple multiplier (a factor of 10) to average annual emissions. | The ratio between short-term and long-term average emission rates may vary from among the different emission sources at a facility. In addition, the use of a simple multiplier means that impacts of maximum short term emissions are modeled for all meteorological conditions, including the worst-case conditions for population exposure. | Potential overestimate due to the fact that worst-case emissions are assumed to occasionally coincide with worst-case meteorology.<br>Overestimate due to lack of actual information on short-term emission rates. |
| **Fate and Transport Modeling** | | | |
| Atmospheric dispersion model choice | AERMOD is one of EPA's recommended models for assessing pollutant concentrations from industrial facilities | Field testing of these models have shown results to generally be within a factor of 2 of measured concentrations. | Overestimate |

**Table 5-1. Summary of General Uncertainties Associated with Risk and Technology Review Risk Assessment**
(continued)

| Parameter | Assumption | Uncertainty/Variability Discussion | Potential Direction of Bias on Risk Estimates |
|---|---|---|---|
| Building downwash | Not included in assessment | Use of this algorithm in AERMOD could improve the dispersion calculations at individual facilities. However, data were not readily available to utilize this option. | Potential underestimate of maximum risks near facility. No effect on risks further out. |
| Plume depletion and deposition | Not included in assessment | Ignoring these impacts for pollutants that deposit minimally and whose risks derive predominantly from inhalation should have minimal effect on risk estimates. | Unbiased or minimal overestimate. |
| Meteorology | One year of meteorological data from the nearest weather station (selected from 122 nationwide) is representative of long-term weather conditions at the facility. | The use of one year of data rather than the five or more adds uncertainty based on whether that year is representative of each location's climatology. Use of weather station data rather than on-site data can add to uncertainty. Additionally, the use of default surface parameters in the generation of the meteorological datasets imparts uncertainty to the results from any individual facility. | Minimal underestimate or overestimate. |
| Reactivity | Not included in the assessment. | Chemical reactions and transformations of individual HAP into other compounds due to solar radiation and reactions with other chemicals happens in the atmosphere. However, in general, the HAP in this assessment do not react quickly enough for these transformations to be important near the sources, where the highest individual risks are estimated. Further, most of the HAP do not react quickly enough for these transformations to be important to risk estimates in the entire modeled domain (i.e., within 50 km of the source). | No impact on maximum risk estimates. Minimal impact on population risks and incidence. |

### Table 5-1. Summary of General Uncertainties Associated with Risk and Technology Review Risk Assessment
(continued)

| Parameter | Assumption | Uncertainty/Variability Discussion | Potential Direction of Bias on Risk Estimates |
|---|---|---|---|
| Maximum modeling distance | 50 kilometers from center of facility | This distance is considered to be the maximum downwind distance for a Gaussian plume model such as AERMOD. This is because, in general, winds cannot be considered to follow straight line trajectories beyond this distance. | No effect on maximum individual risks. Minimal underestimation of incidence. |
| **Exposure Assessment** | | | |
| Locations and short-term movements of individuals | Ambient concentration at centroid of each off-site census block is equal to the exposure concentration for all people living in that census block.<br>Effect of human activity patterns on exposures is not included in the assessment. | People live at different areas within block that may have higher or lower exposures than at the centroid. Individuals also move from outdoors to indoors and from home to school/work to recreation, etc., and this can affect their total exposure from these sources. | Unbiased across population for most pollutants and individuals, likely overestimate for most exposed and underestimate for least exposed persons. |
| Long-term movements of individuals | MIR individual is exposed continuously to the highest exposure concentration for a 70-year lifetime.<br>Population moves into and out of exposure area consistent with national frequency distribution of residency. | MIR (maximum individual risk) is defined in this way to be a maximum theoretical risk at a point where a person can actually reside.<br>Individuals may move into or out of areas impacted by the facilities of interest in ways that don't correspond exactly with national norms or local demographic patterns, and this could lead to localized biases. In general, source categories with larger numbers of facilities should carry less potential for bias. | Unbiased for most individuals, likely overestimate for the actual individual most exposed and likely underestimate for the least exposed. Incidence remains unbiased unless population around facilities increases or decreases over 70 years. |
| **Toxicity Assessment** | | | |

### Table 5-1. Summary of General Uncertainties Associated with Risk and Technology Review Risk Assessment

(continued)

| Parameter | Assumption | Uncertainty/Variability Discussion | Potential Direction of Bias on Risk Estimates |
|---|---|---|---|
| Reference concentrations (RfC) | Consistent with EPA guidance, RfCs are developed including uncertainty factors to be protective of sensitive subpopulations. Additionally, RfCs are developed based on the level producing an effect in the most sensitive target organ or system. | While other organ systems may be impacted at concentrations above the RfC, these are not included in the calculation of target organ-specific hazard indices. | In general, EPA derives RfCs using procedures whose goal is to avoid underestimating risks in light of uncertainty and variability. The greater the uncertainties, the greater the potential for overestimating risks. |
| Unit Risk Estimate (URE) | Use of unit risk estimates developed from dose-response models such as linear low-dose extrapolation. | Uncertainty in extrapolating the impacts from short-duration, high-dose animal or work-related exposures to longer duration, lower-dose environmental impacts. | Overestimate of risks for nonlinear carcinogens and for linear carcinogens with sparse health effects data. In general, EPA derives URE values using procedures aimed at overestimating risks in light of uncertainty and variability. |
| Toxicity of mixtures | Cancer risks and noncancer hazard quotients were calculated for each HAP individually and then summed into a total risk or hazard index (assumption of additivity). | Concurrent exposures to multiple chemicals may result in either increased or decreased toxicity due to chemical interactions but the data needed to quantify these effects are generally not available. | Unbiased overall. Some mixtures may have underestimated risks, some overestimated, and some correctly estimated. |

### Table 5-1. Summary of General Uncertainties Associated with Risk and Technology Review Risk Assessment
(continued)

| Parameter | Assumption | Uncertainty/Variability Discussion | Potential Direction of Bias on Risk Estimates |
|---|---|---|---|
| Surrogate dose-response values for HAPs without values | In the case of groups of HAPs such as glycol ethers, the most conservative dose-response value of the chemical group was used as a surrogate for missing dose-response values in the group. For others, such as unspeciated metals, we have applied speciation profiles appropriate to the source category to develop a composite dose-response value for the group.<br>For HAP which are not in a group and for which no URE's or RfC's are available from credible sources, no assessment of risk is made. | Rather than neglecting the assessment of risks from some HAPs lacking dose response values, conservative assumptions allow the examination of whether these HAPs may pose an unacceptable risk and require further examination, or whether the conservative level examination with surrogates screens out the HAPs from further assessment. | Overestimate where most conservative values used. Unbiased where category-specific profiles applied.<br>There is the potential to underestimate risks for pollutants which are not included in the assessment. |

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# Appendix 2
# Meteorological Data for HEM-AERMOD Modeling

# DRAFT

# METEOROLOGICAL DATA PROCESSING USING AERMET

# FOR

# HEM-AERMOD

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## PROJECT DESCRIPTION AND BACKGROUND

The AERMOD meteorological processor, AERMET, was used to process one year of hourly data from 122 National Weather Service (NWS) surface observation stations across the continental United States, Alaska, Hawaii, and Puerto Rico.

## METEOROLOGICAL DATA PROCESSING

To estimate the boundary layer parameters required by AERMOD, AERMET requires hourly surface weather observations and the full (i.e., meteorological variables reported at all levels) twice-daily upper air soundings. The surface and upper air stations are paired to produce the required input data for AERMOD.

One of the requirements of the project was to use surface observations prior to the introduction of the Automated Surface Observation System (ASOS). Installation and operation of ASOS equipment began in 1992; therefore, data for 1991 were processed with AERMET.

A list of 86 previously paired surface and upper air stations was provided to MACTEC. On review of these stations, it was determined that data for 1991 for three of the stations – Galveston, TX, Houston-Hobby, TX and Boulder, CO – was not available. The remaining 83 stations did not provide adequate coverage for the MACT sources to be modeled with AERMOD. As a result, an additional 39 surface stations were identified to include for processing. These additional surface stations were paired with representative upper air stations. A list of the surface and paired upper air stations are in Table 1.

Data were retrieved from products available from the National Climatic Data Center (NCDC). The surface data for 1991 were retrieved from the Hourly United States Weather Observation (HUSWO) CD. Upper air soundings were obtained from the Radiosonde Data of North America CDs produced by NCDC and the Forecast Systems Laboratory (FSL).

### TABLE 1

### SURFACE STATIONS WITH PAIRED UPPER AIR STATION

| SURFACE | WBAN | LAT | LON | UPPER AIR | WBAN | LAT | LON |
|---|---|---|---|---|---|---|---|
| Paducah, KY | 03816 | 37.07 | -88.77 | Paducah, KY | 03816 | 37.07 | -88.77 |
| Huntsville, AL | 03856 | 34.65 | -86.78 | Nashville, TN | 13897 | 36.13 | -86.68 |
| Huntington, WV | 03860 | 38.37 | -82.55 | Huntington, WV | 03860 | 38.37 | -82.55 |
| Greenville, SC | 03870 | 34.90 | -82.22 | Athens, GA | 13873 | 33.95 | -83.32 |
| Fort Worth, TX | 03927 | 32.90 | -97.02 | Stephenville, TX | 13901 | 32.22 | -98.18 |
| Wichita, KS | 03928 | 37.65 | -97.45 | Topeka, KS | 13996 | 39.07 | -95.63 |
| Lake Charles, LA | 03937 | 30.12 | -93.23 | Lake Charles, LA | 03937 | 30.12 | -93.23 |
| Jackson, MS | 03940 | 32.32 | -90.08 | Jackson, MS | 03940 | 32.32 | -90.08 |
| Kansas City, MO | 03947 | 39.30 | -94.73 | Topeka, KS | 13996 | 39.07 | -95.63 |

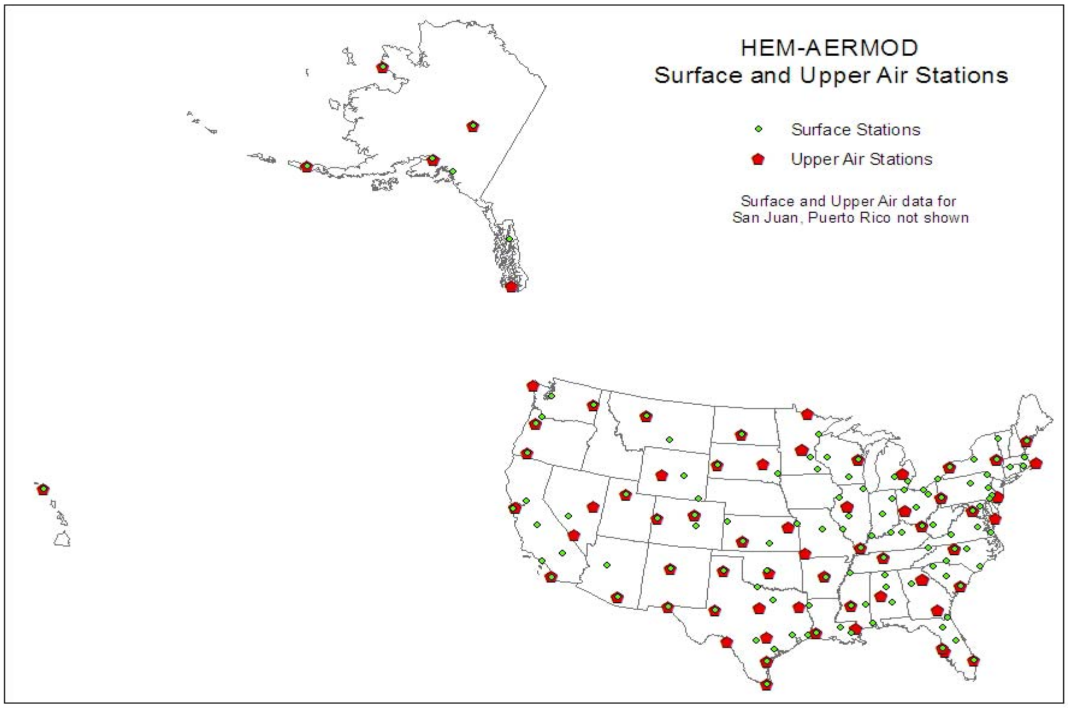
| **SURFACE** | **WBAN** | **LAT** | **LON** | **UPPER AIR** | **WBAN** | **LAT** | **LON** |
|---|---|---|---|---|---|---|---|
| San Juan, PR | 11641 | 18.43 | -66.02 | San Juan, PR | 11641 | 18.43 | -66.00 |
| Orlando, FL | 12815 | 28.45 | -81.32 | Tampa, FL | 12842 | 27.70 | -82.40 |
| Gainesville, FL | 12816 | 29.68 | -82.27 | Waycross, GA | 13861 | 31.25 | -82.40 |
| Tampa, FL | 12842 | 27.97 | -82.53 | Tampa Bay, FL | 12842 | 27.97 | -82.53 |
| W. Palm Beach, FL | 12844 | 26.68 | -80.10 | W. Palm Beach, FL | 12844 | 26.68 | -80.12 |
| Victoria, TX | 12912 | 28.85 | -96.92 | Corpus Christi, TX | 12924 | 29.77 | -97.50 |
| New Orleans, LA | 12916 | 30.00 | -90.25 | Slidell, LA | 53813 | 30.33 | -89.82 |
| Port Arthur, TX | 12917 | 29.95 | -94.02 | Lake Charles, LA | 03937 | 30.12 | -93.23 |
| Brownsville, TX | 12919 | 25.90 | -97.43 | Brownsville, TX | 12919 | 25.90 | -97.43 |
| San Antonio, TX | 12921 | 29.53 | -98.47 | Del Rio, TX | 22010 | 29.37 | -100.92 |
| Corpus Christi, TX | 12924 | 27.77 | -97.52 | Corpus Christi, TX | 12924 | 27.77 | -97.52 |
| Houston, TX | 12960 | 29.98 | -95.37 | Lake Charles, LA | 03937 | 30.12 | -93.23 |
| Raleigh, NC | 13722 | 35.87 | -78.78 | Greensboro, NC | 13723 | 36.10 | -79.95 |
| Greensboro, NC | 13723 | 36.08 | -79.95 | Greensboro, NC | 13723 | 36.08 | -79.95 |
| Norfolk, VA | 13737 | 36.90 | -76.20 | Wallops Island, VA | 93739 | 37.93 | -75.47 |
| Philadelphia, PA | 13739 | 39.87 | -75.23 | Atlantic City, NJ | 93755 | 39.75 | -74.67 |
| Richmond, VA | 13740 | 37.50 | -77.32 | Sterling, VA | 93734 | 38.98 | -77.47 |
| Roanoke, VA | 13741 | 37.32 | -79.97 | Greensboro, NC | 13723 | 36.10 | -79.95 |
| Wilmington, NC | 13748 | 34.27 | -77.90 | Charleston, SC | 13880 | 32.90 | -80.03 |
| Wilmington, DE | 13781 | 39.67 | -75.60 | Atlantic City, NJ | 93755 | 39.75 | -74.67 |
| Meridian, MS | 13865 | 32.33 | -88.75 | Jackson, MS | 03940 | 32.32 | -90.08 |
| Charleston, WV | 13866 | 38.38 | -81.58 | Huntington, WV | 03860 | 38.37 | -82.55 |
| Atlanta, GA | 13874 | 33.63 | -84.45 | Athens, GA | 13873 | 33.95 | -83.33 |
| Birmingham, AL | 13876 | 33.57 | -86.75 | Centerville, AL | 03881 | 32.90 | -87.25 |
| Bristol, TN | 13877 | 36.47 | -82.40 | Huntington, WV | 03860 | 38.37 | -82.55 |
| Charleston, SC | 13880 | 32.90 | -80.03 | Charleston, SC | 13880 | 32.90 | -80.03 |
| Charlotte, NC | 13881 | 35.22 | -80.93 | Greensboro, NC | 13723 | 36.08 | -79.95 |
| Columbia, SC | 13883 | 33.95 | -81.12 | Athens, GA | 13873 | 33.95 | -83.33 |
| Jacksonville, FL | 13889 | 30.50 | -81.70 | Waycross, GA | 13861 | 31.25 | -82.40 |
| Memphis, TN | 13893 | 35.05 | -89.98 | N. Little Rock, AR | 03952 | 34.83 | -92.27 |
| Mobile, AL | 13894 | 30.68 | -88.25 | Slidell, LA | 53813 | 30.33 | -89.82 |
| Montgomery, AL | 13895 | 32.30 | -86.40 | Centerville, AL | 03881 | 32.90 | -87.25 |
| Nashville, TN | 13897 | 36.13 | -86.68 | Nashville, TN | 13897 | 36.13 | -86.68 |
| Shreveport, LA | 13957 | 32.45 | -93.82 | Longview, TX | 03951 | 32.35 | -94.65 |
| Little Rock, AR | 13963 | 34.73 | -92.23 | N. Little Rock, AR | 03952 | 34.83 | -92.27 |
| Wichita Falls, TX | 13966 | 33.98 | -98.50 | Stephenville, TX | 13901 | 32.22 | -98.18 |
| Oklahoma City, OK | 13967 | 35.40 | -97.60 | Norman, OK | 03948 | 35.23 | -97.47 |
| Baton Rouge, LA | 13970 | 30.53 | -91.15 | Slidell, LA | 53813 | 30.33 | -89.82 |
| Dodge City, KS | 13985 | 37.77 | -99.97 | Dodge City, KS | 13985 | 37.77 | -99.97 |
| St. Louis, MO | 13994 | 38.75 | -90.37 | Peoria, IL | 14842 | 40.67 | -89.68 |
| Springfield, MO | 13995 | 38.82 | -92.27 | Monet, MO | 03946 | 36.87 | -93.97 |
| Buffalo, NY | 14733 | 42.93 | -78.73 | Buffalo, NY | 14733 | 42.93 | -78.73 |
| Newark, NJ | 14734 | 41.72 | -75.17 | Atlantic City, NJ | 93755 | 39.75 | -74.67 |
| Albany, NY | 14735 | 42.75 | -73.82 | Albany, NY | 14735 | 42.75 | -73.82 |
| Allentown, PA | 14737 | 40.65 | -75.45 | Albany, NY | 14735 | 42.75 | -73.82 |
| Boston, MA | 14739 | 42.37 | -71.02 | Chatham, MA | 14684 | 41.67 | -69.97 |
| Hartford, CN | 14740 | 41.93 | -72.68 | Albany, NY | 14735 | 42.75 | -73.80 |
| Burlington, VT | 14742 | 44.47 | -73.15 | Albany, NY | 14735 | 42.75 | -73.82 |

| SURFACE | WBAN | LAT | LON | UPPER AIR | WBAN | LAT | LON |
|---|---|---|---|---|---|---|---|
| Portland, ME | 14764 | 43.65 | -70.30 | Portland, ME | 14764 | 43.65 | -70.30 |
| Providence, RI | 14765 | 41.73 | -71.43 | Chatham, MA | 14684 | 41.67 | -69.97 |
| Syracuse, NY | 14771 | 43.12 | -76.12 | Buffalo, NY | 14733 | 42.93 | -78.73 |
| Williamsport, PA | 14778 | 41.27 | -77.05 | Pittsburgh, PA | 94823 | 40.53 | -80.23 |
| Cleveland, OH | 14820 | 41.40 | -81.85 | Pittsburgh, PA | 94823 | 40.53 | -80.23 |
| Columbus, OH | 14821 | 39.98 | -82.88 | Dayton, OH | 13840 | 39.83 | -84.05 |
| Fort Wayne, IN | 14827 | 41.00 | -85.20 | Dayton, OH | 13840 | 39.83 | -84.05 |
| Lansing, MI | 14836 | 42.78 | -84.58 | Flint, MI | 14826 | 42.97 | -83.75 |
| Madison, WI | 14837 | 43.13 | -89.33 | Green Bay, WI | 14898 | 44.48 | -88.13 |
| Erie, PA | 14860 | 42.08 | -80.18 | Buffalo, NY | 14733 | 42.93 | -78.73 |
| Akron, OH | 14895 | 40.92 | -81.43 | Pittsburgh, PA | 94823 | 40.50 | -80.23 |
| Green Bay, WI | 14898 | 44.50 | -88.12 | Green Bay, WI | 14898 | 44.50 | -88.12 |
| Duluth, MN | 14913 | 46.83 | -92.22 | Int'l Falls, MN | 14918 | 48.57 | -93.40 |
| Minneapolis, MN | 14922 | 44.88 | -93.23 | St. Cloud, MN | 14926 | 45.55 | -94.05 |
| Moline, IL | 14923 | 41.45 | -90.52 | Peoria, IL | 14842 | 40.67 | -89.68 |
| Rochester, MN | 14925 | 43.92 | -92.50 | St. Cloud, MN | 14926 | 45.55 | -94.08 |
| Sioux Falls, SD | 14944 | 43.57 | -96.73 | Huron, SD | 14936 | 44.38 | -98.22 |
| Eau Claire, WI | 14991 | 44.87 | -91.48 | St. Cloud, MN | 14926 | 45.55 | -94.08 |
| Lihue, HI | 22536 | 21.98 | -159.33 | Lihue, HI | 22536 | 21.98 | -159.33 |
| Midland, TX | 23023 | 31.95 | -102.18 | Midland, TX | 23023 | 31.95 | -102.18 |
| El Paso, TX | 23044 | 31.82 | -106.38 | El Paso, TX | 23044 | 31.82 | -106.38 |
| Amarillo, TX | 23047 | 35.22 | -101.70 | Amarillo, TX | 23047 | 35.22 | -101.70 |
| Albuquerque, NM | 23050 | 35.03 | -106.62 | Albuquerque, NM | 23050 | 35.03 | -106.62 |
| Denver, CO | 23062 | 39.77 | -104.87 | Denver, CO | 23062 | 39.77 | -104.88 |
| Goodland, KS | 23065 | 39.37 | -101.70 | Dodge City, KS | 13985 | 37.77 | -99.97 |
| Grand Junction, CO | 23066 | 39.12 | -108.53 | Grand Junction, CO | 23066 | 39.12 | -108.53 |
| Tonopah, NV | 23153 | 38.05 | -117.08 | Ely, NV | 23154 | 39.30 | -114.85 |
| Tucson, AZ | 23160 | 32.12 | -110.93 | Tucson, AZ | 23160 | 32.12 | -110.93 |
| Daggett, CA | 23161 | 34.87 | -116.78 | Desert Rock, NV | 03160 | 36.62 | -116.02 |
| Los Angeles, CA | 23174 | 33.93 | -118.38 | Miramar, CA | 03190 | 32.87 | -117.15 |
| Prescott, AZ | 23184 | 34.65 | -112.43 | Tucson, AZ | 23160 | 32.12 | -110.93 |
| San Diego, CA | 23188 | 32.73 | -117.17 | Miramar, CA | 03190 | 32.87 | -117.15 |
| Sacramento, CA | 23232 | 38.52 | -121.50 | Oakland, CA | 23230 | 37.75 | -122.22 |
| San Francisco, CA | 23234 | 37.62 | -122.40 | Oakland, CA | 23230 | 37.72 | -122.22 |
| Bismarck, ND | 24011 | 46.78 | -100.75 | Bismarck, ND | 24011 | 46.78 | -100.75 |
| Cheyenne, WY | 24018 | 41.15 | -104.77 | Denver, CO | 23062 | 39.77 | -104.88 |
| Billings, MT | 24033 | 45.80 | -108.55 | Great Falls, MT | 24143 | 47.47 | -111.38 |
| Casper, WY | 24089 | 42.90 | -106.47 | Lander, WY | 24021 | 42.82 | -108.73 |
| Rapid City, SD | 24090 | 44.05 | -103.07 | Rapid City, SD | 24090 | 44.05 | -103.07 |
| Salt Lake City, UT | 24127 | 40.78 | -111.97 | Salt Lake City, UT | 24127 | 40.78 | -111.97 |
| Great Falls, MT | 24143 | 47.47 | -111.38 | Great Falls, MT | 24143 | 47.47 | -111.38 |
| Spokane, WA | 24157 | 47.62 | -117.53 | Spokane, WA | 24157 | 47.62 | -117.53 |
| Medford, OR | 24225 | 42.37 | -122.87 | Medford, OR | 24225 | 42.37 | -122.87 |
| Portland, OR | 24229 | 45.60 | -122.60 | Salem, OR | 24232 | 44.90 | -123.00 |
| Salem, OR | 24232 | 44.90 | -123.00 | Salem, OR | 24232 | 44.90 | -123.00 |
| Seattle, WA | 24233 | 47.45 | -122.32 | Quillayute, WA | 94240 | 47.93 | -124.55 |
| Juneau, AK | 25309 | 58.37 | -134.58 | Annette Is., AK | 25308 | 55.03 | -131.57 |
| Cold Bay, AK | 25624 | 55.20 | -162.72 | Cold Bay, AK | 25624 | 55.20 | -162.72 |

| SURFACE | WBAN | LAT | LON | UPPER AIR | WBAN | LAT | LON |
|---|---|---|---|---|---|---|---|
| Fairbanks, AK | 26411 | 64.80 | -147.88 | Fairbanks, AK | 26411 | 64.80 | -147.88 |
| Valdez, AK | 26442 | 61.13 | -146.35 | Anchorage, AK | 26409 | 61.22 | -149.85 |
| Anchorage, AK | 26451 | 61.20 | -150.00 | Anchorage, AK | 26409 | 61.22 | -149.85 |
| Nome, AK | 26617 | 64.50 | -165.43 | Nome, AK | 26617 | 64.50 | -165.43 |
| Colo. Springs | 93037 | 38.82 | -104.72 | Denver, CO | 23062 | 39.77 | -104.88 |
| Fresno, CA | 93193 | 36.78 | -119.72 | Oakland, CA | 23230 | 37.72 | -122.22 |
| Baltimore, MD | 93721 | 39.18 | -76.67 | Sterling, VA | 93734 | 38.98 | -77.47 |
| Sterling, VA | 93738 | 38.95 | -77.45 | Sterling, VA | 93734 | 38.98 | -77.47 |
| Evansville, IN | 93817 | 38.05 | -87.52 | Paducah, KY | 03816 | 37.05 | -88.77 |
| Indianapolis, IN | 93819 | 39.73 | -86.28 | Dayton, OH | 13840 | 39.83 | -84.05 |
| Lexington, KY | 93820 | 38.03 | -84.60 | Dayton, OH | 13840 | 39.83 | -84.05 |
| Louisville, KY | 93821 | 38.18 | -85.73 | Dayton, OH | 13840 | 39.83 | -84.05 |
| Springfield, IL | 93822 | 39.85 | -89.68 | Peoria, IL | 14842 | 40.67 | -89.68 |
| Pittsburgh, PA | 94823 | 40.53 | -80.23 | Pittsburgh, PA | 94823 | 40.50 | -80.23 |
| Toledo, OH | 94830 | 41.58 | -83.80 | Flint, MI | 14826 | 42.97 | -83.73 |
| Chicago, IL | 94846 | 42.00 | -87.93 | Peoria, IL | 14842 | 40.67 | -89.68 |
| Detroit, MI | 94847 | 42.23 | -83.33 | Flint, MI | 14826 | 42.97 | -83.75 |

Figure 1 shows the surface stations (green circles) and upper air stations (red pentagons) used in this study.

**FIGURE 1. SURFACE AND UPPER AIR STATIONS**



## MISSING DATA

While AERMET will run if input observations are missing, the output will be incomplete, with missing data indicators in the output file. The input to and output from AERMET were examined for indications of missing input data.

The 1200 Greenwich Mean Time (GMT) sounding is required for AERMET to calculate the convective boundary layer height and several associated parameters. There were many isolated days in which the 1200 GMT sounding was missing for many of the stations. However there also were several stations for which there were two or more consecutive days of missing 1200 GMT soundings. The longest period of consecutive missing 1200 GMT soundings was at Dayton, Ohio with seven days of missing soundings. To minimize the impact on the output from AERMET and not consume too much time and effort, MACTEC substituted upper air data from a representative upper air station for those periods for which the 1200 GMT sounding was missing for two or more consecutive days. Table 2 shows the station substitutions.

### TABLE 2

### UPPER AIR STATIONS WITH MISSING 1200 GMT SOUNDINGS AND STATION USED FOR DATA SUBSTITUTION

| Upper Air Station With Missing Data | WBAN | Station Used for Data Substitution | WBAN |
|---|---|---|---|
| Amarillo, TX | 23047 | Norman, OK | 03948 |
| Athens, GA | 13873 | Greensboro, NC | 13723 |
| Brownsville, TX | 12929 | Corpus Christi, TX | 12924 |
| Centerville, AL | 03881 | Jackson, MS | 03940 |
| Chatham, MA | 14684 | Portland, ME | 14764 |
| Dayton, OH | 13840 | Paducah, KY | 03826 |
| Ely, NV | 23154 | Winnemucca, NV | 24128 |
| Grand Junction, CO | 23066 | Salt Lake City, UT | 24127 |
| Lake Charles, LA | 03937 | Slidell, LA | 53813 |
| Paducah, KY | 03826 | Nashville, TN | 13897 |
| Peoria, IL | 14842 | Omaha, NE | 94918 |
| Pittsburgh, PA | 94823 | Huntington, WV | 03860 |
| Salt Lake City, UT | 24127 | Ely, NV | 23154 |
| St. Cloud, MN | 14926 | Huron, SD | 14936 |

## ANEMOMETER HEIGHTS

The file STNS.TXT located on the HUSWO CD was used for the anemometer heights required by AERMET. These heights are to the nearest meter and were deemed appropriate for use in this application.

## SURFACE CHARACTERISTICS

One of the important requirements of applying the AERMOD model is the specification of surface characteristics for use in processing the meteorological data using AERMET. Application of AERMET requires specification of the surface roughness length, the Bowen ratio (an indicator of surface moisture), and the albedo (an indicator of surface reflectivity). These surface characteristics are used by AERMET to calculate the level of shear-induced mechanical turbulence generated by flow over the surface and for the energy balance calculations used in the determination of the Monin-Obukhov stability parameter and the convective velocity scale.

The surface characteristics can be varied by wind direction sector (upwind) and by month or season. Current guidance specifies defining the characteristics for the meteorological measurement site and extending outward from the measurement location for three kilometers. In an application of this magnitude, it is impractical to evaluate and vary the surface characteristics for each of the 122 stations, therefore, MACTEC used annual values for one sector, as shown in Table 3.

The albedo used here is representative of conditions for all seasons which includes winter without continuous snow cover. Most stations fall into this category and continuous snow coverage for several months even at northern stations in the continental United States is unlikely.

Without a detailed and individual analysis for each of the 122 station locations and for this large an area for an entire year, a value representing an equal partition of the fluxes, or a Bowen ratio of 1.0, is the best representation to use in this type of analysis.

The surface roughness not only includes runways and areas between runways, but usually terminal buildings and other airport structures. In addition, in urban environments, off-airport structures often are within 3 kilometers of the measurement site. This combination of land covers suggests a value of 0.2 – 0.3 meters is appropriate. MACTEC used 0.25 for the roughness length.

## TABLE 3

## SURFACE CHARACTERISTICS

| | |
|---|---|
| Albedo | 0.15 |
| Bowen Ratio | 1.0 |
| Surface Roughness (m) | 0.25 |

## MODIFICATIONS TO AERMET CODE

Recent use of AERMET identified two 'bugs' in the code that required fixing before running AERMET. The first had to do with the hourly surface observations. Incorrect missing indicators in the code for wind speed and direction were output when the data were extracted from the raw input file in Stage 1. When AERMET encountered these flags in Stage 3, AERMET simply stopped processing data, resulting in files with less data than requested. MACTEC modified the code to use correct missing indicators. MACTEC also checked other meteorological variables to be sure the correct missing indicators were used. No other missing indicators were in error.

The second 'bug' was associated with the upper air soundings. AERMET would not process an entire station's data if the surface pressure for the first sounding was less than 850 millibars (mb). Surface pressures less than 850 mb is not uncommon for stations at high elevations such as Denver, CO and Albuquerque, NM. MACTEC modified the code to expand the allowable surface pressures.

Both 'bugs' were fixed prior to running AERMET with the result that AERMET successfully ran to completion for all files.

## RESULTS

AERMET successfully ran for all 122 stations. While the reports and output from AERMET provide an indication of the success of the runs, MACTEC ran AERMOD with a single source and single receptor to obtain information on the number of hours with calm winds or missing data. Table 4 shows these values by surface station.

## TABLE 4

## PERCENT CALM AND MISSING BY STATION

| WBAN | Station | Calms | % Calm | Missing | % Missing | Total | % Total |
|---|---|---|---|---|---|---|---|
| 03816 | Paducah, KY | 820 | 9.4% | 66 | 0.75% | 886 | 10.1% |
| 03856 | Huntsville, AL | 719 | 8.2% | 0 | 0.00% | 719 | 8.2% |
| 03860 | Huntington, WV | 340 | 3.9% | 28 | 0.32% | 368 | 4.2% |
| 03870 | Greenville, SC | 810 | 9.2% | 20 | 0.23% | 830 | 9.5% |
| 03927 | Fort Worth, TX | 508 | 5.8% | 24 | 0.27% | 532 | 6.1% |
| 03928 | Wichita, KS | 215 | 2.5% | 0 | 0.00% | 215 | 2.5% |
| 03937 | Lake Charles, LA | 616 | 7.0% | 15 | 0.17% | 631 | 7.2% |
| 03940 | Jackson, MS | 1228 | 14.0% | 58 | 0.66% | 1286 | 14.7% |
| 03947 | Kansas City, MO | 231 | 2.6% | 0 | 0.00% | 231 | 2.6% |
| 11641 | San Juan, PR | 670 | 7.6% | 11 | 0.13% | 681 | 7.8% |
| 12815 | Orlando, FL | 144 | 1.6% | 0 | 0.00% | 144 | 1.6% |
| 12816 | Gainesville, FL | 952 | 10.9% | 11 | 0.13% | 963 | 11.0% |
| 12842 | Tampa, FL | 572 | 6.5% | 0 | 0.00% | 572 | 6.5% |
| 12844 | W. Palm Beach, FL | 566 | 6.5% | 8 | 0.09% | 574 | 6.6% |
| 12912 | Victoria, TX | 320 | 3.7% | 0 | 0.00% | 320 | 3.7% |
| 12916 | New Orleans, LA | 721 | 8.2% | 8 | 0.09% | 729 | 8.3% |
| 12917 | Port Arthur, TX | 736 | 8.4% | 10 | 0.11% | 746 | 8.5% |
| 12919 | Brownsville, TX | 418 | 4.8% | 36 | 0.41% | 454 | 5.2% |
| 12921 | San Antonio, TX | 913 | 10.4% | 11 | 0.13% | 924 | 10.5% |
| 12924 | Corpus Christi, TX | 371 | 4.2% | 0 | 0.00% | 371 | 4.2% |
| 12960 | Houston, TX | 1097 | 12.5% | 13 | 0.15% | 1110 | 12.7% |
| 13722 | Raleigh, NC | 810 | 9.2% | 0 | 0.00% | 810 | 9.2% |
| 13723 | Greensboro, NC | 542 | 6.2% | 24 | 0.27% | 566 | 6.5% |
| 13737 | Norfolk, VA | 598 | 6.8% | 39 | 0.45% | 637 | 7.3% |
| 13739 | Philadelphia, PA | 154 | 1.8% | 2 | 0.02% | 156 | 1.8% |
| 13740 | Richmond, VA | 605 | 6.9% | 0 | 0.00% | 605 | 6.9% |
| 13741 | Roanoke, VA | 1287 | 14.7% | 1 | 0.01% | 1288 | 14.7% |
| 13748 | Wilmington, NC | 976 | 11.1% | 0 | 0.00% | 976 | 11.1% |
| 13781 | Wilmington, DE | 837 | 9.6% | 0 | 0.00% | 837 | 9.6% |
| 13865 | Meridian, MS | 1567 | 17.9% | 56 | 0.64% | 1623 | 18.5% |
| 13866 | Charleston, WV | 1257 | 14.3% | 29 | 0.33% | 1286 | 14.7% |
| 13874 | Atlanta, GA | 309 | 3.5% | 21 | 0.24% | 330 | 3.8% |
| 13876 | Birmingham, AL | 1228 | 14.0% | 15 | 0.17% | 1243 | 14.2% |
| 13877 | Bristol, TN | 2541 | 29.0% | 28 | 0.32% | 2569 | 29.3% |
| 13880 | Charleston, SC | 487 | 5.6% | 0 | 0.00% | 487 | 5.6% |
| 13881 | Charlotte, NC | 985 | 11.2% | 0 | 0.00% | 985 | 11.2% |
| 13883 | Columbia, SC | 1340 | 15.3% | 20 | 0.23% | 1360 | 15.5% |
| 13889 | Jacksonville, FL | 1134 | 12.9% | 12 | 0.14% | 1146 | 13.1% |
| 13893 | Memphis, TN | 809 | 9.2% | 0 | 0.00% | 809 | 9.2% |
| 13894 | Mobile, AL | 527 | 6.0% | 8 | 0.09% | 535 | 6.1% |
| 13895 | Montgomery, AL | 1027 | 11.7% | 19 | 0.22% | 1046 | 11.9% |
| 13897 | Nashville, TN | 87 | 1.0% | 0 | 0.00% | 87 | 1.0% |
| 13957 | Shreveport, LA | 1088 | 12.4% | 11 | 0.13% | 1099 | 12.5% |
| 13963 | Little Rock, AR | 1090 | 12.4% | 0 | 0.00% | 1090 | 12.4% |

| WBAN | Station | Calms | % Calm | Missing | % Missing | Total | % Total |
|---|---|---|---|---|---|---|---|
| 13966 | Wichita Falls, TX | 622 | 7.1% | 23 | 0.26% | 645 | 7.4% |
| 13967 | Oklahoma City, OK | 158 | 1.8% | 0 | 0.00% | 158 | 1.8% |
| 13970 | Baton Rouge, LA | 787 | 9.0% | 9 | 0.10% | 796 | 9.1% |
| 13985 | Dodge City, KS | 30 | 0.3% | 32 | 0.37% | 62 | 0.7% |
| 13994 | St. Louis, MO | 416 | 4.7% | 26 | 0.30% | 442 | 5.0% |
| 13995 | Springfield, MO | 212 | 2.4% | 39 | 0.45% | 251 | 2.9% |
| 14733 | Buffalo, NY | 181 | 2.1% | 0 | 0.00% | 181 | 2.1% |
| 14734 | Newark, NJ | 197 | 2.2% | 0 | 0.00% | 197 | 2.2% |
| 14735 | Albany, NY | 1217 | 13.9% | 8 | 0.09% | 1225 | 14.0% |
| 14737 | Allentown, PA | 465 | 5.3% | 9 | 0.10% | 474 | 5.4% |
| 14739 | Boston, MA | 36 | 0.4% | 38 | 0.43% | 74 | 0.8% |
| 14740 | Hartford, CN | 204 | 2.3% | 8 | 0.09% | 212 | 2.4% |
| 14742 | Burlington, VT | 155 | 1.8% | 9 | 0.10% | 164 | 1.9% |
| 14764 | Portland, ME | 381 | 4.3% | 25 | 0.29% | 406 | 4.6% |
| 14765 | Providence, RI | 215 | 2.5% | 39 | 0.45% | 254 | 2.9% |
| 14771 | Syracuse, NY | 481 | 5.5% | 0 | 0.00% | 481 | 5.5% |
| 14778 | Williamsport, PA | 1403 | 16.0% | 24 | 0.27% | 1427 | 16.3% |
| 14820 | Cleveland, OH | 271 | 3.1% | 27 | 0.31% | 298 | 3.4% |
| 14821 | Columbus, OH | 734 | 8.4% | 0 | 0.00% | 734 | 8.4% |
| 14827 | Fort Wayne, IN | 440 | 5.0% | 0 | 0.00% | 440 | 5.0% |
| 14836 | Lansing, MI | 632 | 7.2% | 10 | 0.11% | 642 | 7.3% |
| 14837 | Madison, WI | 685 | 7.8% | 30 | 0.34% | 715 | 8.2% |
| 14860 | Erie, PA | 286 | 3.3% | 4 | 0.05% | 290 | 3.3% |
| 14895 | Akron, OH | 232 | 2.6% | 28 | 0.32% | 260 | 3.0% |
| 14898 | Green Bay, WI | 414 | 4.7% | 28 | 0.32% | 442 | 5.0% |
| 14913 | Duluth, MN | 336 | 3.8% | 0 | 0.00% | 336 | 3.8% |
| 14922 | Minneapolis, MN | 311 | 3.6% | 3 | 0.03% | 314 | 3.6% |
| 14923 | Moline, IL | 812 | 9.3% | 24 | 0.27% | 836 | 9.5% |
| 14925 | Rochester, MN | 10 | 0.1% | 0 | 0.00% | 10 | 0.1% |
| 14944 | Sioux Falls, SD | 492 | 5.6% | 0 | 0.00% | 492 | 5.6% |
| 14991 | Eau Claire, WI | 1193 | 13.6% | 0 | 0.00% | 1193 | 13.6% |
| 22536 | Lihue, HI | 6 | 0.1% | 0 | 0.00% | 6 | 0.1% |
| 23023 | Midland, TX | 207 | 2.4% | 19 | 0.22% | 226 | 2.6% |
| 23044 | El Paso, TX | 262 | 3.0% | 0 | 0.00% | 262 | 3.0% |
| 23047 | Amarillo, TX | 113 | 1.3% | 6 | 0.07% | 119 | 1.4% |
| 23050 | Albuquerque, NM | 606 | 6.9% | 0 | 0.00% | 606 | 6.9% |
| 23062 | Denver, CO | 530 | 6.1% | 0 | 0.00% | 530 | 6.1% |
| 23065 | Goodland, KS | 176 | 2.0% | 41 | 0.47% | 217 | 2.5% |
| 23066 | Grand Junction, CO | 295 | 3.4% | 15 | 0.17% | 310 | 3.5% |
| 23153 | Tonopah, NV | 341 | 3.9% | 11 | 0.13% | 352 | 4.0% |
| 23160 | Tucson, AZ | 154 | 1.8% | 24 | 0.27% | 178 | 2.0% |
| 23161 | Daggett, CA | 616 | 7.0% | 11 | 0.13% | 627 | 7.2% |
| 23174 | Los Angeles, CA | 944 | 10.8% | 21 | 0.24% | 965 | 11.0% |
| 23184 | Prescott, AZ | 376 | 4.3% | 23 | 0.26% | 399 | 4.6% |
| 23188 | San Diego, CA | 473 | 5.4% | 21 | 0.24% | 494 | 5.6% |
| 23232 | Sacramento, CA | 1324 | 15.1% | 77 | 0.88% | 1401 | 16.0% |
| 23234 | San Francisco, CA | 376 | 4.3% | 77 | 0.88% | 453 | 5.2% |
| 24011 | Bismarck, ND | 676 | 7.7% | 22 | 0.25% | 698 | 8.0% |

| WBAN | Station | Calms | % Calm | Missing | % Missing | Total | % Total |
|---|---|---|---|---|---|---|---|
| 24018 | Cheyenne, WY | 110 | 1.3% | 0 | 0.00% | 110 | 1.3% |
| 24033 | Billings, MT | 273 | 3.1% | 25 | 0.29% | 298 | 3.4% |
| 24089 | Casper, WY | 138 | 1.6% | 37 | 0.42% | 175 | 2.0% |
| 24090 | Rapid City, SD | 736 | 8.4% | 33 | 0.38% | 769 | 8.8% |
| 24127 | Salt Lake City, UT | 581 | 6.6% | 22 | 0.25% | 603 | 6.9% |
| 24143 | Great Falls, MT | 111 | 1.3% | 26 | 0.30% | 137 | 1.6% |
| 24157 | Spokane, WA | 537 | 6.1% | 36 | 0.41% | 573 | 6.5% |
| 24225 | Medford, OR | 1937 | 22.1% | 0 | 0.00% | 1937 | 22.1% |
| 24229 | Portland, OR | 1180 | 13.5% | 0 | 0.00% | 1180 | 13.5% |
| 24232 | Salem, OR | 1799 | 20.5% | 0 | 0.00% | 1799 | 20.5% |
| 24233 | Seattle, WA | 66 | 0.8% | 14 | 0.16% | 80 | 0.9% |
| 25309 | Juneau, AK | 1781 | 20.3% | 6 | 0.07% | 1787 | 20.4% |
| 25624 | Cold Bay, AK | 119 | 1.4% | 41 | 0.47% | 160 | 1.8% |
| 26411 | Fairbanks, AK | 1393 | 15.9% | 0 | 0.00% | 1393 | 15.9% |
| 26442 | Valdez, AK | 661 | 7.5% | 2 | 0.02% | 663 | 7.6% |
| 26451 | Anchorage, AK | 724 | 8.3% | 0 | 0.00% | 724 | 8.3% |
| 26617 | Nome, AK | 358 | 4.1% | 24 | 0.27% | 382 | 4.4% |
| 93037 | Colo. Springs | 195 | 2.2% | 0 | 0.00% | 195 | 2.2% |
| 93193 | Fresno, CA | 1578 | 18.0% | 76 | 0.87% | 1654 | 18.9% |
| 93721 | Baltimore, MD | 361 | 4.1% | 3 | 0.03% | 364 | 4.2% |
| 93738 | Sterling, VA | 995 | 11.4% | 0 | 0.00% | 995 | 11.4% |
| 93817 | Evansville, IN | 1434 | 16.4% | 66 | 0.75% | 1500 | 17.1% |
| 93819 | Indianapolis, IN | 190 | 2.2% | 0 | 0.00% | 190 | 2.2% |
| 93820 | Lexington, KY | 234 | 2.7% | 0 | 0.00% | 234 | 2.7% |
| 93821 | Louisville, KY | 385 | 4.4% | 0 | 0.00% | 385 | 4.4% |
| 93822 | Springfield, IL | 287 | 3.3% | 25 | 0.29% | 312 | 3.6% |
| 94823 | Pittsburgh, PA | 493 | 5.6% | 26 | 0.30% | 519 | 5.9% |
| 94830 | Toledo, OH | 898 | 10.3% | 13 | 0.15% | 911 | 10.4% |
| 94846 | Chicago, IL | 343 | 3.9% | 38 | 0.43% | 381 | 4.3% |
| 94847 | Detroit, MI | 468 | 5.3% | 11 | 0.13% | 479 | 5.5% |

# Appendix 3:

# Analysis of data on short-term emission rates relative to long-term emission rates

# Analysis of data on short-term emission rates relative to long-term emission rates

*Ted Palma*
*Roy Smith*
*EPA/OAQPS/SBAG*

## 1. Introduction

### 1.1. The problem

The process of listing hazardous air pollutants (HAPs) provided by the Clean Air Act (CAA, section 112(b)(2)) explicitly includes acute toxicity as a listing criterion. For this reason, in addition to chronic exposures, EPA considers acute exposures in risk-based decision-making for the HAP regulatory program. Estimating acute exposures via dispersion modeling requires input data on hourly meteorological conditions (available for most areas of the US) and short-term emission rates of individual facilities (almost universally absent from the National Emissions Inventory (NEI), the Toxic Release Inventory (TRI), and state emission databases).

Lacking short-term emission rates, we must estimate peak short-term rates based on annual average rates, which are available. For Risk and Technology Review (RTR) rulemakings, we have assumed that the 1-hour emission rate for each facility could exceed the annual average hourly emission rate by as much as tenfold, and further assumed that this tenfold emission spike could coincide with worst-case meteorological conditions and the presence of a human receptor at the facility boundary, as a means of screening for potentially significant acute exposures.

In a consultation on the "RTR Assessment Plan", a panel of the EPA's Science Advisory Board (SAB), several reviewers questioned the appropriateness of the factor of ten; some even suggested that this tenfold assumption may underestimate actual maximum short-term emissions for some facilities, and thereby also underestimate maximum acute risks. The SAB recommended an analysis of available short-term emissions data for HAP to test this assumption. This analysis responds to that SAB recommendation and attempts to test the protectiveness of the tenfold assumption using a database of "event emissions" collected from facilities in the Houston-Galveston area, to compare events representative of HAP releases to long-term release rates. We welcome comments from the public on the methods used and the conclusions reached by this analysis.

## 2. Methods

### 2.1. Texas Commission on Environmental Quality event emissions database

The Texas Commission on Environmental Quality (TCEQ) collects emissions data using online reporting required of any facility releasing 100 pounds or more of a listed chemical (primarily ozone-forming VOCs) during a non-routine event. The TCEQ data are intended to improve the state's knowledge of how short-term releases affect tropospheric ozone levels in that area. The database we utilized in our analysis was a subset of the TCEQ data covering emission events that occurred in an eight-county area in eastern Texas during a 756-day period between January 31, 2003 and February 25, 2005.

The complete emissions event data were obtained in April 2007 from Cynthia Folsom Murphy, a research scientists with the University of Texas at Austin (UTA) Center for Energy and Environmental Resources. The data were provided in four Excel spreadsheets generated from an original MS Access file. We used these Excel files to reconstruct a MS Access database in order to facilitate selection of a representative subset of records for this analysis.

Although some of the released substances were HAPs, this was incidental to the database's primary purpose of enhancing the TCEQ's knowledge of photochemical activity. Thus, more than 80% of the released mass was ethene and propene, neither of which are HAPs. The database included release events caused by accidents, equipment failures, maintenance, startup, and shutdown. It also contained facility names, information on amounts of individual compounds released. To provide a basis for comparing the event releases with "typical" emissions, the UTA staff included total VOC emissions data for each facility for calendar year 2004, obtained from the EPA Toxic Release Inventory (TRI). The database did *not* contain any records for facilities that did not experience any reportable events during this period.

### 2.2. Data filtering

Because the event release data were intended for modeling short-term releases of ozone-producing VOCs, the database includes releases from accidents (which are regulated under section 112(r) of the CAA and are therefore not considered in residual risk assessments) and releases of light hydrocarbon compounds that are not HAPs and are much more volatile than most HAPs. This intent of this analysis, on the other hand, was to evaluate short-term releases of HAPs due to normal process variability or scheduled startups, shutdowns, and maintenance, relative to long-term release rates. Because the full emission events database was not representative of likely HAP emissions normally considered under the residual risk program, we filtered the release data as follows in an attempt to improve its representativeness:

1. Hydrocarbons of C5 or less were dropped, except that all HAPs (including non-VOCs) were retained regardless of molecular structure;

2. Accidental releases were dropped, but all others (including startup, shutdown, and maintenance) were retained;

3. Only facilities whose long-term VOC releases exceeded 0.068 tons per day (25 tons per year) were retained, to approximate the population of facilities likely to be subject to residual risk standards (i.e., major facilities);

4. A few release records had to be dropped because their facility numbers did not link to any facility in the database;

5. A few facilities had to be dropped because the database did not include their 2004 TRI VOC release information.

### 2.3. Analysis

Annual VOC emissions and emission event release data were both converted to lb/hr. In order to conform to our atmospheric dispersion models, which estimate ambient concentrations for periods of 1 hour or more, amounts released during events shorter than 1 hour were assigned to the whole hour. For example, a release of 100 lb in ten minutes was converted to 100 lb/hr. Events longer than 1 hour were converted normally, e.g., a release of 100 lb in 120 minutes was converted to 50 lb/hr. The event release rates for individual compounds were summed, yielding a total release rate for each event. This total release rate for each event was divided by the annual VOC release rate for the facility to derive the ratio of peak-to-mean emission rate for the event.

## 3. Results and Discussion

### 3.1. Database filtering

The original database contained 505 individual contaminants, including multiple redundancies. These redundancies did not affect this analysis, so we did not resolve them. After filtering out light, non-HAP, VOCs, 317 contaminants remained (Table 1).

The database contained release records for 150 unique facilities. Of these, 48 facilities (Table 2) were major VOC emitters that reported releases of at least one of the contaminants in Table 1.

The database contained 3641 individual release events reported by the original 150 facilities. Of these, 319 events involved a Table 1 contaminant released by a Table 2 facility during startup, shutdown, or maintenance. For evaluating short-term releases for residual risk assessments, these 319 events comprise the most representative subset of the full database.

### 3.2. Descriptive statistics

For this subset of emission events, ratios of event release rate to long-term release rate varied from 0.00000004 to 74. Distribution statistics appear in Tables 3 and 4. The 99th percentile ratio was 9 (i.e., an event release rate nine times the long-term average). Only 3 ratios exceeded our default assumption of 10, and of these only one exceeded 11. The full cumulative probability density of the ratios is shown in Figure 1.

Figure 2 shows the relationship between ratio and event duration. As expected, the ratio declined as duration increased. Only 18 events lasted less than 2 hours, but these events produced the three highest ratios. Figure 3 is a similar ratio vs. duration plot, but with duration as a percentage of total time. Only 35 events exceeded 1% of the total period covered by the database. Figure 4 shows the relationship between ratio and total amount released, and suggests that the highest ratios were produced by facilities whose routine VOC emissions were relatively small. Thus, the events themselves also tended to be relatively small in absolute terms.

### 3.3. Discussion

These results suggest that the tenfold ratio assumption for short-term releases is protective, and that the facilities for which it may underestimate event releases may tend to be smaller emitters.

However, this analysis is limited in the following ways by the nature of the database and the filtering that we applied:

1. The only long-term release data available from the database were total VOC emissions for 2004. Ideally, we would have preferred to have routine release rates for each individual contaminant. However, retrieving these data from other sources and linking them to this database was not feasible.

2. Removing VOCs that are not representative of HAPs, and comparing the releases against all VOCs, would tend to underestimate the true ratios. This effect could be quantitatively large.

3. Retaining HAPs that are not VOCs (such as toxic metals), and including them in the total to be compared against all VOCs, would tend to overestimate the true ratios. The size of this effect is not known, but seems likely to be less than for (2) above.

4. The database contains only facilities that had at least one release event during the reporting period. The number of facilities in the statistical population that did not experience an event is not known. The lack of data for these facilities (whose ratios in this analysis would have been zero) would cause the descriptive statistics to be skewed toward an overestimate. The size of this effect is unknown.

*Table 1. Event emissions in the Houston-Galveston area. Representative contaminants included in the analysis, selected because they are either HAPs or VOCs with more than 5 carbon atoms. (These data were retrieved directly from the original database, which included multiple redundancies that did not affect the analysis and were left intact.)*

| *Contaminant* | *HAP* | *CAS* | *SAROAD* |
|---|---|---|---|
| 2-Methyloctane | No | 3221-61-2 | 90008 |
| 2-Methylpentane | No | 107-83-5 | 43229 |
| 2-methylhexane | No | 591-76-4 | 43263 |
| 2-Methylpentane | No | 107-83-5 | 43229 |
| 2,2,3-Trimethylpentane | No | 564-02-3 | |
| 2,2,4-Trimethylpentane | Yes | 540-84-1 | 43250 |
| dimethyl butane | No | 75-83-2 | 43291 |
| 2,3-Dimethylbutane | No | 79-29-8 | 43276 |
| 2,3,4-Trimethylpentane | No | 565-75-3 | 43252 |
| 2,3-Dimethylbutane | No | 79-29-8 | 43276 |
| 2,4-Dimethylpentane | No | 108-08-7 | 43247 |
| 2-methylheptane | No | 592-27-8 | 43296 |
| 2-methylhexane | No | 591-76-4 | 43263 |
| 2-Methylpentane | No | 107-83-5 | 43229 |
| 3-Methylhexane | No | 589-34-4 | 43295 |
| 3-Methylpentane | No | 96-14-0 | 43230 |
| 3-Methylhexane | No | 589-34-4 | 43295 |
| 3-Methylpentane | No | 96-14-0 | 43230 |
| 3-Methylheptane | No | 589-81-1 | 43253 |
| 3-Methylhexane | No | 589-34-4 | 43295 |
| 3-Methylpentane | No | 96-14-0 | 43230 |

*Table 1. Event emissions in the Houston-Galveston area. Representative contaminants included in the analysis, selected because they are either HAPs or VOCs with more than 5 carbon atoms. (These data were retrieved directly from the original database, which included multiple redundancies that did not affect the analysis and were left intact.)*

| *Contaminant* | *HAP* | *CAS* | *SAROAD* |
|---|---|---|---|
| Acetaldehyde | Yes | 75-07-0 | 43503 |
| Acetic Acid | No | 64-19-7 | 43404 |
| Acetonitrile | Yes | 75-05-8 | 70016 |
| Acetophenone | Yes | 98-86-2 | |
| Acrolein | Yes | 107-02-8 | 43505 |
| Acrylic acid | Yes | 79-10-7 | 43407 |
| Acrylonitrile | Yes | 107-13-1 | 43704 |
| alkylphenol | No | none | |
| Benzene | Yes | 71-43-2 | 45201 |
| Benzo[a]anthracene | Yes | 56-55-3 | 46716 |
| Benzo[a]pyrene | Yes | 50-32-8 | 46719 |
| Benzo[b]fluoranthene | Yes | 205-99-2 | 46717 |
| Biphenyl | Yes | 92-52-4 | 45226 |
| Butanol | No | 35296-72-1 | |
| Butyl Acrylate | No | 141-32-2 | 43440 |
| t-Butyl Alcohol | No | 75-65-0 | 43309 |
| butylcyclohexane | No | 1678-93-9 | 90101 |
| Butyraldehyde | No | 123-72-8 | 43510 |
| C9 Aromatics | No | none | |
| Naphthalene | Yes | 91-20-3 | 46701 |
| Nonane | No | 111-84-2 | 43235 |
| C9+ | No | none | |
| Carbon tetrachloride | Yes | 56-23-5 | 43804 |
| Carbonyl Sulfide | Yes | 463-58-1 | 43933 |
| Chloral | No | 75-87-6 | |
| Trichloromethane | Yes | 67-66-3 | 43803 |
| Chlorothalonil | No | 1897-45-6 | |
| Petroleum | No | 8002-05-9 | |
| Petroleum | No | 8002-05-9 | |
| Cumene | Yes | 98-82-8 | 45210 |
| Cyclohexane | No | 110-82-7 | 43248 |
| Cyclohexanol | No | 108-93-0 | 43317 |
| Cyclohexanone | No | 108-94-1 | 43561 |
| Cyclohexanone | No | 108-94-1 | 43561 |
| Decane | No | 124-18-5 | 43238 |
| Decane | No | 124-18-5 | 43238 |
| 1,2-Dichloroethane | No | 107-06-2 | 43815 |
| Diethylbenzene (mixture) | No | 25340-17-4 | 45106 |
| Methyl Ether | No | 115-10-6 | 43350 |
| Dimethylcyclohexane | No | 27195-67-1 | 98059 |
| Dimethylcyclopentane | No | 28729-52-4 | 90064 |

*Table 1. Event emissions in the Houston-Galveston area. Representative contaminants included in the analysis, selected because they are either HAPs or VOCs with more than 5 carbon atoms. (These data were retrieved directly from the original database, which included multiple redundancies that did not affect the analysis and were left intact.)*

| *Contaminant* | *HAP* | *CAS* | *SAROAD* |
|---|---|---|---|
| Dimethylcyclopentane | No | 28729-52-4 | 90064 |
| Dimethyl formamide | Yes | 68-12-2 | 43450 |
| Dimethylhexane | No | 28777-67-5 | 90067 |
| Dimethyl pentane | No | 38815-29-1 | 90063 |
| Epichlorohydrin | Yes | 106-89-8 | 43863 |
| Ethyl Alcohol | No | 64-17-5 | 43302 |
| Ethyl Acrylate | Yes | 140-88-5 | 43438 |
| Ethyl Alcohol | No | 64-17-5 | 43302 |
| Ethyl Benzene | Yes | 100-41-4 | 45203 |
| Ethyl Chloride | Yes | 75-00-3 | 43812 |
| Ethylcyclohexane | No | 1678-91-7 | 43288 |
| ethylacetylene | No | 107-00-6 | 43281 |
| Ethyl Benzene | Yes | 100-41-4 | 45203 |
| Ethylene Oxide | Yes | 75-21-8 | 43601 |
| ethylmethylbenzene | No | 25550-14-5 | 45104 |
| formaldehyde | Yes | 50-00-0 | 43502 |
| Furfural | No | 98-01-1 | 45503 |
| straight-run middle distillate | No | 64741-44-2 | |
| Gasoline | No | 86290-81-5 | |
| Gasoline | No | 86290-81-5 | |
| Heavy Olefins | No | none | |
| n-Heptane | No | 142-82-5 | 43232 |
| n-Heptane | No | 142-82-5 | 43232 |
| Heptylene | No | 25339-56-4 | |
| hexane | Yes | 110-54-3 | 43231 |
| hexane | Yes | 110-54-3 | 43231 |
| 2-Methylpentane | No | 107-83-5 | 43229 |
| hexane | Yes | 110-54-3 | 43231 |
| Hexene | No | 25264-93-1 | 43289 |
| Indeno[1,2,3-cd]pyrene | Yes | 193-39-5 | 46720 |
| Isobutyraldehyde | No | 78-84-2 | 43511 |
| 2-Methyl-1-propanol | No | 78-83-1 | 43306 |
| 2-Methyl-1-propanol | No | 78-83-1 | 43306 |
| Isobutyraldehyde | No | 78-84-2 | 43511 |
| Isoheptanes (mixture) | No | 31394-54-4 | 43106 |
| 2-Methylpentane | No | 107-83-5 | 43229 |
| 2,2,4-Trimethylpentane | No | 540-84-1 | 43250 |
| 2,2,4-Trimethylpentane | No | 540-84-1 | 43250 |
| Isopar E | No | | |
| Isoprene | No | 78-79-5 | 43243 |
| 2-Propanol | No | 67-63-0 | 43304 |

*Table 1. Event emissions in the Houston-Galveston area. Representative contaminants included in the analysis, selected because they are either HAPs or VOCs with more than 5 carbon atoms. (These data were retrieved directly from the original database, which included multiple redundancies that did not affect the analysis and were left intact.)*

| *Contaminant* | *HAP* | *CAS* | *SAROAD* |
|---|---|---|---|
| 2-Propanol | No | 67-63-0 | 43304 |
| Cumene | Yes | 98-82-8 | 45210 |
| Isopropylcyclohexane | No | 696-29-7 | 90128 |
| Diisopropyl ether | No | 108-20-3 | 85005 |
| Kerosene | No | 64742-81-0 | |
| Methyl ethyl ketone | No | 78-93-3 | 43552 |
| Methyl isobutenyl ketone | Yes | 141-79-7 | |
| Methanol | Yes | 67-56-1 | 43301 |
| Methyl Acetylene | No | 74-99-7 | 43209 |
| Cresol | Yes | 1319-77-3 | 45605 |
| Methyl Chloride | Yes | 74-87-3 | 43801 |
| methyl cyclohexane | No | 108-87-2 | 43261 |
| Methyl ethyl ketone | No | 78-93-3 | 43552 |
| Iodomethane | No | 74-88-4 | 86025 |
| Methyl Mercaptan | No | 74-93-1 | 43901 |
| methyl cyclohexane | No | 108-87-2 | 43261 |
| Methylcyclopentane | No | 96-37-7 | 43262 |
| 2-Methyldecane | No | 6975-98-0 | 98155 |
| Methylheptane | No | 50985-84-7 | 90045 |
| 2-methylheptane | No | 592-27-8 | 43296 |
| 2-Methyl nonane | No | 871-83-0 | 90047 |
| Tert-butyl methyl ether | No | 1634-04-4 | 43376 |
| meta-xylene | No | 108-38-3 | 45205 |
| Nonane | No | 111-84-2 | 43235 |
| Naphtha | No | 8030-30-6 | 45101 |
| Naphthalene | Yes | 91-20-3 | 46701 |
| Naphtha | No | 8030-30-6 | 45101 |
| Naphthalene | No | 91-20-3 | 46701 |
| Butyl acetate | No | 123-86-4 | 43435 |
| Butyraldehyde | No | 123-72-8 | 43510 |
| Nonane | No | 111-84-2 | 43235 |
| Nonane | No | 111-84-2 | 43235 |
| Octadecene | No | 27070-58-2 | |
| n-Octane | No | 111-65-9 | 43233 |
| Octene (mixed isomers) | No | 25377-83-7 | |
| ortho-xylene | No | 95-47-6 | 45204 |
| Parathion | Yes | 56-38-2 | |
| 4-Aminohippuric Acid | No | 61-78-9 | |
| Phenol | Yes | 108-95-2 | 45300 |
| Silicone | No | 63148-62-9 | |
| Naphtha | No | 8030-30-6 | 45101 |

*Table 1. Event emissions in the Houston-Galveston area. Representative contaminants included in the analysis, selected because they are either HAPs or VOCs with more than 5 carbon atoms. (These data were retrieved directly from the original database, which included multiple redundancies that did not affect the analysis and were left intact.)*

| *Contaminant* | *HAP* | *CAS* | *SAROAD* |
|---|---|---|---|
| Naphtha | No | 8030-30-6 | 45101 |
| Polyethylene | No | 9002-88-4 | |
| Poly(Isobutylene) | No | 9003-27-4 | |
| Chloromethyl pivalate | No | 18997-19-8 | |
| Process fuel gas | No | none | |
| Propionic Acid | No | 79-09-4 | 43405 |
| Propylene oxide | No | 75-56-9 | 43602 |
| para-xylene | No | 106-42-3 | 45206 |
| Styrene | Yes | 100-42-5 | 45220 |
| Sulfolane | No | 126-33-0 | |
| t-Butyl Alcohol | No | 75-65-0 | 43309 |
| t-Butyl Alcohol | No | 75-65-0 | 43309 |
| tert-butyl hydroperoxide | No | 75-91-2 | |
| Toluene | Yes | 108-88-3 | 45202 |
| Aqualyte(TM), LSC cocktail | No | 25551-13-7 | 45107 |
| 1,3,4-Trimethylbenzene | No | 95-63-6 | 45208 |
| trimethylcyclopentane | No | 30498-64-7 | 98058 |
| trimethylpentane | No | 29222-48-8 | 90092 |
| Undecane | No | 1120-21-4 | 43241 |
| Vinyl acetate | Yes | 108-05-4 | 43453 |
| Vinyl acetate | Yes | 108-05-4 | 43453 |
| Vinyl chloride | Yes | 75-01-4 | 43860 |
| vinyl resin | No | none | |
| Vinylcyclohexane | No | 695-12-5 | |
| xylenes | Yes | 1330-20-7 | 45102 |
| xylenes | Yes | 1330-20-7 | 45102 |
| meta-xylene | Yes | 108-38-3 | 45205 |
| ortho-xylene | Yes | 95-47-6 | 45204 |
| para-xylene | Yes | 106-42-3 | 45206 |
| Mineral spirits | No | 64475-85-0 | 43118 |
| Propylene glycol | No | 57-55-6 | 43369 |
| Vinyl chloride | Yes | 75-01-4 | 43860 |
| 1-Decene | No | 872-05-9 | 90014 |
| 2-Ethyl-1-hexanol | No | 104-76-7 | 43318 |
| 2-Pyrrolidone | No | 616-45-5 | |
| Aromatic | No | none | |
| Decene | No | 25339-53-1 | 90014 |
| 2-N,N-Dibutylaminoethanol | No | 102-81-8 | 86007 |
| Diisopropanolamine | No | 110-97-4 | 86004 |
| N,N-Dimethylethanolamine | No | 108-01-0 | 84004 |
| trifluoroethane | No | 27987-06-0 | |

*Table 1. Event emissions in the Houston-Galveston area. Representative contaminants included in the analysis, selected because they are either HAPs or VOCs with more than 5 carbon atoms. (These data were retrieved directly from the original database, which included multiple redundancies that did not affect the analysis and were left intact.)*

| *Contaminant* | *HAP* | *CAS* | *SAROAD* |
|---|---|---|---|
| 2,2'-Oxybisethanol | No | 111-46-6 | 43367 |
| Hydrocarbons | No | none | |
| Methyl Formate | No | 107-31-3 | 43430 |
| Isopropylamine | No | 75-31-0 | 86014 |
| n-Butanol | No | 71-36-3 | 43305 |
| Polypropylene glycol ether | No | | |
| N-Vinyl-2-Pyrrolidinone | No | 88-12-0 | |
| 1,1-Di(t-Amylperoxy) Cyclohexane | No | 15667-10-4 | |
| 1,2,3-Trimethyl-4-ethylbenzene | No | none | |
| 2-Methyldecane | No | 6975-98-0 | 98155 |
| 2-methylheptane | No | 592-27-8 | 43296 |
| 2-Methyl nonane | No | 871-83-0 | 90047 |
| 2,5-Dimethylhexane-2,5-dihydroperoxide | No | 3025-88-5 | |
| Butyl ether | No | 142-96-1 | 43372 |
| 1,2-Dichloroethane | Yes | 107-06-2 | 43815 |
| Hydrindene | No | 496-11-7 | 98044 |
| Methylheptane | No | 50985-84-7 | 90045 |
| methyl methacrylate | No | 80-62-6 | 43441 |
| Naphtha | No | 8030-30-6 | 45101 |
| hexane | Yes | 110-54-3 | 43231 |
| tert-amyl hydroperoxide | No | 3425-61-4 | |
| 1,3,4-Trimethylbenzene | No | 95-63-6 | 45208 |
| n-Butanol | No | 71-36-3 | 43305 |
| 2-Butoxy ethanol | Yes | 111-76-2 | 43308 |
| hexane | Yes | 110-54-3 | 43231 |
| cycloheptane | No | 291-64-5 | 43115 |
| n-Heptane | No | 142-82-5 | 43232 |
| n-Octane | No | 111-65-9 | 43233 |
| Hexyl Carbitol | No | 112-59-4 | |
| Nonene | No | 27215-95-8 | |
| Silane, ethenyltrimethoxy | No | 2768-02-7 | |
| tetrahydrofuran | No | 109-99-9 | 70014 |
| Vinyl chloride | Yes | 75-01-4 | 43860 |
| Methyl Formate | No | 107-31-3 | 43430 |
| Phenyl ether | No | 101-84-8 | |
| phosgene | Yes | 75-44-5 | |
| 1,2-Dichloroethane | No | 107-06-2 | 43815 |
| 2-Butoxy ethanol | Yes | 111-76-2 | 43308 |
| Gasoline | No | 86290-81-5 | |
| 1-Tridecanol | No | 112-70-9 | |

*Table 1. Event emissions in the Houston-Galveston area. Representative contaminants included in the analysis, selected because they are either HAPs or VOCs with more than 5 carbon atoms. (These data were retrieved directly from the original database, which included multiple redundancies that did not affect the analysis and were left intact.)*

| *Contaminant* | *HAP* | *CAS* | *SAROAD* |
|---|---|---|---|
| 1,2,4-Trichlorobenzene | Yes | 120-82-1 | 45208 |
| 2-(2-Butoxyethoxy)ethanol | Yes | 112-34-5 | 43312 |
| 2,3,4-trihydroxybenzophenone Ester | No | 1143-72-2 | |
| Methyl n-amyl ketone | No | 110-43-0 | 43562 |
| 4,4-Cyclohexylidenebis[phenol] | No | 843-55-0 | |
| Anisole | No | 100-66-3 | |
| 2-Butoxy ethanol | Yes | 111-76-2 | 43308 |
| Cresol-Formaldehyde novolac Resin | No | proprietary | |
| Decane | No | 124-18-5 | 43238 |
| gamma-Butyrolactone | No | 96-48-0 | |
| Dimethyl pentane | No | 38815-29-1 | 90063 |
| Dodecyl Benzenesulfonic Acid | No | 27176-87-0 | |
| Ethanol Amine | No | 141-43-5 | 43777 |
| ethyl lactate | No | 687-47-8 | |
| Hexamethyldisilazane | No | 999-97-3 | |
| Methyl ethyl ketone | No | 78-93-3 | 43552 |
| Cresol | Yes | 1319-77-3 | 45605 |
| Naphthalene Sulfonic Acid Resin | No | | |
| Naphthalene Sulfonic Acid Resin | No | | |
| n-Butanol | No | 71-36-3 | 43305 |
| Decane | No | 124-18-5 | 43238 |
| 1-Methyl-2-pyrrolidinone | No | 872-50-4 | 70008 |
| Pentyl Ester Acetic Acid | No | | |
| Phenol Formaldehyde Resin, Novolac | No | | |
| Phenol Formaldehyde Resin, Novolac | No | | |
| Propylene Glycol Monomethyl Ether | No | 107-98-2 | 70011 |
| Pyrocatechol | No | 120-80-9 | |
| Carbon Disulfide | Yes | 75-15-0 | 43934 |
| Hexene | No | 592-41-6 | 43245 |
| VOC | No | none | |
| Methacrylic acid | No | 79-41-4 | 84009 |
| Methyl 3-hydroxybutyrate | No | 1487-49-6 | |
| t-Butyl Alcohol | No | 75-65-0 | 43309 |
| methyl valeraldehyde | No | 123-15-9 | |
| Butyl Methacrylate | No | 97-88-1 | 85008 |
| dipropyl ether | No | 111-43-3 | |
| n-Propanol | No | 71-23-8 | 43303 |
| Propyl propionate | No | 106-36-5 | 86052 |

*Table 1. Event emissions in the Houston-Galveston area. Representative contaminants included in the analysis, selected because they are either HAPs or VOCs with more than 5 carbon atoms. (These data were retrieved directly from the original database, which included multiple redundancies that did not affect the analysis and were left intact.)*

| *Contaminant* | *HAP* | *CAS* | *SAROAD* |
|---|---|---|---|
| 1,2-Epoxybutane | Yes | 106-88-7 | |
| Methylamine | No | 74-89-5 | |
| 1,1-Dimethylcyclohexane | No | 590-66-9 | |
| 1,1-Dimethylcyclopentane | No | 1638-26-2 | |
| 2-Methylpentane | No | 107-83-5 | 43229 |
| dimethyl butane | No | 75-83-2 | 43291 |
| 2,3,3-Trimethylpentane | No | 560-21-4 | |
| 2,3-Dimethylhexane | No | 584-94-1 | |
| 2,3-Dimethylpentane | No | 565-59-3 | |
| 2,4-Dimethylhexane | No | 589-43-5 | |
| 2,5-Dimethyl-hexane | No | 592-13-2 | |
| 2-Butoxy ethanol | Yes | 111-76-2 | 43308 |
| 2-mercaptoethanol | No | 60-24-2 | |
| Bisphenol A | No | 80-05-7 | |
| straight-run middle distillate | No | 64741-44-2 | |
| 4-Vinylcyclohexene | No | 100-40-3 | |
| straight-run middle distillate | No | 64741-44-2 | |
| Allyl alcohol | No | 107-18-6 | |
| xylenes | Yes | 1330-20-7 | 45102 |
| Naphthalene | Yes | 91-20-3 | 46701 |
| 3-Methylethylcyclohexane | No | | |
| VOC | No | none | |
| Gasoline | No | 86290-81-5 | |
| Butyl ether | No | 142-96-1 | |
| dimethyl butane | No | 75-83-2 | |
| Dodecene | No | 25378-22-7 | |
| Styrene | Yes | 100-42-5 | 45220 |
| tetrahydrofuran | No | 109-99-9 | 70014 |
| hexane | Yes | 110-54-3 | 43231 |
| 2-Propanol | No | 67-63-0 | 43304 |
| liquified petroleum gas | No | 68476-85-7 | |
| Methyl acetylene propadiene | No | | |
| methyl isobutyl ketone | Yes | 108-10-1 | |
| Methyl n-amyl ketone | No | 110-43-0 | 43562 |
| Methylpentane | No | 43133-95-5 | |
| Tert-butyl methyl ether | Yes | 1634-04-4 | 43376 |
| Toluene | Yes | 108-88-3 | 45202 |
| Mineral oil | No | 8012-95-1 | |
| Gasoline | No | 86290-81-5 | |
| 2,2-Dimethylpropane | No | 463-82-1 | 43222 |
| n-propylbenzene | No | 103-65-1 | |

*Table 1. Event emissions in the Houston-Galveston area. Representative contaminants included in the analysis, selected because they are either HAPs or VOCs with more than 5 carbon atoms. (These data were retrieved directly from the original database, which included multiple redundancies that did not affect the analysis and were left intact.)*

| *Contaminant* | *HAP* | *CAS* | *SAROAD* |
|---|---|---|---|
| propylcyclohexane | No | 1678-92-8 | |
| n-Octane | No | 111-65-9 | 43233 |
| ortho-xylene | No | 95-47-6 | 45204 |
| Gasoline | No | 86290-81-5 | |
| propylenimine | No | 75-55-8 | |
| Gasoline | No | 86290-81-5 | |
| Technical White Oil | No | | |
| Total Alkylate - non-speciated | No | | |
| Trichloroethylene | Yes | 79-01-6 | |
| Di(2-ethylhexyl) peroxydicarbonate | No | 16111-62-9 | |
| trimethylcyclopentane | No | 30498-64-7 | 98058 |
| Ultraformate | No | | |
| 4-Vinylcyclohexene | No | 100-40-3 | |

*Table 2. Event emissions in the Houston-Galveston area. Major emitters reporting at least one release event of a representative substance.*

| *Company Name* | *2004 VOC Emission Rate (lb/h)* |
|---|---:|
| ATOFINA PETROCHEMICALS LA PORTE PLANT | 47.88 |
| BALL METAL BEVERAGE CONTAINER CONROE FACILITY | 24.18 |
| BASF FREEPORT SITE | 46.47 |
| BELVIEU ENVIRONMENTAL FUELS | 112.3 |
| BOC GROUP CLEAR LAKE BOC GASES PLANT | 9.52 |
| BP AMOCO CHEMICAL CHOCOLATE BAYOU PLANT | 130.4 |
| BP AMOCO CHEMICAL PASADENA PLANT | 36.92 |
| BP AMOCO POLYMERS | 57.18 |
| BP PRODUCTS NORTH AMERICA TEXAS CITY | 737.4 |
| BP TEXAS CITY CHEMICAL PLANT B | 112.2 |
| CELANESE BAY CITY PLANT | 17.12 |
| CELANESE CLEAR LAKE PLANT | 53.11 |
| CELANESE PASADENA PLANT | 5.934 |
| CHEVRON PHILLIPS CEDAR BAYOU PLANT | 105.3 |
| CHEVRON PHILLIPS CHEMICAL SWEENY COMPLEX | 106.7 |
| CHEVRON PHILLIPS HOUSTON CHEMICAL COMPLEX | 215.7 |
| CROWN BEVERAGE PACKAGING | 18.05 |
| CROWN CENTRAL PETROLEUM PASADENA PLANT | 114.3 |
| CROWN CORK & SEAL | 18.10 |
| DEER PARK LIQUID STORAGE TERMINAL | 124.8 |
| DOW CHEMICAL LA PORTE SITE | 5.902 |
| DOW TEXAS OPERATIONS FREEPORT | 203.2 |
| E I DUPONT DE NEMOURS AND COMPANY - LA PORTE PLANT | 51.30 |
| EQUISTAR CHEMICALS CHANNELVIEW COMPLEX | 275.4 |
| EQUISTAR CHEMICALS CHOCOLATE BAYOU COMPLEX | 84.87 |
| EQUISTAR CHEMICALS LA PORTE COMPLEX | 90.97 |
| EXXON MOBIL CHEMICAL BAYTOWN OLEFINS PLANT | 84.73 |
| EXXONMOBIL CHEMICAL BAYTOWN CHEMICAL PLANT | 313.7 |
| EXXONMOBIL CHEMICAL MONT BELVIEU PLASTICS PLANT | 40.64 |
| GOODYEAR HOUSTON CHEMICAL PLANT | 85.68 |
| ISP TECHNOLOGIES TEXAS CITY PLANT | 22.12 |
| KANEKA TEXAS CORPORATION | 20.55 |
| KINDER MORGAN LIQUID TERMINALS PASADENA | 913.9 |
| KINDER MORGAN LIQUIDS TERMINALS | 132.7 |
| LBC HOUSTON BAYPORT TERMINAL | 12.83 |
| LYONDELL CHEMICAL BAYPORT PLANT | 30.04 |
| LYONDELL CHEMICAL CHANNELVIEW | 74.15 |
| MARATHON ASHLAND PETROLEUM TEXAS CITY REFINERY | 111.8 |
| MOBIL CHEMICAL HOUSTON OLEFINS PLANT | 26.29 |
| MORGANS POINT PLANT | 31.03 |
| PASADENA PLANT | 13.40 |

Table 2. Event emissions in the Houston-Galveston area. Major emitters reporting at least one release event of a representative substance.

| Company Name | 2004 VOC Emission Rate (lb/h) |
|---|---|
| SHELL OIL DEER PARK | 405.2 |
| SOLUTIA CHOCOLATE BAYOU PLANT | 53.09 |
| STOLTHAVEN HOUSTON TERMINAL | 7.347 |
| SWEENY COMPLEX | 157.1 |
| UNION CARBIDE TEXAS CITY OPERATIONS | 174.4 |
| VALERO REFINING TEXAS CITY | 260.1 |
| WHARTON GAS PLANT | 7.552 |

*Table 3. Frequency distribution for ratio of event emission rate to long-term emission rate*

| *Bin* | *Frequency* | *Cumulative Frequency* |
|---|---|---|
| 1.00E-08 | 0 | 0 |
| 3.16E-08 | 0 | 0 |
| 1.00E-07 | 2 | 2 |
| 3.16E-07 | 1 | 3 |
| 1.00E-06 | 0 | 3 |
| 3.16E-06 | 2 | 5 |
| 1.00E-05 | 1 | 6 |
| 3.16E-05 | 2 | 8 |
| 1.00E-04 | 5 | 13 |
| 3.16E-04 | 9 | 22 |
| 1.00E-03 | 15 | 37 |
| 3.16E-03 | 28 | 65 |
| 1.00E-02 | 33 | 98 |
| 3.16E-02 | 41 | 139 |
| 1.00E-01 | 59 | 198 |
| 3.16E-01 | 38 | 236 |
| 1.00E+00 | 33 | 269 |
| 3.16E+00 | 31 | 300 |
| 1.00E+01 | 16 | 316 |
| 3.16E+01 | 2 | 318 |
| 1.00E+02 | 1 | 319 |
| 3.16E+02 | 0 | 319 |

*Table 4. Statistics for ratio of event emission rate to long-term emission rate*

| *Statistic for Ratio* | *Value* |
|---|---|
| Median | 0.043923 |
| 75th %ile | 0.342655 |
| 90th %ile | 2.204754 |
| 95th %ile | 3.344422 |
| 96th %ile | 3.400832 |
| 97th %ile | 3.8126 |
| 98th %ile | 4.790098 |
| 99th %ile | 8.973897 |
| Max | 74.37138 |
| Average | 0.815352 |

Figure 1. Cumulative probability density for ratio of event to routine emission rates.

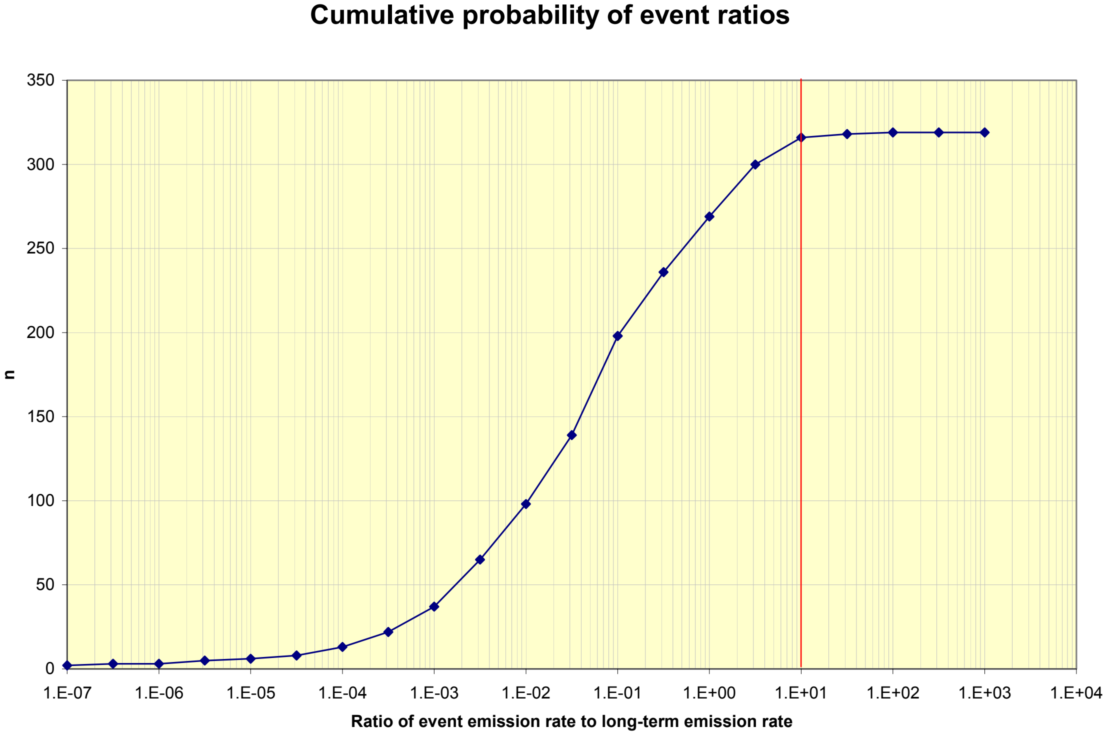


Figure 2. Relationship between ratio of event to duration emission rate and emission duration.

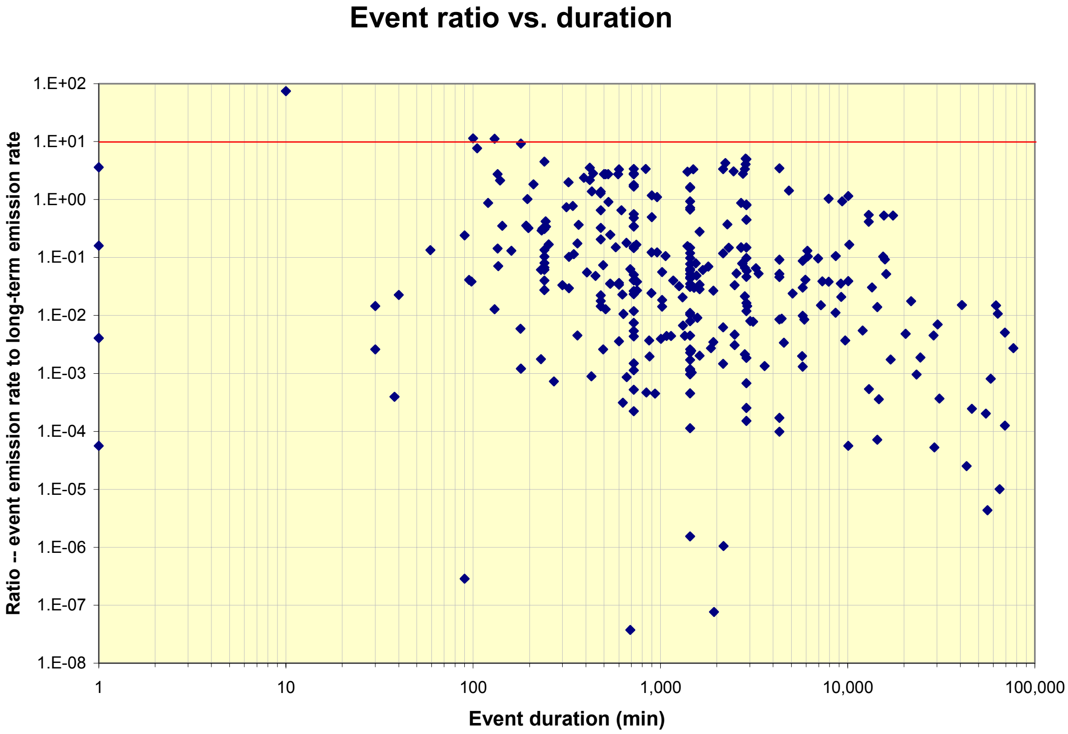


Figure 3. Relationship between ratio of event to duration emission rate and emission duration, as percentage of total time.

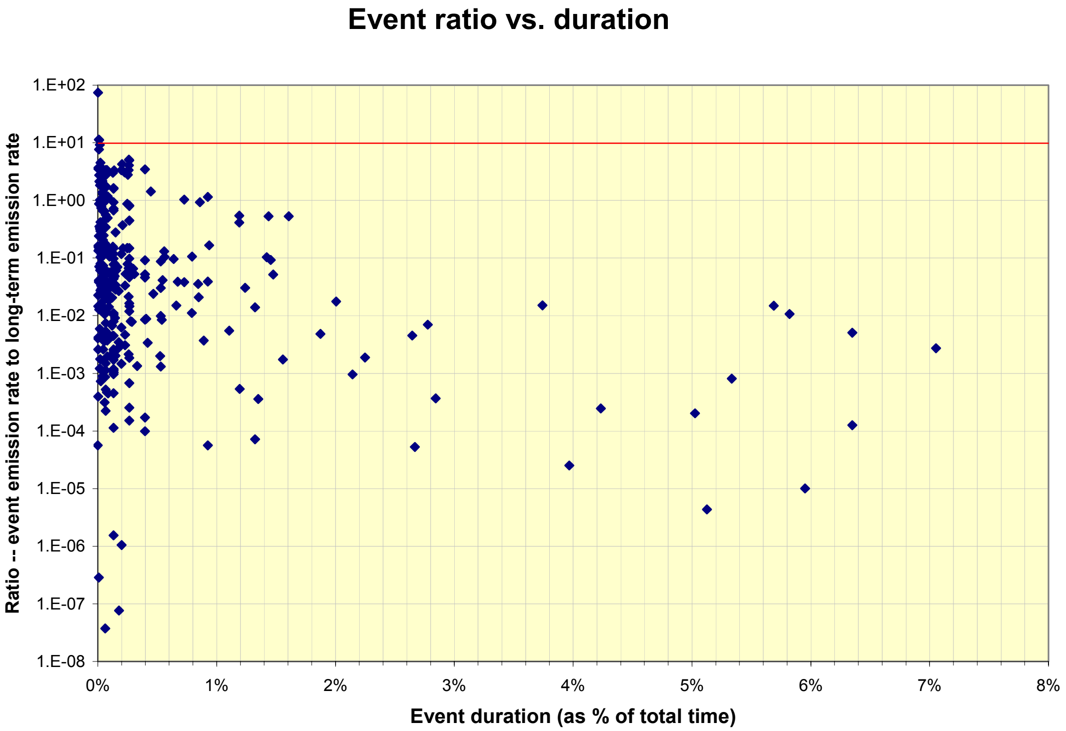
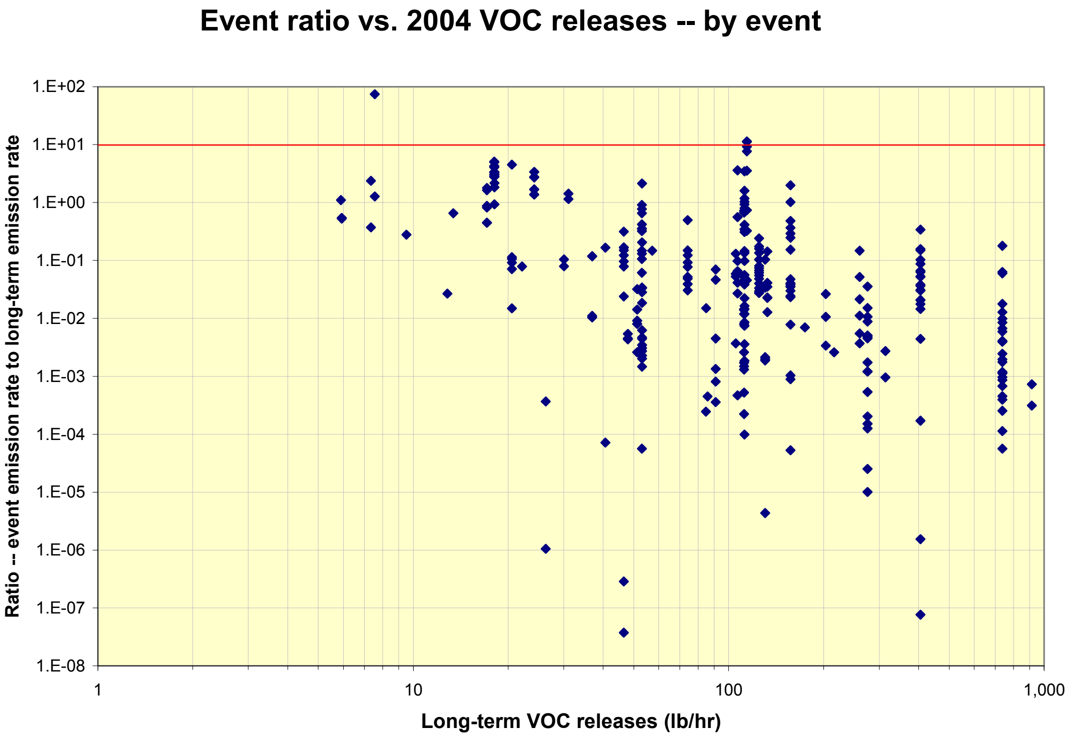


Figure 4. Relationship between ratio of event to duration emission rate and total amount emitted during the event.



# APPENDIX 4: Technical Support Document for TRIM-Based Multipathway Tiered Screening Methodology for RTR

# Technical Support Document for the TRIM-Based Multipathway Tiered Screening Methodology for RTR

June 29, 2012

Prepared For:

U.S. Environmental Protection Agency
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# Table of Contents

# 1. Introduction and Background

Section 112 of the Clean Air Act (CAA) directs the U.S. Environmental Protection Agency (EPA) to assess the risk remaining (i.e., residual risk) from emissions of hazardous air pollutants (HAPs) following the implementation of maximum achievable control technology (MACT) standards for emission sources. This risk assessment is a major component of EPA's Risk and Technology Review (RTR) program. As part of this program, EPA must consider additional emission standards for a source category if the current emission standards—with MACT regulations in place—do not provide an "ample margin of safety" for human health. One aspect of human health that EPA must consider under RTR is the potential for health effects resulting from exposures to persistent and bioaccumulative HAPs (PB-HAPs) via non-inhalation pathways, namely ingestion and dermal exposure. These non-inhalation human health risks are considered in combination with estimated inhalation human health risks, potential ecological impacts, and other factors to support decisions about residual risk for RTR source categories. For PB-HAPs, exposures via ingestion are anticipated to be significantly higher than any dermal exposures that might occur as a result of the same emissions. Consequently, a methodology has been developed to evaluate ingestion exposure and risk for PB-HAPs efficiently in the context of EPA's RTR program.

To evaluate ingestion exposures and human health risks for RTR on a source category basis, an iterative approach was developed that enables EPA to confidently screen out PB-HAP emissions unlikely to pose health risks above levels of concern (i.e., a cancer risk of 1 in 1 million or a noncancer hazard of 1.0) and to focus additional resources on sources of greater concern within the category. To estimate exposure and risk, the methodology uses two models: the Fate, Transport, and Ecological Exposure module of EPA's Total Risk Integrated Methodology (TRIM.FaTE) to model the fate and transport of pollutants released to the environment and the Multimedia Ingestion Risk Calculator (MIRC) to estimate transfer and uptake into the food chain and exposure to receptors consuming contaminated food products and soil. This approach is divided into four tiers of increasing refinement, as follows.

- **Tier 1** of the approach begins by identifying the facility-level emissions of PB-HAPs within a source category and comparing them to risk-based emission thresholds. The risk-based thresholds are derived using the aforementioned models applied for a hypothetical environmental and exposure scenario, assuming ingestion of locally caught fish, locally grown produce and livestock, and local soil. This "screening scenario" is intended to represent a situation in which the ingestion exposure is unlikely to be exceeded at any facility evaluated through the RTR program. The thresholds for Tier 1 are derived by estimating the emission rate that corresponds to a lifetime cancer risk of 1 in 1 million or a chronic non-cancer hazard quotient (HQ) of 1 for an individual exposed according to the characteristics associated with the screening scenario. For a facility, if the emission rate of each PB-HAP is less than the Tier 1 threshold emission rate, risks are assumed to be below levels of concern and no additional multipathway assessment for RTR is required. If, however, the emission rate of any PB-HAP exceeds the Tier 1 threshold emission rate, the facility must be evaluated further in Tier 2.
- In **Tier 2**, the location of the facility emitting PB-HAPs is used to refine the assumptions associated with the environmental scenario while maintaining the Tier 1 ingestion exposure scenario assumptions. The assumptions are refined by incorporating site-specific meteorological data and evaluating the presence and location of fishable lakes near the facility. The risk-based threshold for each PB-HAP is then adjusted for that facility based on an understanding of how exposure concentrations estimated for the

screening scenario change with meteorology and lake location. PB-HAP emissions that do not exceed the adjusted threshold are assumed to pose risks below levels of concern, and facilities having emissions that exceed the thresholds for Tier 2 are evaluated further in the next tier.

- In **Tier 3**, the health-protective assumptions for ingestion rates associated with the exposure scenario are relaxed. Estimated exposures are considered for a distribution of exposure assumptions that take into account the likelihood of individual foodstuffs being consumed, rather than the single set of health-protective assumptions that underlie the screening scenario used in Tiers 1 and 2. The results of this analysis are used to derive a distribution of individual risk. These analyses are intended to provide a more informative representation of the range of potential risks associated with a facility. (Note that at present, the full methodology for Tier 3 has not been developed. Nevertheless, an overview of the general approach and the topics that will be explored in the development of this tier are provided in this overview document.)
- For facilities emitting PB-HAPs at levels that cannot be ruled out as being above levels of concern following a Tier 3 analysis, a **Tier 4** analysis can be conducted by completing a site-specific assessment. Such an assessment would incorporate location- or facility-specific characteristics regarding the environment to which PB-HAPs are emitted, relevant exposure pathways, ingestion rates or other exposure factors, and other parameters. A range of exposure scenarios could be evaluated as part of a Tier 4 assessment, resulting in a range of risk estimates.

The key processes and decisions that make up this approach are summarized in Exhibit 2-1. In the remainder of this overview, each of the four tiers in the multipathway assessment method is described in additional detail. Attachments to this appendix provide a comprehensive record of the characteristics and methods associated with Tier 1 (Attachment A), Tier 2 (Attachment B), and Tier 3 (Attachment C) of this approach.

# 2. Tier 1

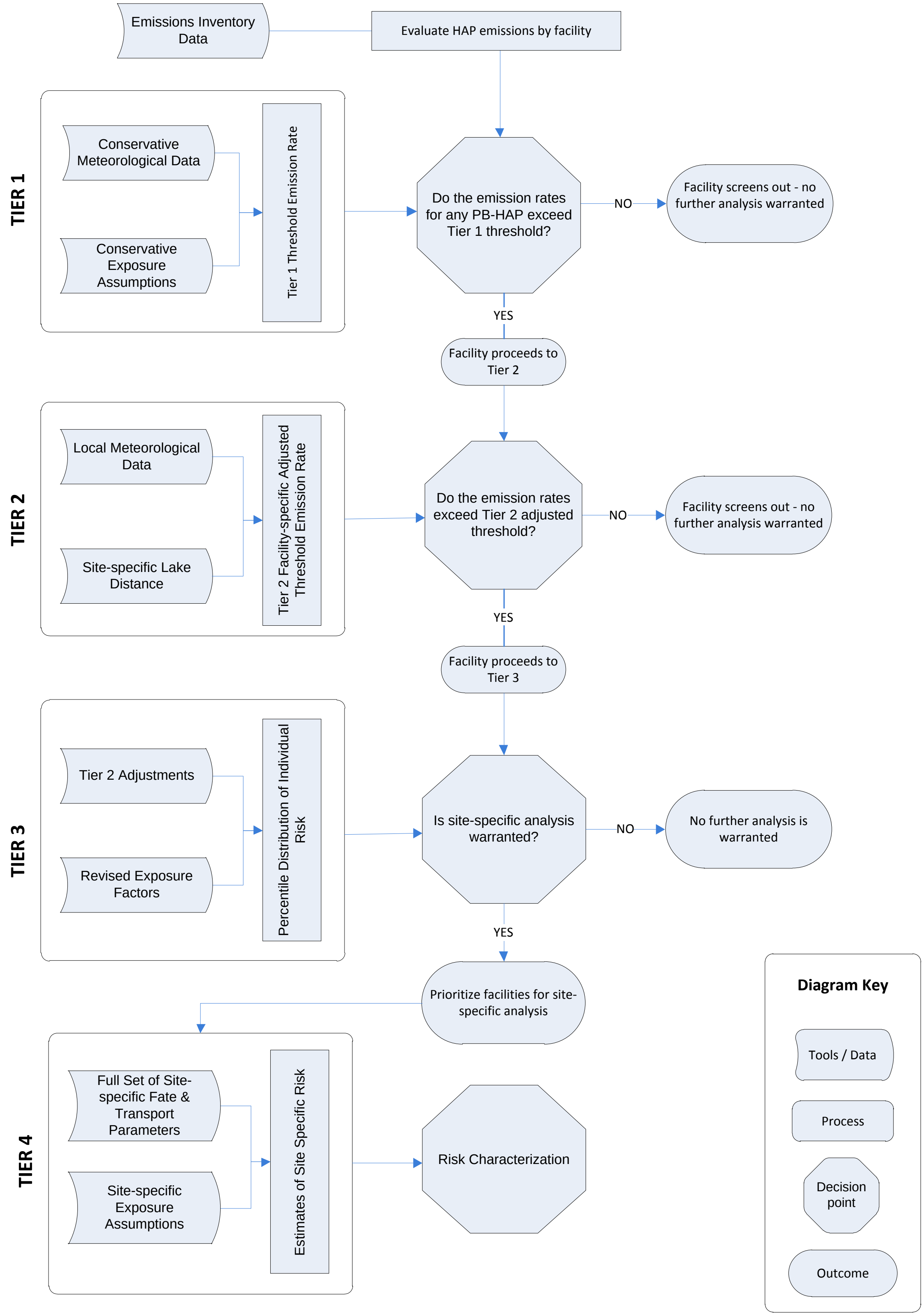
The methods used in Tier 1 are intended to enable EPA to evaluate PB-HAP emissions from multiple sources in a particular category quickly and efficiently and to remove from consideration those that are unlikely to pose risks above the level of concern, while also minimizing the possibility of EPA’s failing to identify risks that exceed levels of concern. The scenario used to estimate Tier 1 thresholds is designed to be health-protective in estimating exposures and risks; specifically, it is intended to avoid underestimating exposures to PB-HAPS that might be encountered for any location throughout the United States. The scenario also is intended to avoid grossly overestimating risk to the point where no emissions screen out (i.e., overprotective, resulting in too many “false positives”).

## 2.1 Chemicals of Concern

The assessment of risk from multipathway exposures begins with a review of data for sources in a particular category to determine if emissions of any of the following PB-HAPs are reported:

- Cadmium compounds,
- Chlorinated dibenzodioxins and furans (dioxins),
- Mercury compounds, and
- Polycyclic organic matter (POM).

**Exhibit 2-1. Conceptual Decision Tree for Evaluating Non-Inhalation Exposures for PB-HAPs**



Based on current emissions and toxicity considerations, emissions of these four PB-HAPs are expected to pose the vast majority of the non-inhalation risks to humans from air emissions at sources subject to residual risk provisions of the CAA.[1] Thus, although EPA has identified nine other PB-HAPs that should be evaluated as part of residual risk assessments, the methods for multipathway assessment described here encompass only these four. If a facility under evaluation in RTR emits other PB-HAPs, these PB-HAPs must be evaluated using other methods and exposure scenarios appropriate to them.

If emissions of any of the four PB-HAPs are reported for a facility, the emission rate for each PB-HAP is compared to the threshold emissions rate derived for that chemical using the TRIM-based screening scenario. This threshold is the emission rate that, when input to the models used in evaluating multipathway risk for RTR, results in a specified cancer risk or non-cancer HQ threshold level of concern. For the screening scenario, thresholds were calculated for a cancer risk of 1 in 1 million or an HQ of 1.0, depending on the more sensitive health effect of the PB-HAP.

Important to note for dioxins and POM is that the screening methodology assesses individual congeners, taking into account differences in both the fate and transport and the toxicity among the various congeners. The details of the methods for assessing dioxins and POM are provided in Attachment A—Technical Support Document for TRIM-Based Multipathway Tier 1 Scenario for RTR—to this appendix.

## 2.2 Development of Emission Thresholds

Generally, the approach used to assess ingestion exposures and resulting risks for RTR has four components:

1. **Fate and transport modeling** of PB-HAPs emitted to air that partition into soil, water, and other environmental media (including fish);
2. **Modeling of uptake** of PB-HAPs by farm food chain media from soil and air;
3. **Estimating ingestion exposures** in terms of average daily dose for consumption of farm food items by a hypothetical exposed human; and
4. **Calculating lifetime cancer risk estimates or chronic non-cancer HQs** for each HAP and corresponding screening threshold emission rates.

The TRIM.FaTE model is used in the first component, and the MIRC model is used to conduct calculations for the other three components. To derive the emission thresholds used in Tier 1, these models are used to estimate the emission rate corresponding to health risk levels of concern for each PB-HAP within the hypothetical environmental scenario, as described in more detail in the following sections.

### *2.2.1 Modeling Fate and Transport*

To model chemical fate and transport in the environment when deriving emission thresholds for Tier 1, the TRIM.FaTE module of the TRIM system was used. The modeled domain includes a

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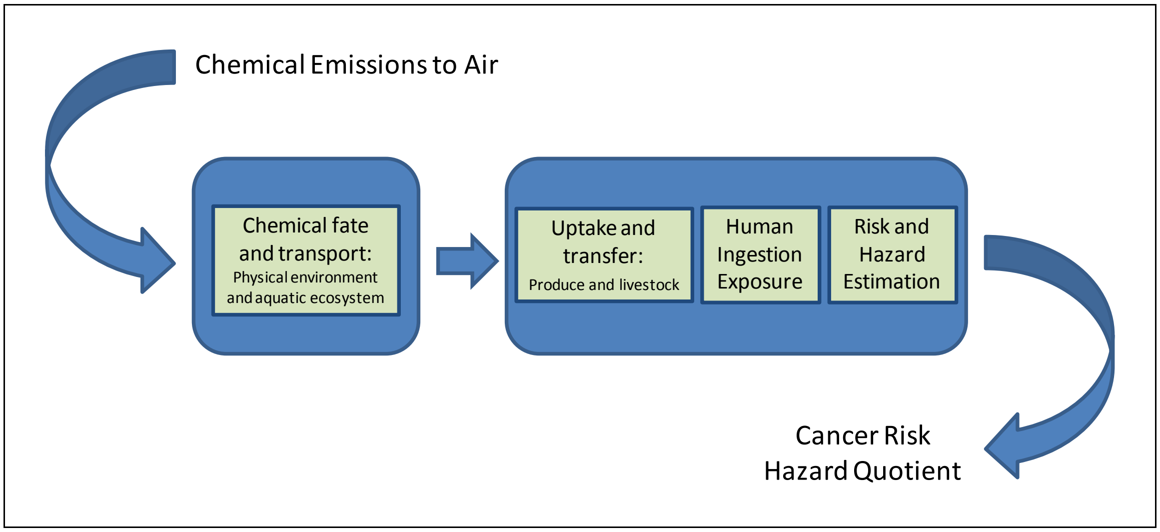
[1] Potential impacts on human health from non-inhalation exposures to lead are evaluated for RTR using the National Ambient Air Quality Standard for lead, which takes into account multipathway risks.

farm homestead and a fishable lake near an emissions source, which are assumed to be the primary food sources for exposed individuals. The spatial layout and other physical aspects of the scenario configuration are designed to be generally health-protective, which results in an ingestion exposure situation that is unlikely to be exceeded at any facility evaluated under the RTR program. The environmental and chemical-specific properties governing fate and transport of PB-HAPs are parameterized with either conservative (i.e., health protective) values or central-tendency values. For this modeling approach, the spatial layout of the modeled domain and the meteorological data used (or a combination of these two factors) are generally more influential than physical/chemical parameters in dictating the resulting chemical concentrations in air, soil, water, sediment, and fish. The Tier 1 assumptions about these two components of fate and transport modeling are refined with site-specific data in subsequent tiers. The spatial layout used to develop the threshold emission levels in Tier 1 and other details of the Tier 1 methodology are presented in Attachment A to this appendix.

**Exhibit 2-2. Overview of Ingestion Exposure and Risk Screening Evaluation Method**



### 2.2.2 Modeling Transfer and Uptake

MIRC was developed to conduct the required calculations involving farm food chain transfer, ingestion exposure, and risk. TRIM.FaTE outputs that are used as inputs to MIRC include:

- PB-HAP concentrations in air,
- Air-to-surface deposition rates for PB-HAPs in both particle and vapor phases,
- PB-HAP concentrations in fish tissue for fish consumed, and
- PB-HAP concentrations in surface soil and root zone soil.

From these inputs, MIRC calculates the transfer and uptake of PB-HAPs through the farm food chain using algorithms based on those included in EPA's *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities* (EPA 2005) and biotransfer factors (e.g., soil-to-plant factors, which are the ratios of the concentrations in plants to concentrations in soil). The outputs of MIRC are PB-HAP concentrations in contaminated food items.

### *2.2.3 Estimating Ingestion Exposure*

MIRC is used to estimate exposure in terms of average daily doses (ADDs), normalized to body weight for the following exposure pathways:

- Incidental ingestion of soil
- Ingestion of homegrown produce
- Ingestion of homegrown beef
- Ingestion of milk from homegrown cows
- Ingestion of homegrown poultry/eggs
- Ingestion of homegrown pork
- Ingestion of fish
- Ingestion of breast milk (children <1 year old; dioxins only)

Chemicals are modeled separately to evaluate the potential for risks, with exposures (in terms of ADD) for each PB-HAP summed across all ingestion exposure pathways. For the screening scenario used in Tiers 1 and 2 of this analysis, exposure characteristics were selected that result in a highly health protective estimate of total exposure. The ingestion rate for each exposure pathway listed above was set (as feasible) equal to the 90th percentile of the distribution of national data of consumers of that food type recommended by EPA in the *Exposure Factors Handbook* (U.S. EPA 2011a) or in other sources as appropriate. All media were assumed to be obtained from a location impacted by the modeled source. This approach results in an overestimate of total chemical exposure for a hypothetical exposure scenario. For example, the resulting total food ingestion rate is extremely high for a hypothetical consumer, with ingestion rates in the 90th percentile for every farm food type. This scenario, however, intentionally was designed to avoid underestimating exposure for any single farm food type. These health protective exposure assumptions are replaced in subsequent tiers of the assessment as appropriate (e.g., with distributions of the data for key exposure factors).

Dermal absorption of chemicals that are originally airborne is generally relatively minor, and this pathway was not included in the scenario used to calculate Tier 1 emission thresholds (this topic is discussed further in Attachment A).

### *2.2.4 Calculating Lifetime Cancer Risk and Non-Cancer HQs*

Lifetime cancer risks and the potential for chronic non-cancer effects are estimated using chemical-specific oral cancer slope factors and oral reference doses. Lifetime cancer risk estimates are calculated separately for each PB-HAP. Similarly, HQs are calculated separately for each PB-HAP and for each age group, and the HQ for the most sensitive age group is used to determine the screening threshold emission rate.

### *2.2.5 Determining Threshold Emission Rates*

Tier 1 emission thresholds were calculated by conducting iterative model simulations in TRIM.FaTE and MIRC using the screening scenario described above to determine emission rates for cadmium, mercury, dioxins, and POM that correspond to a cancer risk of 1 in 1 million or a chronic non-cancer HQ of 1. Given the generally health protective nature of the scenario inputs, these thresholds are assumed to be appropriate for screening facilities emitting these PB-HAPs.

## 3. Tier 2

The Tier 1 screening approach is, by design, generic and health protective. It was constructed for quick application to a large number of facilities in a source category with the least chance of returning false negatives for risk. Once the initial screen is complete, however, facilities that fail for any PB-HAPs must be scrutinized further. Based on screening analyses conducted for RTR to date, many facilities could “fail” the Tier 1 screen for some source categories. A full site-specific analysis of all facilities that cannot be screened out in Tier 1 would not be practical.

Site-specific values for some influential variables, however, can be determined without intensive effort during the assessment. The use of these site-specific values instead of the values used in Tier 1 can be used to justify adjusting the screening threshold for a given PB-HAP at that facility, potentially eliminating the facility from concern while maintaining a high degree of confidence that risks above levels of concern have not been overlooked. Specifically, for Tier 2, location-specific data on two types of variables are taken into account:

- Meteorological characteristics, including the fraction of time the wind blows toward the farm and lake (“wind direction”), wind speed, precipitation rate, and mixing height; and
- Distance from the facility to the nearest fishable lake(s).[2]

These variables affect the PB-HAP concentrations in environmental media estimated by TRIM.FaTE (and thus can be used to justify upward scaling of the emission threshold associated with risks above the level of concern), but they are not related to specific exposure assumptions. The exposure assumptions, such as ingestion rate and fraction of diet derived from the lake and farm remain at fixed, health-protective values in Tier 2. In selecting the fate and transport variables to include in Tier 2, a balance was struck between the degree of impact on the risk estimate, the ease of implementation in TRIM.FaTE, and the ease of obtaining relatively certain site-specific values for all facilities that might be evaluated under the RTR program.

For efficient Tier 2 evaluation of the impacts these parameters could have on specific facilities, a series of TRIM.FaTE simulations was performed that systematically varied the values used in the screening scenario for the five selected variables (four meteorological variables and lake location). The values of each of the five variables were changed, independent of any other changes. The alternative values (three or four for each variable) were selected using statistics on U.S. meteorological data or professional judgment to capture the expected range in the facility data. Three or four values were selected to result in a total number of runs that was reasonable. This set of values was used to develop “bins” for each variable.

Based on the TRIM.FaTE results of these simulations (and the subsequent exposure and risk characterization, conducted using MIRC), threshold adjustment factors were calculated for each unique combination of the five parameters, for each PB-HAP. These adjustment factors represent the ratio between the risk metric (i.e., cancer risk or HQ) obtained using the baseline Tier 1 screening scenario and the risk metric obtained from the adjusted run. For a given facility, an adjusted Tier 2 emission threshold can be estimated by multiplying the Tier 1 emission threshold by the adjustment factor that best corresponds to the meteorological conditions present at the site and the presence and location of lakes at the site.

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[2] The lake size also was changed for each new facility lake distance, which allowed for the simulations to maintain a constant ratio between watershed and erosion area compared with lake area.

To facilitate the implementation of this approach without requiring facility-specific data searches for each new source category evaluated, databases of the relevant U.S. meteorological and lake data were created that could be accessed on the fly during a Tier 2 evaluation. The meteorological database includes annual-average summary statistics on wind direction, wind speed, and precipitation for 1,305 surface stations located throughout the United States. The mixing heights for these stations were estimated using the closest upper air data. The database of fishable lakes includes information on the location and size of lakes in the United States. To focus on lakes that can support angling of upper trophic level fish, only lakes greater than 25 acres are included.

When the Tier 2 screening is conducted, one additional processing step is completed before looking up the appropriate adjustment factors. For each facility that will be analyzed in Tier 2, the distance to the closest relevant lake near the facility in each of eight directional “octants” is recorded using GIS software. For the purposes of Tier 2, a “relevant” lake is considered to be one located within a 50-km radius of the facility and above the size threshold of 25 acres. To access these databases, a Microsoft® Excel tool was created that merges the TRIM.FaTE Tier 2 adjustment factors with the lake and meteorology information relevant to a specific facility from the databases. In the tool, each facility is matched with the closest meteorological station, and the values for the four relevant parameters at that station are recorded. The distances from the facility to the nearest lakes estimated using GIS are also imported. These five values become the set of facility-specific parameters. Then, the adjustment factors for each chemical for the combination of these five variables are determined. The Tier 1 screening emission threshold is then multiplied by the appropriate adjustment factor to obtain an updated, Tier 2 emission threshold for that PB-HAP. Any emissions below the adjusted Tier 2 threshold are assumed to pose a risk below the level of concern.

## 4. Tier 3

If emissions of any PB-HAP at a facility are above the Tier 2 threshold, the facility is considered further in Tier 3. In Tier 3, the site-specific meteorological and lake location parameters estimated in Tier 2 for that facility continue to be used. In Tier 3, however, exposure assumptions are varied from their health-protective values in Tiers 1 and 2 to a distribution of all possible values in the U.S. population. Unlike for the first two tiers, Tier 3 does not result in a simple “pass” or “fail” conclusion. Instead, this tier enables the risk assessor to determine *how much* the exposure assumptions would have to be adjusted to obtain a risk in an acceptable range. Tier 3 does not facilitate the absolute elimination of facilities from concern (as is possible in the first two tiers), but it does provide additional information regarding estimated risks. This information could be used to inform next steps, such as the prioritization of facilities that might require labor-intensive, comprehensive site-specific analyses in Tier 4, or policy determinations for a source category.

The exposure assumptions examined in Tier 3 include the pathway-dependent ingestion rates and the fraction of the diet derived from the nearby lake and farm. In the Tier 1 and 2 analyses, the ingestion rates are set to relatively high values representative of subsistence anglers and subsistence farmers. For Tier 3, a broader distribution of individual ingestion rates (and not just those associated with subsistence lifestyles) is evaluated for each ingestion pathway. In addition, the assumption that individual dietary consumption of farm products and fish all derive from the area farm and lake is relaxed in Tier 3 to develop distributions of dietary fractions.

To estimate the risk distributions for each PB-HAP at each facility, Monte Carlo techniques will be used to create a large set of pathway ingestion rates and fractions of diet coming from the lake and farm. For each simulated hypothetical individual (i.e., each "Monte Carlo realization"), each pathway ingestion rate distribution and dietary fraction distribution will be independently sampled. This sampling involves selecting a random number between 0 and 1 and using the percentiles as bins to select a variable value. For example, if the random number for poultry ingestion rate is 0.87, the value corresponding to the closest percentile (0.9) would be used for that individual. Whether each variable should be considered independently or some exposure assumptions should be correlated also will be decided. In addition, the total ingestion rate percentiles for all pathways together will be used to ensure no person consumes far too little or far too much food in total, compared with the actual distribution.

By sampling all ingestion rates and dietary fractions independently, a set of thousands of Monte Carlo realizations can be created. Tier 3 risks associated with each facility will be computed for each realization using Tier 2 concentrations combined with the Tier 3 exposure estimates for that realization. These calculations can be made using only MIRC simulations, without having to run TRIM.FaTE, which will require significantly fewer resources.

The estimates of individual Tier 3 risks associated with each facility can be presented as a percentile plot along with indications of policy-relevant risk levels. A risk assessor then can judge at which individual risk percentile the policy-relevant risk levels fall. The lower the percentile, the greater the chance that individuals will be adversely affected by the facility emissions and the higher the priority for running a full Tier 4 analysis. (As noted above, the Tier 3 methodology, which has not been fully developed, is presented here only to provide information on the methods that are being considered.)

# 5. Tier 4

In examining the Tier 3 risk distributions, if a risk assessor concludes that there is a reasonable probability that individuals could be adversely affected by the facility emissions, a Tier 4 site-specific analysis might be performed. Examples of recent Tier 4-type analyses include assessments of two coal-fired electric utility units conducted in support of EPA's utility rule (U.S. EPA 2011c), residual risk assessments of two secondary lead smelting facilities (U.S. EPA 2011b), and a case study evaluation of a portland cement facility included with other RTR materials presented to the Science Advisory Board for review (Appendix I of U.S. EPA 2009).

Whereas a Tier 2 analysis incorporates some site-specific but low-resolution information on meteorology and water bodies, and a Tier 3 analysis calculates ranges of possible health risk from possible ingestion behaviors, a Tier 4 analysis uses site-specific data to parameterize more accurately (to the extent possible) each important factor that affects pollutant fate and transport. These site-specific properties are incorporated into model scenarios configured in TRIM.FaTE and MIRC. Important site-specific properties likely would include emission release height and plume buoyancy, hourly meteorology (e.g., wind flow, temperature, mixing height, and precipitation), surface compartments based on watershed and terrain data, local farms and water bodies, land use, soil, erosion, runoff, surface water and sediment, water transfer, and aquatic ecosystems.

The outputs from the site-specific run of TRIM.FaTE (i.e., chemical concentrations in environmental media and fish) are used in MIRC to produce estimates of exposure and health risk. These media concentrations, exposure estimates, and risk estimates can be subset by various compartments (e.g., surface compartments, food web compartments) and ingestion rates for each modeled PB-HAP. These subsets enable the risk assessor to understand, based on TRIM.FaTE and MIRC, the sources and pathways of possible human health risk from emissions of PB-HAPs.

## 6. References

U.S. EPA (U.S. Environmental Protection Agency) (2005) Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities. EPA Office of Solid Waste. EPA-530/R-05-006. 09/2005.

U.S. EPA. (2009) Risk and Technology Review (RTR) Risk Assessment Methodologies: For Review by the EPA's Science Advisory Board with Case Studies – MACT I Petroleum Refining Sources and Portland Cement Manufacturing. EPA Office of Air Quality Planning and Standards. EPA-452/R-09-006. 06/2009.

U.S. EPA. (2011a) Exposure Factors Handbook: 2011 edition. National Center for Environmental Assessment, Washington, DC; EPA/600/R-09/052F. Available from the National Technical Information Service, Springfield, VA, and online at http://www.epa.gov/ncea/efh.

U.S. EPA. (2011b) Human Health Multipathway Residual Risk Assessment for the Secondary Lead Smelting Source Category. Draft Report. Prepared by ICF International for EPA Risk and Exposure Assessment Group. 02/15/2011.

U.S. EPA. (2011c) Technical Support Document: Case Study Analyses of Potential Local-scale Human Health Risks Associated with Mercury Emissions from Electric Utility Steam-generating Units. Draft. Prepared by ICF International for EPA Office of Air Quality Planning and Standards. 02/17/2011.

## Technical Support Document for the TRIM-Based Multipathway Tiered Screening Methodology for RTR

# Attachment A. Tier 1 Screening Methodology

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# LIST OF EXHIBITS

# 1 Introduction

As discussed in the Overview Document, the U.S. Environmental Protection Agency (EPA) will implement a four-tiered approach to evaluate multipathway exposures and human health risks for the Risk and Technology Review (RTR) program. In the first tier, a screening evaluation is conducted that focuses on the identity and magnitude of emissions of hazardous air pollutant (HAP), as defined in Section 112 of the Clean Air Act, from a given facility to determine whether a facility passes certain human health risk-based criteria. Sources that are "screened out" in the Tier 1 analysis are assumed to pose no risks to human health above the levels of concern (e.g., a cancer risk of 1 in 1,000,000 or a noncancer hazard index of 1.0 or greater) and are not considered in further analyses. For sources that do not pass the Tier 1 screen, more refined assessments, up to and including site-specific multipathway assessments, are conducted as appropriate. The results of these analyses are considered, in combination with estimated inhalation human health risks, potential ecological risks, and other factors, to support decisions about residual risk for RTR source categories.

This document describes the technical basis for the first, screening-level tier of EPA's multipathway human health evaluation of RTR emission sources. Specifically, the scenarios, models, configurations, and inputs used to derive screening threshold emission rates in the first tier of the approach are described in detail in the following sections.

- Section 2 presents an overview of how screening is conducted in Tier 1, the chemicals and exposure scenario evaluated in Tier 1, and the models and methods used to conduct the screen.
- Sections 3 and 4 present technical descriptions of the hypothetical environmental setting and the exposure modeling scenario used in Tier 1 as well as the models used in the screen.
- Section 5 provides a brief discussion of the screening threshold emissions for each of the chemicals assessed. References cited in this report are listed in Section 6.

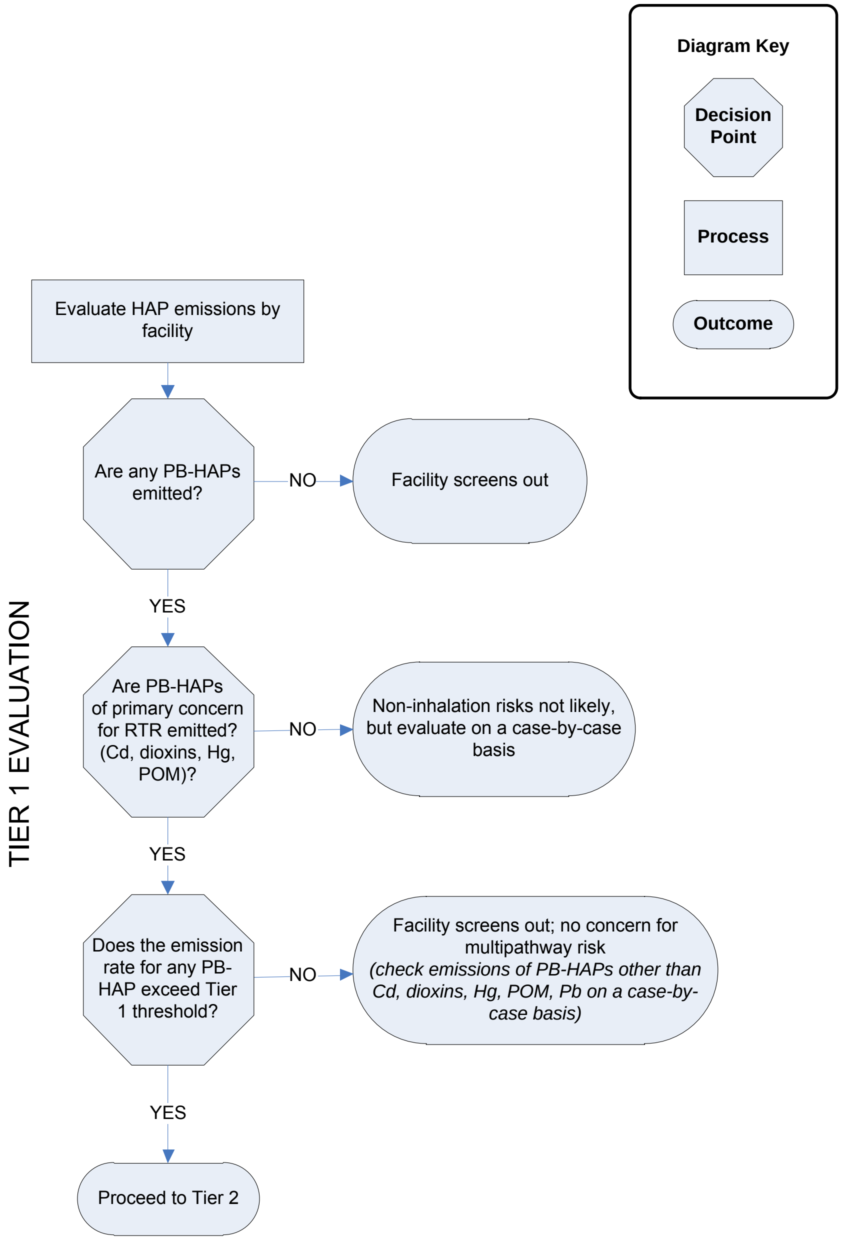
More refined multipathway risk assessment methods, when required for facilities that do not screen out of the Tier 1 analysis, use as their starting point the same TRIM-based modeling approach described herein, making adjustments to modeling inputs based on some site-specific characteristics of the facility being assessed. Tier 2 and Tier 3 screening methods and tools are discussed separately in Attachment B and Attachment C, respectively. Tier 4 consists of a full site-specific multipathway risk assessment. Although a Tier 4 analysis uses the same models and methods to estimate risks, the modeling and exposure scenarios are developed independently based on site-specific characteristics and are not based on the scenarios presented herein.

# 2 Summary of Approach

## 2.1 Overview

The Tier 1 approach for evaluating non-inhalation, multipathway exposures to PB-HAPs for RTR is diagrammed in Exhibit 1. Air toxics emitted by a source under consideration are reviewed to determine, first, whether emissions are reported for any of the four PB-HAPs of concern for non-inhalation pathways. If such emissions are reported, the emission rates are compared to

# Exhibit 1. Conceptual Decision Tree for Evaluation of Non-Inhalation Exposures of PB-HAPs



Tier 1 threshold-screening emission rates that have been derived using the TRIM-based Tier 1 scenario described in this document.

The TRIM-based multipathway modeling configuration, referred to in this document as the Tier 1 scenario, is a key component of the first tier of this approach, and is the technical basis for determining the Tier 1 emission thresholds. The term, Tier 1 scenario, is used to refer collectively to the specific TRIM.FaTE and exposure modeling configuration described herein, including the set of assumptions and input values associated with a hypothetical watershed and the exposure and risk scenarios evaluated for this watershed. The Tier 1 scenario is a static configuration, and its primary purpose is as a modeling tool to calculate the Tier 1 emission rate thresholds for PB-HAPs of concern.

The two potential outcomes of the Tier 1 evaluation are:

- Non-inhalation exposures are unlikely to pose a human health problem (i.e., the emissions evaluated “pass” the screen); or
- The potential for non-inhalation exposures leading to risks above the levels of concern cannot be ruled out and further assessment is required to determine the potential for exceeding the levels of concern.

An ideal screening approach strikes a balance between being *health-protective*—to ensure that risks above levels of concern are identified, and being *accurate*—to minimize results suggesting that additional assessment is required when in fact the actual risk is low. Typically, gains in accuracy in environmental modeling are accompanied by additional resource requirements. Stated another way, a suitable approach minimizes both false negatives and false positives. False negatives (i.e., results that suggest that the risk is acceptable when in fact the actual risk is high) can lead to inappropriate and non-protective health or environmental policy decisions. False positives (i.e., results that suggest more assessment is required when in fact the actual risk is low) can result in wasted resources by leading to additional, unnecessary analysis. For the evaluation of multipathway human health exposures to PB-HAPs, the methods for screening described in this document are intended to achieve this balance.

Because the Tier 1 evaluation enables EPA to confidently eliminate from consideration those facilities where risks from non-inhalation exposures are projected to be minimal, resources can be targeted toward those facilities that do not pass the screening test. For facilities that do not pass the Tier 1 screening, in additional tiers of analysis, some of the Tier 1 parameters are reassessed, and if appropriate, are changed to more accurately reflect site-specific characteristics. With each successive tier of the assessment, additional Tier 1 assumptions are evaluated and refined to better reflect site-specific characteristics of the facility being modeled.

The Tier 1 screening evaluation for RTR compares reported air emission rates of PB-HAPs (summed by PB-HAP for each facility) to screening threshold emission rates derived using the Tier 1 scenario. A threshold emission rate is the level that, when input to a risk model using emissions as a parameter, corresponds to a specified cancer risk or non-cancer hazard quotient (HQ) that, for the purposes of the evaluation being conducted, is assumed to be below a level of concern. Tier 1 threshold rates were calculated for a cancer risk of 1 in 1 million or an HQ of 1.0 and are presented in

Exhibit 2.[1] Conceptually, a threshold level for the RTR multipathway screening evaluation could be obtained by back-calculating the emission rate that results in the specified cancer risk or HQ level, taking into account the exposure and fate and transport calculations included in the model. Because the models used in this assessment are not designed to run "backwards," the rates instead were derived from regression equations established following a series of TRIM.FaTE and exposure/risk model runs spanning a wide range of emission rates for each chemical. The estimated screening-level emission rates are verified by performing model runs using the estimated threshold emission rate to confirm that the emission rates result in a cancer risk of 1 in 1 million or an HQ of 1.0.

**Exhibit 2. Emission Thresholds for Screening of Multipathway Exposures**

| Chemical | Screening Threshold Emission Rate (TPY) | Basis of Threshold (Type of Health Endpoint) |
|---|---|---|
| POM (as benzo(a)pyrene equivalents)[a] | 3.09E−03 | Cancer |
| Dioxins (as 2,3,7,8-TCDD equivalents)[a] | 6.38E-09 | Cancer |
| Cadmium | 7.00E−02 | Non-cancer |
| Divalent mercury | 1.94E−03 | Non-cancer |

TPY = U.S. short tons per year
[a]See Section 2.7 for a discussion on the derivation of equivalent emissions.

The more probable risk for each emission rate would be lower than the level corresponding to the screening threshold risk quantities in nearly all circumstances, given the conservative (health protective) and highly general nature of the Tier 1 scenario configuration.

Tier 1 emission thresholds were developed individually for elemental and divalent mercury. Both were based on the lower of the thresholds associated with multipathway exposures to divalent mercury and methyl mercury.[2] Only speciated emissions of divalent mercury are screened because the sum of elemental mercury emissions across all National Emission Inventory (NEI) facilities is less than the elemental mercury screening threshold level.

## 2.2 Chemicals of Potential Concern

EPA's assessment of multipathway human exposures for RTR focuses on persistent and bioaccumulative hazardous air pollutants (PB-HAPs)[3] that the Office of Air Quality Planning and

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[1] For chemicals known to cause both cancer and chronic non-cancer impacts, *and* for which acceptable quantitative dose-response values are available for both cancer and non-cancer endpoints, the endpoint that results in the lower threshold emission level is used for screening (i.e., the threshold will be based on the effect that occurs at the lower exposure level). For the set of PB-HAPs for which screening threshold levels have been derived, only chlorinated dibenzo-dioxins and -furans meet both criteria. Because the cancer dose-response value is lower than that for non-cancer effects, the screening threshold value is based on the cancer endpoint.

[2] Note that TRIM.FaTE models the transformation of mercury within the environment; thus, emissions of only divalent mercury will result in multipathway exposures to both elemental and methyl mercury. Emissions of only elemental mercury will result in multipathway exposures to both divalent and methyl mercury.

[3] Although POM (polycyclic organic matter) is the name of the HAP listed in the Clean Air Act, the term "polycyclic aromatic hydrocarbons" or PAHs is used in many cases. Much of the literature regarding

Standards (OAQPS) has identified as candidates for multipathway risk assessments. OAQPS developed a list of 14 chemicals and chemical groups that are PB-HAPs based on a two-step process taking into account the following (U.S. EPA 2004a):

- their presence on three existing EPA lists of persistent, bioaccumulative, and toxic substances, and
- a semiquantitative ranking of toxicity and bioaccumulation potential of the entire list of HAPs.

The list's development and utility in hazard identification for multipathway risk assessment are explained further in Chapter 14 and Appendix D of Volume I of EPA's *Air Toxics Risk Assessment (ATRA) Reference Library* (U.S. EPA 2004a). Exhibit 3 presents the 14 chemicals and groups that are PB-HAPs.

The screening scenario described in this document is not configured for evaluating the risk potential for all 14 PB-HAPs on the list. Currently, the scenario can be used to estimate exposures and risks quantitatively for four PB-HAPs (indicated in bold in Exhibit 3). These PB-HAPs are the focus of the current scenario because, based on current emissions and toxicity considerations, they are expected to pose the vast majority of the non-inhalation risks to humans from air emissions at sources subject to residual risk provisions of the Clean Air Act.[4]

## 2.3 Conceptual Exposure Scenario

A conceptual exposure scenario was developed that encompasses the specific exposure routes and pathways of interest for the four PB-HAPs that are assessed quantitatively in the Tier 1 analysis. Exposure routes and pathways describe the movement of air toxics from the point of release to the point where exposure occurs and generally consist of the following elements:

- Release to the environment (i.e., emissions);
- A retention medium, or a transport mechanism and subsequent retention medium in cases involving media transfer of chemicals;
- A point of potential human contact with the contaminated medium; and
- An exposure route.

An exposure route is the particular means of entry into the body. Receptors are exposed to chemicals emitted to the atmosphere via two primary routes: either directly via inhalation, or indirectly via ingestion or dermal contact with various media that have been contaminated with the emitted PB-HAPs. (Inhalation pathways are assessed separately and are not considered in the Tier 1 assessment presented here.)

PB-HAPs can persist in the environment for long periods of time and also build up in soil and in the food chain, including fish, fruits and vegetables, and animal products (e.g., meat, dairy,

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toxicity and fate and transport of this chemical group refers to PAHs rather than POM. In addition, the individual POM species that are of concern with respect to health risk for RTR evaluations are all PAHs (i.e., there are no POM species explicitly evaluated for RTR that do not include an aromatic ring). The terms are used interchangeably throughout this text.

[4] Potential impacts on human health from non-inhalation exposures to lead are evaluated for RTR using the National Ambient Air Quality Standard for lead, which takes into account multipathway risks. Non-inhalation exposures to the other nine PB-HAPs not addressed by the modeling scenario discussed in this report will be evaluated on an individual facility or source category basis as appropriate.

eggs). For this reason, ingestion of foods grown within an area impacted by RTR sources can be an important source of exposure to PB-HAPs.

### Exhibit 3. OAQPS PB-HAP Compounds

| PB-HAP Compound[a] | Addressed by Screening Scenario? |
|---|---|
| **Cadmium compounds** | **Yes** |
| Chlordane | No |
| **Chlorinated dibenzodioxins and furans** | **Yes** |
| DDE (1,1-dichloro-2,2-bis(p-chlorophenyl) ethylene) | No |
| Heptachlor | No |
| Hexachlorobenzene | No |
| Hexachlorocyclohexane (all isomers) | No |
| Lead compounds | No |
| **Mercury compounds** | **Yes** |
| Methoxychlor | No |
| Polychlorinated biphenyls | No |
| **Polycyclic organic matter (POM)** | **Yes** |
| Toxaphene | No |
| Trifluralin | No |

[a] Source of list: U.S. EPA (2004a). Compounds in bold text can be evaluated using the current version of the TRIM-based screening scenario.

To assess risks from hazardous waste combustion facilities, EPA identified several hypothetical receptor scenarios, noting that these scenarios are considered appropriate for a broad range of situations, rather than to represent any actual scenario. These scenarios are described in EPA's *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities,* or HHRAP (U.S. EPA 2005a). In this document, EPA recommends assessment of the following hypothetical receptors: a Farmer, Farmer Child, Resident, Resident Child, Fisher, Fisher Child, Acute Receptor, and Nursing Infant. These receptors are distinguished by their pathways of exposures. EPA further notes in HHRAP that some exposure settings might warrant including additional exposure pathways; such as including exposure through fish ingestion for the farmer receptor. For the RTR screening scenario, risks are assessed for a single hypothetical receptor. Based on the guidance provided in HHRAP, a health protective exposure scenario was developed whereby the hypothetical receptor receives ingestion exposure via both the farm food chain and the fish ingestion pathways. The exposure scenario for the RTR Tier 1 analysis includes the following ingestion pathways:

- Incidental ingestion of soil,
- Ingestion of homegrown fruits and vegetables,
- Ingestion of homegrown beef,

- Ingestion of dairy products from homegrown cows,
- Ingestion of homegrown poultry and eggs,
- Ingestion of homegrown pork,
- Ingestion of locally caught fish, and
- Ingestion of breast milk (for children less than 1 year old and for dioxins only).

As discussed in detail in Section 4.2, exposure via these pathways is assessed for adults, various age categories for children, and nursing infants (for dioxins only).

Other non-inhalation exposure routes of possible concern for PB-HAPs discussed in HHRAP include the use of surface waters as a drinking water source and dermal exposure. These exposure routes, however, are not evaluated in the current assessment. The drinking water exposure pathway is not likely for the modeling scenario developed for this analysis because the likelihood that humans would use a lake as a drinking water source was assumed to be low.[5] Dermal absorption of chemicals that are originally airborne has been shown to a relatively minor pathway of exposure compared to other exposure pathways (U.S. EPA 2006, Cal/EPA 2000). Preliminary calculations of estimated dermal exposure and risk of PB-HAPs, presented in Addendum 3, showed that the dermal exposure route is not a significant risk pathway relative to ingestion exposures. Assessment of dermal exposure through incidental contact with soil could be conducted on facilities that require refined evaluation if deemed necessary.

## 2.4 Approach to Development of the Tier 1 Scenario

The TRIM-based Tier 1 scenario described in this document is used to provide a means to *qualitatively estimate the potential for non-inhalation risks above the levels of concern for PB-HAPs emissions from facilities* in the context of residual risk assessments conducted as part of RTR. The Tier 1 scenario used to derive the threshold emission rates is not intended to be representative of any particular situation. Rather, it was developed for the purpose of RTR to portray an exposure scenario that is inclusive of any potential exposure situation that might plausibly be encountered in the United States. A range of conditions was assessed when conceptualizing and developing the screening scenario. The final configuration was chosen so that for a given individual, any potential long-term exposure conditions for a given geographic region would be reasonably likely to be captured. These criteria were met by constructing a hypothetical scenario that would be protective in key aspects, including spatial orientation, meteorology, types of exposures, and ingestion rates. The overall result is a scenario that is unlikely to occur at any one location but has a high likelihood of representing the upper end of all *potential* exposures. This latter aspect accomplishes the goal of striking a balance between health protectiveness and the level of accuracy called for in the ideal screening approach previously discussed.

The development and application of the Tier 1 scenario for residual risk evaluations considered EPA's technical and policy guidelines presented in the *Residual Risk Report to Congress* (U.S. EPA 1999); Volumes I and II of the *Air Toxics Risk Assessment Reference Library* (U.S. EPA 2004a, 2005a); and other EPA publications. The scenario described in this appendix is the

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[5] An exception to this generality would be reservoirs used for drinking water supplies. This situation might be worthy of additional analysis, if warranted by the characteristics of a given assessment (e.g., to estimate PB-HAP concentrations in treated drinking water derived from reservoirs).

culmination of analyses completed since 2005; it provides the basis for an efficient and scientifically defensible method for screening multipathway human health risk and provides a solid baseline from which to perform Tier 2 and Tier 3 analyses, as described in Attachment B and Attachment C, respectively. Nevertheless, this scenario should not be considered “final” but rather a product that can continue to evolve based on feedback from the scientific community and Agency reviewers, lessons learned as the scenario is further applied for RTR, variations in EPA’s needs and requirements, and other factors.

### *2.4.1 Modeling Framework*

The approach for multipathway risk screening and evaluation for RTR can be divided into four steps:

1. Fate and transport modeling of PB-HAPs emitted to air by the source that partition into soil, water, and other environmental media (including fish[6]);

2. Modeling of transfer and uptake of PB-HAPs into farm food chain media (e.g., produce, livestock, dairy products) from soil and air;

3. Estimating exposures from ingestion of selected media and estimating average daily ingestion doses for a hypothetical human receptor; and

4. Calculating lifetime cancer risk estimates or chronic non-cancer HQs, as appropriate, for each PB-HAP and comparing these to selected evaluation criteria.

The relationship among these four processes is shown in Exhibit 4.

As shown in Exhibit 4, two models are used to evaluate the four steps outlined above. EPA’s TRIM methodology was conceived as a comprehensive modeling framework for evaluating risks from air toxics, and the TRIM system was designed to address each of the four steps involved in screening ingestion risk.[7] Currently, however, only one component corresponding to the first step included in Exhibit 4—the fate and transport module—is available for application in an ingestion risk assessment. EPA has completed some development activities for TRIM.Expo-Ingestion and TRIM.Risk-Human Health, two additional modules that cover the other three steps. Modeling software, however, is not currently available for these modules. For the RTR screening scenario, the Multimedia Ingestion Risk Calculator (MIRC), a Microsoft Excel-based computer framework, was constructed to complete the calculations required for estimating PB-HAP concentrations in farm food chain media, average daily ingestion doses, and cancer risks and chronic non-cancer HQs. This framework is conceptually identical to the ingestion exposure and risk analyses that TRIM is intended to cover.

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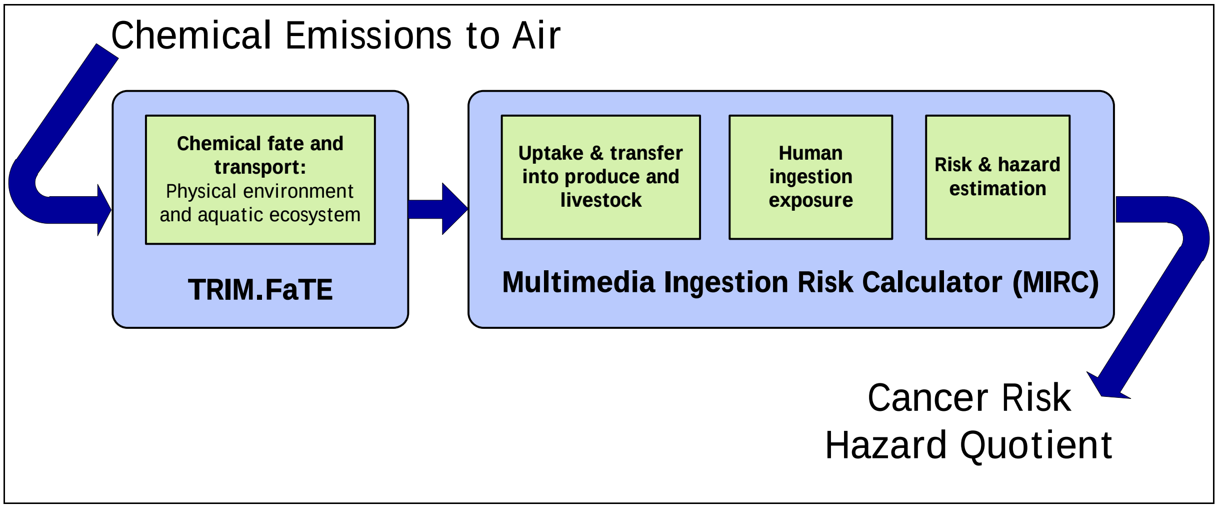
[6] As discussed below, concentrations in fish calculated by the TRIM.FaTE model were used to estimate ingestion exposures for humans consuming fish. Modeling of fish concentrations is therefore discussed herein as part of the fate and transport modeling. Uptake of PB-HAPs into all other biotic media assumed to be ingested is modeled in the second step of the modeling framework.

[7] Information about the current status of TRIM modules and comprehensive documentation of modules developed thus far can be accessed on EPA’s Technology Transfer Network (TTN) on the Fate, Exposure, and Risk Analysis website (http://www.epa.gov/ttn/fera/).

### *2.4.1 Model Configuration and Parameterization*

The Tier 1 scenario is intended to reduce the possibility that EPA would ***not*** mis-identify risks above levels of concern. Although the health protective approach likely overestimates risk, EPA determined that this approach is appropriate for the purposes of screening assessments. As was done with the preliminary multipathway screening for RTR conducted in 2006 (U.S. EPA 2006), exposures were modeled for a hypothetical farm homestead and fishable lake located adjacent to an emissions source. The hypothetical individual for which exposures were calculated was assumed to derive all potentially contaminated foodstuffs from adjacent locations, and many of the exposure/activity assumptions (e.g., amount of food consumed per day) were selected from the upper ends of representative exposure parameter distributions.

**Exhibit 4. Overview of Ingestion Exposure and Risk Screening Evaluation Method**



The physical/chemical environment represented in the screening scenario was parameterized with two types of values. One type is typical values, such as national averages. The second type is health-protective values, or values that would tend to overestimate concentrations in media driving ingestion exposures for humans, based on knowledge of exposure patterns. In general, the spatial and temporal aspects of the scenario and the components of the scenario that influence air concentrations and deposition rates (which in turn affect all other exposures) were defined to be health protective. Chemical-specific and non-chemical-specific properties of the environmental media were parameterized with either typical or health protective values; properties having greater uncertainty were assigned a greater level of health protective bias.

The spatial layout of the Tier 1 scenario and the meteorological data (or a combination of these two factors) are generally more influential than physical/chemical parameters in dictating the screening model outcomes, taking into account the potential range of variation in possible values. For example, where and how the layout is spatially oriented relative to the dominant wind direction can dramatically affect the concentrations in air, thereby driving estimated concentrations of PB-HAPs in soil, water, and biota. In contrast, a relatively large change in soil characteristics within the range of possible values (e.g., organic carbon content, water content) might result in relatively small changes in media concentrations.

The mix of health protective and central-tendency assumptions and parameterization is expected to result in a scenario configuration that, on average, is likely to overpredict environmental concentrations of PB-HAPs in media of interest for this evaluation. Given the intended application of this scenario as a screening tool, this health protective bias was deliberate, because of the desire to ensure that risks above levels of concern are not overlooked (i.e., to minimize false negatives). Although the inclusion of central-tendency values where warranted is intended to minimize the number of false positives, some false positives are to be expected from a screening scenario. False positives are addressed in subsequent tiers of the screening evaluation for a particular source.

## 2.5 Fate and Transport Modeling (TRIM.FaTE)

The fate and transport modeling step depicted in the first box in Exhibit 4 is implemented for RTR using the Fate, Transport, and Ecological Exposure module of the TRIM modeling system (TRIM.FaTE).[8] In developing the Tier 1 scenario, Version 3.6.2 of TRIM.FaTE was used to model the fate and transport of emitted PB-HAPs and to estimate concentrations in relevant media. Additional information about TRIM.FaTE, including support documentation, software, and the TRIM.FaTE public reference library, is available at http://www.epa.gov/ttn/fera/.

The algorithms used to model mercury species and polyaromatic hydrocarbons (PAHs) are described in Volume II of the *TRIM.FaTE Technical Support Document* (U.S. EPA 2002a). A comprehensive evaluation of the performance of TRIM.FaTE for modeling mercury was documented in Volumes I and II of the T*RIM.FaTE Evaluation Report* (U.S. EPA 2002b, 2005b). Algorithms specific to the fate and transport of 14 chlorinated dibenzo-dioxin and -furan congeners were added following the addition of those for mercury and PAHs. Documentation of the application of TRIM.FaTE for dioxin emissions is contained in the third volume of the *TRIM.FaTE Evaluation Report* (U.S. EPA 2004b). More recently (largely as part of this current project), the TRIM.FaTE public reference library was updated to include information on modeling for cadmium. In general, many of the algorithms and properties included in the public reference library that are used to model mercury (except for the mercury transformation algorithms) are also applicable to cadmium. Comprehensive technical documentation of TRIM.FaTE algorithms specific to cadmium has not yet been compiled; however, all chemical-specific properties used by TRIM.FaTE to model cadmium (as well as PAHs, mercury, and dioxins) are documented in Addendum 1 to this document. Based on a thorough 2011 evaluation of TRIM.FaTE performance in modeling mercury's fate, transport, and transformation in the aquatic food web, a zooplankton compartment was added to TRIM.FaTE's aquatic compartment to increase the resolution and accuracy of the aquatic food web modeling. Parameterization of the TRIM.FaTE scenario used for RTR screening is described in more detail in Section 3.

## 2.6 Exposure Modeling and Risk Characterization (MIRC)

The algorithms included in MIRC that calculate chemical concentrations in farm food chain media and ingestion exposures for hypothetical individuals were obtained from EPA's *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities,* or HHRAP (U.S.

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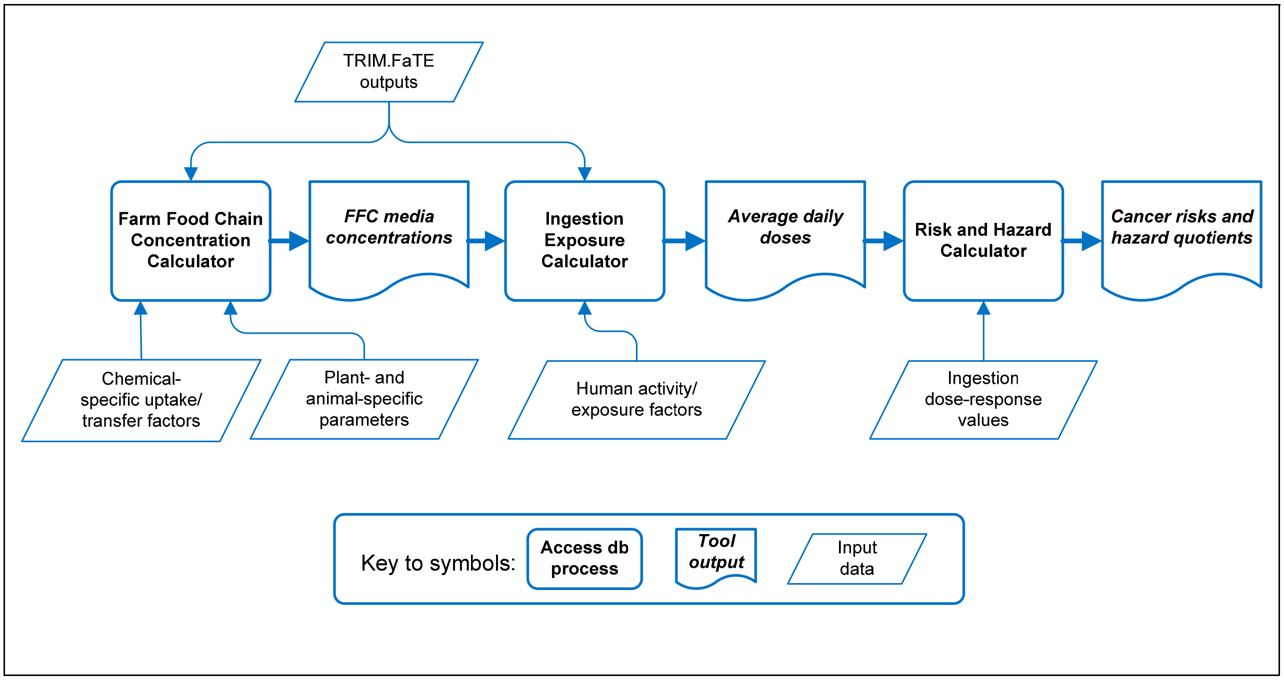
[8] TRIM.FaTE is a spatially explicit, compartmental mass balance model that describes movement and transformation of pollutants over time, through a user-defined, bounded system that includes both biotic and abiotic compartments. Outputs include pollutant concentrations in multiple environmental media and biota.

EPA 2005a).[9] These algorithms, and the required exposure factors and other parameter values, were compiled into a database. An overview of the computational processes this tool carries out and the types of input data it requires is presented in Exhibit 5. This exhibit demonstrates the general relationships between the relevant TRIM.FaTE outputs (i.e., chemical concentrations in environmental media and fish) and the ingestion exposure and risk calculations carried out using MIRC. Additional discussion of exposure and risk calculations for the Tier 1 scenario is presented in Section 4 and Addendum 2, and all inputs required by these calculations are documented in Addendum 2.

**Exhibit 5. Overview of Process Carried Out in the Multimedia Ingestion Risk Calculator**



## 2.7 Implementation of Risk-based Emission Scaling Factors for POM and Dioxin Emissions

Two of the four PB-HAPs for which screening emission thresholds have been developed for RTR—POM and dioxins—are chemical groups comprising numerous individual entities. The members of these categories reported in NEI include both specific chemicals and groups containing multiple chemicals. For example, for POM, emissions reported in NEI include various species, such as benz [a]anthracene, 2-methylnaphthalene, and chrysene, as well as non-specific entries, such as "PAH, total." The constituents included in the POM and dioxin PB-HAP categories are grouped together not only because they are types of the "same" HAP, but also because members of these groups are assumed to have similar characteristics with respect to toxicity and behavior in the environment.

To facilitate a practical application of the multipathway screening methods for RTR, reported emissions of POM and dioxins are normalized or scaled to a single reference chemical for each group. The reference chemicals used in RTR for POM and dioxins are benzo[a]pyrene and

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[9] The farm food chain calculations and ingestion exposure equations to be included in the TRIM.Expo software are expected to be very similar to those included in HHRAP.

2,3,7,8-TCDD, respectively. These compounds were selected because they are relatively well-studied among the members of the two groups and are also among the most toxic species within each group.

Derivation of appropriate scaling factors begins with an evaluation of the basic relationship used to characterize health risk:

$$\mathit{Risk} \propto (\mathit{Exposure\ Concentration}) \times (\mathit{Toxicity})$$

For a given air pollutant, the incremental exposure concentration is directly proportional to the emissions of that substance. That is, as the emissions increase, so too does the exposure to that substance. Furthermore, toxicity is assumed to increase linearly with concentration. Consequently, emissions of one substance (e.g., chrysene) can be scaled proportional to a reference compound (e.g., benzo(a)pyrene or BaP) by applying weighting factors corresponding to the relative differences in exposure behavior and toxicity. Using the POM group as an example and BaP as the reference compound, this scaling can be expressed through an equation as follows:

$$Emiss_{PAHi:BaP} = Emiss_{PAHi} \times EEF_{PAHi:BaP} \times TEF_{PAHi:BaP}$$

where

$Emiss_{PAHi:BaP}$ = Risk-weighted emissions of $PAH_i$ (weighted according to cancer risk relative to BaP for oral exposures)

$Emiss_{PAHi}$ = Emission rate of $PAH_i$

$EEF_{PAHi:BaP}$ = Exposure equivalency (weighting) factor accounting for difference in relative oral exposure between $PAH_i$ and BaP

= Toxicity equivalency (weighting) factor accounting for difference in relative toxicity via oral route between $PAH_i$ and BaP

In combination, the product of the EEF and TEF for a given substance is considered to be a "risk equivalency factor" for the purposes of RTR evaluations that enables scaling of emissions of a given substance for a given exposure scenario.

The TEF for each PAH and dioxin species can be calculated on the basis of relative toxicities. Toxicities were not evaluated separately for RTR but are based on analyses conducted by EPA elsewhere. For PAHs, oral toxicity values for individual species have been derived following the same approach used to develop inhalation toxicity values. For dioxins, TEFs are based on the relative toxicities developed by EPA recently and are ultimately based on the values developed by the World Health Organization (van der Berg et al. 2006). Refer to Addendum B for more information on these values.

The EEFs can be calculated directly for each individual chemical that can be modeled in TRIM.FaTE and MIRC. TRIM.FaTE is configured for 14 POM congeners and 17 dioxin/furan congeners. For these substances, EEFs were calculated directly using the modeling approach and parameterization scheme for the Tier 1 scenario described in this document. Several other POM and dioxin emissions, however, are reported in the NEI. For these, exposure surrogates must be assigned after evaluating the correlation between chemical properties of the POM or dioxin congener and exposure quantified as lifetime average daily dose. The specific calculations for EEFs and exposure surrogates for each chemical group are discussed in the sections that follow.

### *2.7.1 Calculation of Scaling Factors for POM Congeners*

The calculated EEFs, TEFs, and total REFs for the 14 POM congeners that are configured in TRIM.FaTE are shown in Exhibit 6. To determine appropriate exposure surrogates for chemicals not parameterized in TRIM.FaTE, EPA evaluated the relationships between chemical-specific properties (e.g., $K_{ow}$ and Henry's law constant, $k_h$) and intermediate modeled values (e.g., deposition) and exposure in terms of lifetime average daily dose (LADDs) where the average daily doses (ADDs) for the youngest two age groups were adjusted by the age-dependent adjustment factors (ADAFs) to account for the mutagenic mode of action of PAHs. The correlation between $K_{ow}$ and exposure is stronger than for any other chemical-specific property. Exposure surrogates were thus identified for each congener by calculating Total Lifetime Average Daily Dose (Age Adjusted) for each

**Exhibit 6. Exposure, Toxicity, and Risk Equivalency Factors Relative to BaP for Modeled POM Congeners**

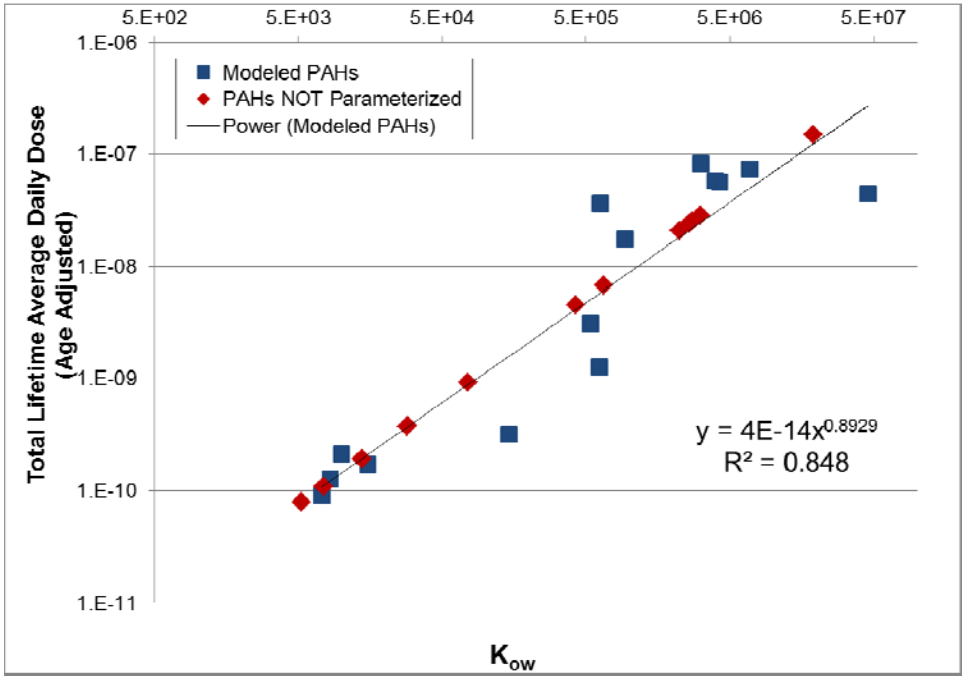
| Chemical | Exposure Equivalency Factor (EEF) | Toxicity Equivalency Factor (TEF)[a] | Risk Equivalency Factor (REF) |
|---|---|---|---|
| 7,12-Dimethylbenz(a)anthracene | 2.07 | 34.2 | 70.83 |
| Dibenz[a,h]anthracene | 4.67 | 0.56 | 2.62 |
| Benzo(a)pyrene | 1.0 | 1.0 | 1.0 |
| Benzo(k)fluoranthene | 4.20 | 0.16 | 0.69 |
| Benzo(b)fluoranthene | 3.25 | 0.16 | 0.53 |
| Indeno(1,2,3-cd)pyrene | 2.51 | 0.16 | 0.41 |
| Benzo(g,h,i)perylene | 3.21 | 0.07 | 0.22 |
| Benzo(a)anthracene | 0.07 | 0.16 | 0.012 |
| Chrysene | 0.18 | 0.014 | 0.0024 |
| Fluoranthene | 0.018 | 0.068 | 0.0012 |
| Acenaphthylene | 0.012 | 0.068 | 0.00082 |
| Fluorene | 0.010 | 0.068 | 0.00066 |
| Acenaphthene | 0.0073 | 0.068 | 0.00050 |
| 2-Methylnaphthalene | 0.0051 | 0.068 | 0.00035 |

[a] TEFs are calculated as the ratio of the CSF for each specific POM congener to the CSF for benzo(a)pyrene. Dose response values, including CSFs, that are used in the screening assessment are discussed in Section 4 of Addendum 2.

based on the congener's $K_{ow}$ and the power regression of the modeled PAHs. Exhibit 7 shows that as $K_{ow}$ increases, so too does exposure.

For POMs reported as unspeciated groups (i.e., "PAH, total" and "Polycyclic Organic Matter") EPA assigned surrogates with $K_{ow}$ values near the upper end of the range of all of the $K_{ow}$ values, corresponding to an exposure near the upper end of the range (log $K_{ow}$ = 6.5). This assignment is assumed to be health protective and likely will not under predict exposure.

**Exhibit 7. Relationship between Exposure and Kow for POM Congeners**



The calculated EEFs, TEFs, and REFs for the 17 dioxin congeners that are configured in TRIM.FaTE are presented in Exhibit 8. Although there are many dioxins reported in the NEI other than the 17 configured for TRIM.FaTE, to date, none of them have been included in emissions datasets that have been screened. Therefore, no surrogate EEF's have been developed for dioxins. In future screening assessments, if surrogate EEFs are needed, an approach similar to that used for POM will be used to develop surrogate EEFs for dioxins.

**Exhibit 8. Exposure and Toxicity Equivalency Factors Relative to TCDD for Modeled Dioxin Congeners**

| Chemical | Exposure Equivalency Factor (EEF) | Toxicity Equivalency Factor (TEF)[a] | Risk Equivalency Factor (REF) |
|---|---|---|---|
| PentaCDD, 1,2,3,7,8- | 3.96 | 1.0 | 3.96 |
| TetraCDD, 2,3,7,8- | 1.0 | 1.0 | 1.0 |
| Dioxins, Total, w/o Indiv. Isomers Rptd. | 1.0 | 1.0 | 1.0 |

## Exhibit 8. Exposure and Toxicity Equivalency Factors Relative to TCDD for Modeled Dioxin Congeners

| Chemical | Exposure Equivalency Factor (EEF) | Toxicity Equivalency Factor (TEF)[a] | Risk Equivalency Factor (REF) |
|---|---|---|---|
| Dioxins | 1.0 | 1.0 | 1.0 |
| 2,3,7,8-TCDD TEQ | 1.0 | 1.0 | 1.0 |
| HexaCDD, 1,2,3,4,7,8- | 1.65 | 0.10 | 0.17 |
| PentaCDF, 2,3,4,7,8- | 0.50 | 0.30 | 0.15 |
| HexaCDD, 1,2,3,6,7,8- | 1.11 | 0.1 | 0.11 |
| HexaCDF, 1,2,3,7,8,9- | 0.64 | 0.1 | 0.064 |
| HexaCDF, 1,2,3,6,7,8- | 0.63 | 0.10 | 0.063 |
| HexaCDD, 1,2,3,7,8,9 - | 1.11 | 0.041 | 0.046 |
| HexaCDF, 1,2,3,4,7,8- | 0.42 | 0.1 | 0.042 |
| HexaCDF, 2,3,4,6,7,8- | 0.36 | 0.1 | 0.036 |
| PentaCDF, 1,2,3,7,8- | 0.61 | 0.03 | 0.018 |
| TetraCDF, 2,3,7,8- | 0.16 | 0.1 | 0.016 |
| HeptaCDD, 1,2,3,4,6,7,8- | 1.17 | 0.01 | 0.012 |
| HeptaCDF, 1,2,3,4,6,7,8- | 0.33 | 0.01 | 0.0033 |
| HeptaCDF, 1,2,3,4,7,8,9- | 0.30 | 0.01 | 0.0030 |
| OctaCDD, 1,2,3,4,6,7,8,9- | 0.45 | 0.0003 | 0.00014 |
| OctaCDF, 1,2,3,4,6,7,8,9- | 0.37 | 0.0003 | 0.00011 |

[a] Values from Van den Berg et al. (2006), except for 1,2,3,7,8,9-hexaCDD, which is calculated based on the ratio of the IRIS-based CSF for 1,2,3,7,8,9-hexaCDD to the IRIS-based CSF for 2,3,7,8-TCDD. Dose response values, including CSFs, that are used in the screening assessment are discussed in Section 4 of Addendum 2.

### *2.7.1 Calculation of Scaling Factors for Dioxin Congeners*

Many facilities report dioxins as “Dioxins, Total, without Individual Isomers Reported,” “Dioxins,” or as “2,3,7,8-TCDD TEQ,” and in three cases, we do not adjust or scale the emissions. That is, we assume that they behave like and possess the toxic characteristics of TCDD. This approach could be improved by obtaining information on the speciation of dioxin emissions for each facility or an average speciation profile that could be assumed to apply to all facilities in a source category.

# 3 Description of Environmental Modeling Scenario

As described in Section 2.4.1, the physical configuration of the RTR Screening Scenario was designed to encompass the upper end of potential long-term PB-HAP exposures, and the environmental and chemical-specific properties were parameterized with either health protective or central-tendency values. Information regarding the scenario configuration and important aspects of the parameterization process, justifications for selecting particular property values, and model uncertainties is presented in the sections that follow. Comprehensive documentation of TRIM.FaTE property values for this scenario is provided in Addendum 1.

## 3.1 Chemical Properties

The general chemical/physical properties that TRIM.FaTE requires, such as Henry's law constant, molecular weight, and melting point, were obtained from peer-reviewed and standard reference sources. Numerous other chemical-specific properties are related more specifically to a particular abiotic or biotic compartment type; these properties are discussed generally in the sections that follow and are documented in Addendum 1.

## 3.2 Spatial Layout

For the purpose of estimating media concentrations, the TRIM.FaTE scenario is intended to represent a farm homestead and a fishable lake (and its surrounding watershed) located near the emissions source of interest. A diagram of the surface parcel layout is presented in Exhibit 9. The source parcel is parameterized as a square with sides of 250 m, which is assumed to be a fair estimation for the size of a relatively small-to-medium facility at the fence line. With a predominant wind direction toward the east, the modeled layout is generally symmetric about an east-west line and is wedge-shaped to reflect Gaussian dispersion of the emission plume.

A lateral, downwind distance of 10 km was established for the watershed included in the scenario. Based on the results of dispersion modeling (results not presented here), the location of the maximum air concentration and deposition rate would be expected to occur relatively close to the facility (probably within a few hundred meters, with the exact location varying with stack height and other parameters) and well within a 10-km radius. Additionally, deposition rates for the PB-HAPs for which this screening scenario is applicable would be expected to decrease by about two orders of magnitude relative to the predicted maximum rate within a 10-km radius. Extending the modeling layout beyond a 10-km downwind distance would increase the amount of deposition "captured" by the modeled watershed, but the incremental chemical mass expected to accumulate in the watershed diminishes rapidly with distance. In addition, the impact of this additional deposited mass on ingestion exposures is expected to be negligible.[10] Given these conditions, a downwind length of 10 km was determined to be appropriate for the screening scenario.

The north-south width of the wedge-shaped watershed was set based on the observed behavior of chemicals emitted to the ambient air. If meteorological stability is known or can be assumed,

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[10] Mass deposited at the outer edge of the watershed is expected to result in only a very small increase in estimated exposure via fish consumption by increasing the chemical mass transported to the lake through erosion and runoff. The distance from these more distant locations to the lake would attenuate transport of chemical mass by erosion and runoff, dampening the effect of including additional deposition beyond 10 km. (Other exposure pathways largely would be unaffected; the soil concentrations used to calculate exposures for the farm food scenario are derived from soil parcels located close to the source and unaffected by deposition to the far reaches of the watershed.)

the lateral spread of the plume ($\sigma_y$, measured from the centerline) at a certain distance from the source can be estimated using the Pasquill-Gifford curves. Turner (1970) derived the equations for these curves, which can be found in the Industrial Source Complex 3 Dispersion Model Manual (among other sources).[11] For a relatively neutral atmosphere (stability class D), σ at 10km is about 550 m using this estimation. In a Gaussian distribution, about 99.6 percent of the

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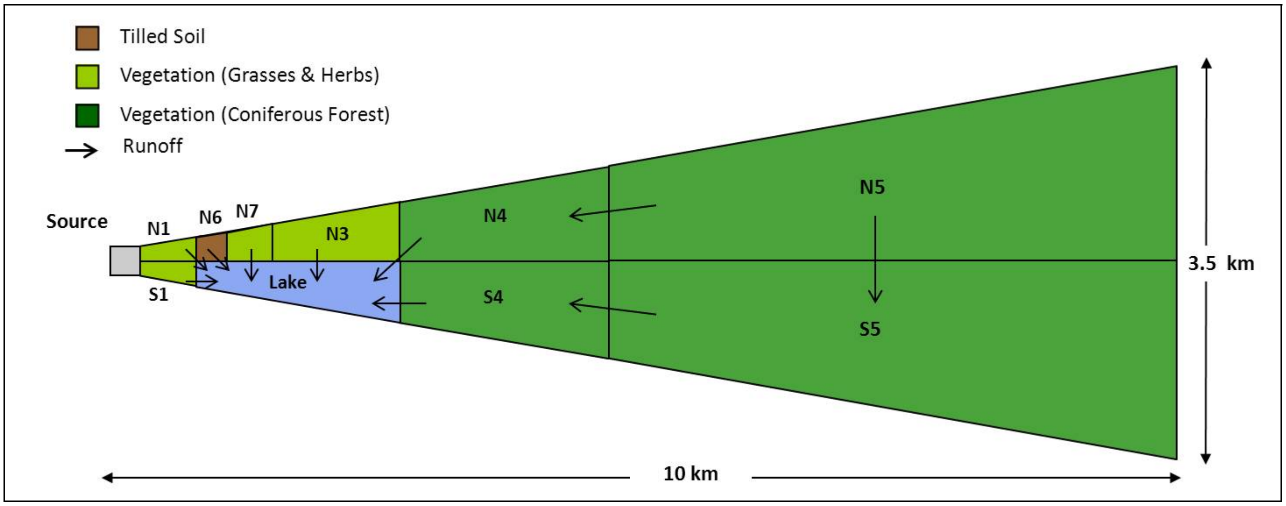
[11] http://www.epa.gov/scram001/userg/regmod/isc3v2.pdf

### Exhibit 9. TRIM.FaTE Surface Parcel Layout



plume spread area is contained within 3σ of the median line. Therefore, the plume σ was set at 3 times 550 m, or approximately 1.75 km from the centerline at a distance of 10 km. The plume width for these conditions is expected to be about twice this distance, or 3.5 km. These dimensions were used to define the dimensions of the overall air and surface parcel layouts for the screening scenario.

The surface (land and surface water) modeling area was initially divided into five pairs of parcels the areas of which increase with distance from the source, which approximately corresponds to the spatial gradient that is expected in the downwind direction from the source. The second north parcel from the source was divided further into two parts; one of them tilled soil (Parcel N6) to represent agricultural conditions and the other untilled to represent pasture.

The depth of the surface soil compartments was set to 1 cm, except for Parcel N6, for which the depth was set to 20 cm to simulate the effect of tillage. Characteristics of the soil layers (e.g., organic carbon content, air and water content, and subsoil depth) generally were set to represent typical or national averages as summarized by McKone et al. (2001), for example.

Initial considerations when the layout was configured included the presence of a stream that ran along the bisecting east-west line from the southwestern corner of Parcel N3 through the eastern edge of the layout. In that configuration, the eastern extent of the pond was restricted by a parcel (S3) directly south of Parcel N3. The stream received chemical mass from Parcels S3, S4, and S5 and flowed directly into the pond. Preliminary modeling runs showed that the existence of a stream somewhat decreased the concentrations of 2,3,7,8-TCDD in the pond parcel and significantly decreased concentrations in Parcels S3 and S4. These results indicated that the pond was receiving more 2,3,7,8-TCDD mass through surface soil transfer than through the stream, perhaps due to a chemical sink into stream sediment. Given the goal of creating a scenario that is protective of health, a stream was not included in the final layout.

The overall shape and boundaries of the air parcel layout mirror those of the surface parcel layout. A single air parcel (N2) overlies surface Parcels N6 and N7, and the air over the lake is divided into air Parcels S2 and S3 (mirroring the analogous parcels on the north side of the lake).

## 3.3 Watershed and Water Body Parameterization

Properties associated with the watershed soil and lake determine how pollutants in the system are transported through and accumulate in various compartments. These properties describe the physical characteristics of the environmental media included in the modeled region, as well as the assumed connections and relationships between media types and modeled spatial components that in turn affect chemical transport via water runoff, ground infiltration, deposition of suspended sediments in the water column, and other processes. This section presents the justification for setting the key properties of the soil, water, and sediment compartments. Also discussed are some of the chemical properties related to watershed and waterbody processes (chemical-specific compartment properties in TRIM.FaTE) and the configuration of terrestrial plants included in the scenario.

### *3.3.1 Water Balance*

Water-related properties of the lake and related watershed characteristics (e.g., runoff rates from each surface soil compartment) were set so that a simplified water balance is achieved. Although TRIM.FaTE maintains a chemical mass balance, the model does not calculate or maintain media mass balances (e.g., for water) except where specified in certain formulas. For the Tier 1 scenario, the parameters were set to satisfy two equations relating water volume. The first equation maintains a balance of water entering and leaving the terrestrial portion of the scenario:

*[total precipitation] = [evapotranspiration] + [total runoff]*

In this equation, total runoff is equal to the sum of overland runoff to the lake and seepage to the lake via groundwater.

The second equation describes the volumetric balance of transfers of water to and from the lake:

*[total runoff] + [direct precipitation to the lake] = [evaporation from the lake surface] + [outflow from the lake]*

Note that TRIM.FaTE actually uses only some of these properties (e.g., precipitation rate and surface runoff, but not evapotranspiration). The water characteristics assumed for the Tier 1 scenario are meant to represent a relatively wet and moderately warm location in the United States (USGS 1987). Following are the assumptions for this scenario:

- 35 percent of the total precipitation leaves the scenario through evapotranspiration.
- 65 percent of total precipitation remains in the modeled system and contributes to total runoff.
- Total runoff is divided between overland runoff and seepage to groundwater as follows:
- 40 percent of total precipitation contributes to overland runoff.
- 25 percent of total precipitation infiltrates into the groundwater and eventually flows into the lake.

For these calculations, the source parcel was considered to be outside the watershed and therefore was not included in the water balance. The evaporation rate from the lake was assumed to be 700 mm/yr based on data reported by Morton (1986) for various lakes. This estimate is probably more representative of cooler locations [by comparison, the overall average of evaporation rates from various reservoirs is reported by McKone et al. (2001) to be close to 1,200 mm/yr]. The runoff rate was defined to be spatially constant and temporally constant (i.e., it is not linked to precipitation events) throughout the modeled domain. Based on these assumptions, the outflow of water from the lake is about 18 million $m^3$/yr, which translates to a volumetric turnover rate of about 12.2 lake volumes per year.

Other quantitative water body and watershed characteristics TRIM.FaTE uses are listed in Addendum 1.

### *3.3.2 Sediment Balance*

A simplified balance of sediment transfers between the watershed and the lake was also maintained for the screening scenario via the parameterization of sediment-related properties. As with water, the model does not internally balance sediment mass; these calculations were performed externally for the purposes of setting parameter values. The sediment balance maintained is described by the following equation, where terms represent mass of sediment:

*[total surface soil transfers to the lake via erosion] =*
*[removal of sediment from the water column via outflow] + [sediment burial]*

where the second term (removal of sediment from the water column via outflow) is accounted for in TRIM.FaTE by lake flushing rate and the third term (sediment burial) is the transfer of sediment from the unconsolidated benthic sediment compartment to the consolidated sediment layer.

To maintain the sediment balance, erosion rates were calculated for each surface soil compartment using the universal soil loss equation (USLE, Wischmeier and Smith 1978), assuming a relatively high rate of erosion. The total suspended sediment concentration is assumed to remain constant in TRIM.FaTE, and the flushing rate of the lake (calculated via the water balance approach described above) was then used to estimate the removal of sediment from the modeling domain via lake water outflow. The difference between these sediment fluxes was taken to be the sediment burial rate. The sediment burial rate is the rate at which sediment particles in the unconsolidated benthic sediment layer are transported to the consolidated sediment, where the particles can no longer freely interact with the water column.

In TRIM.FaTE, the consolidated sediment layer is represented with a sediment sink; as with all sinks in TRIM.FaTE, chemical mass sorbed to buried sediment that is transported to the sink cannot be returned to the modeling domain. The burial rate is a formula property calculated by the model according to the difference between user-specified values for sediment deposition velocity (from the water column to the benthic sediment) and sediment resuspension velocity (back into the water column from the benthic sediments). These formula properties assume a constant volume of particles in the sediment layer (because the densities for benthic and suspended sediment particles were defined to the same value, the mass of particles in the sediment is also constant).

For the Tier 1 scenario described here, the average sediment delivery rate (i.e., transfer of sediment mass from watershed surface soil to the lake due to erosion) for the entire watershed was estimated to be about 0.0036 kg/$m^2$-day, based on calculations using the USLE. The HHRAP documentation notes that using the USLE to calculate sediment load to a lake from the surrounding watershed sometimes leads to overestimates (U.S. EPA 2005a). For the Tier 1 scenario, however, this approach was considered to be appropriate in that health protective assumptions are a goal of the screening scenario.[12] Surface soil compartments adjacent to the lake are linked directly to the lake for the purposes of estimating erosion and runoff transfers (see layout in Exhibit 9). Erosion and runoff from the source parcel are linked directly to a sink and do not enter the Tier 1 scenario lake. The transport of sediment to the lake via overland is thus assumed to be efficient. Note that erosion from parcels not directly adjacent to the lake is assumed to be somewhat attenuated, effected by using a lower sediment delivery ratio in the USLE.

Using the calculated surface soil erosion rates for the scenario, the total average daily sediment load to the lake from the watershed is about 16,600 kg/day. About 15 percent of this load is removed from the lake via outflow of suspended sediments (based on a calculated flush rate of 12.2 volume turnovers per year) with the remainder of the sediment input to the lake transferred to the sediment burial sink.

## 3.4 Meteorology

Meteorological properties used in TRIM.FaTE algorithms include air temperature, mixing height, wind speed and direction, and precipitation rate. These properties, which can vary significantly among geographic locations, and seasonally and hourly for a single location, greatly influence the chemical concentrations predicted in media of interest. Because the screening scenario is intended to be generally applicable for any U.S. location, and to minimize the frequency of false negatives, a health protective configuration was used. The meteorology of the screening scenario was defined to ensure that (when used in combination with the selected spatial layout) the maximum exposures that might be encountered for the scenarios of interest would be encompassed (i.e., consumption of home-grown farm foodstuffs and self-caught fish, with all farm foods and fish obtained from locations impacted by chemicals emitted from the local source). Ensuring that the meteorological parameters were not overly protective of health, such as *always* having the wind blow toward the location of interest, however, was also important to avoid too many false positives.

The meteorological data for the screening scenario are intended to be representative of a location with a low wind speed, a wind direction that strongly favors the watershed, and a relatively high amount of total precipitation falling on the watershed. The values used were based on actual data trends for U.S. locations as specified in Exhibit 10 but an artificial data set was compiled for this analysis (for example, temporally variable meteorological parameters were made to vary only on a daily basis). This simplified approach allowed for greater control (relative to selecting a data set for an actual location) so that desired trends or outcomes could be specified. Also, using a meteorological data set with values varying on a daily basis rather than a shorter period (such as hourly, which is the typical temporal interval for meteorological measurements) reduced required model run time. Meteorological inputs are summarized in Exhibit 10.

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[12] Based on sensitivity analysis, a higher erosion rate will both increase surface water concentrations and decrease surface soil concentrations; the relative impact on resulting concentrations, however, will be proportionally greater in the waterbody.

## Exhibit 10. Summary of Key Meteorological Inputs

| Meteorological Property | Selected Value | Justification |
|---|---|---|
| Air temperature | Constant at 298 Kelvin | Recommended default value listed in HHRAP (U.S. EPA 2005a). Value is similar to the mean daily June temperature in much of the U.S. Southern Plains and Southeast.[a] |
| Mixing height | Constant at 710 m | Value is 5th percentile of annual average mixing heights for 75 U.S. locations, using data obtained from EPA's SCRAM Web site.[b] Value is the approximate U.S. median for periods without precipitation, based on data compiled by Holzworth (1972). Value is conservative compared to the 1- to 2-km typical mid-latitude daytime value (Stull 1988). |
| Wind direction | Blows from source parcel into scenario domain (west to east) 3 days per week; during other times does not blow into domain | A wind direction that favors the location of interest (for example, a watershed downwind of a source of concern) will tend to result in more emitted mass accumulating in the location of interest. For much of the U.S. mid-Atlantic and western regions, the wind tends to favor the eastward direction.[a] Among the NCDC 1981–2010 normalized wind vector data, the average wind direction had a strong eastward component at over one-third of the stations.[c] For the hypothetical RTR scenario, a more extreme example of this pattern is represented by conditions in Yakima, Washington, where the wind blows eastward approximately 40 percent of the time based on a review of wind direction data compiled by the National Weather Service (NCDC 1995). This pattern was approximated in the RTR scenario with a configuration in which the modeled domain is downwind of the source 3 out of 7 days. |
| Horizontal wind speed | Constant at 2.8 m/sec | Set to 5th percentile of annual average speed for 239 stations across the contiguous United States (about 50 years of data per station). Value is similar to the annual average wind speeds of many areas of the U.S. east coast and west coast.[a] |
| Precipitation frequency | Precipitation occurs 3 days per week; wind direction blows into domain 2 of these days | This value was selected so that two-thirds of the total precipitation occurs when the domain is downwind of the modeled source. This pattern approximates that for rainy U.S. locations, where precipitation occurs 35–40% of the time (Holzworth 1972). These locations include parts of the U.S. Northeast and Northwest.[a] |
| Total Precipitation | 1.5 m/yr | Assumed to represent rainy conditions for the United States. This annual precipitation amount is experienced in parts of the U.S. Deep South and parts of the U.S. northwest coast.[a] Conditional precipitation rate (rainfall rate when precipitation is occurring) is 9.59 mm/d, which is similar to conditions in many areas along the U.S. east coast and in the Midwest and Plains.[a] |

[a] National Climatic Data Center CliMaps (NCDC-CliMaps) (2007). http://cdo.ncdc.noaa.gov/cgi-bin/climaps/climaps.pl.
[b] Support Center for Regulatory Atmospheric Modeling; http://www.epa.gov/ttn/scram/.
[c] National Climatic Data Center 1981-2010 Climate Normals; http://www.ncdc.noaa.gov/oa/climate/normals/usnormals.html

The sensitivity of modeled 2,3,7,8-TCDD concentrations to changes in these meteorological variables was tested. Lower wind speeds and mixing heights affected concentrations the most. This sensitivity is not unexpected because lower wind speeds should increase pollutant deposition onto the soil and lower mixing heights should reduce the volume through which pollutants disperse. The wind speed used for the screening scenario was 2.8 m/s, the 5thpercentile of the annual averages among 239 stations; by comparison, the mean annual average wind speed is approximately 4 m/s in the contiguous United States). The mixing height (mean heights from 4 states) used was 710 m (the 5th percentile of annual averages among all 40 states in the SCRAM database).

## 3.5 Aquatic Food Web

The aquatic food web is an important part of the screening scenario because the chemical concentrations modeled in fish are used to calculate human ingestion exposure and risks associated with eating contaminated local fish. A biokinetic approach to modeling bioaccumulation in fish is used in the RTR screening scenario. The primary producers (first trophic level) in the TRIM.FaTE aquatic ecosystems are algae and macrophytes in the water column and detritus in the sediments (the latter simulated as sediment particles). The scenario includes a benthic invertebrate compartment to represent the primary invertebrate consumers (second trophic level) in the benthic environment, and the fish compartments represent the higher tropic levels in the aquatic system. For TRIM.FaTE to provide reasonable predictions of the distribution of a chemical across biotic and abiotic compartments in aquatic systems, the biomass of the aquatic biotic compartments must represent all biota in the system and the distribution of biomass among the trophic levels and groups must be as realistic as possible.

To support the development of a relatively generic freshwater aquatic ecosystem in which to model bioaccumulation in fish, a literature search, review, and analysis was conducted in support of developing and parameterizing aquatic biotic compartments for TRIM.FaTE (ICF 2005). This research demonstrated that the diversity of species and food webs across U.S. aquatic ecosystems is substantial, reflecting the wide range of sizes, locations, and physical/chemical attributes of both flowing (rivers, streams) and low-flow water bodies (ponds, lakes, reservoirs). In general, lentic bodies of water (lakes and ponds) can accumulate higher levels of contaminants in both sediments and biota than lotic systems (rivers, streams). Also, the previous research (ICF 2005) suggests that a lake of at least 60 hectares (ha) or 150 acres could support higher trophic level predatory fish, with some fraction of their diet comprising smaller fish.

The RTR Tier 1 scenario includes a generic aquatic ecosystem with a 47-ha (116-acre) lake. Although slightly smaller than the size suggested by the previous review (ICF 2005), a 47-ha lake is large enough to support higher trophic level fish given appropriate conditions (e.g., high productivity given a sufficient nutrient base and temperature). Also, this size was compatible with the overall size of the defined watershed in the screening scenario. The fish types, biomass, diet fractions, and body weights recommended for fish compartments for the Tier 1 scenario are listed in **Exhibit 11.** Biomass is based on an assumption that the total fish biomass (wet-weight) for the aquatic ecosystem is 5.7 grams per square meter ($g_w/m^2$, ICF 2005).

In general, the food web implemented in the Tier 1 scenario is intended to be generally applicable across the United States and is intended to be generally health protective (to simulate a food web that maximizes bioaccumulation).

**Exhibit 11. Aquatic Biota Parameters for the TRIM.FaTE Screening Scenario**

| TRIM.FaTE Compartment Type | Organisms Represented by Compartment | Biomass | | Diet | Average Body Weight (kg) |
|---|---|---|---|---|---|
| | | Areal density ($g_w/m^2$) | Fraction of Total Fish Biomass | | |
| Algae | green algae, diatoms, blue-green algae | 7.95 | – | Autotrophic | – |
| Zooplankton | crustaceans, rotifers, protozoans | 6.36 | – | 100% algae[a] | 5.7 E−8 |
| Macrophyte | hydrilla, milfoil | 500 | – | – | – |
| Water column planktivore | young-of-the-year, minnows | 2.0 | 35.1% | 100% zooplankton | 0.025 |
| Water column omnivore | sucker, carp | 0.5 | 8.8% | 100% water column planktivore | 0.25 |
| Water column carnivore | largemouth bass, walleye | 0.2 | 3.5% | 100% water column omnivore | 2.0 |
| Benthic invertebrate | aquatic insect larvae, crustaceans, mollusks[b] | 20 | – | detritus in sediments | 0.000255 |
| Benthic omnivore | small catfish, rock bass | 2.0 | 35.1% | 100% benthic invert. | 0.25 |
| Benthic carnivore | large catfish, sculpins | 1.0 | 17.5% | 50% benthic invert.<br>50% benthic omniv. | 2.0 |
| **Total Fish Biomass** [c] | | **5.7** | | | |

[a] Algae is modeled as a phase of surface water in TRIM.FaTE.

[b] Benthic invertebrates include aquatic insects (e.g., nymphs of mayflies, caddisflies, dragonflies, and other species that emerge from the water when they become adults), crustaceans (e.g., amphipods, crayfish), and mollusks (e.g., snails, mussels).

[c] Total fish biomass does not include algae, macrophytes, zooplankton, or benthic invertebrates.

## 3.6 Using TRIM.FaTE Media Concentrations

The Tier 1 scenario outputs include average PB-HAP concentrations and deposition rates for each year and for each parcel of the model scenario. In each surface parcel, deposition rates to the soil are provided as are soil concentrations for the surface, root, and vadose zones and grass or leaf concentrations as appropriate for the plants. For each air parcel, air concentrations are provided. For the lake, surface water concentrations and concentrations in the various levels of the aquatic food chain are provided. For the ingestion exposure calculations, some concentrations are used to calculate direct exposure, and some are used to perform the farm food chain concentration calculations in the various media that humans can ingest (see Exhibit 4).

Regardless of whether the concentration and deposition values are used to calculate ingestion directly or are used in farm food chain calculations, selecting the parcel that is the source of the values used as inputs to succeeding calculations is necessary. The locations that determine direct and indirect exposures were selected assuming generally health protective assumptions. In general, decisions regarding which TRIM.FaTE outputs to use in calculating exposures for the Tier 1 scenario assume exposure at locations near the modeled source, thereby resulting in higher exposures to emitted chemicals. These assumptions are summarized in Exhibit 12.

TRIM.FaTE can output instantaneous chemical concentrations for a user-specified time step and also can be configured to calculate temporal averages (e.g., annual averages). For the Tier 1 scenario, the model is set up to output results on a daily basis, largely because daily is the smallest time step over which input data change (i.e., wind direction and precipitation rate). Daily concentration results were averaged to obtain annual average concentrations. The default assumption is annual average concentrations for media during the fiftieth year of emissions.

For the chemicals modeled in this scenario, long-term concentrations in environmental media will be relatively constant at 50 years (aside from mercury, chemicals modeled for RTR approach steady state before 50 years).

**Exhibit 12. Spatial Considerations – TRIM.FaTE Results Selected for Calculating Farm Food Chain Media Concentrations and Receptor Exposures**

| TRIM.FaTE Output Used in Exposure Calculations | Representative Compartment |
|---|---|
| Concentration in air, for uptake by plants via vapor transfer | Air compartment in air Parcel N2 (air over tilled soil) |
| Deposition rates, for uptake by farm produce | Deposition to surface soil compartment in surface Parcel N6 (tilled soil) |
| Concentration in surface soil, for incidental ingestion by humans and farm animals | Surface soil compartment in surface Parcel N1 (untilled soil, closest to facility) |
| Concentration in soil, for uptake by farm produce and animal feed | Surface soil compartment in surface Parcel N6 (tilled soil) |
| Concentration in fish consumed by angler | Water column carnivore compartment in lake (50% of fish consumed) and benthic carnivore in lake (50% of fish consumed) |

# 4 Description of Exposure and Risk Modeling Scenario

This section describes the approach for modeling chemical concentrations in farm food chain (FFC) media (Section 4.1); estimating human exposures associated with ingestion of FFC media, incidental ingestion of soil, ingestion of fish, and infant consumption of breast milk (Section 4.2); and calculating human health screening risk metrics associated with these exposure pathways (Section 4.3). All of these calculations are conducted using MIRC. For this multipathway screening evaluation, partitioning into FFC media is accomplished with the same model used to model exposure and risk, not as a part of the TRIM.FaTE modeling scenario. Consequently, processes and inputs related to estimating chemical levels in FFC media are summarized in this section and discussed in detail in Addendum 2.

## 4.1 Calculating Concentrations in Farm Food Chain Media

As was shown in Exhibit 5., MIRC was compiled to calculate concentrations of PB-HAPs in foodstuffs that are part of the farm food chain. The FFC media included in this screening scenario include:

- exposed and protected fruit,
- exposed and protected vegetables,
- root vegetables,
- beef,
- dairy products,
- pork, and
- poultry and eggs.

The algorithms used in MIRC were obtained from EPA's *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities* (HHRAP; U.S. EPA 2005a). These algorithms model the transfer of concentrations of PB-HAPs in FFC media using biotransfer factors. Environmental media concentrations (i.e., the chemical source terms in these algorithms) are obtained from TRIM.FaTE. As noted in Section 0, the TRIM.FaTE outputs included as inputs to MIRC are the following:

- PB-HAP concentrations in air;
- air-to-surface deposition rates for PB-HAPs in both particle and vapor phases;
- PB-HAP concentrations in fish tissue for water column carnivores and benthic carnivores; and
- PB-HAP concentrations in surface soil and root zone soil.

In general, plant- and animal-specific parameter values, including chemical-specific transfer factors for FFC media, were obtained from the Hazardous Waste Companion Database included in HHRAP (U.S. EPA 2005a). Addendum 2 provides parameter values used in MIRC for the Tier 1 assessment.

## 4.2 Ingestion Exposure

MIRC was used to estimate ingestion rates as ADDs, normalized to body weight for a range of exposure pathways. Exposure pathways included are incidental ingestion of soil and consumption of fish, produce, and farm animals and related products. The ingestion exposure pathways included in the screening evaluation and the environmental media through which these exposures occur are summarized in Exhibit 13.

## Exhibit 13. Summary of Ingestion Exposure Pathways and Routes of Uptake

| Ingestion Exposure Pathway | Medium Ingested | Intermediate Exposure Pathway – Farm Animals[a] | Environmental Uptake Route | |
|---|---|---|---|---|
| | | | Medium | Process[b] |
| Incidental ingestion of soil | Untilled surface soil | N/A | Surface soil | Deposition; transfer via erosion and runoff [c] |
| Consumption of fish | Fish from local water body | N/A | Fish tissue | Direct uptake from water and consumption of food compartments modeled in TRIM.FaTE[c] |
| Consumption of breast milk[d] | Breast milk | N/A | Breast milk | Ingested by mother and then partition to breast milk |
| Consumption of produce | Aboveground produce, exposed fruits and vegetables | N/A | Air<br>Air<br>Soil | Deposition to leaves/plants<br>Vapor transfer<br>Root uptake |
| | Aboveground produce, protected fruits and vegetables | N/A | Soil | Root uptake |
| | Belowground produce | N/A | Soil | Root uptake |
| Consumption of farm animals and related food products | Beef | Ingestion of forage | Air<br>Air<br>Soil | Direct deposition to plant<br>Vapor transfer to plant<br>Root uptake |
| | | Ingestion of silage | | |
| | | Ingestion of grain | Soil | Root uptake |
| | | Ingestion of soil | Soil | Ingestion from surface |
| | Dairy (milk) | Ingestion of forage | Air<br>Air<br>Soil | Direct deposition to plant<br>Vapor transfer to plant<br>Root uptake |
| | | Ingestion of silage | | |
| | | Ingestion of grain | Soil | Root uptake |
| | | Ingestion of soil | Soil | Ingestion from surface |
| | Pork | Ingestion of silage | Air<br>Air<br>Soil | Direct deposition to plant<br>Vapor transfer to plant<br>Root uptake |
| | | Ingestion of grain | Soil | Root uptake |
| | | Ingestion of soil | Soil | Ingestion from surface |
| | Poultry | Ingestion of grain | Soil | Root uptake |
| | | Ingestion of soil | Soil | Ingestion from surface |
| | Eggs | Ingestion of grain | Soil | Root uptake |
| | | Ingestion of soil | Soil | Ingestion from surface |

[a] Calculation of intermediate exposure concentrations were required only for the farm animal/animal product ingestion pathways.

[b] Process by which HAP enters medium ingested by humans.

[c] Modeled in TRIM.FaTE.

[d] The consumption of breast milk exposure scenario is discussed in Section 0.

### *4.2.1 Exposure Scenarios and Corresponding Inputs*

Specific exposure scenarios are developed by defining the ingestion activity patterns (i.e., estimating how much of each medium is consumed and the fraction of the consumed medium that is grown in or obtained from contaminated areas) and the characteristics of the hypothetical human exposed (e.g., age and body weight). MIRC computes exposure doses and risks for each ingestion pathway separately, enabling the pathway(s) of interest for each PB-HAP to be determined. Data related to exposure factors and receptor characteristics were obtained primarily from EPA's *Exposure Factors Handbook* (U.S. EPA 2011).

For the Tier 1 scenario described here, exposure characteristics that would result in a highly health protective estimate of total exposure were selected. The ingestion rate for each medium was set at high-end values (typically equal to the $90^{th}$ percentile of the distribution of national data for that medium). All media were assumed to be obtained from locations impacted by the modeled source. Although this approach results in an overestimate of total chemical exposure for a hypothetical exposure scenario (for example, note that the total food ingestion rate that results is extremely high for a hypothetical consumer with ingestion rates in the $90^{th}$ percentile for every farm food type), it was selected to avoid underestimating exposure for any single farm food type. The exposure characteristics selected for the Tier 1 scenario are summarized in Exhibit 14.

### *4.2.2 Calculating Average Daily Doses*

MIRC calculates chemical-specific ADDs normalized to body weight (mg PB-HAP per kg of body weight per day). Equations used to calculate ADDs were adapted from the algorithms provided in the technical documentation of EPA's *Multimedia, Multipathway, and Multireceptor Risk Assessment (3MRA) Modeling System* (U.S. EPA 2003), which derived much of its input data from the *Exposure Factors Handbook* (U.S. EPA 2011). The ingestion exposure modeling approach embodied by 3MRA is conceptually similar to that presented in HHRAP. A discussion of exposure dose estimation and the equations to calculate ADDs for each ingestion pathway are provided in Addendum 2.

### *4.2.3 Infant Ingestion of Breast Milk*

A nursing mother exposed to contaminants by any ingestion pathway described above can pass the contaminants to her infant through breast milk (ATSDR 1998). The nursing infant's exposure can be estimated from the levels of chemical concentrations in the breast milk, which in turn can be estimated based on the mother's chemical intake. Exposures can occur for infants via this pathway for dioxins.

Exposure to TCDD via breast milk consumption during the first year of life was estimated to account for approximately 30 percent of an adult's lifetime ADD. This ratio was determined to be independent of the scenario being modeled and is based on the assumption that the mother's exposure is approximately equal to the adult lifetime ADD exclusive of breast milk exposure. The 30 percent ratio and the validity of the supporting assumption were established by performing multiple MIRC model iterations using different scenarios. In the absence of congener-specific data, dioxin congeners were assumed to manifest the same tendency to accumulate in breast milk as TCDD. As a consequence, exposure to all dioxin congeners via breast milk consumption during the first year of life was assumed to account for approximately 30 percent of an adult's lifetime exposure to those congeners. Exposure via the breast milk pathway during the first year of life was, in this way, accounted for in developing the threshold

## Exhibit 14. Overview of Exposure Factors Used for RTR Multipathway Screening[a,b]

| Exposure Factor | Selection for Screening Assessment |
|---|---|
| Age group evaluated | Infants under 1 year (breast milk only)<br>Children 1–2 years of age<br>Children 3–5 years of age<br>Children 6–11 years of age<br>Children 12–19 years of age<br>Adult (20–70 years) |
| Body weight (BW; varies by age) | Weighted mean of national distribution |
| Intake rate and ingestion rate (IR) for farm produce and animal products (varies by age and media consumed) | 90th percentile of distribution of consumers who produce own food |
| Ingestion rate for fish | 105.5 g/day (represents the 99th percentile of fish consumption in the adult U.S. general population including consumers and non-consumers[c]; this estimate is considered within the range of average values for subsistence anglers[d]); lower values were assumed for younger age groups, also based on the 99th percentile of U.S. general population. Value reflects "as prepared" consumption rate so cooking and preparation losses did not need to be considered. |
| Exposure frequency (EF) | 365 days/year |
| Exposure duration | Lifetime, for estimating cancer risk; varies by chemical for chronic non-cancer evaluation |
| Fraction contaminated (FC) (varies by media consumed)[e] | 1 |
| Cooking loss[f] | Assumed to be "typical"; varies depending on food product (see Addendum 2). Cooking losses were not considered for fish consumption because intake rates represent "as prepared" values. |

[a] Data for exposure characteristics are presented in Addendum 2. Exposure parameter values were based on data obtained from the *Exposure Factors Handbook* (U.S. EPA 2011). See Addendum 2 for details.

[b] Exposure factor inputs are used in calculating ADD estimates for each exposure pathway. ADD equations for each pathway evaluated in this screening assessment are provided in Addendum 2.

[c] Fish consumption rates were obtained from *Estimated Per Capita Fish Consumption in the United States (U.S. EPA 2002c).* Consumption rates were averaged by body weight to represent the age groups used in the screening scenario.

[d] The relationship equating the 99th percentile of fish consumption in the general population with the range of average fish consumption rates for subsistence anglers was obtained from *Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health (U.S. EPA 2000)*.

[e] Fraction contaminated represents the fraction of food product that is derived from the environment included in the screening scenario (e.g., produce grown on soil impacted by PB-HAPs). This parameter is defined separately for each FFC medium; however, for the Tier 1 scenario, all ingested media are assumed to be impacted.

[f] Cooking loss inputs were included to simulate the amount of a food product that is not ingested due to loss during preparation or cooking, or after cooking.

screening level for dioxins. For mercury, cadmium, and POM, however, the breast milk pathway did not contribute a significant portion of an adult's lifetime ADD. Therefore, exposures to these chemicals via the breast milk pathway were not considered in developing the screening emission thresholds for mercury, cadmium, and POM.

## 4.3 Calculating Risk

MIRC was used to calculate excess lifetime cancer risk and non-cancer hazard (expressed as the hazard quotient or HQ) using the calculated ADDs and ingestion dose-response values. Chemical dose-response data include CSFs for ingestion and non-cancer oral RfDs. The CSFs and RfDs for the PB-HAPs included in the Tier 1 scenario are presented in Exhibit 15 and are discussed in more detail in Addendum 2. Equations used to estimate cancer risk and non-cancer hazard also are provided in Addendum 2.

Estimated individual cancer risks for the PAHs included in the screening scenario were adjusted upward to account for the mutagenic cancer potency of these compounds during childhood, as specified by EPA in supplemental guidance for cancer risk assessment (U.S. EPA 2005c). Specifically, cancer potency for PAHs is assumed to be tenfold greater for the first 2 years of life and threefold greater for the next 14 years. These factors were incorporated into a time-weighted total increase in potency over a lifetime of 70 years. The cancer potency adjustment for chemicals with a mutagenic mode of action is discussed in Addendum 2.

**Exhibit 15. Dose-response Values for PB-HAPs Addressed by the Screening Scenario**

| PB-HAP | CSF ($[\text{mg/kg-day}]^{-1}$) | Source | RfD (mg/kg-day) | Source |
|---|---|---|---|---|
| ***Inorganics*** | | | | |
| Cadmium compounds (as Cd) | not available | | 1E−3 | IRIS |
| Elemental mercury | not available | | not available | |
| Divalent mercury | not available | | 3E−4 | IRIS |
| Methyl mercury | not available | | 1E−4 | IRIS |
| ***Organics*** | | | | |
| Benzo[a]pyrene[a] | 10 | IRIS | not available | |
| 2,3,7,8-TCDD | 1.5E+5 | EPA ORD | 7E−10 | IRIS |

Source: U.S. EPA (2007).
CSF = cancer slope factor; RfD = reference dose; IRIS = Integrated Risk Information System; Cal/EPA = California Environmental Protection Agency; EPA ORD = EPA's Office of Research and Development

[a] For consistency with the overall approach for dose-response assessment of PAHs, the CSF listed in IRIS for benzo[a]pyrene ($[7.3 \text{ mg/kg-day}]^{-1}$) was adjusted due to its mutagenic mode of action as discussed below (see also Addendum 2).

## 4.4 Summary of Tier 1 Assumptions

As emphasized previously, the screening scenario created for evaluating PB-HAP emissions from RTR facilities is intended to be health protective to prevent underestimating risk. The overall degree to which the scenario is health protective is the sum of the multiple assumptions that affect the outputs of the fate and transport, exposure, and risk modeling. Exhibit 16 summarizes important characteristics that influence exposure and risk estimates for this scenario and indicates the general degree of health protectiveness associated with the values for each assumption. Although this summary does not provide a quantitative estimate of the output uncertainty or the degree to which exposures and risks estimated using the scenario would be overestimated, it does demonstrate qualitatively that the scenario generally overestimates exposure and thus favors a health-protective risk output.

## Exhibit 16. Summary of RTR Screening Scenario Assumptions

| Characteristic | Value | Neutral or Health Protective? | Comments on Assumptions |
|---|---|---|---|
| ***General Spatial Attributes*** | | | |
| Farm location | 375 m from source; generally downwind | Health Protective | Location dictates soil and air concentrations and deposition rates used to calculate chemical levels in farm produce. |
| Lake location | 375 m from source; generally downwind | Health Protective | Location dictates where impacted fish population is located. |
| Surface soil properties | Typical values or national averages | Neutral | Based on existing EPA documentation and other references. |
| Size of farm parcel | About 4 ha | Health Protective | Relatively small parcel size results in higher chemical concentration. |
| Size of lake | 46 ha; about 3 m average depth | Health Protective | Lake is large enough to support an aquatic ecosystem with higher trophic-level fish, but is relatively small and shallow (thus increasing surface area-to-volume ratio). |
| ***Meteorological Inputs*** | | | |
| Total precipitation | 1.5 m/yr | Health Protective | Intended to represent rainy U.S. location; set to highest state-wide average for the contiguous United States. |
| Precipitation frequency (with respect to impacted farm/lake) | 2/3 of total precipitation fall on farm/lake and watershed | Health Protective | Most of total precipitation occurs when the farm/lake are downwind of the source. |
| Wind direction | Farm/lake are downwind 40% of the time | Health Protective | Farm/lake located in the predominantly downwind direction. Temporal dominance of wind direction based on data from Yakima, Washington, where wind is predominantly from the west. |
| Wind speed | 2.8 m/sec | Health Protective | Low wind speed (5th percentile of long-term averages for contiguous United States); increases net deposition to lake/watershed. |
| Air temperature | 298 K | Neutral | Typical for summer temperatures in central and southern United States. |
| Mixing height | 710 m | Health Protective | Relatively low long-term average mixing height (5th percentile of long-term averages for contiguous United States); increases estimated air concentration. |
| ***Watershed and Water Body Characteristics*** | | | |
| Evaporation of lake surface water | 700 mm/yr | Neutral | Value is representative of cooler climates. |
| Surface runoff into lake | Equal to 40% of total precipitation | Health Protective | Based on typical water flow in wetter U.S. locations; higher runoff results in greater transfer of chemical to lake. |

## Exhibit 16. Summary of RTR Screening Scenario Assumptions

| Characteristic | Value | Neutral or Health Protective? | Comments on Assumptions |
|---|---|---|---|
| Surface water turnover rate in lake | About 12 turnovers per year | Neutral | Consistent with calculated water balance; reasonable in light of published values for small lakes. Might overestimate flushing rate if water inputs are also overestimated. Note that after evapotranspiration, remaining water volume added via precipitation is assumed to flow into or through lake. |
| Soil erosion from surface soil into lake | Varies by parcel; ranges from 0.002 to 0.01 kg/m$^2$-day | Neutral | Erosion rates were calculated using the universal soil loss equation (USLE); inputs to USLE were selected to be generally conservative with regard to concentration in the pond (i.e., higher erosion rates were favored). Might underestimate erosion for locations susceptible to high erosion rates. Note that higher erosion increases concentration in lake (and fish) but decreases levels in surface soil (and farm products). |
| Aquatic food web structure and components | Multilevel; includes large, upper trophic-level fish | Health Protective | Inclusion of upper trophic-level fish and absence of large-bodied herbivore/detritivore fish favor higher concentrations of bioaccumulative chemicals and result in higher concentrations in consumed fish. Linear food-chain maximizes concentration of bioaccumulative chemicals in higher trophic-level fish. |
| ***Parameters for Estimating Concentrations in Farm Food Chain Media*** | | | |
| Fraction of plants and soil ingested by farm animals that is contaminated | 1.0 (all food and soil from contaminated areas) | Health Protective | Assumes livestock feed sources (including grains and silage) are derived from most highly impacted locations. |
| Soil- and air-to-plant transfer factors for produce and related parameters | Typical (see Addendum 2 for details) | Neutral | Obtained from peer-reviewed and standard EPA reference sources. |
| Biotransfer factors for efficiency of uptake by animal of chemical in food/soil | Typical (see Addendum 2 for details) | Neutral | Obtained from peer-reviewed and standard EPA reference sources. |
| Bioavailability of chemicals in soil (for soil ingested by animals) | 1.0 (relative to bioavailability of chemical in plant matter) | Health Protective | Probably overestimates bioavailability in soil; many chemicals are less bioavailable in soil than in plants. |

## Exhibit 16. Summary of RTR Screening Scenario Assumptions

| Characteristic | Value | Neutral or Health Protective? | Comments on Assumptions |
|---|---|---|---|
| ***Ingestion Exposure Assumptions*** | | | |
| Ingestion rates for all farm produce/livestock types | Person obtains all food sources from local farm; ingestion rate is 90th percentile of rates for home-produced food items | Health Protective | All food derived from impacted farm; total food ingestion rate would exceed expected body weight-normalized ingestion rates (prevents underestimating any individual food type). |
| Fish ingestion rate | 1.48 g/kg-day for adults; between 1.29 and 2.08 g/kg-day for children ages 1–19 years | Health Protective | Rates are based on the 99th percentile of general population fish consumption from EPA's analysis of freshwater and estuarine fish consumption derived from the USDA *Continuing Survey of Food Intake by Individuals* (2002). Consumption rates were averaged by body weight to represent the age groups used in the screening scenario. These ingestion rates likely overestimate long-term fish consumption rates for the general population. See Addendum 2 for a detailed discussion. |
| Exposure frequency | Consumption of contaminated food items occurs 365 days/yr | Health Protective | All meals from local farm products. |
| Body weight | Mean of national distribution | Neutral | Note that this does not affect the body-weight-normalized rates for produce and animal products. |
| ***Other Chemical-Specific Characteristics*** | | | |
| General chemical properties used in fate and transport modeling (Henry's law, $K_{ow}$, etc.) | Varies | Neutral | Obtained from peer-reviewed sources; intended to be representative of typical behavior and characteristics. |
| "General" physical properties (plant matter density, aquatic life biomass, algal growth rate, etc.) | Varies | Neutral | Obtained from peer-reviewed sources; intended to be representative of typical behavior and characteristics. |
| Dose-response values | Varies | Neutral to Health Protective | Values used are those determined to be appropriate for risk assessment by OAQPS; values are developed to be health protective. |

# 5 Evaluation of Screening Scenario

## 5.1 Introduction

The screening scenario developed for assessing multipathway human health risk for EPA's Risk and Technology Review has been subjected to a series of evaluations. The major PB-HAP categories of concern for this analysis are cadmium compounds (Section 5.2), mercury compounds (Section 5.3), dioxins (Section 5.4), and POM (Section 5.5). The scenario evaluations were focused primarily on assessing the behavior of these HAP categories in the environment, the accumulation of these chemicals in ingestible food products, and the predominant pathways of human exposure.

## 5.2 Cadmium Compounds

Some of the largest anthropogenic sources of cadmium to air are facilities that process, mine, or smelt cadmium-zinc ores or cadmium-zinc-lead ores, coal- and oil-fired boilers, other urban and industrial facilities, phosphate fertilizer manufacturing facilities, road dust, and municipal sewage sludge incinerators (ATSDR 2008).

### *5.2.1 Behavior in the Environment*

Once emitted into the environment, airborne cadmium particles can be transported over long distances before being they are deposited. Cadmium has been observed to partition primarily to soil when released to the environment (ATSDR 2008). The mobility of cadmium in soil depends strongly on soil pH, clay content, and availability of organic matter—factors that determine whether the cadmium is dissolved or sorbed in surface soil. In general, cadmium adsorbs to soil particles in the surface layers of the soil profile, but to a lesser degree than many other heavy metals (HSDB 2005a). Cadmium also binds strongly to organic matter, rendering the metal relatively immobile in some soils. Nonetheless, some plants still can take up cadmium efficiently, thus providing an entry point for cadmium into the food chain (ATSDR 2008).

Cadmium also enters surface waters, which can occur via atmospheric deposition, runoff and erosion, or wastewater streams. Most cadmium compounds entering the water column are quickly removed through adsorption to organic matter in sediment or to other suspended compounds. Cadmium that remains in the water column is expected to exist primarily in the dissolved state where it is available for uptake by aquatic organisms.

Freshwater fish accumulate cadmium primarily through direct uptake of the dissolved form through the gills and secondarily through the diet, which plays a variable role in total cadmium uptake (Reinfelder et al. 1998; Chen et al. 2000; Saiki et al. 1995). Although some biomagnification of cadmium has been reported for aquatic food chains in saltwater systems, biomagnification in freshwater systems appears to be present only at lower trophic levels (Chen et al. 2000) and in narrowly defined niches (e.g., plankton/macroinvertebrate food chains; Croteau et al. 2005). Biomagnification factors (BMFs) of less than 1 generally have been reported for fish at higher trophic levels, indicating that cadmium concentrations generally biodiminish from lower to higher trophic levels (Chen et al. 2000; Mason et al. 2000).

For the RTR screening scenario, the partitioning behavior modeled in TRIM.FaTE was consistent with the behavior of cadmium expected in the natural environment.

### *5.2.2 Concentrations in Ingestible Products*

Most non-inhalation exposure to cadmium outside of occupational settings is through dietary intake. Available data indicate that cadmium accumulates in plants, aquatic organisms, and terrestrial animals, offering multiple ingestion exposure pathways (ATSDR 2008). Actual cadmium levels in ingestible products, however, varies based on type of food, agricultural and cultivation practices, atmospheric deposition rates, characteristics of environmental media, and presence of other anthropogenic pollutants. Meat and fish generally contain lower amounts of cadmium overall, but cadmium can be highly concentrated in certain organ meats, such as kidney and liver (ATSDR 2008). In a study of cadmium concentrations in 14 food groups (including prepared foods), meat, cheese, and fruits generally contained low levels of cadmium (ATSDR 2008).

For the RTR screening scenario, the cadmium concentrations output by MIRC were consistent with reported values in all ingestible media products. The products with higher reported cadmium levels in the literature, including soil, plants, and fish, also contained the higher modeled concentrations.

### *5.2.3 Average Daily Dose (ADD)*

To determine the media most relevant to exposure and risk, the ingestion exposure factors must be considered in addition to the estimated media concentrations (i.e., a higher concentration for a particular medium does not necessarily mean higher risk). In Exhibit 17, the contributions of ingestion exposure pathways to the average daily dose (ADD) (and thus the HQ) for the different age categories are presented. As shown in the exhibit, fish ingestion is the dominant exposure pathway across all age categories, accounting for as much as 98 percent of the ADD for some groups. The combined contribution from all other exposure pathways accounts for less than 5 percent of the total ADD for all age groups. Most of the additional exposure was from ingestion of fruits and vegetables. The highest ADD corresponds to children aged 1–2 years; thus, the exposure corresponding to this group was used to determine the emission threshold for cadmium.

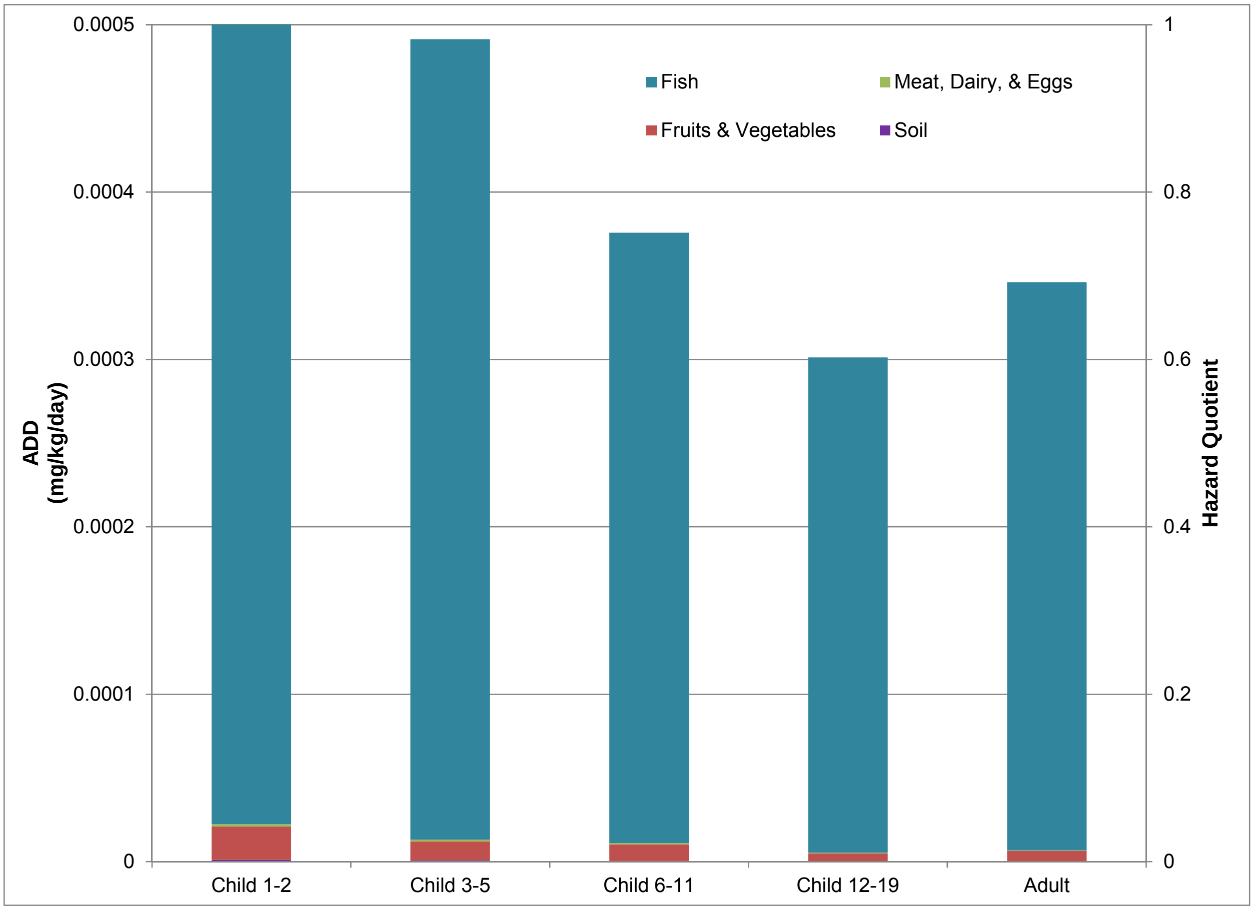
## 5.3 Mercury Compounds

Some of the largest anthropogenic sources of mercury to air are facilities that process, mine, or smelt mercury ores; industrial/commercial boilers; fossil fuel combustion activities (primarily coal); cement production facilities; other urban and industrial facilities; and medical and municipal waste incinerators (ATSDR 1999). These facilities can emit a mixture of elemental and divalent mercury, mostly in the gaseous phase, with some divalent forms in particle-bound phases (U.S. EPA 1997).

### *5.3.1 Behavior in the Environment*

Once emitted into the environment, mercury undergoes changes in form and species as it moves through environmental media. Elemental mercury is the most prevalent species of mercury in the atmosphere. Due to the long residence time of elemental mercury in the atmosphere, this compound is relatively well distributed, even on a global scale.

## Exhibit 17. Estimated Contributions of Modeled Food Types to Cadmium Ingestion Exposures and Hazard Quotients



Divalent mercury is removed from the atmosphere at a faster rate than elemental mercury, and it can be transferred to the surface near the emission source via wet or dry deposition where it appears to adsorb tightly to soil particles (U.S. EPA 1997) or dissolved organic carbon. Divalent mercury in soil also can be methylated by microbes or reduced to elemental mercury and revolatilized back into the atmosphere. Most divalent mercury from atmospheric deposition will remain in the soil profile, however, in the form of inorganic compounds bound to soil organic matter. Although this complexing behavior with organic matter significantly limits mercury transport, the ability of mercury to form these complexes greatly depends on soil conditions such as pH, temperature, and soil humic content. For example, mercury strongly adsorbs to humic materials and sesquioxides in soil at pH > 4 and in soils with high iron and aluminum content (ATSDR 1999). Small amounts of mercury in soil can be transported to surface water via runoff or leaching.

Mercury could also enter the water column through atmospheric fallout. Once in the water body, divalent mercury can be methylated through microbial activity. In addition, divalent and methyl mercury can be further reduced to elemental mercury, which can volatilize and reenter the atmosphere. Solid forms of inorganic mercury compounds could adsorb to particulates in the water column or partition to the sediment bed (U.S. EPA 1997).

The solubility of mercury in water depends on the species and form of mercury present as well as properties of the water such as water pH and chloride ion concentration (ATSDR 1999). Low pH favors the methylation of mercury in the water column, typically performed by sulfur-reducing bacteria in anaerobic conditions. Methyl mercury is typically of greatest concern because it readily bioaccumulates and efficiently biomagnifies in aquatic organisms. A considerable amount (25–60 percent) of both divalent mercury compounds and methyl mercury is strongly bound to particulates in the water column (U.S. EPA 1997). The remaining mercury is dissolved. Most of the elemental mercury produced as a result of reduction of divalent mercury volatilizes back into the atmosphere.

For the screening scenario, the partitioning behavior modeled in TRIM.FaTE generally was consistent with trends noted in the literature. Divalent mercury was the most prevalent species in modeled surface soil, surface water, and sediment compartments, while methyl mercury was the dominant species in fish.

### *5.3.2 Concentrations in Ingestible Products*

Available data indicate that mercury bioaccumulates in plants, aquatic organisms, and terrestrial animals, providing multiple ingestion exposure pathways (U.S. EPA 1997; ATSDR 1999). Low levels of mercury are found in plants, with leafy vegetables containing higher concentrations than potatoes, grains, legumes, and other vegetables and fruits (ATSDR 1999; EPA 1997). Cattle demethylate mercury in the rumen and, therefore, store very little of the mercury they ingest by foraging or consuming silage or grain. Thus, mercury content in meat and cow’s milk is low (ATSDR 1999). Concentrations of methyl mercury in fish are generally highest in larger, older specimens at the higher trophic levels (U.S. EPA 1997).

Although data on mercury in foods other than fish are not abundant in the literature, total mercury concentrations output by MIRC were generally consistent with the reported values that were available. The exposure pathways that most influenced the mercury HQs in the model are presented in Exhibit 18. As shown, the dominant exposure pathway for all age groups is ingestion of fish. Relative to divalent mercury, methyl mercury concentrations in fish were very high (approximately 95 percent of total mercury).

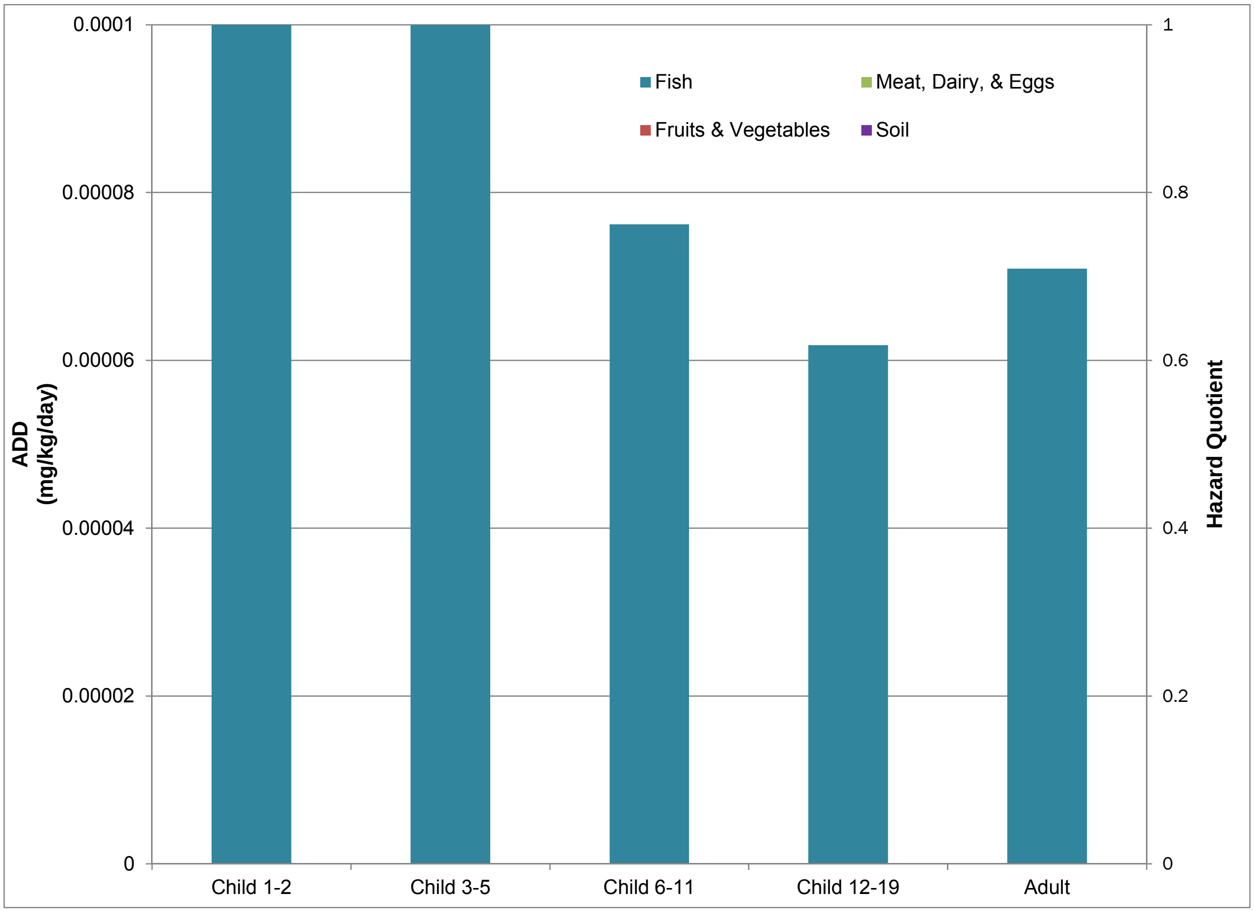
### *5.3.3 Average Daily Dose*

In Exhibit 18, the contributions of ingestion exposure pathways to the ADD (and thus the HQ) for methyl mercury across the different age categories are presented. As shown, fish is the dominant exposure pathway across all age categories, accounting for nearly 100 percent of the ADD for each group. The combined contribution of all other exposure pathways accounts for less than 1 percent of the total ADD for all age groups. The high degree of exposure to methyl mercury through fish ingestion is attributed to the ease with which this compound bioaccumulates and biomagnifies in fish and to the health protective ingestion assumptions used in the screening scenario. The highest ADD corresponds to children aged 1–2 years; thus, the exposure corresponding to this group was used to determine the emission threshold for mercury.

## 5.4 Dioxins

Incineration and combustion processes are believed to be the primary emission sources for chlorinated dioxins (ATSDR 1998). The five stationary source categories that generate the vast majority of 2,3,7,8-TCDD emissions in the United States are municipal waste incineration, medical waste incineration, hazardous waste kilns from Portland cement manufacturing, secondary aluminum smelting, and biological incineration.

**Exhibit 18. Estimated Contributions of Modeled Food Types to Methyl Mercury Ingestion Exposures**



### *5.4.1 Behavior in the Environment*

Dioxins emitted to the atmosphere can be transported long distances in vapor form or bound to particulates, depositing in soils and water bodies in otherwise pristine locations far from the source. Although airborne dioxins are susceptible to wet and dry deposition, most dioxins emitted to the atmosphere through incineration/combustion processes are not deposited close to the source (ATSDR 1998).

In soil, dioxins strongly adsorb to organic matter and show very little vertical movement, particularly in soils with a high organic carbon content (ATSDR 1998). Most dioxins deposited in soil are expected to remain buried in the soil profile, with erosion of contaminated soil particles the only significant mechanism for transport to water bodies.

The dry deposition of dioxins from the atmosphere to water bodies is another important transport process. Because of the hydrophobic nature of dioxins, most dioxins entering the water column are expected to adsorb to suspended organic particles or partition to bed sediment, which appears to be the primary environmental sink for this chemical group (U.S. EPA 2004c). Although dioxins bound to aquatic sediment primarily become buried in the sediment compartment, some resuspension and remobilization of congeners can occur if sediments are disturbed by benthic organisms (ATSDR 1998).

Bioaccumulation factors (BAFs) in fish are high as a result of the lipophilic nature of chlorinated dioxins. Although the processes by which freshwater fish accumulate dioxins are not well understood, both fish and invertebrates bioaccumulate congeners that have partitioned to sediment or have become suspended in water (U.S. EPA 2004c). Because most dioxins in the aquatic environment are adsorbed to suspended particles, however, direct uptake from the water is unlikely to be the primary route of exposure for most aquatic organisms at higher trophic levels (ATSDR 1998). At lower trophic levels, the primary route of exposure appears to be through uptake of water in contaminated sediment pores, and the primary route of exposure in the higher trophic levels appears to be through food chain transfer. Following ingestion, some fish can slowly metabolize certain congeners, such as 2,3,7,8-TCDD, and release the polar metabolites in bile. This process ultimately might limit bioaccumulation at higher trophic levels (ATSDR 1998).

For the RTR screening scenario, the partitioning behavior modeled in TRIM.FaTE was consistent with the behavior of 2,3,7,8-TCDD expected in the natural environment. Also of note is that dioxins readily partition into breast milk due to the lipophilic nature of these compounds.

### *5.4.2 Concentrations in Ingestible Products*

The primary source of non-inhalation exposure to dioxins outside of occupational settings is through dietary intake, which accounts for more than 90 percent of daily dioxin exposure (ATSDR 1998). Available data indicate that dioxins concentrate in plants, aquatic organisms, and animals, offering multiple ingestion exposure pathways. Actual congener levels in ingestible products, however, can vary based on type of food, agricultural and cultivation practices, atmospheric deposition rates, characteristics of environmental media, and presence of other anthropogenic pollutants. Dioxins appear to enter the terrestrial food chain primarily through vapor-phase deposition onto surfaces of plants, which are then consumed by larger animals. Another major source of exposure to dioxins is through ingestion of contaminated soil by animals.

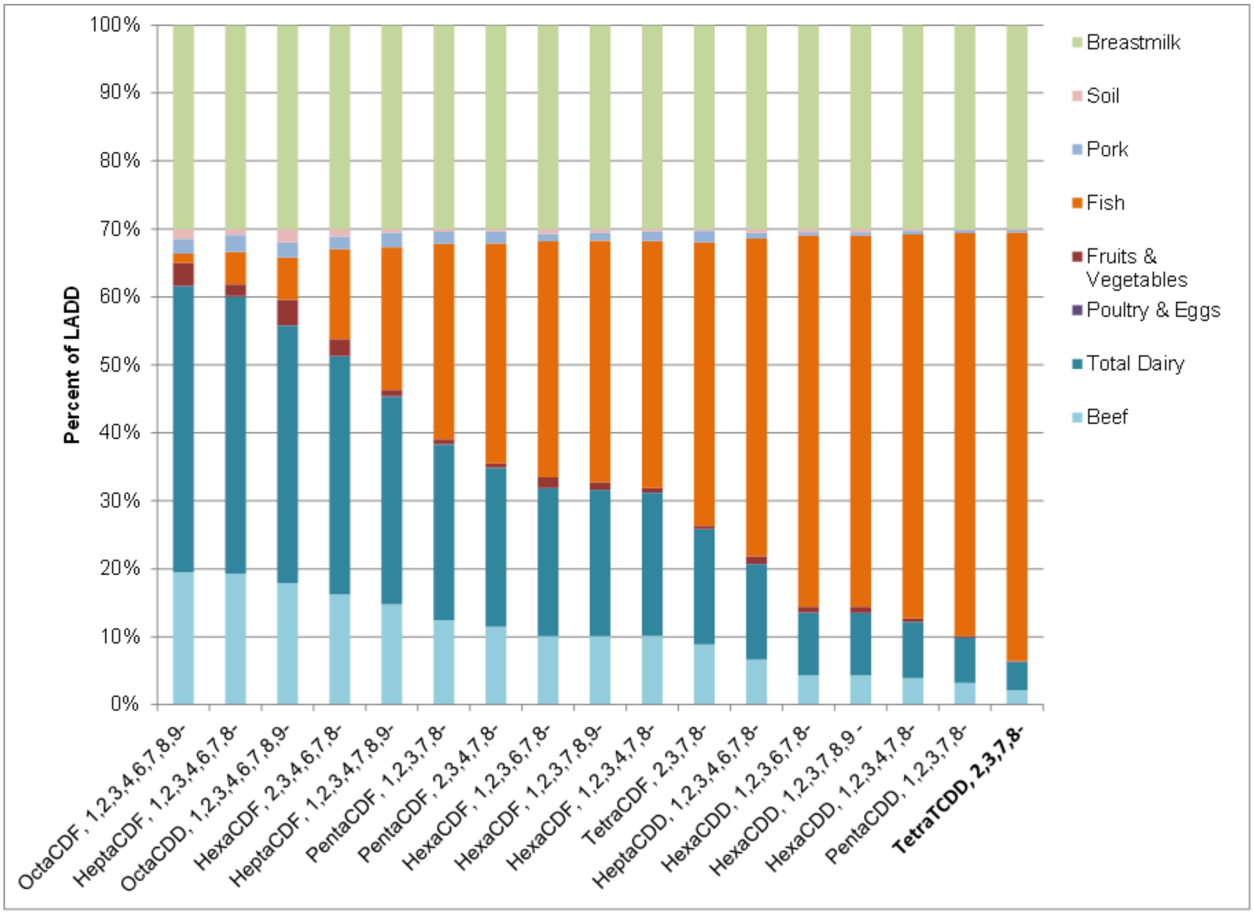
Observed trends indicate that meat, dairy, and fish consumption are the dominant exposure pathways, comprising 90 percent of dioxin dietary intake (ATSDR 1998). Consistent with the literature, the modeled concentration of 2,3,7,8-TCDD in the fish compartment for the screening scenario was at least one order of magnitude greater than concentrations in the other compartments. Among the compartments with the lowest concentrations were fruits and vegetables, which do not readily accumulate 2,3,7,8-TCDD.

Ingestion of breast milk during infancy and fish ingestion contribute to nearly 94 percent of lifetime dioxin exposure for 2,3,7,8-TCDD in the screening scenario. Daily intakes of 2,3,7,8-TCDD from cow's milk, produce, and fish have been reported in the literature to comprise 27 percent, 11 percent, and 10 percent, respectively, of the total daily intake in the general population. Some studies note that specific subpopulations, such as subsistence farmers and anglers, however, might have very different exposure profiles in which fish, meat, and dairy drive congener exposure (ATSDR 1998). Given the subsistence diet modeled in the RTR screening scenario, the high exposure from consumption of fish is appropriate within the context of this analysis.

### *5.4.3 Lifetime Average Daily Dose (LADD)*

The contributions of ingestion exposure pathways to the lifetime average daily dose (LADD) (and thus lifetime cancer risk) for the modeled dioxin congeners are presented in Exhibit 19. Based on the modeling methodology and assumptions used, exposures via the breast milk

**Exhibit 19. Estimated Contributions of Modeled Food Types to Dioxin Ingestion Exposures**



pathway consistently account for approximately 30 percent of the lifetime exposure for all congeners, while exposure via fish, soil, and the various farm food chain pathways is highly variable across congeners. This variability can be explained in part by differences in the physiochemical properties that drive the environmental transport processes of these congeners (e.g., $K_{ow}$, molecular weight). The differences are also likely attributed to differences in the congener-specific half-life in abiotic media and the degree to which the congener is metabolized in biotic media.

## 5.5 Polycyclic Aromatic Hydrocarbons

PAHs can enter the atmosphere as a result of a variety of combustion processes, both natural and anthropogenic. Stationary emission sources account for approximately 80 percent of total annual PAH emissions. Although the primary source of stationary source PAH emissions is thought to be residential wood burning, other processes such as power generation; incineration; coal tar, coke, and asphalt production; and petroleum catalytic cracking are also major contributors (ATSDR 1995).

### *5.5.1 Behavior in the Environment*

PAHs emitted to the atmosphere can travel long distances in vapor form or attached to particles, or they can deposit relatively close to an emission source via wet or dry deposition onto water, soil, and vegetation. In the atmosphere, PAHs are found primarily in the particle-bound phase, and atmospheric residence time and transport distances are highly influenced by climatic conditions and the size of the particles to which they are bound (ATSDR 1995).

As a result of sustained input from anthropogenic sources, PAHs are ubiquitous in soil. High molecular weight PAHs, such as benzo(a)pyrene, strongly adsorb to organic carbon in soil, indicating that adsorption to soil particles will limit the mobility of these compounds following deposition to soil (ATSDR 1995).

Most PAHs enter the water column directly through atmospheric deposition (ATSDR 1995). Following deposition onto surface waters, approximately two-thirds of PAHs adsorb strongly to sediment and suspended particles, while only small amounts revolatilize back to the atmosphere (ATSDR 1995). Aquatic organisms can accumulate PAHs via uptake from water, sediment, or food. Although fish and other organisms readily take up PAHs from contaminated food, biomagnification generally does not occur because many organisms can rapidly metabolize PAHs (ATSDR 1995). As a result, concentrations of PAHs have generally been observed to decrease with increasing trophic levels (ATSDR 1995). Due to this ability to metabolize PAHs, BAFs in fish are not expected to be especially high. Sediment-dwelling organisms can experience increased exposure to PAHs through association (e.g., direct uptake, consumption) with contaminated sediment (ATSDR 1995).

For the screening scenario, the partitioning behavior of benzo(a)pyrene is generally consistent with trends reported in the literature.

### *5.5.2 Concentrations in Ingestible Products*

The primary source of non-inhalation exposure to benzo(a)pyrene outside of occupational settings is through dietary intake. Exposure can depend on the origin of the food (higher values are often recorded at contaminated sites) and the method of food preparation (higher values have been reported for food that is smoked or grilled). PAHs have been observed to bioaccumulate in aquatic organisms and terrestrial animals through uptake of contaminated water, soil, and food. These compounds are readily metabolized by higher trophic level organisms, including humans, however, so biomagnification is not considered to be significant (ATSDR 1995). Plants accumulate PAHs primarily through atmospheric deposition, but chemical concentrations tend to be below detection levels. PAHs in meat have been observed at concentrations below detection levels up to higher concentrations when the meat is smoked. Similar concentrations have been reported for fish, with smoked fish concentrations sometimes quadruple those found in terrestrial animals. Because PAH concentrations are highest in products that are smoked or grilled, most of the available data for benzo(a)pyrene in food is for products that have been prepared using these processes. As a result, reported values might be significantly higher than those output by MIRC.

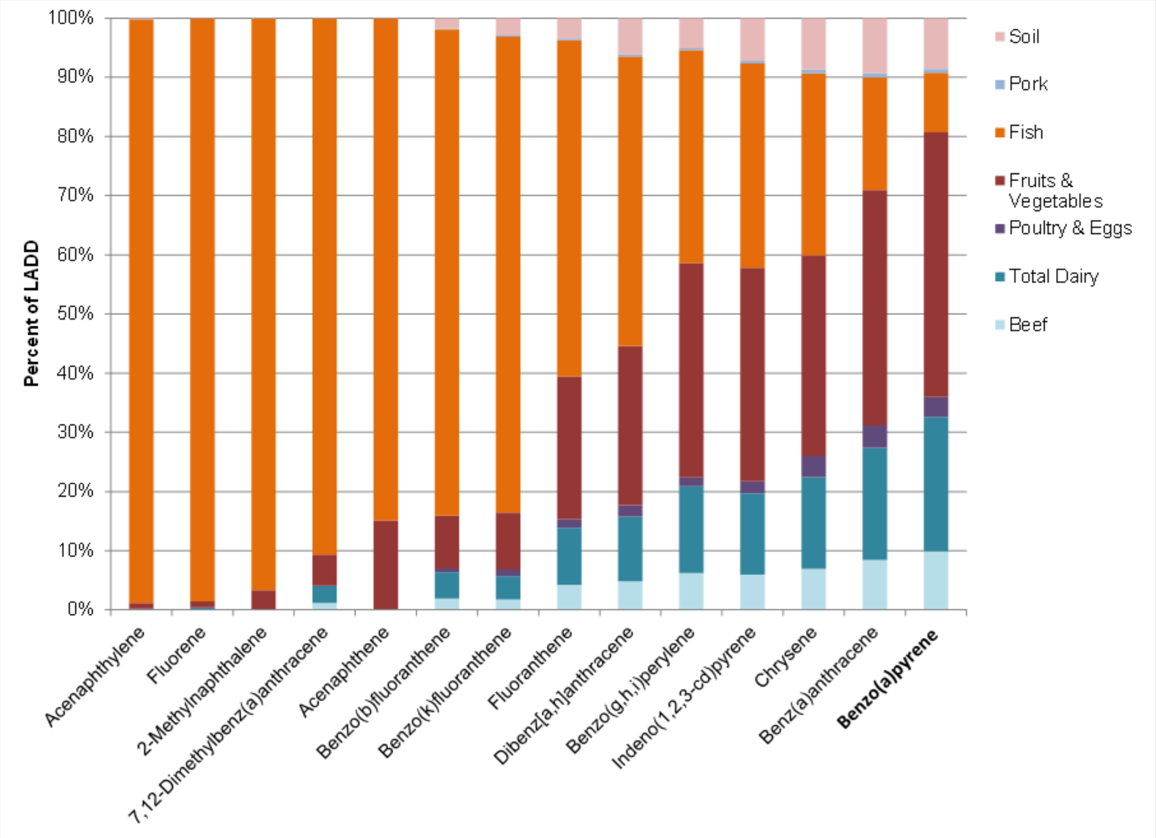
For the RTR screening scenario, concentrations output by MIRC were generally lower than the reported ranges for benzo(a)pyrene in ingestible products. This trend is likely the result of background exposure in reported measurements and available data that are skewed toward concentrations in highly contaminated products. Considering these mitigating factors, the RTR screening scenario output concentrations are within the range of plausible values for PAHs in ingestible products.

### *5.5.3 Lifetime Average Daily Dose*

The contributions of ingestion exposure pathways to the LADD (and thus lifetime cancer risk) for various PAHs are presented in Exhibit 20. As shown, the variability in the driving exposure pathways across PAHs is significant, with fish, beef, dairy, fruits, and vegetables comprising between 86 and 99 percent of exposure for different PAHs.

This variability can be accounted for in part by differences in the physiochemical properties that drive the environmental fate and transport processes of these PAHs (e.g., $K_{ow}$, molecular weight, chemical structure), differences in the PAH-specific half-life in abiotic media, and the degree to which the PAHs are metabolized in biotic media. The variability in exposure pathways is consistent with information provided in the literature.

**Exhibit 20. Estimated Contributions of Modeled Food Types to PAH Ingestion Exposures**



## 5.6 Summary

This analysis provides a summary of the fate and transport processes and the major routes of exposure for the PB-HAP categories of interest to EPA's Risk and Technology Review Program, as modeled in TRIM.FaTE. In general, the modeled behavior of the compounds is consistent with data found in the literature.

This analysis reveals that fish ingestion is a major route of exposure for cadmium, mercury, dioxins, and PAHs. For organics (i.e., dioxins and PAHs), the farm-food-chain also is a major route of exposure, with beef and dairy contributing significantly to the LADD.

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## Technical Support Document for the TRIM-Based Multipathway Tiered Screening Methodology for RTR

# ADDENDUM 1: TRIM.FaTE Inputs

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# Exhibits

This attachment provides tables of the modeling inputs for the TRIM.FaTE screening scenario. Exhibit 1 presents runtime settings for TRIM.FaTE. Exhibits 2 and 3 present meteorological and air parameters, respectively, entered into the model. Exhibits 4, 5, and 6 present the parameters for soil and groundwater, runoff assumptions, and the USLE (universal soil loss equation) erosion parameters, respectively, for the screening scenario. Exhibits 7 and 8 present terrestrial parameters. Exhibits 9 through 11 present lake parameters, and Exhibits12 through 27 present parameters specific to the chemicals modeled in the scenario.

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### Exhibit 1. TRIM.FaTE Simulation Parameters for the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value Used | Reference |
|---|---|---|---|
| Start of simulation | date/time | 1/1/1990, midnight | Consistent with met data. |
| End of simulation | date/time | 1/1/2040, midnight | Consistent with met data set; selected to provide a 50-year modeling period. |
| Simulation time step | hr | 1 | Selected value. |
| Output time step[a] | hr | 4 | Selected value. |

[a] Output time step is set in TRIM.FaTE using the scenario properties "simulationStepsPerOutputStep" and "simulationTimeStep."

## Exhibit 2. Meteorological Inputs for the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value Used | Reference |
|---|---|---|---|
| **Meteorological Inputs** | | | |
| Air temperature | degrees K | 298 | USEPA 2005. |
| Horizontal wind speed | m/sec | 2.8 | 5th percentile annual average value for contiguous United States, calculated from 30 yrs of annual normal temperature values. |
| Vertical wind speed | m/sec | 0.0 | Professional judgment; vertical wind speed not used by any of the algorithms in the version of the TRIM.FaTE library used for screening. |
| Wind direction | degrees clockwise from N (blowing from) | 3-days-on 4-days-off | On is defined as time during which wind is blowing into the model domain. A conservative estimate of time during which wind should blow into the modeling domain was determined by evaluating HUSWO; it was concluded that a conservative estimate would be approximately 42% of the time. |
| Rainfall rate | $m^3$[rain]/$m^2$ [surface area]-day | varies daily | 1.5 m/yr is the maximum statewide 30-year (1971-2000) average for the contiguous United States, excluding Rhode Island because of extreme weather conditions on Mt. Washington. Data obtained from the National Climatic Data Center at http://www.ncdc.noaa.gov/oa/climate/online/ccd/nrmpcp.txt. The precipitation frequency was 3-days-on:4-days-off based on data from Holzworth, 1972. |
| Mixing height (used to set air VE property named "top") | m | 710 | 5th percentile annual average mixing heights (calculated from daily morning and afternoon values), for all stations on SCRM (40 state, 70 stations). |
| isDay_SteadyState_forAir | unitless | -- | Value not used in current dynamic runs (would need to be reevaluated if steady-state runs are needed). |
| isDay_SteadyState_forOther | unitless | -- | |

## Exhibit 3. Air Parameters for the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value Used | Reference |
|---|---|---|---|
| Atmospheric dust load | kg[dust]/m$^3$[air] | 6.15E-08 | Bidleman 1988 |
| Density of air | g/cm$^3$ | 0.0012 | USEPA 1997b |
| Dust density | kg[dust]/m$^3$[dust] | 1,400 | Bidleman 1988 |
| Fraction organic matter on particulates | unitless | 0.2 | Harner and Bidleman 1998 |

## Exhibit 4. Soil and Groundwater Parameters for the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value Used | Reference |
|---|---|---|---|
| **Surface Soil Compartment Type** | | | |
| Air content | volume[air]/volume[compartment] | 0.28 | McKone et al. 2001. |
| Average vertical velocity of water (percolation) | m/day | 8.22E-04 | Assumed to be 0.2 times average precipitation for site. |
| Boundary layer thickness above surface soil | m | 0.005 | Thibodeaux 1996; McKone et al. 2001 (Table 3). |
| Density of soil solids (dry weight) | kg[soil]/m$^3$[soil] | 2600 | Default in McKone et al. 2001 (Table 3). |
| Thickness - untilled[a] | m | 0.01 | McKone et al. 2001 (p. 30). |
| Thickness - tilled[a] | m | 0.20 | USEPA 2005. |
| Erosion fraction | unitless | varies[b] | See Exhibit 5. |
| Fraction of area available for erosion | m$^2$[area available]/m$^2$[total] | 1 | Professional judgment; area assumed rural. |
| Fraction of area available for runoff | m$^2$[area available]/m$^2$[total] | 1 | Professional judgment; area assumed rural. |
| Fraction of area available for vertical diffusion | m$^2$[area available]/m$^2$[total] | 1 | Professional judgment; area assumed rural. |
| Fraction sand | unitless | 0.25 | Professional judgment. |
| Organic carbon fraction | unitless | 0.008 | U.S. average in McKone et al. 2001 (Table 16 and A-3). |
| pH | unitless | 6.8 | Professional judgment. |
| Runoff fraction | unitless | varies[b] | See Exhibit 5. |
| Total erosion rate | kg [soil]/m$^2$/day | varies[b] | See Exhibit 6. |

## Exhibit 4. Soil and Groundwater Parameters for the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value Used | Reference |
|---|---|---|---|
| Total runoff rate | $m^3$[water]/$m^2$/day | 1.64E-03 | Calculated using scenario-specific precipitation rate and assumptions associated with water balance. |
| Water content | volume[water]/volume[compartment] | 0.15 | McKone et al. 2001 |
| **Root Zone Soil Compartment Type** | | | |
| Air content | volume[air]/volume[compartment] | 0.25 | McKone et al 2001 (Table 16). |
| Average vertical velocity of water (percolation) | m/day | 8.22E-04 | Assumed as 0.2 times average precipitation for New England in McKone et al. 2001. |
| Density of soil solids (dry weight) | kg[soil]/$m^3$[soil] | 2,600 | McKone et al. 2001 (Table 3). |
| Fraction sand | unitless | 0.25 | Professional judgment. |
| Thickness - untilled[a] | m | 0.79 | McKone et al. 2001 (Table 16 - U.S. average). |
| Thickness - tilled[a] | m | 0.6 | Adjusted from McKone et al. 2001 (Table 16). |
| Organic carbon fraction | unitless | 0.008 | McKone et al. 2001 (Tables 16 and A-3, U.S. average). |
| pH | unitless | 6.8 | Professional judgment. |
| Water content | volume[water]/volume[compartment] | 0.15 | McKone et al. 2001 |
| **Vadose Zone Soil Compartment Type** | | | |
| Air content | volume[air]/volume[compartment] | 0.22 | McKone et al. 2001 (Table 17). |
| Average vertical velocity of water (percolation) | m/day | 8.22E-04 | Assumed as 0.2 times average precipitation for New England in McKone et al. 2001. |

## Exhibit 4. Soil and Groundwater Parameters for the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value Used | Reference |
|---|---|---|---|
| Density of soil solids (dry weight) | kg[soil]/m$^3$[soil] | 2,600 | Default in McKone et al. 2001 (Table 3). |
| Fraction sand | unitless | 0.35 | Professional judgment. |
| Thickness[a] | m | 1.4 | McKone et al. 2001 (Table 17). |
| Organic carbon fraction | unitless | 0.003 | McKone et al. 2001 (Tables 16 and A-3, U.S. average). |
| pH | unitless | 6.8 | Professional judgment. |
| Water content | volume[water]/volume[compartment] | 0.21 | McKone et al. 2001 (Table 17 - national average). |
| **Groundwater Compartment Type** | | | |
| Thickness[a] | m | 3 | McKone et al. 2001 (Table 3). |
| Fraction sand | unitless | 0.4 | Professional judgment. |
| Organic carbon fraction | unitless | 0.004 | Professional judgment. |
| pH | unitless | 6.8 | Professional judgment. |
| Porosity | volume[total pore space]/volume[compartment] | 0.2 | Default in McKone et al. 2001 (Table 3). |
| Density of solid material in aquifer | kg[soil]/m$^3$[soil] | 2,600 | Default in McKone et al. 2001 (Table 3). |

[a] Set using the volume element properties file.

[b] See separate tables (Exhibits 5 & 6) for erosion/runoff fractions and total erosion rates.

## Exhibit 5. Runoff Assumptions for the TRIM.FaTE Screening Scenario

| Originating Compartment | Destination Compartment | Runoff/Erosion Fraction |
|---|---|---|
| SurfSoil_Source | SurfSoil_N1 | 0.0 |
| | SurfSoil_S1 | 0.0 |
| | sink | 1.0 |
| SurfSoil_N1 | SW_Pond | 1.0 |
| | SurfSoil_Source | 0.0 |
| | SurfSoil_N6 | 0.0 |
| | SurfSoil_S1 | 0.0 |
| | sink | 0.0 |
| SurfSoil_S1 | SW_Pond | 1.0 |
| | SurfSoil_Source | 0.0 |
| | SurfSoil_N1 | 0.0 |
| | sink | 0.0 |
| SurfSoil_N6 | SW_Pond | 1.0 |
| | SurfSoil_N1 | 0.0 |
| | SurfSoil_N7 | 0.0 |
| | sink | 0.0 |
| SurfSoil_N7 | SW_Pond | 1.0 |
| | SurfSoil_N6 | 0.0 |
| | SurfSoil_N3 | 0.0 |
| | sink | 0.0 |
| SurfSoil_N3 | SW_Pond | 1.0 |
| | SurfSoil_N7 | 0.0 |
| | SurfSoil_N4 | 0.0 |
| | sink | 0.0 |
| SurfSoil_N4 | SW_Pond | 1.0 |
| | SurfSoil_N3 | 0.0 |
| | SurfSoil_N5 | 0.0 |
| | SurfSoil_S4 | 0.0 |
| | sink | 0.0 |
| SurfSoil_S4 | SW_Pond | 1.0 |
| | SurfSoil_N4 | 0.0 |
| | SurfSoil_S5 | 0.0 |
| | sink | 0.0 |
| SurfSoil_N5[a] | SW_Pond | 0.0 |
| | SurfSoil_N4 | 0.5 |
| | SurfSoil_S5 | 0.5 |
| | sink | 0.0 |
| SurfSoil_S5[a] | SW_Pond | 0.0 |
| | SurfSoil_N5 | 0.0 |
| | SurfSoil_S4 | 1.0 |
| | sink | 0.0 |

[a] Assumes that N5 is higher ground than S5, and half of the runoff flows into N4, and the other half into S5. Assumes all runoff from S5 flows into S4.

## Exhibit 6. USLE Erosion Parameters for the TRIM.FaTE Screening Scenario

| **Soil Parcel** | **Area** | **Rainfall/Erosivity Index** | **Soil Erodibility Index** | **Length-Slope Factor** | **Land Use** | **Cover Mgmt Factor** | **Supporting Practices Factor** | **Unit Soil Loss** | | **Sediment Delivery Ratio**[a] | **Calculated (Adjusted) Erosion Rate** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Code | $m^2$ | R (100 ft-ton/ac) | K (ton/ac/(100 ft-ton/acre)) | LS (USCS) | type | C (USCS) | P | A (ton/ac/yr) | A ($kg/m^2/d$) | SDR[a] | $kg/m^2/d$ |
| N1 | 5.8E+04 | 300 | 0.39 | 1.5 | grass | 0.1 | 1 | 17.55 | 0.010779 | 0.533 | 0.005740 |
| N6 | 4.1E+04 | 300 | 0.39 | 1.5 | crops | 0.2 | 1 | 35.1 | 0.021557 | 0.557 | 0.012014 |
| N7 | 7.3E+04 | 300 | 0.39 | 1.5 | grass | 0.1 | 1 | 17.55 | 0.010779 | 0.518 | 0.005580 |
| N3 | 3.5E+05 | 300 | 0.39 | 1.5 | grass | 0.1 | 1 | 17.55 | 0.010779 | 0.385 | 0.004151 |
| N4 | 2.0E+06 | 300 | 0.39 | 1.5 | forest | 0.1 | 1 | 17.55 | 0.010779 | 0.309 | 0.003331 |
| N5 | 6.7E+06 | 300 | 0.39 | 1.5 | forest | 0.1 | 1 | 17.55 | 0.010779 | 0.196 | 0.002116 |
| S1 | 5.8E+04 | 300 | 0.39 | 1.5 | grass | 0.1 | 1 | 17.55 | 0.010779 | 0.533 | 0.005740 |
| S4 | 2.0E+06 | 300 | 0.39 | 1.5 | forest | 0.1 | 1 | 17.55 | 0.010779 | 0.309 | 0.003331 |
| S5 | 6.7E+06 | 300 | 0.39 | 1.5 | forest | 0.1 | 1 | 17.55 | 0.010779 | 0.196 | 0.002116 |

[a] Calculated using $SDR = a * (AL)^{-b}$; where *a* is the empirical intercept coefficient (based on the size of the watershed), AL is the total watershed area receiving deposition ($m^2$), and *b* is the empirical slope coefficient (always 0.125).

## Exhibit 7. Terrestrial Plant Placement for the TRIM.FaTE Screening Scenario

| Surface Soil Volume Element | Surface Soil Depth (m) | Coniferous Forest | Grasses/ Herbs | None |
|---|---|---|---|---|
| Source | 0.01 | | | x |
| N1 | 0.01 | | x | |
| N6 | 0.20 (tilled) | | | x |
| N7 | 0.01 | | x | |
| N3 | 0.01 | | x | |
| N4 | 0.01 | x | | |
| N5 | 0.01 | x | | |
| S1 | 0.01 | | x | |
| S4 | 0.01 | x | | |
| S5 | 0.01 | x | | |

## Exhibit 8. Terrestrial Plant Parameters for the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Coniferous[a] | | Grass/Herb[a] | |
|---|---|---|---|---|---|
| | | Value Used | Reference | Value Used | Reference |
| **Leaf Compartment Type** | | | | | |
| Allow exchange | 1=yes, 0=no | 1 | - | Seasonal[b] | - |
| Average leaf area index | $m^2$[leaf]/ $m^2$[area] | 5.0 | Harvard Forest, dom. red oak and red maple, CDIAC website | 5.0 | Mid-range of 4-6 for old fields, R.J. Luxmoore, ORNL. |
| Calculate wet deposition interception fraction (Boolean) | 1=yes, 0=no | 0 | Professional judgment. | 0 | Professional judgment. |
| Correction exponent, octanol to lipid | unitless | 0.76 | From roots, Trapp 1995. | 0.76 | From roots, Trapp 1995. |
| Degree stomatal opening | unitless | 1 | Set to 1 for daytime based on professional judgment (stomatal diffusion is turned off at night using a different property, IsDay). | 1 | Set to 1 for daytime based on professional judgment (stomatal diffusion is turned off at night using a different property, IsDay). |
| Density of wet leaf | $kg/m^3$ | 820 | Paterson et al. 1991. | 820 | Paterson et al. 1991. |
| Leaf wetting factor | m | 3.00E-04 | 1E-04 to 6E-04 for different crops and elements, Muller and Prohl 1993. | 3.00E-04 | 1E-04 to 6E-04 for different crops and elements, Muller and Prohl 1993. |
| Length of leaf | m | 0.01 | Professional judgment. | 0.05 | Professional judgment. |
| Lipid content | kg/kg wet weight | 0.00224 | European beech, Riederer 1995. | 0.00224 | European beech, Riederer 1995. |
| Litter fall rate | 1/day | 0.0021 | value assumes 1st-order relationship and that 99% of leaves fall over 6 years | Seasonal[c] | - |
| Stomatal area normalized effective diffusion path length | 1/m | 200 | Wilmer and Fricker 1996. | 200 | Wilmer and Fricker 1996. |

## Exhibit 8. Terrestrial Plant Parameters for the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Coniferous[a] | | Grass/Herb[a] | |
|---|---|---|---|---|---|
| | | Value Used | Reference | Value Used | Reference |
| Vegetation attenuation factor | $m^2$/kg | 2.9 | Grass/hay, Baes et al. 1984. | 2.9 | Grass/hay, Baes et al. 1984. |
| Water content | unitless | 0.8 | Paterson et al. 1991. | 0.8 | Paterson et al. 1991. |
| Wet deposition interception fraction | unitless | 0.2 | Calculated based on 5 years of local met data, 1987-1991. | 0.2 | Calculated based on 5 years of local met data, 1987-1991. |
| Wet mass of leaf per soil area | kg[fresh leaf]/$m^2$[area] | 2.0 | Calculated from leaf area index, leaf thickness (Simonich and Hites, 1994), density of wet foliage. | 0.6 | Calculated from leaf area index and Leith 1975. |
| **Particle on Leaf Compartment Type** | | | | | |
| Allow exchange | 1=yes, 0=no | 1 | - | Seasonal[b] | - |
| Volume particle per area leaf | $m^3$[leaf particles]/$m^2$[leaf] | 1.00E-09 | Based on particle density and size distribution for atmospheric particles measured on an adhesive surface, Coe and Lindberg 1987. | 1.00E-09 | Based on particle density and size distribution for atmospheric particles measured on an adhesive surface, Coe and Lindberg 1987. |

## Exhibit 8. Terrestrial Plant Parameters for the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Coniferous[a] | | Grass/Herb[a] | |
|---|---|---|---|---|---|
| | | Value Used | Reference | Value Used | Reference |
| **Root Compartment Type - Nonwoody Only** | | | | | |
| Allow exchange | 1=yes, 0=no | | | Seasonal[b] | - |
| Correction exponent, octanol to lipid | unitless | | | 0.76 | Trapp 1995. |
| Lipid content of root | kg/kg wet weight | | | 0.011 | Calculated. |
| Water content of root | kg/kg wet weight | | | 0.8 | Professional judgment. |
| Wet density of root | kg/m$^3$ | | | 820 | Soybean, Paterson et al. 1991. |
| Wet mass per soil area | kg/m$^2$ | | | 1.4 | Temperate grassland, Jackson et al. 1996. |

## Exhibit 8. Terrestrial Plant Parameters for the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Coniferous[a] | | Grass/Herb[a] | |
|---|---|---|---|---|---|
| | | Value Used | Reference | Value Used | Reference |
| **Stem Compartment Type - Nonwoody Only** | | | | | |
| Allow exchange | 1=yes, 0=no | | | Seasonal[b] | - |
| Correction exponent, octanol to lipid | unitless | | | 0.76 | Trapp 1995. |
| Density of phloem fluid | kg/m$^3$ | | | 1,000 | Professional judgment. |
| Density of xylem fluid | kg/cm$^3$ | | | 900 | Professional judgment. |
| Flow rate of transpired water per leaf area | m$^3$[water]/m$^2$[leaf] | | | 0.0048 | Crank et al. 1981. |
| Fraction of transpiration flow rate that is phloem rate | unitless | | | 0.05 | Paterson et al. 1991. |
| Lipid content of stem | kg/kg wet weight | | | 0.00224 | Leaves of European beech, Riederer 1995. |
| Water content of stem | unitless | | | 0.8 | Paterson et al. 1991 |
| Wet density of stem | kg/m$^3$ | | | 830 | Professional judgment. |
| Wet mass per soil area | kg/m$^2$ | | | 0.24 | Calculated from leaf and root biomass density based on professional judgment. |

[a] See Exhibit 7 for assignment of plant types to surface soil compartments.

[b] Begins March 9 (set to 1), ends November 7 (set to 0). Nationwide 80th percentile.

[c] Begins November 7, ends December 6; rate = 0.15/day during this time (value assumes 99 percent of leaves fall in 30 days).

## Exhibit 9. Surface Water Parameters for the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value Used | Reference |
|---|---|---|---|
| Algae carbon content (fraction) | unitless | 0.465 | APHA 1995. |
| Algae density in water column | g[algae]/L[water] | 0.0025 | Millard et al. 1996 as cited in ICF 2005. |
| Algae growth rate | 1/day | 0.7 | Hudson et al. 1994 as cited in Mason et al. 1995b. |
| Algae radius | um | 2.5 | Mason et al. 1995b. |
| Algae water content (fraction) | unitless | 0.9 | APHA 1995. |
| Average algae cell density (per volume cell, not water) | g[algae]/m$^3$[algae] | 1,000,000 | Mason et al. 1995b, Mason et al. 1996. |
| Boundary layer thickness above sediment | m | 0.02 | Cal EPA 1993. |
| Chloride concentration | mg/L | 8.0 | Kaushal et al. 2005. |
| Chlorophyll concentration | mg/L | 0.0029 | ICF 2005. |
| Depth[a] | m | 3.18 | WI DNR 2007 - calculation based on relationship between drainage basin and lake area size. |
| Dimensionless viscous sublayer thickness | unitless | 4 | Ambrose et al. 1995. |
| Drag coefficient for water body | unitless | 0.0011 | Ambrose et al. 1995. |
| Flush rate | 1/year | 12.17 | Calculated based on pond dimensions and flow calculations. |
| Fraction Sand | unitless | 0.25 | Professional judgment. |
| Organic carbon fraction in suspended sediments | unitless | 0.02 | Professional judgment. |
| pH | unitless | 7.3 | Professional judgment. |
| Suspended sediment deposition velocity | m/day | 2 | USEPA 1997b. |
| Total suspended sediment concentration | kg[sediment]/m$^3$[water column] | 0.05 | USEPA 2005. |
| Water temperature | degrees K | 298 | USEPA 2005. |

[a] Set using the volume element properties named "top" and "bottom."

## Exhibit 10. Sediment Parameters for the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value Used | Reference |
|---|---|---|---|
| Depth[a] | m | 0.05 | McKone et al. 2001 (Table 3). |
| Fraction sand | unitless | 0.25 | Professional judgment. |
| Organic carbon fraction | unitless | 0.02 | McKone et al. 2001 (Table 3). |
| Porosity of the sediment zone | volume[total pore space]/volume[sediment compartment] | 0.6 | USEPA 2005. |
| Solid material density in sediment | kg[sediment]/m$^3$[sediment] | 2,600 | McKone et al. 2001 (Table 3). |
| pH | unitless | 7.3 | Professional judgment. |
| Sediment resuspension velocity | m/day | 6.69E-05 | Calculated from water balance model. |

[a] Set using the volume element properties named "top" and "bottom."

## Exhibit 11. Aquatic Animals Food Chain, Density, and Mass for the TRIM.FaTE Screening Scenario

| Aquatic Biota (Consuming Organism) | Fraction Diet | | | | | | | | Biomass ($kg/m^2$) | Body Weight (kg) | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Algae | Zooplankton | Benthic Invertebrate | Water Column Herbivore | Benthic Omnivore | Water Column Omnivore | Benthic Carnivore | Water Column Carnivore | | | |
| Benthic Invertebrate | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0.020 | 2.55E-04 | Professional judgment. |
| Water Column Herbivore | 0% | 100% | 0% | 0% | 0% | 0% | 0% | 0% | 0.002 | 0.025 | Professional judgment. |
| Benthic Omnivore | 0% | 0% | 100% | 0% | 0% | 0% | 0% | 0% | 0.002 | 2.50E-01 | Professional judgment. |
| Water Column Omnivore | 0% | 0% | 0% | 100% | 0% | 0% | 0% | 0% | 0.001 | 0.25 | Professional judgment. |
| Benthic Carnivore | 0% | 0% | 50% | 0% | 50% | 0% | 0% | 0% | 0.001 | 2.0 | Professional judgment. |
| Water Column Carnivore | 0% | 0% | 0% | 0% | 0% | 100% | 0% | 0% | 0.0002 | 2.0 | Professional judgment. |
| Zooplankton | 100% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0.0064 | 5.70E-08 | Professional judgment. |

## Exhibit 12. Cadmium Chemical-Specific Parameters for the TRIM.FaTE Screening Scenario

| Parameter Name[a] | Units | Value | Reference |
|---|---|---|---|
| CAS number[b] | unitless | 7440-43-9 | - |
| Diffusion coefficient in pure air | $m^2$[air]/day | 0.71 | USEPA 1999 (Table A-2-35). |
| Diffusion coefficient in pure water | $m^2$[water]/day | 8.16E-05 | USEPA 1999 (Table A-2-35). |
| Henry's Law constant | Pa-$m^3$/mol | 1.00E-37 | USEPA 1999 (Table A-2-35; assumed to be zero). |
| Melting point | degrees K | 594 | ATSDR 1999. |
| Molecular weight | g/mol | 112.41 | ATSDR 1999. |
| Octanol-air partition coefficient ($K_{oa}$) | $m^3$[air]/$m^3$[octanol] | - | - |
| Octanol-carbon partition coefficient ($K_{oc}$) |  | - | - |
| Octanol-water partition coefficient ($K_{ow}$) | L[water]/kg[octanol] | - | - |

[a] All parameters in this table are TRIM.FaTE chemical properties.

[b] This CAS numbers applies to elemental Cd; however, the cations of cadmium are being modeled.

## Exhibit 13. Mercury Chemical-Specific Parameters for the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value | | | Reference |
|---|---|---|---|---|---|
| | | Hg(0)[b] | Hg(2)[b] | MHg[b] | |
| CAS number | unitless | 7439-97-6 | 14302-87-5 | 22967-92-6 | - |
| Diffusion coefficient in pure air | $m^2$[air]/day | 0.478 | 0.478 | 0.456 | USEPA 1997b. |
| Diffusion coefficient in pure water | $m^2$[water]/day | 5.54E-05 | 5.54E-05 | 5.28E-05 | USEPA 1997b. |
| Henry's Law constant | Pa-$m^3$/mol | 719 | 7.19E-05 | 0.0477 | USEPA 1997b. |
| Melting point | degrees K | 234 | 5.50E+02 | 443 | CARB 1994. |
| Molecular weight | g/mol | 201 | 201 | 216 | USEPA 1997b. |
| Octanol-water partition coefficient ($K_{ow}$) | L[water]/kg[octanol] | 4.15 | 3.33 | 1.7 | Mason et al. 1996. |
| Vapor washout ratio | $m^3$[air]/$m^3$[rain] | 1,200 | 1.6E+06 | 0 | USEPA 1997b, based on Petersen et al. 1995. |

[a] All parameters in this table are TRIM.FaTE chemical properties.
[b] On this and all following tables, Hg(0) = elemental mercury, Hg(2) = divalent mercury, and MHg = methyl mercury.

## Exhibit 14. PAH Chemical-Specific Parameters for the TRIM.FaTE Screening Scenario

| **Parameter Name** | **Units** | **Value** | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | **2Methyl** | **712DMB** | **Acenaphthene** | **Acenaphthylene** | **BaA** | **BaP** | **BbF** | **BghiP** |
| CAS number | unitless | 91-57-6 | 57-97-6 | 83-32-9 | 208-96-8 | 56-55-3 | 50-32-8 | 205-99-2 | 191-24-2 |
| Diffusion coefficient in pure air | $m^2$/day | 0.451 | 0.691 | 0.009 | 0.388 | 0.441 | 0.372 | 0.009 | 0.190 |
| Diffusion coefficient in pure water | $m^2$/day | 6.70E-05 | 6.91E-05 | 8.64E-05 | 6.03E-05 | 7.78E-05 | 7.78E-05 | 8.64E-05 | 4.54E-05 |
| Henry's Law constant | Pa-$m^3$/mol | 50.56 | 0.20 | 18.50 | 12.70 | 1.22 | 0.07 | 0.05 | 0.03 |
| Melting point | degrees K | 307.75 | 396.65 | 366.15 | 365.65 | 433 | 452 | 441 | 550.15 |
| Molecular weight | g/mol | 142.20 | 256.35 | 154.21 | 152.20 | 228.29 | 252.32 | 252.32 | 276.34 |
| Octanol-water partition coefficient ($K_{ow}$) | L[water]/L[octanol] | 7.24E+03 | 6.31E+05 | 8.32E+03 | 1.00E+04 | 6.17E+05 | 9.33E+05 | 6.03E+05 | 4.27E+06 |

## Exhibit 14. PAH Chemical-Specific Parameters for the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value | | | | | |
|---|---|---|---|---|---|---|---|
| | | BkF | Chr | DahA | Fluoranthene | Fluorene | IcdP |
| CAS number | unitless | 207-08-9 | 218-01-9 | 53-70-3 | 206-44-0 | 86-73-7 | 193-39-5 |
| Diffusion coefficient in pure air | $m^2$/day | 0.009 | 0.009 | 0.009 | 0.009 | 0.009 | 0.009 |
| Diffusion coefficient in pure water | $m^2$/day | 8.64E-05 | 8.64E-05 | 8.64E-05 | 8.64E-05 | 8.64E-05 | 8.64E-05 |
| Henry's Law constant | Pa-$m^3$/mol | 0.04 | 0.53 | 0.01 | 1.96 | 9.81 | 0.03 |
| Melting point | degrees K | 490 | 531 | 539 | 383.15 | 383.15 | 437 |
| Molecular weight | g/mol | 252.32 | 228.29 | 278.33 | 202.26 | 166.20 | 276.34 |
| Octanol-water partition coefficient ($K_{ow}$) | L[water]/L[octanol] | 8.71E+05 | 5.37E+05 | 3.16E+06 | 1.45E+05 | 1.51E+04 | 5.25E+06 |

## Exhibit 14. PAH Chemical-Specific Parameters for the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Reference |
|---|---|---|
| CAS number | unitless | - |
| Diffusion coefficient in pure air | $m^2$/day | USEPA 2005. Exceptions include USEPA 1997a (7,12-Dimethylbenz(a)anthracene), and USEPA 2007 (2-Methylnaphthalene, Acenaphthylene, and Benzo(g,h,i)perylene) |
| Diffusion coefficient in pure water | $m^2$/day | USEPA 2005. Exceptions include USEPA 1997a (7,12-Dimethylbenz(a)anthracene), and USEPA 2007 (2-Methylnaphthalene, Acenaphthylene, and Benzo(g,h,i)perylene) |
| Henry's Law constant | Pa-$m^3$/mol | USEPA 2005. Exceptions include USEPA 2003 (2-Methylnaphthalene) HSDB 2001a (7,12-Dimethylbenz(a)anthracene), HSDB 2001b (Acenaphthylene), and HSDB 2001c (Benzo(g,h,i)perylene) |
| Melting point | degrees K | Budavari 1996. Exceptions include USEPA 2003 (2-Methylnaphthalene), HSDB 2001a (7,12-Dimethylbenz(a)anthracene), HSDB 2001b (Acenaphthylene), HSDB 2001c (Benzo(g,h,i)perylene), and USEPA 2005 (Acenaphthene, Fluoranthene, and Fluorene) |
| Molecular weight | g/mol | Budavari 1996. Exceptions include USEPA 2003 (2-Methylnaphthalene), HSDB 2001a (7,12-Dimethylbenz(a)anthracene), HSDB 2001b (Acenaphthylene), HSDB 2001c (Benzo(g,h,i)perylene), and USEPA 2005 (Acenaphthene, Fluoranthene, and Fluorene) |
| Octanol-water partition coefficient ($K_{ow}$) | L[water]/L[octanol] | Hansch et al. 1995. Exceptions include Passivirta et al. 1999 (Acenaphthylene, Benzo(k)fluoranthene, and Indeno(1,2,3-cd)pyrene), and Sangster 1993 (Benzo(b)fluoranthene) |

## Exhibit 15. Dioxin Chemical-Specific Parameters for the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 1,2,3,4,6,7,8,9-OCDD | 1,2,3,4,6,7,8,9-OCDF | 1,2,3,4,6,7,8-HpCDD | 1,2,3,4,6,7,8-HpCDF | 1,2,3,4,7,8,9-HpCDF | 1,2,3,4,7,8-HxCDD | 1,2,3,4,7,8-HxCDF |
| CAS number | unitless | 3268-87-9 | 39001-02-0 | 35822-46-9 | 67562-39-4 | 55673-89-7 | 39227-28-6 | 70648-26-9 |
| Diffusion coefficient in pure air | $m^2$/day | 0.751 | 0.168 | 0.782 | 0.176 | 0.176 | 0.816 | 0.183 |
| Diffusion coefficient in pure water | $m^2$/day | 6.91E-05 | 6.91E-05 | 6.91E-05 | 6.91E-05 | 6.91E-05 | 6.91E-05 | 6.91E-05 |
| Henry's Law constant | Pa-$m^3$/mol | 0.684 | 0.19 | 1.22 | 1.43 | 1.42 | 1.08 | 1.45 |
| Melting point | degrees K | 603.0 | 259.0 | 538.0 | 236.5 | 222.0 | 546.0 | 499.0 |
| Molecular weight | g/mol | 460 | 443.76 | 425.2 | 409.31 | 409.31 | 391 | 374.87 |
| Octanol-water partition coefficient ($K_{ow}$) | L[water]/L[octanol] | 1.58E+08 | 1.00E+08 | 1.00E+08 | 2.51E+07 | 7.94E+06 | 6.31E+07 | 1.00E+07 |

## Exhibit 15. Dioxin Chemical-Specific Parameters for the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 1,2,3,6,7,8-HxCDD | 1,2,3,6,7,8-HxCDF | 1,2,3,7,8,9-HxCDD | 1,2,3,7,8,9-HxCDF | 1,2,3,7,8-PeCDD | 1,2,3,7,8-PeCDF | 2,3,4,6,7,8-HxCDF |
| CAS number | unitless | 57653-85-7 | 57117-44-9 | 19408-74-3 | 72918-21-9 | 40321-76-4 | 57117-41-6 | 60851-34-5 |
| Diffusion coefficient in pure air | $m^2$/day | 0.816 | 0.183 | 0.816 | 0.183 | 0.854 | 0.192 | 0.183 |
| Diffusion coefficient in pure water | $m^2$/day | 6.91E-05 | 6.91E-05 | 6.91E-05 | 6.91E-05 | 6.91E-05 | 6.91E-05 | 6.91E-05 |
| Henry's Law constant | Pa-$m^3$/mol | 1.11 | 0.741 | 1.11 | 1.11 | 0.263 | 0.507 | 1.11 |
| Melting point | degrees K | 558.0 | 506.0 | 517.0 | 509.0 | 513.0 | 499.0 | 512.5 |
| Molecular weight | g/mol | 390.84 | 374.87 | 390.84 | 374.87 | 356.4 | 340.42 | 374.87 |
| Octanol-water partition coefficient ($K_{ow}$) | L[water]/L[octanol] | 1.62E+08 | 8.24E+07 | 1.62E+08 | 3.80E+07 | 1.86E+07 | 6.17E+06 | 8.31E+07 |

## Exhibit 15. Dioxin Chemical-Specific Parameters for the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value | | | Reference |
|---|---|---|---|---|---|
| | | 2,3,4,7,8-PeCDF | 2,3,7,8-TCDD | 2,3,7,8-TCDF | |
| CAS number | unitless | 57117-31-4 | 1746-01-6 | 51207-31-9 | - |
| Diffusion coefficient in pure air | $m^2$/day | 0.192 | 0.899 | 0.203 | US EPA 2005 |
| Diffusion coefficient in pure water | $m^2$/day | 6.91E-05 | 4.84E-05 | 5.19E-05 | US EPA 2005 |
| Henry's Law constant | Pa-$m^3$/mol | 0.505 | 3.33 | 1.46 | US EPA 2005 |
| Melting point | degrees K | 469.3 | 578.0 | 500.0 | Mackay et al. 2000. Exceptions include USEPA 2000a (1,2,3,6,7,8-HxCDD, 1,2,3,7,8,9-HxCDF, and 1,2,3,7,8-PeCDD), ATSDR 1998 (1,2,3,6,7,8-HxCDF, 1,2,3,7,8-PeCDF, and 2,3,4,6,7,8-HxCDF), and NLM 2002 (1,2,3,7,8,9-HxCDD) |
| Molecular weight | g/mol | 340.42 | 322 | 306 | Mackay et al. 2000. Exceptions include ATSDR 1998 (1,2,3,6,7,8-HxCDF, 1,2,3,7,8,9-HxCDF, 1,2,3,7,8-PeCDD, 1,2,3,7,8-PeCDF, and 2,3,4,6,7,8-HxCDF) and NLM 2002 (1,2,3,6,7,8-HxCDD and 1,2,3,7,8,9-HxCDD) |
| Octanol-water partition coefficient ($K_{ow}$) | L[water]/L[octanol] | 3.16E+06 | 6.31E+06 | 1.26E+06 | Mackay et al. 1992 as cited in USEPA 2000b. Exceptions include Mackay et al. 2000 (1,2,3,4,7,8,9-HpCDF), USEPA 2000a (1,2,3,6,7,8-HxCDD, 1,2,3,6,7,8-HxCDF, 1,2,3,7,8,9-HxCDD, 1,2,3,7,8,9-HxCDF, and 2,3,4,6,7,8-HxCDF), and Sijm et al. 1989 as cited in USEPA 2000b (1,2,3,7,8-PeCDD) |

## Exhibit 16. Cadmium Chemical-Specific Parameters for Abiotic Compartments in the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value | Reference |
|---|---|---|---|
| **Air Compartment Type** | | | |
| Particle dry deposition velocity | m/day | 260 | Calculated from Muhlbaier and Tissue 1980. |
| Washout ratio | $m^3$[air]/$m^3$[rain] | 200,000 | MacKay et al. 1986. |
| **Surface Soil Compartment Type** | | | |
| Use input characteristic depth (Boolean) | 0 = no, Else = yes | 0 | Professional judgment. |
| **Root Zone Soil Compartment Type** | | | |
| Use input characteristic depth (Boolean) | 0 = no, Else = yes | 0 | Professional judgment. |
| **Vadose Zone Soil Compartment Type** | | | |
| Use input characteristic depth (Boolean) | 0 = no, Else = yes | 0 | Professional judgment. |
| **Surface Water Compartment Type** | | | |
| Ratio of concentration in water to concentration in algae to concentration dissolved in water | L[water]/g[algae wet wt] | 1.87 | McGeer et al. 2003. |

## Exhibit 17. Mercury Chemical-Specific Parameters for Abiotic Compartments in the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value | | | Reference |
|---|---|---|---|---|---|
| | | Hg(0) | Hg(2) | MHg | |
| **Air Compartment Type** | | | | | |
| Particle dry deposition velocity | m/day | 500 | 500 | 500 | CalTOX value cited in McKone et al. 2001. |
| Demethylation rate | 1/day | N/A | N/A | 0 | Professional judgment. |
| Methylation rate | 1/day | 0 | 0 | 0 | Professional judgment. |
| Oxidation rate | 1/day | 0.00385 | 0 | 0 | Low end of half-life range (6 months to 2 years) in USEPA 1997b. |
| Reduction rate | 1/day | 0 | 0 | 0 | Professional judgment. |
| Washout ratio | $m^3$[air]/$m^3$[rain] | 200,000 | 200,000 | 200,000 | Professional judgment. |
| **Surface Soil Compartment Type** | | | | | |
| Use input characteristic depth (Boolean) | 0 = no, Else = yes | 0 | 0 | 0 | Professional judgment. |
| Soil-water partition coefficient | L[water]/kg[soil wet wt] | 1,000 | 58,000 | 7,000 | USEPA 1997b. |
| Vapor dry deposition velocity | m/day | 50 | 2500 | 0 | Hg(0) - from Lindberg et al. 1992; Hg(2) - estimate by USEPA using the Industrial Source Complex (ISC) Model - [See Vol. III, App. A of the Mercury Study Report (USEPA 1997b)]. |
| Demethylation rate | 1/day | N/A | N/A | 0.06 | Range reported in Porvari and Verta 1995 is 3E-2 to 6E-2 /day; value is average maximum potential demethylation rate constant under anaerobic conditions. |
| Methylation rate | 1/day | 0 | 0.001 | 0 | Range reported in Porvari and Verta 1995 is 2E-4 to 1E-3 /day; value is average maximum potential methylation rate constant under anaerobic conditions. |

## Exhibit 17. Mercury Chemical-Specific Parameters for Abiotic Compartments in the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value | | | Reference |
|---|---|---|---|---|---|
| Oxidation rate | 1/day | 0 | 0 | 0 | Value assumed in USEPA 1997b. |
| Reduction rate | 1/day | 0 | 1.25E-05 | 0 | Value used for untilled surface soil (2cm), 10% moisture content, in USEPA 1997b; general range is (0.0013/day)*moisture content to (0.0001/day)*moisture content for forested region (Lindberg 1996; Carpi and Lindberg 1997). |
| **Root Zone Soil Compartment Type** | | | | | |
| Use input characteristic depth (Boolean) | 0 = no, Else = yes | 0 | 0 | 0 | Professional judgment. |
| Soil-water partition coefficient | L[water]/kg[soil wet wt] | 1,000 | 58,000 | 7,000 | USEPA 1997b. |
| Demethylation rate | 1/day | N/A | N/A | 0.06 | Range reported in Porvari and Verta 1995 is 3E-2 to 6E-2 /day; value is average maximum potential demethylation rate constant under anaerobic conditions. |
| Methylation rate | 1/day | 0 | 0.001 | 0 | Range reported in Porvari and Verta 1995 is 2E-4 to 1E-3 /day; value is average maximum potential methylation rate constant under anaerobic conditions. |
| Oxidation rate | 1/day | 0 | 0 | 0 | Value assumed in USEPA 1997b. |
| Reduction rate | 1/day | 0 | 3.25E-06 | 0 | Value used for tilled surface soil (20cm), 10% moisture content, in USEPA 1997b (Lindberg 1996; Carpi and Lindberg 1997). |
| **Vadose Zone Soil Compartment Type** | | | | | |
| Use input characteristic depth (Boolean) | 0 = no, Else = yes | 0 | 0 | 0 | Professional judgment. |
| Soil-water partition coefficient | L[water]/kg[soil wet wt] | 1,000 | 58,000 | 7,000 | USEPA 1997b. |

## Exhibit 17. Mercury Chemical-Specific Parameters for Abiotic Compartments in the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value | | | Reference |
|---|---|---|---|---|---|
| Demethylation rate | 1/day | N/A | N/A | 0.06 | Range reported in Porvari and Verta 1995 is 3E-2 to 6E-2 /day; value is average maximum potential demethylation rate constant under anaerobic conditions. |
| Methylation rate | 1/day | 0 | 0.001 | 0 | Range reported in Porvari and Verta 1995 is 2E-4 to 1E-3 /day; value is average maximum potential methylation rate constant under anaerobic conditions. |
| Oxidation rate | 1/day | 0 | 0 | 0 | Value assumed in USEPA 1997b. |
| Reduction rate | 1/day | 0 | 3.25E-06 | 0 | Value used for tilled surface soil (20cm), 10% moisture content, in USEPA 1997b (Lindberg 1996; Carpi and Lindberg 1997). |
| **Groundwater Compartment Type** | | | | | |
| Soil-water partition coefficient | L[water]/kg[soil wet wt] | 1,000 | 58,000 | 7,000 | USEPA 1997b. |
| Demethylation rate | 1/day | N/A | N/A | 0.06 | Range reported in Porvari and Verta 1995 is 3E-2 to 6E-2 /day; value is average maximum potential demethylation rate constant under anaerobic conditions. |
| Methylation rate | 1/day | 0 | 0.001 | 0 | Range reported in Porvari and Verta 1995 is 2E-4 to 1E-3 /day; value is average maximum potential methylation rate constant under anaerobic conditions. |
| Oxidation rate | 1/day | 1.00E-08 | 0 | 0 | Small default nonzero value (0 assumed in USEPA 1997b). |
| Reduction rate | 1/day | 0 | 3.25E-06 | 0 | Value used for tilled surface soil (20cm), 10% moisture content, in USEPA 1997b (Lindberg 1996; Carpi and Lindberg 1997). |

## Exhibit 17. Mercury Chemical-Specific Parameters for Abiotic Compartments in the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value | | | Reference |
|---|---|---|---|---|---|
| **Surface Water Compartment Type** | | | | | |
| Algal surface area-specific uptake rate constant | nmol/[µm$^2$-day-nmol] | 0 | 2.04E-10 | 3.60E-10 | Assumes radius = 2.5mm, Mason et al. 1995b, Mason et al. 1996; Hg(0) assumed same as Hg(2). |
| $D_{ow}$ ("overall $K_{ow}$") | L[water]/kg[octanol] | 0 | -[a] | -[b] | Mason et al. 1996. |
| Solids-water partition coefficient | L[water]/kg[solids wet wt] | 1,000 | 100,000 | 100,000 | USEPA 1997b. |
| Vapor dry deposition velocity | m/day | N/A | 2500 | | USEPA 1997b (Vol. III, App. A). |
| Demethylation rate | 1/day | N/A | N/A | 0.013 | Average range of 1E-3 to 2.5E-2/day from Gilmour and Henry 1991. |
| Methylation rate | 1/day | 0 | 0.001 | 0 | Value used in EPA 1997; range is 1E-4 to 3E-4/day (Gilmour and Henry 1991). |
| Oxidation rate | 1/day | 0 | 0 | 0 | Professional judgment. |
| Reduction rate | 1/day | 0 | 0.0075 | 0 | Value used in USEPA 1997b; reported values range from less than 5E-3/day for depths greater than 17m, up to 3.5/day (Xiao et al. 1995; Vandal et al. 1995; Mason et al. 1995a; Amyot et al. 1997). |
| **Sediment Compartment Type** | | | | | |
| Solids-water partition coefficient | L[water]/kg[solids wet wt] | 3,000 | 50,000 | 3,000 | USEPA 1997b. |
| Demethylation rate | 1/day | N/A | N/A | 0.0501 | Average range of 2E-4 to 1E-1/day from Gilmour and Henry 1991. |
| Methylation rate | 1/day | 0 | 1.00E-04 | 0 | Value used in EPA 1997b; range is 1E-5 to 1E-3/day, Gilmour and Henry 1991. |
| Oxidation rate | 1/day | 0 | 0 | 0 | Professional judgment. |

## Exhibit 17. Mercury Chemical-Specific Parameters for Abiotic Compartments in the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value | | | Reference |
|---|---|---|---|---|---|
| Reduction rate | 1/day | 0 | 1.00E-06 | 0 | Inferred value based on presence of Hg(0) in sediment porewater (USEPA 1997b; Vandal et al. 1995). |

[a] TRIM.FaTE Formula Property, which varies from 0.025 to 1.625 depending on pH and chloride concentration.
[b] TRIM.FaTE Formula Property, which varies from 0.075 to 1.7 depending on pH and chloride concentration.

## Exhibit 18. PAH Chemical-Specific Parameters for Abiotic Compartments in the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Values | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **2Methyl** | **712DMB** | **Acenaph-thene** | **Acenaph-thylene** | **BaA** | **BaP** | **BbF** | **BghiP** | **BkF** |
| **Air Compartment Type** | | | | | | | | | | |
| Particle dry deposition velocity | m/day | 500 | 500 | 500 | 500 | 500 | 500 | 500 | 500 | 500 |
| Half-life | day | 0.154 | 0.092 | 0.3 | 0.208 | 0.125 | 0.046 | 0.596 | 0.215 | 0.458 |
| Washout ratio | | 200000 | 200000 | 200000 | 200000 | 200000 | 200000 | 200000 | 200000 | 200000 |
| **Surface Soil Compartment Type** | | | | | | | | | | |
| User input characteristic depth (Boolean) | 0 = No, Else = Yes | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Half-life | day | 18 | 24 | 56 | 66.5 | 680 | 530 | 610 | 415 | 2140 |
| **Root Zone Soil Compartment Type** | | | | | | | | | | |
| User input characteristic depth (Boolean) | 0 = No, Else = Yes | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Half-life | day | 18 | 24 | 56 | 66.5 | 680 | 530 | 610 | 415 | 2140 |
| **Vadose Zone Soil Compartment Type** | | | | | | | | | | |
| User input characteristic depth (Boolean) | 0 = No, Else = Yes | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Half-life | day | 36 | 48 | 112 | 133 | 1360 | 1060 | 1220 | 830 | 4280 |
| **Groundwater Compartment Type** | | | | | | | | | | |
| Half-life | day | 36 | 48 | 112 | 133 | 1360 | 1060 | 1220 | 830 | 4280 |

## Exhibit 18. PAH Chemical-Specific Parameters for Abiotic Compartments in the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Values | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 2Methyl | 712DMB | Acenaph-thene | Acenaph-thylene | BaA | BaP | BbF | BghiP | BkF |
| **Surface Water Compartment Type** | | | | | | | | | | |
| Ratio Of Conc In Algae To Conc Dissolved In Water | (g[chem]/kg[algae]) / (g[chem]/L[water]) | 2.6 | 333.4 | 3 | 3.7 | 325 | 510 | 317 | 1539 | 473 |
| Half-life | day | 78 | 216 | 25 | 184 | 0.375 | 0.138 | 90 | 1670 | 62.4 |
| **Sediment Compartment Type** | | | | | | | | | | |
| Half-life | day | 2290 | 2290 | 2290 | 2290 | 2290 | 2290 | 2290 | 2290 | 2290 |

## Exhibit 18. PAH Chemical-Specific Parameters for Abiotic Compartments in the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value | | | | | Reference |
|---|---|---|---|---|---|---|---|
| | | Chr | DahA | Fluoranthene | Fluorene | IcdP | |
| **Air Compartment Type** | | | | | | | |
| Particle dry deposition velocity | m/day | 500 | 500 | 500 | 500 | 500 | McKone et al. 2001. |
| Half-life | day | 0.334 | 0.178 | 0.46 | 0.46 | 0.262 | Howard et al. 1991 / upper bound measured or estimated value. Exceptions include ATSDR 2005 (2-Methylnaphthalene), USEPA 1998 (7,12-Dimethylbenz(a)anthracene, Benzo(g,h,i)perylene, and Fluoranthene) / average of range, HSDB 2001d (Acenaphthene), HSDB 2001b (Acenaphthylene), and Spero et al. 2000 (Fluorene). |
| Washout ratio | | 200000 | 200000 | 200000 | 200000 | 200000 | Mackay et al. 1986. |
| **Surface Soil Compartment Type** | | | | | | | |
| User input characteristic depth (Boolean) | 0 = No, Else = Yes | 0 | 0 | 0 | 0 | 0 | Professional judgment. |
| Half-life | day | 1000 | 940 | 275 | 33 | 730 | MacKay et al. 2000 / average of range. Exceptions include ATSDR 2005 (2-Methylnaphthalene), USEPA 1998 (7,12-Dimethylbenz(a)anthracene, Benzo(g,h,i)perylene, and Fluoranthene) / average of range, HSDB 2001d (Acenaphthene), HSDB 2001b (Acenaphthylene), and HSDB 2001e (Fluorene). |

## Exhibit 18. PAH Chemical-Specific Parameters for Abiotic Compartments in the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value | | | | | Reference |
|---|---|---|---|---|---|---|---|
| | | Chr | DahA | Fluoranthene | Fluorene | IcdP | |
| **Root Zone Soil Compartment Type** | | | | | | | |
| User input characteristic depth (Boolean) | 0 = No, Else = Yes | 0 | 0 | 0 | 0 | 0 | Professional judgment. |
| Half-life | day | 1000 | 940 | 275 | 33 | 730 | Howard et al. 1991 / upper bound measured or estimated value. Exceptions include ATSDR 2005 (2-Methylnaphthalene), USEPA 1998 (7,12-Dimethylbenz(a)anthracene, Benzo(g,h,i)perylene, and Fluoranthene) / average of range, HSDB 2001d (Acenaphthene), HSDB 2001b (Acenaphthylene), and HSDB 2001e (Fluorene). |
| **Vadose Zone Soil Compartment Type** | | | | | | | |
| User input characteristic depth (Boolean) | 0 = No, Else = Yes | 0 | 0 | 0 | 0 | 0 | Professional judgment. |
| Half-life | day | 2000 | 1880 | 550 | 66 | 1460 | Howard et al. 1991 / upper bound measured or estimated value. Exceptions include ATSDR 2005 (2-Methylnaphthalene), USEPA 1998 (7,12-Dimethylbenz(a)anthracene, Benzo(g,h,i)perylene, and Fluoranthene) / twice average of range, HSDB 2001d (Acenaphthene) / multiplied by 2, HSDB 2001b (Acenaphthylene) / multiplied by 2, and HSDB 2001e (Fluorene) / multiplied by 2. |

## Exhibit 18. PAH Chemical-Specific Parameters for Abiotic Compartments in the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value | | | | | Reference |
|---|---|---|---|---|---|---|---|
| | | Chr | DahA | Fluoranthene | Fluorene | IcdP | |
| **Groundwater Compartment Type** | | | | | | | |
| Half-life | day | 2000 | 1880 | 550 | 66 | 1460 | Howard et al. 1991 / upper bound measured or estimated value. Exceptions include ATSDR 2005 (2-Methylnaphthalene), USEPA 1998 (7,12-Dimethylbenz(a)anthracene, Benzo(g,h,i)perylene, and Fluoranthene) / twice average of range, HSDB 2001d (Acenaphthene) / multiplied by 2, HSDB 2001b (Acenaphthylene) / multiplied by 2, and HSDB 2001e (Fluorene) / multiplied by 2. |
| **Surface Water Compartment Type** | | | | | | | |
| RatioOfConcInAlgaeToConcDissolvedInWater | (g[chem]/kg[algae]) / (g[chem]/L[water]) | 280 | 1388 | 67.4 | 5.8 | 1653 | $K_{ow}$ from Del Vento and Dachs 2002. |
| Half-life | day | 1.626 | 97.8 | 160 | 8.5 | 750 | Howard et al. 1991 / upper bound measured or estimated value. Exceptions include HSDB 2005 (2-Methylnaphthalene), HSDB 2001a (7-12 Dimethylbenz(a)anthracene), HSDB 2001d (Acenaphthene), HSDB 2001b (Acenaphthylene), and HSDB 2001c (Benzo(g,h,i)perylene), Montgomery 2000 (Fluoranthene), and Boyle 1985 (Fluorene). |

## Exhibit 18. PAH Chemical-Specific Parameters for Abiotic Compartments in the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value | | | | | Reference |
|---|---|---|---|---|---|---|---|
| | | Chr | DahA | Fluoranthene | Fluorene | IcdP | |
| **Sediment Compartment Type** | | | | | | | |
| Half-life | day | 2290 | 2290 | 2290 | 2290 | 2290 | Mackay et al. 1992 / PAH values are the mean half-life of the log class that Mackay et al. assigned for sediment, except for BbF and IcdP, which were not in Table 2.3 of Mackay et. al. |

## Exhibit 19. Dioxin Chemical-Specific Parameters for Abiotic Compartments in the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1,2,3,4,6,7,8,9-OCDD | 1,2,3,4,6,7,8,9-OCDF | 1,2,3,4,6,7,8-HpCDD | 1,2,3,4,6,7,8-HpCDF | 1,2,3,4,7,8,9-HpCDF | 1,2,3,4,7,8-HxCDD |
| **Air Compartment Type** | | | | | | | |
| Deposition Velocity | m/day | 500 | 500 | 500 | 500 | 500 | 500 |
| Halflife | day | 162 | 321 | 64 | 137 | 122 | 42 |
| Washout Ratio | $m^3$[air]/$m^3$[rain] | 91000 | 22000 | 64000 | 32000 | 32000 | 9000 |
| **Surface Soil Compartment Type** | | | | | | | |
| Input characteristic depth | m | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 |
| Use input characteristic depth (Boolean) | 0 = No, Else = Yes | 0 | 0 | 0 | 0 | 0 | 0 |
| Halflife | day | 3650 | 3650 | 3650 | 3650 | 3650 | 3650 |
| **Root Zone Soil Compartment Type** | | | | | | | |
| Input characteristic depth | m | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 |
| Use input characteristic depth | 0 = No, Else = Yes | 0 | 0 | 0 | 0 | 0 | 0 |
| Halflife | day | 3650 | 3650 | 3650 | 3650 | 3650 | 3650 |
| **Vadose Zone Soil Compartment Type** | | | | | | | |
| Input characteristic depth | m | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 |
| Use input characteristic depth (Boolean) | 0 = No, Else = Yes | 0 | 0 | 0 | 0 | 0 | 0 |
| Halflife | day | 1008 | 1008 | 1008 | 1008 | 1008 | 1008 |
| **Groundwater Compartment Type** | | | | | | | |
| Half-life | day | 1008 | 1008 | 1008 | 1008 | 1008 | 1008 |
| **Surface Water Compartment Type** | | | | | | | |
| Ratio Of Conc In Algae To Conc Dissolved In Water | (g[chem]/g[algae])/(g[chem]/L[water]) | 5.31 | 4.54 | 4.54 | 2.83 | 1.9 | 3.88 |
| Half-life | day | 0.67 | 0.58 | 47 | 0.58 | 0.58 | 6.3 |
| **Sediment Compartment Type** | | | | | | | |
| Half-life | day | 1095 | 1095 | 1095 | 1095 | 1095 | 1095 |

## Exhibit 19. Dioxin Chemical-Specific Parameters for Abiotic Compartments in the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1,2,3,4,7,8-HxCDF | 1,2,3,6,7,8-HxCDD | 1,2,3,6,7,8-HxCDF | 1,2,3,7,8,9-HxCDD | 1,2,3,7,8,9-HxCDF | 1,2,3,7,8-PeCDD |
| **Air Compartment Type** | | | | | | | |
| Deposition velocity | m/day | 500 | 500 | 500 | 500 | 500 | 500 |
| Half-life | day | 78 | 28 | 55 | 28 | 51 | 18 |
| Washout ratio | $m^3$[air]/$m^3$[rain] | 10000 | 9000 | 10000 | 9000 | 10000 | 18000 |
| **Surface Soil Compartment Type** | | | | | | | |
| Input characteristic depth | m | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 |
| Use input characteristic depth (Boolean) | 0 = No, Else = Yes | 0 | 0 | 0 | 0 | 0 | 0 |
| Half-life | day | 3650 | 3650 | 3650 | 3650 | 3650 | 3650 |
| **Root Zone Soil Compartment Type** | | | | | | | |
| Input characteristic depth | m | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 |
| Use input characteristic depth | 0 = No, Else = Yes | 0 | 0 | 0 | 0 | 0 | 0 |
| Half-life | day | 3650 | 3650 | 3650 | 3650 | 3650 | 3650 |
| **Vadose Zone Soil Compartment Type** | | | | | | | |
| Input characteristic depth | m | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 |
| Use input characteristic depth (Boolean) | 0 = No, Else = Yes | 0 | 0 | 0 | 0 | 0 | 0 |
| Half-life | day | 1008 | 1008 | 1008 | 1008 | 1008 | 1008 |
| **Groundwater Compartment Type** | | | | | | | |
| Half-life | day | 1008 | 1008 | 1008 | 1008 | 1008 | 1008 |
| **Surface Water Compartment Type** | | | | | | | |
| Ratio Of Conc In Algae To Conc Dissolved In Water | (g[chem]/g[algae])/ (g[chem]/L[water]) | 2.06 | 5.36 | 4.25 | 5.36 | 3.26 | 1.55 |
| Half-life | day | 0.58 | 6.3 | 0.58 | 6.3 | 0.58 | 2.7 |
| **Sediment Compartment Type** | | | | | | | |
| Half-life | day | 1095 | 1095 | 1095 | 1095 | 1095 | 1095 |

## Exhibit 19. Dioxin Chemical-Specific Parameters for Abiotic Compartments in the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value | | | | |
|---|---|---|---|---|---|---|
| | | 1,2,3,7,8-PeCDF | 2,3,4,6,7,8-HxCDF | 2,3,4,7,8-PeCDF | 2,3,7,8-TCDD | 2,3,7,8-TCDF |
| **Air Compartment Type** | | | | | | |
| Deposition velocity | m/day | 500 | 500 | 500 | 500 | 500 |
| Half-life | day | 31 | 59 | 33 | 12 | 19 |
| Washout ratio | $m^3$[air]/$m^3$[rain] | 13000 | 10000 | 14000 | 18000 | 19000 |
| **Surface Soil Compartment Type** | | | | | | |
| Input characteristic depth | m | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 |
| Use input characteristic depth (Boolean) | 0 = No, Else = Yes | 0 | 0 | 0 | 0 | 0 |
| Half-life | day | 3650 | 3650 | 3650 | 3650 | 3650 |
| **Root Zone Soil Compartment Type** | | | | | | |
| Input characteristic depth | m | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 |
| Use input characteristic depth | 0 = No, Else = Yes | 0 | 0 | 0 | 0 | 0 |
| Half-life | day | 3650 | 3650 | 3650 | 3650 | 3650 |
| **Vadose Zone Soil Compartment Type** | | | | | | |
| Input characteristic depth | m | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 |
| Use input characteristic depth (Boolean) | 0 = No, Else = Yes | 0 | 0 | 0 | 0 | 0 |
| Half-life | day | 1008 | 1008 | 1008 | 1008 | 1008 |
| **Groundwater Compartment Type** | | | | | | |
| Half-life | day | 1008 | 1008 | 1008 | 1008 | 1008 |
| **Surface Water Compartment Type** | | | | | | |
| Ratio Of Conc In Algae To Conc Dissolved In Water | (g[chem]/g[algae])/(g[chem]/L[water]) | 1.75 | 4.26 | 1.39 | 1.76 | 0.71 |
| Half-life | day | 0.19 | 0.58 | 0.19 | 2.7 | 0.18 |
| **Sediment Compartment Type** | | | | | | |
| Half-life | day | 1095 | 1095 | 1095 | 1095 | 1095 |

## Exhibit 19. Dioxin Chemical-Specific Parameters for Abiotic Compartments in the TRIM.FaTE Screening Scenario

| Parameter Name | Reference |
|---|---|
| **Air Compartment Type** | |
| Deposition velocity | McKone et al. 2001. |
| Half-life | Atkinson 1996 as cited in USEPA 2000b; vapor phase reaction with hydroxyl radical. |
| Washout ratio | Vulykh et al. 2001. |
| **Surface Soil Compartment Type** | |
| Input characteristic depth | Not used (model set to calculate value). |
| Use input characteristic depth (Boolean) | Professional judgment. |
| Half-life | Mackay et al. 2000; the degradation rate was cited by multiple authors, value is for 2,3,7,8-TCDD. |
| **Root Zone Soil Compartment Type** | |
| Input characteristic depth | Not used (model set to calculate value). |
| Use input characteristic depth | Professional judgment. |
| Half-life | Mackay et al. 2000; the degradation rate was cited by multiple authors, value is for 2,3,7,8-TCDD. |
| **Vadose Zone Soil Compartment Type** | |
| Input characteristic depth | Not used (model set to calculate value). |
| Use input characteristic depth (Boolean) | Professional judgment. |
| Half-life | Average value of the range presented in Mackay et al. 2000; based on estimated unacclimated aerobic biodegradation half-life, value is for 2,3,7,8-TCDD. |
| **Groundwater Compartment Type** | |
| Half-life | Average value of the range presented in Mackay et al. 2000; based on estimated unacclimated aerobic biodegradation half-life, value is for 2,3,7,8-TCDD. |
| **Surface Water Compartment Type** | |
| Ratio Of Conc In Algae To Conc Dissolved In Water | Estimated from $K_{ow}$ value using model from DelVento and Dachs 2002 |
| Half-life | Kim and O'Keefe 1998, as cited in USEPA 2000b. |
| **Sediment Compartment Type** | |
| Half-life | Estimation based on Adriaens and Grbic-Galic 1992,1993 and Adriaens et al. 1995 as cited in USEPA 2000b. |

## Exhibit 20. Cadmium Chemical-Specific Parameters for Plant Compartments in the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value | Reference |
|---|---|---|---|
| **Leaf Compartment Type** | | | |
| Transfer factor to leaf particle | 1/day | 0.002 | Professional judgment. |
| **Particle on Leaf Compartment Type** | | | |
| Transfer factor to leaf | 1/day | 0.200 | Professional judgment. |
| **Root Compartment Type - Grasses and Herbs**[a] | | | |
| Root to Root Soil Partition-Alpha of Steady State | unitless | 0.95 | Henning et al. 2001. |
| Root to Root Soil Partition-Partitioning Coefficient | $m^3$[bulk root soil]/$m^3$[root] | 0.23 | Nriagu 1980; based on average value calculated from various agricultural plant species. |
| Root to Root Soil Partition-Time to Reach Alpha | day | 28 | Henning et al. 2001. |
| **Stem Compartment Type - Grasses and Herbs**[a] | | | |
| Transpiration stream concentration factor (TSCF) | $m^3$[soil pore water]/$m^3$[xylem fluid] | 0.45 | Tsiros et al. 1999. |

[a] Roots and stems are not modeled for deciduous or coniferous forest in the current version of TRIM.FaTE.

## Exhibit 21. Mercury Chemical-Specific Parameters for Plant Compartments in the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value | | | Reference |
|---|---|---|---|---|---|
| | | Hg(0) | Hg(2) | MHg | |
| **Leaf Compartment Type** | | | | | |
| Transfer factor to leaf particle | 1/day | 0.002 | 0.002 | 0.002 | Professional judgment (assumed 1% of transfer factor from leaf particle to leaf). |
| Demethylation rate | 1/day | N/A | N/A | 0.03 | Calculated from Bache et al. 1973. |
| Methylation rate | 1/day | 0 | 0 | 0 | Assumed from Gay 1975, Bache et al. 1973. |
| Oxidation rate | 1/day | 1.0E+06 | 0 | 0 | Professional judgment; assumed close to instantaneous |
| Reduction rate | 1/day | 0 | 0 | 0 | Professional judgment. |
| **Particle on Leaf Compartment Type** | | | | | |
| Transfer factor to leaf | 1/day | 0.2 | 0.2 | 0.2 | Professional judgment. |
| Demethylation rate | 1/day | N/A | N/A | 0 | Professional judgment. |
| Methylation rate | 1/day | 0 | 0 | 0 | Professional judgment. |
| Oxidation rate | 1/day | 0 | 0 | 0 | Professional judgment. |
| Reduction rate | 1/day | 0 | 0 | 0 | Professional judgment. |
| **Root Compartment Type - Grasses and Herbs**[a] | | | | | |
| Alpha for root-root zone bulk soil | unitless | 0.95 | 0.95 | 0.95 | Selected value. |
| Root/root-zone-soil-water partition coefficient | $m^3$[bulk root soil]/ $m^3$[root] | 0 | 0.18 | 1.2 | $Hg^{2-}$ geometric mean Leonard et al. 1998, John 1972, Hogg et al. 1978; MHg- assumed, based on Hogg et al. 1978. |
| t-alpha for root-root zone bulk soil | day | 21 | 21 | 21 | Professional judgment. |
| Demethylation rate | 1/day | N/A | N/A | 0 | Professional judgment. |

## Exhibit 21. Mercury Chemical-Specific Parameters for Plant Compartments in the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value | | | Reference |
|---|---|---|---|---|---|
| | | Hg(0) | Hg(2) | MHg | |
| Methylation rate | 1/day | 0 | 0 | 0 | Professional judgment. |
| Oxidation rate | 1/day | 0 | 0 | 0 | Professional judgment. |
| Reduction rate | 1/day | 0 | 0 | 0 | Professional judgment. |
| **Stem Compartment Type - Grasses and Herbs**[a] | | | | | |
| Transpiration stream concentration factor (TSCF) | $m^3$[soil pore water]/ $m^3$[xylem fluid] | 0 | 0.5 | 0.2 | Calculation from Norway spruce, Scots pine, Bishop et al. 1998. |
| Demethylation rate | 1/day | N/A | N/A | 0.03 | Calculated from Bache et al. 1973. |
| Methylation rate | 1/day | 0 | 0 | 0 | Professional judgment. |
| Oxidation rate | 1/day | 0 | 0 | 0 | Professional judgment. |
| Reduction rate | 1/day | 0 | 0 | 0 | Professional judgment. |

[a] Roots and stems are not modeled for deciduous or coniferous forest in the current version of TRIM.FaTE.

## Exhibit 22. PAH Chemical-Specific Parameters for Plant Compartments in the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 2Methyl | 712DMB | Acenaph-thene | Acenaph-thylene | BaA | BaP | BbF | BghiP | BkF |
| **Leaf Compartment Type** | | | | | | | | | | |
| Transfer factor to leaf particle | 1/day | 1.00E-04 | 1.00E-04 | 1.00E-04 | 1.00E-04 | 1.00E-04 | 1.00E-04 | 1.00E-04 | 1.00E-04 | 1.00E-04 |
| Half-life | day | 3.50 | 3.50 | 3.50 | 3.50 | 3.50 | 3.50 | 3.50 | 3.50 | 3.50 |
| **Particle on Leaf Compartment Type** | | | | | | | | | | |
| Transfer factor to leaf | 1/day | 1.00E-04 | 1.00E-04 | 1.00E-04 | 1.00E-04 | 1.00E-04 | 1.00E-04 | 1.00E-04 | 1.00E-04 | 1.00E-04 |
| Half-life | day | 2.31 | 2.31 | 2.31 | 2.31 | 1.84 | 2.31 | 3.56 | 2.31 | 17.80 |
| **Root Compartment Type - Grasses and Herbs**[a] | | | | | | | | | | |
| Half-life | day | 34.60 | 34.60 | 34.60 | 34.60 | 34.60 | 34.60 | 34.60 | 34.60 | 34.60 |
| Root soil-water interaction - alpha | unitless | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| **Stem Compartment Type - Grasses and Herbs**[a] | | | | | | | | | | |
| Half-life | day | 3.50 | 3.50 | 3.50 | 3.50 | 3.50 | 3.50 | 3.50 | 3.50 | 3.50 |

[a] Roots and stems are not modeled for deciduous or coniferous forest in the current version of TRIM.FaTE.

## Exhibit 22. PAH Chemical-Specific Parameters for Plant Compartments in the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value | | | | | Reference |
|---|---|---|---|---|---|---|---|
| | | Chr | DahA | Fluoran-thene | Fluorene | IcdP | |
| **Leaf Compartment Type** | | | | | | | |
| Transfer factor to leaf particle | 1/day | 1.00E-04 | 1.00E-04 | 1.00E-04 | 1.00E-04 | 1.00E-04 | Professional judgment. |
| Half-life | day | 3.50 | 3.50 | 3.50 | 3.50 | 3.50 | Edwards 1988 (calculated from metabolic rate constant). |
| **Particle on Leaf Compartment Type** | | | | | | | |
| Transfer factor to leaf | 1/day | 1.00E-04 | 1.00E-04 | 1.00E-04 | 1.00E-04 | 1.00E-04 | Professional judgment. |
| Half-life | day | 4.12 | 17.80 | 2.31 | 2.31 | 17.80 | Calculated as 2 times the measured photolysis half-life from Mackay et al. 1992. Exceptions include values that have been set equal to Benzo(a)pyrene (2-Methylnaphthalene; 7,12-Dimethylbenz(a)anthracene; Acenaphthene; Acenaphthylene; Benzo(ghi)perylene; Fluoranthene; and Fluorene). |
| **Root Compartment Type - Grasses and Herbs**[a] | | | | | | | |
| Half-life | day | 34.60 | 34.60 | 34.60 | 34.60 | 34.60 | Edwards 1988 (calculated from metabolic rate constant). |
| Root soil water interaction - alpha | unitless | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | Professional judgment. |
| **Stem Compartment Type - Grasses and Herbs**[a] | | | | | | | |
| Half-life | day | 3.50 | 3.50 | 3.50 | 3.50 | 3.50 | Edwards 1988 (calculated from metabolic rate constant). |

[a] Roots and stems are not modeled for deciduous or coniferous forest in the current version of TRIM.FaTE.

### Exhibit 23. Dioxin Chemical-Specific Parameters for Plant Compartments in the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value<br>All Dioxins | Reference |
|---|---|---|---|
| **Leaf Compartment Type** | | | |
| Transfer factor to leaf particle | 1/day | 0.003 | Calculated as 1 percent of transfer factor to leaf; highly uncertain. |
| Half-life | day | 70 | Arjmand and Sandermann 1985, as cited in Komoba et al. 1995; soybean root cell culture metabolism test data for DDE. |
| **Particle on Leaf Compartment Type** | | | |
| Transfer factor to leaf | 1/day | 0.3 | Professional judgment based on USEPA 2000b (an estimate for mercury) and Trapp 1995; highly uncertain. |
| Half-life | day | 4.4 | McCrady and Maggard 1993; photodegradation sorbed to grass foliage in sunlight; assumed 10% sunlight per day. |
| **Root Compartment Type - Grasses and Herbs**[a] | | | |
| Half-life | day | 70 | Arjmand and Sandermann 1985, as cited in Komoba et al. 1995; soybean root cell culture metabolism test data for DDE. |
| Root soil-water interaction - alpha | unitless | 0.95 | Professional judgment. |
| **Stem Compartment Type - Grasses and Herbs**[a] | | | |
| Half-life | day | 70 | Arjmand and Sandermann 1985, as cited in Komoba et al. 1995; soybean root cell culture metabolism test data for DDE. |

[a] Roots and stems are not modeled for deciduous or coniferous forest in the current version of TRIM.FaTE.

## Exhibit 24. Cadmium Chemical-Specific Parameters for Aquatic Species in the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value | Reference |
|---|---|---|---|
| **Zooplankton Compartment Type** | | | |
| Absorption rate constant | L[water]/kg[fish wet wt]-day | 1500 | Goulet 2007. |
| Assimilation efficiency from algae | unitless | 0.5 | Goulet 2007. |
| Elimination rate constant | 1/day | 0.03 | Goulet 2007. |
| **Benthic Invertebrate Compartment Type** | | | |
| Sediment partitioning - alpha of equilibrium | unitless | 0.95 | Professional judgment. |
| Sediment oartitioning - partition coefficient | kg[bulk sed/kg[invertebrate wet wt] | 0.27 | Professional judgment. |
| Sediment partitioning - time to reach alpha of equilibrium | day | 21 | Hare et al. 2001. |
| **Benthic Omnivore Compartment Type** | | | |
| Assimilation efficiency from food | unitless | 0.1 | Professional judgment based on Yan and Wang 2002. |
| Absorption rate constant | unitless | 1.23 | Calculated based on body weight from regression in Hendriks and Heikens 2001. |
| Elimination rate constant | unitless | 1.73E-02 | Professional judgment. |
| **Benthic Carnivore Compartment Type** | | | |
| Assimilation efficiency from food | unitless | 0.1 | Professional judgment based on Yan and Wang 2002. |
| Absorption rate constant | unitless | 0.66 | Calculated based on body weight from regression in Hendriks and Heikens 2001. |

### Exhibit 24. Cadmium Chemical-Specific Parameters for Aquatic Species in the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value | Reference |
|---|---|---|---|
| Elimination rate constant | unitless | 1.68E-03 | Professional judgment. |
| **Water-column Herbivore Compartment Type** | | | |
| Assimilation efficiency from food | unitless | 0.1 | Assumed value based on Yan and Wang 2002. |
| Assimilation efficiency from plants | unitless | 0.1 | Assumed value based on Yan and Wang 2002. |
| Absorption rate constant | unitless | 2.46 | Calculated based on body weight from regression in Hendriks and Heikens 2001. |
| Elimination rate constant | unitless | 1.73E-02 | Professional judgment. |
| **Water-column Omnivore Compartment Type** | | | |
| Assimilation efficiency from food | unitless | 0.1 | Professional judgment based on Yan and Wang 2002. |
| Assimilation efficiency from plants | unitless | 0.1 | Professional judgment based on Yan and Wang 2002. |
| Absorption rate constant | unitless | 1.23 | Calculated based on body weight from regression in Hendriks and Heikens 2001. |
| Elimination rate constant | unitless | 1.73E-02 | Professional judgment. |
| **Water-column Carnivore Compartment Type** | | | |
| Assimilation efficiency from food | unitless | 0.1 | Professional judgment based on Yan and Wang 2002. |
| Absorption rate constant | unitless | 0.66 | Calculated based on body weight from regression in Hendriks and Heikens 2001. |
| Elimination rate constant | unitless | 1.73E-02 | Professional judgment. |

## Exhibit 25. Mercury Chemical-Specific Parameters for Aquatic Species in the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value | | | Reference |
|---|---|---|---|---|---|
| | | Hg(0) | Hg(2) | MHg | |
| **Zooplankton Compartment Type** | | | | | |
| Assimilation Efficiency From Algae | unitless | 0.2 | 0.015 | 0.5 | Environment Canada 2002. |
| Half-life | day | 1.0E+09 | 1.0E+09 | 1.0E+09 | Professional judgment. |
| How Much Faster Hg Elimination Is Than For MHg | unitless | 3 | 3 | 1 | Professional judgment. |
| Methylation rate | 1/day | 0 | 0 | 0 | Professional judgment. |
| Oxidation rate | 1/day | 0 | 1.0E+06 | 0 | Professional judgment. |
| Reduction rate | 1/day | 0 | 0 | 0 | Professional judgment. |
| **Benthic Invertebrate Compartment Type** | | | | | |
| Alpha of equilibrium for sediment partitioning | unitless | 0.95 | 0.95 | 0.95 | Selected value (i.e., proportion of equilibrium achieved by time “t”). |
| Benthic invertebrate-bulk sediment partition coefficient | kg[bulk sediment]/kg[invertebrate wet wt] | 0.0824 | 0.0824 | 5.04 | Hg(0) - assumed based on Hg(2) value; Hg(2) and MHg - Saouter et al. 1991. |
| t-alpha for equilibrium for sediment partitioning | day | 14 | 14 | 14 | Experiment duration from Saouter et al. 1991. |

### Exhibit 25. Mercury Chemical-Specific Parameters for Aquatic Species in the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value | | | Reference |
|---|---|---|---|---|---|
| | | Hg(0) | Hg(2) | MHg | |
| **All Fish Compartments Types**[a] | | | | | |
| Elimination adjustment factor | unitless | 3 | 3 | 1 | Trudel and Rasmussen 1997. |
| Assimilation efficiency from food | unitless | 0.06 | 0.06 | 0.5 | Williams et al. 2010. |
| Demethylation rate | 1/day | N/A | N/A | 0 | Professional judgment. |
| Methylation rate | 1/day | 0 | 0 | 0 | Professional judgment. |
| Oxidation rate | 1/day | 1.0E+06 | 0 | 0 | Professional judgment. |
| Reduction rate | 1/day | 0 | 0 | 0 | Professional judgment. |
| **Water-column Herbivore Compartment Type** | | | | | |
| Assimilation efficiency from plankton | unitless | 0.06 | 0.06 | 0.5 | Williams et al. 2010. |

[a] Screening scenario includes: Benthic Omnivore, Benthic Carnivore, Water-column Herbivore, Water-column Omnivore, and Water-column Carnivore.

## Exhibit 26. PAH Chemical-Specific Parameters for Aquatic Species in the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 2Methyl | 712DMB | Acenaph-thene | Acenaph-thylene | BaA | BaP | BbF | BghiP | BkF |
| **Zooplankton Compartment Type** | | | | | | | | | | |
| Absorpotion rate constant | L[water]/kg[fish wet wt]-day | 790 | 42650.94 | 42231 | 42302.18 | 42650.81 | 42652.78 | 42650.68 | 42655.77 | 42652.5 |
| Assimilation efficiency from algae | unitless | 0.5 | 0.25 | 0.5 | 0.5 | 0.46 | 0.25 | 0.25 | 0.25 | 0.25 |
| Elimination rate constant | 1/day | 169.68 | 2.03 | 148.07 | 123.44 | 2.073 | 1.3864 | 2.12 | 0.33 | 1.48 |
| Half-life | day | 0.007788 | 17 | 0.00239 | 0.00239 | 1.284 | 16.5 | 17 | 17 | 17 |
| **Benthic Invertebrate Compartment Type** | | | | | | | | | | |
| Clearance constant | unitless | 100.6 | 100.6 | 100.6 | 100.6 | 100.6 | 100.6 | 100.6 | 100.6 | 100.6 |

## Exhibit 26. PAH Chemical-Specific Parameters for Aquatic Species in the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 2Methyl | 712DMB | Acenaph-thene | Acenaph-thylene | BaA | BaP | BbF | BghiP | BkF |
| $V_d$ (ratio of concentration in benthic invertebrates to concentration in water) | ml/g | 7235 | 7235 | 7235 | 7235 | 7235 | 7235 | 7235 | 7235 | 7235 |
| Half-life | day | 0.722 | 17 | 0.722 | 0.722 | 1.284 | 16.5 | 17 | 17 | 17 |
| **All Fish Compartment Types**[a] | | | | | | | | | | |
| Gamma fish | unitless | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| Assimilation efficiency from food | unitless | 0.5 | 0.15 | 0.5 | 0.32 | 0.15 | 0.15 | 0.15 | 0.15 | 0.15 |
| Half-life | day | 0.2 | 2 | 0.2 | 0.2 | 0.408 | 1.925 | 2 | 2 | 2 |

[a] Screening scenario includes: Benthic Omnivore, Benthic Carnivore, Water-column Herbivore, Water-column Omnivore, and Water-column Carnivore.

## Exhibit 26. PAH Chemical-Specific Parameters for Aquatic Species in the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value | | | | | Reference |
|---|---|---|---|---|---|---|---|
| | | Chr | DahA | Fluoranthene | Fluorene | IcdP | |
| **Zooplankton Compartment Type** | | | | | | | |
| Absorpotion rate constant | L[water]/kg[fish wet wt]-day | 42649.95 | 42655.48 | 142000 | 15000 | 42655.93 | $K_{ow}$ from Arnot et al. 2004. Exception is Berrojalbiz et al. 2009 (2-Methylnaphthalene, Fluoranthene, and Fluorene). |
| Assimilation efficiency from algae | unitless | 0.46 | 0.25 | 0.49 | 0.5 | 0.25 | $K_{ow}$ from Arnot et al. 2004. Exception is maximum value from Wang and Wang 2006 (7,12-Dimethylbenz(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(g,h,i)perylene, Benzo(k)fluoranthene, Dibenz(a,h)anthracene, and Indeno(1,2,3-cd)pyrene). |
| Elimination rate constant | 1/day | 2.3746 | 0.4331 | 8.678 | 81.87 | 0.269 | $K_{ow}$ from Arnot et al. 2004. |
| Half-life | day | 0.495 | 17 | 0.00239 | 0.0002476 | 17 | McElroy 1990. Exceptions include Berrojalbiz et al. 2009 (2-Methylnaphthalene, Fluoranthene, and Fluorene) and Moermond et al. 2007 (Benz(a)anthracene and Benzo(a)pyrene). |
| **Benthic Invertebrate Compartment Type** | | | | | | | |
| Clearance constant | unitless | 100.6 | 100.6 | 100.6 | 100.6 | 100.6 | Stehly et al. 1990. |

## Exhibit 26. PAH Chemical-Specific Parameters for Aquatic Species in the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value | | | | | Reference |
|---|---|---|---|---|---|---|---|
| | | **Chr** | **DahA** | **Fluoranthene** | **Fluorene** | **IcdP** | |
| $V_d$ (ratio of concentration in benthic invertebrates to concentration in water) | ml/g | 7235 | 7235 | 7235 | 7235 | 7235 | Stehly et al. 1990. |
| Half-life | day | 0.495 | 17 | 0.722 | 0.722 | 17 | Moermond et al. 2007. |
| **All Fish Compartment Types**[a] | | | | | | | |
| Gamma fish | unitless | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | Thomann 1989. |
| Assimilation efficiency from food | unitless | 0.15 | 0.15 | 0.14 | 0.14 | 0.15 | Lemair et al. 1992. Exceptions include Barber 2008 (2-Methylnaphthalene and Acenaphthene) and Niimi and Palazzo 1986 (Acenaphthylene, Fluoranthene, and Fluorene). |
| Half-life | day | 0.533 | 2 | 0.165 | 0.2 | 2 | Moermond et al. 2007. |

[a] Screening scenario includes: Benthic Omnivore, Benthic Carnivore, Water-column Herbivore, Water-column Omnivore, and Water-column Carnivore.

## Exhibit 27. Dioxin Chemical-Specific Parameters for Aquatic Species in the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1,2,3,4,6,7,8,9-OCDD | 1,2,3,4,6,7,8,9-OCDF | 1,2,3,4,6,7,8-HpCDD | 1,2,3,4,6,7,8-HpCDF | 1,2,3,4,7,8,9-HpCDF | 1,2,3,4,7,8-HxCDD | 1,2,3,4,7,8-HxCDF | 1,2,3,6,7,8-HxCDD | 1,2,3,6,7,8-HxCDF |
| **Zooplankton Compartment** | | | | | | | | | | |
| Absorption rate constant | L[water]/kg[fish wet wt]-day | 8640 | 8640 | 8640 | 8640 | 8640 | 8640 | 8640 | 8640 | 8640 |
| Assimilation efficiency from algae | unitless | 0.08 | 0.05 | 0.21 | 0.09 | 0.2 | 0.31 | 0.31 | 0.31 | 0.31 |
| Elimination rate constant | 1/day | 0.0102 | 0.016 | 0.016 | 0.0616 | 0.1829 | 0.0252 | 0.1474 | 0.0099 | 0.0194 |
| Half-life | day | 7E+06 | 7E+06 | 7E+06 | 7E+06 | 7E+06 | 7E+06 | 7E+06 | 7E+06 | 7E+06 |
| **Benthic Invertebrate Compartment** | | | | | | | | | | |
| Clearance constant | unitless | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sediment partitioning partition coefficient | kg/kg | 0.0013 | 0.0017 | 0.0055 | 0.0012 | 0.042 | 0.033 | 0.0081 | 0.013 | 0.02 |
| Sediment partitioning alpha of equilibrium | unitless | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Sediment partitioning time to reach alpha of equilibrium | days | 120 | 42 | 120 | 42 | 42 | 120 | 42 | 120 | 42 |
| $V_d$ (ratio of concentration in benthic invertebrates to concentration in water) | ml/g | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

## Exhibit 27. Dioxin Chemical-Specific Parameters for Aquatic Species in the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1,2,3,4,6,7,8,9-OCDD | 1,2,3,4,6,7,8,9-OCDF | 1,2,3,4,6,7,8-HpCDD | 1,2,3,4,6,7,8-HpCDF | 1,2,3,4,7,8,9-HpCDF | 1,2,3,4,7,8-HxCDD | 1,2,3,4,7,8-HxCDF | 1,2,3,6,7,8-HxCDD | 1,2,3,6,7,8-HxCDF |
| Half-life | day | 5776.2 | 5776.2 | 5776.2 | 5776.2 | 5776.2 | 5776.2 | 5776.2 | 5776.2 | 5776.2 |
| **All Fish Compartments**[a] | | | | | | | | | | |
| Assimilation efficiency from food | unitless | 0.08 | 0.05 | 0.21 | 0.09 | 0.2 | 0.37 | 0.31 | 0.31 | 0.31 |
| Chemical uptake rate via gill | L[water]/kg[fish wet wt]-day | 11 | 6 | 56 | 25 | 50 | 102 | 200 | 300 | 200 |
| Half-life | day | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 |

[a] Screening scenario includes: Benthic Omnivore, Benthic Carnivore, Water-column Herbivore, Water-column Omnivore, and Water-column Carnivore.

## Exhibit 27. Dioxin Chemical-Specific Parameters for Aquatic Species in the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1,2,3,7,8,9-HxCDD | 1,2,3,7,8,9-HxCDF | 1,2,3,7,8-PeCDD | 1,2,3,7,8-PeCDF | 2,3,4,6,7,8-HxCDF | 2,3,4,7,8-PeCDF | 2,3,7,8-TCDD | 2,3,7,8-TCDF |
| **Zooplankton Compartment** | | | | | | | | | |
| Absorption Rate Constant | L[water]/kg[fish wet wt]-day | 8640 | 8640 | 8640 | 8640 | 8640 | 8640 | 8640 | 8640 |
| Assimilation Efficiency from Algae | unitless | 0.31 | 0.31 | 0.42 | 0.42 | 0.31 | 0.42 | 0.41 | 0.51 |
| Elimination Rate Constant | 1/day | 0.0099 | 0.0413 | 0.0819 | 0.2316 | 0.0192 | 0.4331 | 0.2268 | 1.0375 |
| Half-life | day | 7E+06 | 7E+06 | 7E+06 | 7E+06 | 7E+08 | 7E+08 | 7E+06 | 7E+08 |
| **Benthic Invertebrate Compartment** | | | | | | | | | |
| Clearance Constant | unitless | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sediment Partitioning Partition Coefficient | kg/kg | 0.015 | 0.067 | 0.098 | 0.024 | 0.072 | 0.17 | 0.205 | 0.056 |
| Sediment Partitioning Alpha of Equilibrium | unitless | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 |
| Sediment Partitioning Time to Reach Alpha of Equilibrium | days | 120 | 42 | 120 | 42 | 42 | 42 | 120 | 42 |
| $V_d$ (ratio of concentration in benthic invertebrates to concentration in water) | ml/g | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Half-life | day | 5776.2 | 5776.2 | 5776.2 | 5776.2 | 5776.2 | 5776.2 | 5776.2 | 5776.2 |

## Exhibit 27. Dioxin Chemical-Specific Parameters for Aquatic Species in the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Value | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1,2,3,7,8,9-HxCDD | 1,2,3,7,8,9-HxCDF | 1,2,3,7,8-PeCDD | 1,2,3,7,8-PeCDF | 2,3,4,6,7,8-HxCDF | 2,3,4,7,8-PeCDF | 2,3,7,8-TCDD | 2,3,7,8-TCDF |
| **All Fish Compartments**[a] | | | | | | | | | |
| Assimilation efficiency from food | unitless | 0.31 | 0.31 | 0.42 | 0.42 | 0.31 | 0.42 | 0.41 | 0.51 |
| Chemical uptake rate via gill | L[water]/kg[fish wet wt]-day | 300 | 200 | 700 | 300 | 200 | 400 | 600 | 400 |
| Half-life | day | 70 | 70 | 70 | 70 | 70 | 70 | 70 | 70 |

[a] Screening scenario includes: Benthic Omnivore, Benthic Carnivore, Water-column Herbivore, Water-column Omnivore, and Water-column Carnivore.

### Exhibit 27. Dioxin Chemical-Specific Parameters for Aquatic Species in the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Reference |
|---|---|---|
| **Zooplankton Compartment** | | |
| Absorption rate constant | L[water]/kg[fish wet wt]-day | Zhang et al. 2011; used copepod $k_u$ value. |
| Assimilation efficiency from algae | unitless | Morrison et al. 1999. Exceptions include Niimi and Oliver 1986 (1,2,3,4,6,7,8,9-OCDD, 1,2,3,4,6,7,8,9-OCDF), Berntssen et al. 2007 (1,2,3,4,6,7,8-HpCDD, 1,2,3,4,6,7,8-HpCDF), and 1,2,3,4,7,8,9-HpCDF set conservatively as approximate linear interpolation between values for 1,2,3,4,7,8-HxCDD and 1,2,3,4,6,7,8-HpCDD / 1,2,3,4,6,7,8-HpCDF (i.e., 0.3 to 0.1–0.2). |
| Elimination rate constant | 1/day | Arnot and Gobas 2004; used $K_{ow}$ value. |
| Half-life | day | Morrison et al. 1999; used metabolic rates for invertebrates. |
| **Benthic Invertebrate Compartment** | | |
| Clearance constant | unitless | Professional judgment. |
| Sediment partitioning partition coefficient | kg/kg | Rubinstein et al. 1990; used TCDD data for sandworm. |
| Sediment partitioning alpha of equilibrium | unitless | Rubinstein et al. 1990. |
| Sediment Partitioning Time to Reach Alpha of Equilibrium | days | Rubinstein et al. 1990. |
| $V_d$ (ratio of concentration in benthic invertebrates to concentration in water) | ml/g | Professional judgment. |
| Half-life | day | Rubinstein et al. 1990; used TCDD data for sandworm. |

## Exhibit 27. Dioxin Chemical-Specific Parameters for Aquatic Species in the TRIM.FaTE Screening Scenario

| Parameter Name | Units | Reference |
|---|---|---|
| **All Fish Compartments**[a] | | |
| Assimilation Efficiency from Food | unitless | Morrison et al. 1999. Exceptions include Niimi and Oliver 1996 (1,2,3,4,6,7,8,9-OCDD, 1,2,3,4,6,7,8,9-OCDF), Van den Berg et al. 1994 (1,2,3,4,6,7,8-HpCDD), Berntssen et al. 2007 ( 1,2,3,4,6,7,8-HpCDF), and 1,2,3,4,7,8,9-HpCDF set conservatively as approximate linear interpolation between values for 1,2,3,4,7,8-HxCDD and 1,2,3,4,6,7,8-HpCDD / 1,2,3,4,6,7,8-HpCDF (i.e., 0.3 to 0.1–0.2). |
| Chemical Uptake Rate Via Gill | L[water]/kg[fish wet wt]-day | Muir et al. 1985. Exception is Opperhuizen et al. 1986 (1,2,3,7,8,9-HxCDF, 1,2,3,7,8-PeCDD, 1,2,3,7,8-PeCDF, 2,3,4,7,8-PeCDF, 2,3,7,8-TCDD, 2,3,7,8-TCDF). |
| Half-life | day | Berntssen et al. 2007. |

[a] Screening scenario includes: Benthic Omnivore, Benthic Carnivore, Water-column Herbivore, Water-column Omnivore, and Water-column Carnivore.

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## Technical Support Document for the TRIM-Based Multipathway Tiered Screening Methodology for RTR

# Addendum 2: Description of Multimedia Ingestion Risk Calculator (MIRC) Used for RTR Exposure and Risk Estimates

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# LIST OF EXHIBITS

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# 1 Introduction

## 1.1 Purpose and Overview

This document provides a detailed description of the *Multimedia Ingestion Risk Calculator* (MIRC), a modeling tool and database designed to assist in estimating risks via multiple ingestion pathways, particularly for food products grown or raised at home or on a farm.[1] MIRC was designed to estimate risks to humans from ingestion of produce or animal products, fish, and water in the vicinity of a source of chemical emissions to air. The user can evaluate either generalized (e.g., health protective default) or more site-specific scenarios using the same tool. MIRC includes a database of exposure parameter values, offering the user the option of selecting mean, median, and upper percentile values for many parameters, data permitting. Generally health protective default values were assigned to each parameter in the tool and the default configuration is used for initial risk screening efforts by EPA's Office of Air Quality Planning and Standards' (OAQPS) for Risk and Technology Review (RTR) multimedia risk assessments. MIRC also allows the user to define the farm food chain (FFC) parameter values and receptor characteristics to better represent a site-specific scenario.

With user-input concentrations for one or more chemicals in air and soil and air-to-surface deposition rates, MIRC calculates the chemical's concentrations in home- or farm-grown produce and animal food products using FFC algorithms adapted from EPA's *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities* (hereafter referred to as HHRAP; EPA 2005a). MIRC uses these calculated concentrations, along with user-input chemical concentrations for fish and drinking water, to estimate chemical intake rates, as average daily doses (ADDs), for adults, children, and nursing infants. Users can obtain chemical input concentrations and deposition rates from measurements at an actual site or from a transport and fate model, such as TRIM.FaTE, as is done for RTR risk assessment.

For a specified set of chemical concentrations and MIRC parameter options, MIRC calculates ADDs separately for adults, four age groups of children, and infants to reflect differences in food ingestion rates and diet at different lifestages. MIRC estimates age-specific hazard quotients (HQs) as the ratio of age-specific ADDs to the reference dose (RfD) for a chemical. The most appropriate HQ for a chemical depends on its toxic mode of action and the duration of exposure required to produce an effect. MIRC also estimates average lifetime ADDs and compares those to cancer slope factors (CSFs) to estimate cancer risks. A breast milk ingestion pathway is available to estimate exposure and risks to nursing infants.

MIRC was developed to be a flexible, transparent application. The tool includes chemical transfer and ingestion exposure algorithms and a database of parameter values, many with several options, used by these equations. The MIRC database includes values for the relevant physiochemical properties and toxicity reference values for more than 500 chemicals, including approximately 60 inorganics taken primarily from a database developed for HHRAP (EPA 2005a). Although designed for OAQPS' RTR assessments for sources of hazardous air pollutants (HAPs), the tool is flexible in its design and can be used to assess risks in many other contexts where soil and air concentrations are predicted or measured.

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[1] Fully functional versions of MIRC are available in both Access-based and Excel-based formats.

## 1.2 Scope of MIRC

For persistent and bioaccumulative (PB) chemicals, risks from direct inhalation of the chemical can be much less than risks from ingestion of the chemical in water, fish, and food products grown in an area of chemical deposition. Vegetables and fruits in such areas can become contaminated directly by deposition of the airborne chemical to foliage, fruits, and vegetables or indirectly by root uptake of the chemical deposited to soils. Livestock can be exposed to the PB chemicals via ingestion of contaminated forage and incidental ingestion of contaminated soils.

For PB chemicals, evaluation of the inhalation pathway for air pollutants may reveal only a portion of the risk to individuals in such populations. Households that consume high quantities of self-caught fish or locally grown produce and animal products may be particularly susceptible to ingestion of chemicals transferred from air in the vicinity of an air emissions source. For PB chemicals in particular, therefore, EPA developed methods of estimating risk from indirect exposure pathways associated with the deposition of airborne chemicals to gardens and farms, as described in HHRAP (EPA 2005a).

## 1.3 Use in EPA's Air Toxics Program

MIRC was designed to help predict human health risks from PB HAPs for EPA's RTR assessments. EPA evaluates the fate of HAP releases to air from source categories after implementation of technology-based Maximum Achievable Control Technology (MACT) standards. For volatile chemicals that do not partition to other environmental media and for non-persistent chemicals that degrade relatively quickly in the environment, evaluation of health risks from direct inhalation of the chemical in air can provide reasonable estimates of total risk.

For PB-HAPs, however, indirect exposure pathways, such as ingestion, might contribute more to total risk than the inhalation pathway. EPA therefore developed several computer software tools to assist in evaluating exposure and risk from non-inhalation pathways. EPA developed the *Total Risk Integrated Methodology* (TRIM) *Environmental Fate, Transport, and Ecological Exposure* (TRIM.FaTE) computer program to simulate the release, transport, and fate of HAPs from a specific source throughout the area in which local (non-source) chemical deposition is likely to be a concern. TRIM.FaTE models the transport of individual chemicals from the source through air by advection (wind) of particle- and vapor-phase chemical and deposition of the chemical from air to terrestrial and aquatic ecosystems by wet and dry deposition. Movement of the chemical through a watershed via erosion and runoff, uptake by plants, and other abiotic and biotic transfer processes also are simulated. For the chemical that reaches surface waters, TRIM.FaTE models uptake and bioaccumulation to trophic level (TL) 3 and 4 fish (i.e., pan fish and game fish, respectively).

MIRC was developed to process TRIM.FaTE results, in particular, air deposition rates and the concentrations of a chemical, after a specified duration of emissions, in several spatially explicit environmental compartments, including air, surface and root-zone soils, surface and ground waters, and fish. MIRC uses those results to calculate exposure to the chemical through ingestion of locally grown foods, including various types of fruits and vegetables, poultry, swine, and dairy (and beef) cattle. MIRC also calculates the associated risks for individuals who consume those foods. MIRC was designed to use specific TRIM.FaTE results to estimate FFC concentrations, ingestion exposures, and human health risks for OAQPS' RTR assessments. It uses the same approach that OAQPS intends to implement directly in its TRIM system via three modules beyond TRIM.FaTE: TRIM Farm Food Chain, TRIM.Expo$_{\text{Ingestion}}$, and TRIM.Risk.[2]

## 1.4 MIRC Highlights

Although designed to assist EPA OAQPS in its RTR assessments, MIRC is a stand-alone software application that can be used in other contexts. A user can supply either measured or estimated chemical concentrations for soil, air, water, and fish and air deposition rates likely for the location(s) of interest based on local meteorology. The user can accept the default values for many exposure parameters and screen for small possibilities of risk, or the user can select other options or overwrite parameter values to tailor the estimates to a specific scenario or location.

MIRC complies with EPA's latest guidelines for exposure and risk assessment, including HHRAP; the Agency's 2005 *Guidelines for Carcinogen Risk Assessment* (Cancer Guidelines), *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens* (Supplemental Guidance), and *Guidance on Selecting Age Groups for Monitoring and Assessing Childhood Exposures to Environmental Contaminants* (EPA 2005b,c,d); and its 2008 *Child-Specific Exposure Factors Handbook* (EPA 2008a). In particular, MIRC provides several important capabilities:

- When provided air and soil concentrations, the MIRC software package allows rapid calculation of screening-level exposures and risks associated with household consumption of locally grown/raised foods.
- MIRC can calculate exposures and risks associated with incidental ingestion of surface soils, fish consumption, and drinking water.
- The tool calculates ADDs (i.e., chemical intake rates) for six "built-in" age groups to allow use of age-group-specific body weights, ingestion rates, food preferences, and susceptibility to toxic effects.
- Its database of chemical information covers plant- and animal-specific transfer factors and other inputs that determine concentrations in farm food stuffs.
- Value options for receptor characteristics in the database include the mean and 50th, 90th, 95th, and 99th percentile values where data permit.
- For carcinogens with a mutagenic mode of action, MIRC estimates a lifetime ADD using the three lifestages and potency adjustment factors recommended in EPA's 2005 Cancer Guidelines and Supplemental Guidance.
- The data for exposure parameters in the tool have been updated to include the latest recommended values for children issued September 30, 2008, in the Agency's Child-Specific Exposure Factors Handbook (CSEFH) (EPA 2008a).

## 1.5 Organization of This Document

Sections 2 through 5 of this document describe the exposure and risk models implemented in MIRC. Section 2 provides an overview of the FFC exposure scenario and indicates options available to a user to tailor the scenario to specific applications. Section 3 describes the

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[2] General information about the TRIM system is available at http://www.epa.gov/ttn/fera/trim_gen.html.

exposure algorithms used in MIRC, including how ADDs are calculated. Section 4 presents the toxicity reference values included in MIRC to calculate risks. Section 5 describes the risk characterization algorithms in MIRC. Section 6 of this document describes data input options for the model. Section 7 describes the default parameterization of MIRC for application to health protective risk screening assessments, and Section 8 provides the references.

Note that the default parameterization described in Section 7 was used to estimate screening threshold emission rates of PB-HAPs from RTR facilities. These emissions levels are assumed to pose negligible risk to subsistence communities in the vicinity of a facility emitting the PB-HAPs to air. Users of MIRC can modify the default values for many of the parameters to better represent a specific exposure scenario.

# 2 MIRC Overview

The *Multimedia Ingestion Risk Calculator* (MIRC) software package is designed to allow rapid calculation of screening-level exposures and risks associated with subsistence and recreational farmer/fisher populations in the vicinity of a source of chemical emissions to air. The tool allows a user to assess human exposures via ingestion pathways, including drinking water consumption, incidental soil ingestion, fish ingestion, and ingestion of ten types of farm food chain (FFC) products: exposed fruits, protected fruits, exposed vegetables, protected vegetables, root vegetables, beef, total dairy, pork, poultry, and eggs. The tool also includes a breast milk ingestion and risk module for nursing infants. For fruits and vegetables, the terms "exposed" and "protected" refer to whether the edible portion of the plant is exposed to the atmosphere.

The remainder of this overview consists of three sections. The first (Section 2.1) provides an overview of the MIRC software package. The second and third sections summarize the ingestion exposure pathways included in the tool and the "built-in" receptor age categories, respectively (Sections 2.2 and 2.3).

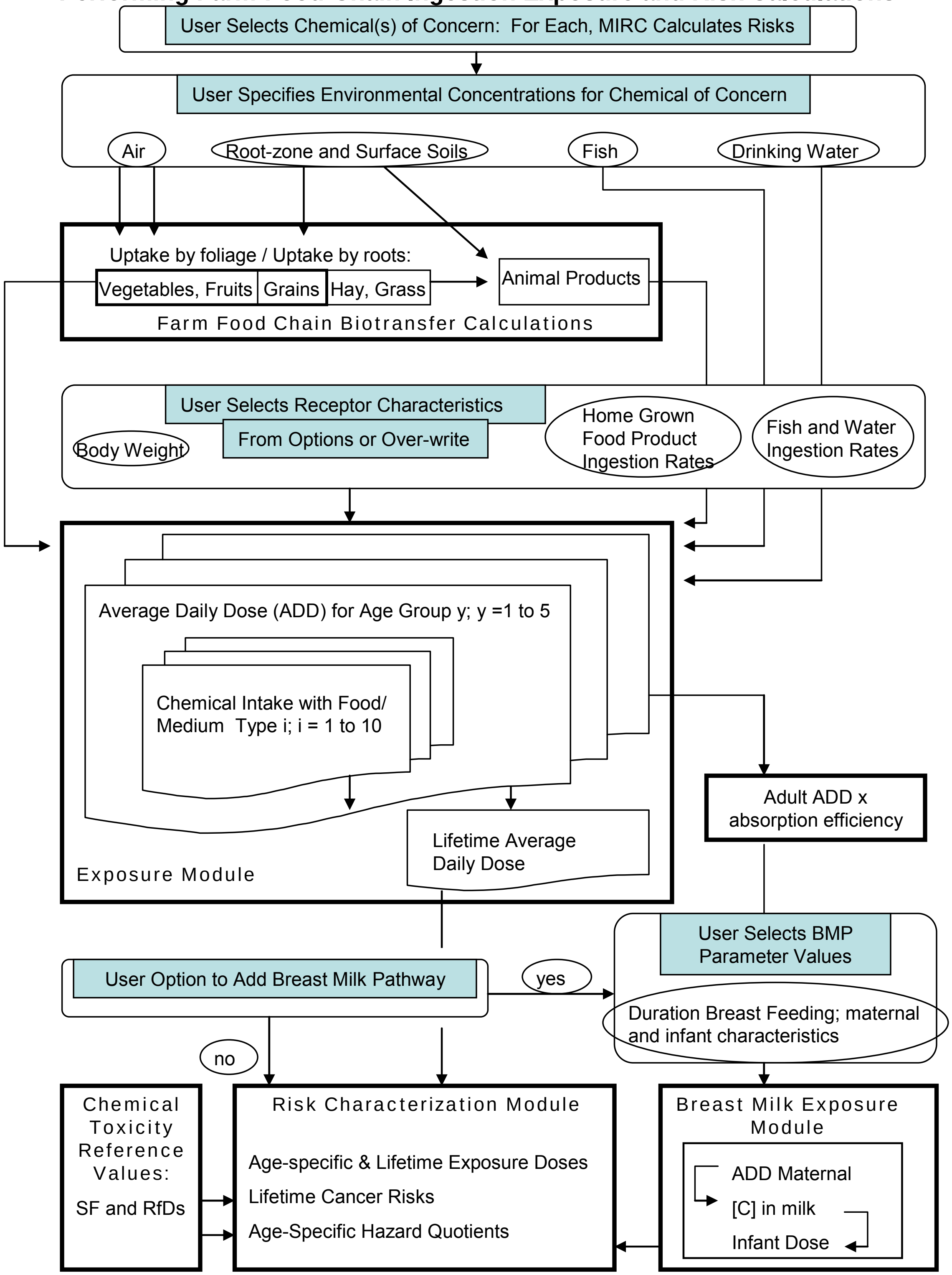
## 2.1 Software

The MIRC application includes the following components:

- A graphical user interface through which the user locates and accesses various input and output tables.
- Input tables in which the user can enter environmental concentrations of a chemical estimated for air, soil, drinking water, and fish tissue.
- Internal chemical transfer and exposure algorithms and database of options for FFC algorithm parameter value, chemical-specific inputs, and exposure factors.
- Tabulated outputs of calculated chemical concentrations in the various farm food products (e.g., fruits, vegetables, beef, eggs) and ADDs for those foods and for water and fish ingestion for each receptor category.
- Output tables with estimated cancer risks and non-cancer hazard estimates associated with total ingestion exposure to each chemical for each receptor category.

Exhibit 2-1 provides a flowchart displaying the types of inputs required or optional and general flow of calculations carried out by the tool.

## Exhibit 2-1. Overview of MIRC Software Application for Performing Farm-Food-Chain Ingestion Exposure and Risk Calculations



A form within the graphical user interface enables the user to construct specific scenarios by choosing ingestion sources, receptor ages, and other input choices (e.g., diet composition, body weight percentiles). This feature facilitates the analysis of various exposure scenarios. To begin an analysis, the user must supply values for the following chemical-specific parameters for the scenario being evaluated:

- Air concentration of total chemical,
- Fraction chemical in air in vapor-phase,
- Wet and dry deposition rates for particle-phase chemical,
- Drinking water concentration,
- Chemical concentration in surface soils (two locations; can be tilled and untilled),
- Chemical concentration in root-zone soils (two locations; can be tilled and untilled), and
- Chemical concentrations in pan fish and in game fish.

Users can input measured values or values estimated by TRIM.FaTE or other models for these parameters.

The MIRC application uses the input data and a variety of empirical transfer factor values (included in its database) to estimate chemical concentrations in nine categories of FFC food types (Section 2.2). The FFC algorithms and transfer factor values included in MIRC are based on those presented in Chapter 5 of EPA's HHRAP (EPA 2005a).

For outputs, MIRC is designed to calculate individual cancer risk and non-cancer hazard quotients for one chemical at a time. It is up to the risk assessor to determine if cancer risks or hazard quotients may be additive across two or more chemicals (i.e., if they cause toxic effects in the same target organ by the same mode of action, such as multiple polycyclic aromatic hydrocarbons (PAHs) that are carcinogenic by a mutagenic mode of action).

The tool assumes that the same individuals (farming family or household that gardens and raises animals) are exposed via all of the pathways specified (i.e., pathways with non-zero ingestion rates). The tool therefore is useful in estimating risk to the maximally exposed individuals (MEI) in a risk assessment. To evaluate multiple populations, the user must specify the full exposure scenario for each population separately.

## 2.2 Exposure Pathways

MIRC estimates the concentrations of chemicals in FFC food categories grown in an area of airborne chemical deposition using algorithms and parameter values provided in HHRAP (EPA 2005a). FFC foods are evaluated in ten categories: exposed fruit, protected fruit, exposed vegetables, protected vegetables, root vegetables, beef, total dairy, pork, poultry, and eggs. Exhibit 2-2 summarizes the pathways by which chemicals are transferred to these food media. Note that for a general screening-level assessment, all of the pathways can be modeled, as is the case for EPA's *Risk and Technology Review* (RTR) calculation of screening threshold emission rates for persistent and bioaccumulative hazardous air pollutants (PB-HAPs) (EPA 2008b).

**Exhibit 2-2. Transfer Pathways for Modeled Farm Food Chain (FFC) Media**

| Farm Food Media | Chemical Transfer Pathways |
|---|---|
| Exposed fruit and vegetables | • Direct deposition from air of particle-bound chemical<br>• Air-to-plant transfer of vapor phase chemical<br>• Root uptake from soil |
| Protected fruit and vegetables (including root vegetables) | • Root uptake from soil |
| Beef and total dairy (including milk) | • Ingestion of forage, silage, and grain [a]<br>• Soil ingestion |
| Pork | • Ingestion of silage and grain [a]<br>• Soil ingestion |
| Poultry and eggs | • Ingestion of grain [a]<br>• Soil ingestion |

[a] Chemical concentrations in forage, silage, and grain are estimated via intermediate calculations analogous to those used for aboveground produce.

Produce types included in the FFC can accumulate a chemical directly from air and/or soil. For exposed produce, chemical mass is assumed to be transferred to plants from the air in two ways. First, particle-bound chemical can deposit directly on the plant surface. Second, the uptake of vapor-phase chemicals by plants through their foliage can occur. For both exposed and protected produce, the concentration in the plant derived from exposure to the chemical in soil is estimated using an empirical bioconcentration factor (BCF) that relates the concentration in the plant to the concentration present in the soil. For belowground root vegetables, a root concentration factor is applied. The algorithms used to estimate produce concentrations are presented in Section 3.1.1.

Chemical concentrations in animal products are estimated based on the amount of chemical consumed through the diet, including incidental ingestion of soil while grazing. The diet options for farm animals in MIRC include forage (plants grown on-site for animal grazing, such as grass), silage (wet forage grasses, fresh-cut hay, or other fresh plant material that has been stored and fermented), and feed grain products grown on the farm (e.g., corn, soybeans). All three animal feed products are assumed to accumulate chemical via root uptake from the soil. Forage and silage also can accumulate chemical via direct deposition of particle-bound chemical and vapor transfer.

The algorithms in MIRC are based on the assumptions that beef and dairy cattle consume all three feed products, while pigs consume only silage and grain and chickens consume only grain. The incidental ingestion of the chemical in soils during grazing or consumption of foods placed on the ground is estimated using empirical soil ingestion values. For secondary animal products (dairy products and eggs), chemical concentrations are estimated by applying a biotransfer factor to the estimated concentration in the "source" animal (cows and chickens, respectively). The algorithms used to estimate animal product concentrations are described in Section 3.1.2.

## 2.3 Receptor Groups

As noted in EPA risk assessment guidelines (EPA 2005b,c,d, 2008a), exposures of children are expected to differ from exposures of adults due to differences in body weights, ingestion rates, dietary preferences, and other factors. It is important, therefore, to evaluate the contribution of exposures during childhood to total lifetime risk using appropriate exposure factor values.

EPA's HHRAP (Chapter 4, EPA 2005a) recommends assessing exposures for children and adults separately, but considers all non-infant children in one category. Specifically, HHRAP recommends eight categories of receptor: farmer, child farmer, resident, child resident, fisher, child fisher, acute receptor, and nursing infant. Over time, different EPA programs have used different child age groupings to evaluate body weights, ingestion rates, and other parameter values needed to estimate chemical exposures and risks to children.

To improve the match between age groups used to estimate values across exposure parameters, in 2005, EPA recommended a standard set of child age categories for exposure and risk assessments (EPA 2005b). EPA recommended four age groups for infants: birth to < 1 month; 1 to < 3 months; 3 to < 6 months; and 6 to < 12 months. For young children, EPA recommended an additional four age groups: 1 to < 2 years; 2 to < 3 years; 3 to < 6 years; and 6 to < 11 years. Two age groupings were recommended for teenagers and young adults: 11 to < 16 years; and 16 to < 21 years. These age groupings correspond to different developmental stages and reflect different food ingestion rates per unit body weight, with the highest ingestion rates occurring for the youngest, most rapidly growing, age groups.

For assessment of cancer risks from early-life exposure, EPA recognizes that infants and children may be more sensitive to a carcinogenic chemical than adults, with cancers appearing earlier in life or with lower doses experienced during childhood (EPA 2005c, d). Thus, the "potency" of a carcinogen might be higher for infants and children than for adults. To date, however, data by which to evaluate the relative sensitivity of children and adults to the same daily dose of a carcinogen remain limited. Based on analyses of radioactive and other carcinogenic chemicals, EPA recommends evaluating two lifestages for children separately from adults for chemicals that cause cancer by a mutagenic mode of action (MOA): from birth to < 2 years and from 2 to < 16 years (EPA 2005c,d). EPA also suggests that, as data become available regarding carcinogens with a mutagenic MOA, further refinements of these age groupings may be considered.

For purposes of RTR assessment using MIRC, the selection of age categories is limited by the categories for which most of the FFC food ingestion rates have been calculated. In Chapter 13 of both its *Exposure Factors Handbook* (EFH; EPA 2011) and its *Child-Specific Exposure Factors Handbook* (CSEFH; EPA 2008a), EPA summarized home-grown/raised food ingestion rates for four children's age groups: 1 to < 3 years; 3 to < 6 years; 6 to < 12 years; and 12 to < 20 years. Intake rates were not calculated for children younger than 1 year because infants are unlikely to consume those foods. They are more likely to be nursing or to be fed formula and other commercial baby-food products.

Although the age groupings used to estimate FFC ingestion rates do not match precisely the groupings that EPA recommended in 2005 for Agency exposure assessments (EPA 2005b), they are the only age-groupings for which such data are available. The U.S. Department of Agriculture's (USDA's) 1987-1988 *Nationwide Food Consumption Survey* (USDA 1992, 1993, 1994) remains the most recent survey of ingestion rates for home-grown foods, and EPA's analysis of those data, published in its 2011 EFH, remains the most recently published major analysis of those data. Because ingestion of home-grown produce and animal products are the primary exposure pathways for which MIRC was developed, those are the age groupings used for all child parameter values used to estimate exposure and risk in MIRC.

Thus, in MIRC, values for each exposure parameter were estimated for adults (20 to 70 years) and five children's age groups:

- infants under 1 year (i.e., 0 to < 1 year);
- children ages 1 through 2 years (i.e., 1 to < 3 years);
- children ages 3 through 5 years (i.e., 3 to < 6 years);
- children ages 6 through 11 years(i.e., 6 to < 12 years) and
- children ages 12 through 19 years (i.e., 12 to < 20 years).

Exposure and risks to infants under 1 year of age are estimated only for the breast-milk-ingestion pathway.

For assessing risks from exposures to carcinogenic chemicals that act via a mutagenic MOA, the two early lifestages recommended by EPA (EPA 2005c,d) also are included in MIRC:

- children under the age of 2 years (i.e., 0 to < 2 years); and
- children from 2 through 15 years (i.e., 2 to < 16 years).

Different age groupings are needed for the assessment of risks from carcinogenic chemicals with a mutagenic MOA and other carcinogens with other or unknown MOAs.  Currently in MIRC, the only PB-HAPs with a mutagenic mode of carcinogenesis are some of the PAHs.

# 3 Exposure Algorithms

The exposure algorithms in MIRC are described below in four sections. Section 3.1 presents the algorithms used to estimate chemical concentrations in FFC foods from chemical concentrations in soil and air. Pathway-specific algorithms used to estimate chemical intakes by adults and non-infant children are described in Section 3.2, and total chemical intake calculations are described in Section 3.3. Finally, the sets of algorithms used to estimate chemical intake via consumption of breast milk by nursing infants are described in Section 3.4. As noted previously, the exposure algorithms used in MIRC are based on those presented in HHRAP (EPA 2005b). Any differences between MIRC and HHRAP are explained in this section.

## 3.1 Farm Food Chain Algorithms

The algorithms and parameters used to estimate chemical concentrations in produce and animal products are described in Sections 3.1.1 and 3.1.2, respectively. Discussions of the parameter value options and the values selected as defaults in MIRC for RTR risk assessment are provided in Section 6.2. The use of TRIM.FaTE to model chemical fate and transport in the environment prior to FFC calculations drives the most significant difference between the FFC algorithms included in HHRAP and the equations used for RTR. The approach in HHRAP uses estimated ambient air concentrations and deposition rates from dispersion model simulations that use unitized emission rates. Chemical-specific emission rates (adjusted for vapor and particle-bound fractions) are then incorporated into some of the HHRAP FFC algorithms to calculate concentrations in FFC media. Soil concentrations are calculated using a similar approach in HHRAP. For assessment of multipathway exposures for RTR, TRIM.FaTE is used to estimate air concentrations, air-to-surface deposition rates, and soil concentrations, and these outputs are used in the FFC algorithms.

### *3.1.1 Estimating Chemical Concentrations in Produce*

Produce (vegetables and fruits) can become contaminated directly by deposition of airborne chemicals to foliage and fruits or indirectly by uptake of chemicals deposited to the soil. Given these two contamination processes, produce is divided into two main groups: aboveground and belowground produce. Aboveground produce is divided into fruits and vegetables. These groups are further subdivided into “exposed” and “protected” depending on whether the edible portion of the plant is exposed to the atmosphere or is protected by a husk, hull, or other outer covering.

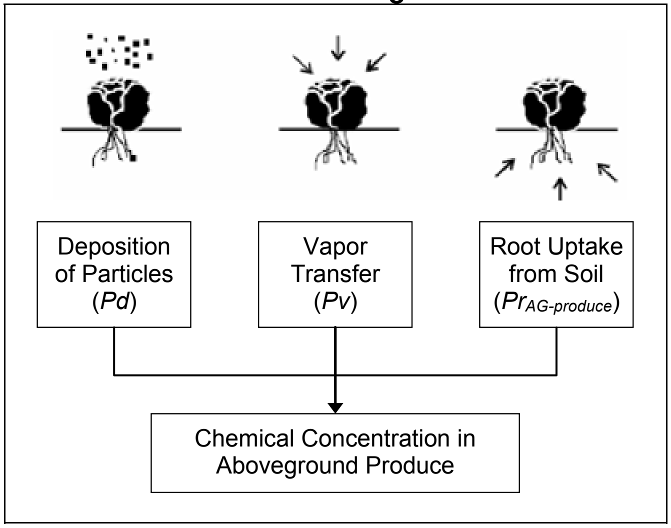
Exhibit 3-1 lists the pathways by which chemicals are transferred to the FFC produce categories. Note that for a general screening-level assessment, all of the pathways can be modeled, as was done for EPA’s calculation of screening threshold emission rates for PB-HAPs in its RTR assessments (EPA 2008b), and as described in the Technical Support Document. Sections 3.1.1.1 and 3.1.1.2 describe the transfer pathways and algorithms for aboveground and belowground produce, respectively.

**Exhibit 3-1. Chemical Transfer Pathways for Produce**

| Farm Food Media | | Chemical Transfer Pathways |
|---|---|---|
| Aboveground Produce | Exposed fruits and vegetables | • Direct deposition from air of particle-bound chemical<br>• Air-to-plant transfer of vapor phase chemical<br>• Root uptake from soil |
| | Protected fruits and vegetables | • Root uptake from soil |
| Belowground Produce | Root vegetables | • Root uptake from soil |

### 3.1.1.1 Aboveground Produce

**Exhibit 3-2. Estimating Chemical Concentration in Aboveground Produce**



For aboveground *exposed* produce, chemical mass is assumed to be transferred to plants from the air in three ways, as illustrated in Exhibit 3-2. First, particle-bound chemical can deposit directly on the plant surface via deposition (*Pd*). The amount of chemical accumulated is estimated based on the areal fraction of chemical deposition intercepted by the plant surface, minus a loss factor that is intended to account for removal of deposited chemical by wind and rain and changes in concentration due to growth dilution. Second, for chemical present in air in the vapor phase, the concentration of chemical accumulated by the plant's foliage is estimated using an empirical air-to-plant biotransfer factor (*Pv*). Third, the chemical concentration in the plant due to root uptake from the soil ($Pr_{AG\text{-}produce}$) is estimated using an empirical bioconcentration factor ($Br_{AG\text{-}produce}$ ) that relates the chemical concentration in the plant to the average chemical concentration in the soil at the root-zone depth in the produce-growing area ($Cs_{root\text{-}zone\_produce}$).

The edible portions of aboveground *protected* produce are not subject to contamination via particle deposition (*Pd*) or vapor transfer *(Pv*). Therefore, root uptake of chemicals is the primary mechanism through which aboveground protected produce becomes contaminated. The chemical concentration in the aboveground plant due to root uptake from soil ($Pr_{AG\text{-}produce\text{-}DW}$) is estimated using an empirical bioconcentration factor ($Br_{AG\text{-}produce\text{-}DW}$) that relates the chemical concentration in the plant to the average chemical concentration in the soil at the root-zone depth in the produce-growing area ($Cs_{root\text{-}zone\_produce}$).

### Equation 3-1. Chemical Concentration in Aboveground Produce

$$C_{AG-produce-DW(i)} = \Pr_{AG-produce-DW(i)} + Pd_{(i)} + Pv_{(i)}$$

where:

$C_{AG\text{-}produce\text{-}DW(i)}$ = Concentration of chemical in edible portion of aboveground produce type *i*, exposed or protected, on a dry-weight (DW) basis (mg/kg produce DW)

$Pd_{(i)}$ = Chemical concentration in edible portion of aboveground produce type *i* due to deposition of particles (mg/kg produce DW); for *protected* aboveground produce, *Pd* equals zero

$Pr_{AG\text{-}produce\text{-}DW(i)}$ = Chemical concentration in edible portion of aboveground produce type *i*, exposed or protected, due to root uptake from soil at the root-zone depth of the produce growing area (mg/kg produce DW)

$Pv_{(i)}$ = Chemical concentration in edible portion of aboveground produce type *i* due to air-to-plant transfer (µg/g [or mg/kg] produce DW); for *protected* aboveground produce, *Pv* equals zero

### Equation 3-2. Chemical Concentration in Aboveground Produce Due to Root Uptake

$$\Pr_{AG-produce-DW(i)} = Cs_{\text{root-zone\_produce}} \times Br_{AG-produce-DW(i)}$$

where:

$Pr_{AG\text{-}produce\text{-}DW(i)}$ = Concentration of chemical in edible portion of aboveground produce type *i*, *exposed* or *protected*, due to root uptake from soil at root-zone depth in the produce-growing area, on a dry-weight (DW) basis (mg/kg produce DW)

$Cs_{root\text{-}zone\_produce}$ = Average chemical concentration in soil at root-zone depth in produce-growing area (mg/kg soil DW)

$Br_{AG\text{-}produce\text{-}DW(i)}$ = Chemical-specific plant/soil chemical bioconcentration factor for edible portion of aboveground produce type *i*, *exposed* or *protected* (g soil DW / g produce DW)

### Equation 3-3. Chemical Concentration in Aboveground Produce Due to Deposition of Particle-phase Chemical

$$Pd_{(i)} = \frac{1{,}000 \times (Drdp + (Fw \times Drwp)) \times Rp_{(i)} \times (1 - e^{(-kp(i)*Tp(i))})}{Yp_{(i)} \times kp_{(i)}}$$

where:

$Pd_{(i)}$ = Chemical concentration in aboveground produce type *i* on a dry-weight (DW) basis due to particle deposition (mg/kg produce DW); set equal to zero for *protected* aboveground produce

$Drdp$ = Average annual dry deposition of particle-phase chemical (g/m$^2$-yr)

$Fw$ = Fraction of wet deposition that adheres to plant surfaces; 0.2 for anions, 0.6 for cations and most organics (unitless)

$Drwp$ = Average annual wet deposition of particle-phase chemical (g/m$^2$-yr)

$Rp_{(i)}$ = Interception fraction of the edible portion of plant type *i* (unitless)

$kp_{(i)}$ = Plant surface loss coefficient for plant type *i* (yr$^{-1}$)

$Tp_{(i)}$ = Length of exposure to deposition in the field per harvest of the edible portion of plant type *i* (yr)

$Yp_{(i)}$ = Yield or standing crop biomass of the edible portion of plant type *i* (kg produce DW/m$^2$)

Note that Equation 3-3 differs from Equation 5-14 in HHRAP, from which it is derived. In HHRAP, Equation 5-14 includes the term *Q* x (*1 – Fv*) to indicate the emissions rate, in g/sec, of chemical from the source and the proportion of the chemical that remains in, or partitions to, the particle-phase in the air. Also in HHRAP, the dry and wet particle phase deposition rates, *Dydp* and *Dywp,* respectively, are normalized to the emission rate and are expressed in units of sec/m$^2$-yr.

With MIRC, the user inputs both the dry and wet particle-phase deposition rates, *Drdp* and *Drwp*, respectively, in units of g/m$^2$-yr for a specific location relative to an emissions source. Those deposition rates might be values measured near that location or estimated using a fate and transport model, such as TRIM.FaTE, in conjunction with local meteorological information and emissions rate data. The chemical emissions term used in HHRAP, *Q*, therefore, is not used in MIRC's Equation 3-3. In addition, in MIRC, *Drdp* and *Drwp*, the average annual dry- and wet-particle-phase deposition rates, respectively, are in units of g/m$^2$-yr. Users of TRIM.FaTE should note that the dry- and wet-particle-deposition rates output from TRIM.FaTE are in units of g/m$^2$-day; therefore, users must adjust the TRIM.FaTE output values to units of g/m$^2$-yr (i.e., multiply by 365 days/yr) before inputting values for *Drdp* and *Drwp* into MIRC.

### Equation 3-4. Chemical Concentration in Aboveground Produce Due to Air-to-Plant Transfer of Vapor-phase Chemical

$$Pv_{(i)} = \frac{Ca \times Fv \times Bv_{AG(i)} \times VG_{AG(i)}}{\rho_a}$$

where:

| | | |
|---|---|---|
| $Pv_{(i)}$ | = | Concentration of chemical in edible portion of aboveground produce type *i* from air-to-plant transfer of vapor-phase chemical on a dry-weight (DW) basis (µg/g produce DW); set equal to zero for *protected* aboveground produce |
| $Ca$ | = | Average annual *total* chemical concentration in air (g/m$^3$) |
| $Fv$ | = | Fraction of airborne chemical in vapor phase (unitless) |
| $Bv_{AG(i)}$ | = | Air-to-plant biotransfer factor for aboveground produce type *i* for vapor-phase chemical in air ([mg/g produce DW] / [mg/g air], i.e., g air/ g produce DW) |
| $VG_{AG(i)}$ | = | Empirical correction factor for aboveground *exposed* produce type *i* to address possible overestimate of the diffusive transfer of chemical from the outside to the inside of bulky produce, such as fruit (unitless) |
| $\rho_a$ | = | Density of air (g/m$^3$) |

Note that Equation 3-4 differs from Equation 5-18 in HHRAP, from which it is derived. In HHRAP, Equation 5-18 includes the term *Q* x *Fv* to indicate the emissions rate, in g/sec, of chemical from the source and the fraction of the chemical in vapor phase in the air. HHRAP also includes the parameter *Cyv*, or the *unitized* yearly average air concentration of vapor-phase chemical in units of µg-sec/g-m$^3$. For MIRC, the user inputs the average annual total air concentration of the chemical, *Ca*, for a specific location relative to the source in units of g/m$^3$; MIRC includes a chemical-specific default value for *Fv* for chemicals included in its database. The air concentration might be a value measured near that location or a value estimated by a fate and transport model such as TRIM.FaTE. Users of TRIM.FaTE should note that the average annual concentration of the total chemical in air (i.e., total of both vapor and particulate phases), *Ca*, output from TRIM.FaTE is in units µg/m$^3$; therefore, the user must adjust the value to units of g/m$^3$ (i.e., divide by 1,000 µg/g) before entering it in MIRC.

The calculations of chemical concentration in aboveground produce, ($C_{AG\text{-}produce\text{-}DW}$), shown above, are on a dry-weight (DW) basis. The family FFC food ingestion rates, on the other hand, are on a fresh- or wet-weight (WW) basis. MIRC therefore calculates the concentration in aboveground produce on a wet-weight basis, $C_{AG\text{-}produce\text{-}WW}$, using Equation 3-5 and the moisture content (*MAF*) of the FFC food category.

**Equation 3-5. Conversion of Aboveground Produce Chemical Concentration from Dry- to Wet-Weight Basis**

$$C_{AG-produce-WW(i)} = C_{AG-produce-DW(i)} \times \left( \frac{(100 - MAF_{(i)})}{100} \right)$$

where:

$C_{AG\text{-}produce\text{-}WW(i)}$ = Chemical concentration in edible portion of aboveground produce type *i* on a wet-weight (WW) basis (mg/kg produce WW)

$C_{AG\text{-}produce\text{-}DW(i)}$ = Chemical concentration in edible portion of aboveground produce type *i* on a dry-weight (DW) basis (mg/kg produce DW)

$MAF_{(i)}$ = Moisture adjustment factor for aboveground produce type *i* to convert the chemical concentration estimated for dry-weight produce to the corresponding chemical concentration for full-weight fresh produce (percent water)

### 3.1.1.2 Belowground Produce

The equations by which chemical concentrations are estimated in belowground produce are different for nonionic organic chemicals than for inorganic chemicals and ionic organic chemicals.

#### *3.1.1.2.1 Nonionic Organic Chemicals*

For belowground produce, the nonionic organic chemical concentration in the tuber or root vegetable is derived from exposure to the chemical in soil and is estimated using an empirical root concentration factor (*RCF*) and the average chemical concentration in the soil at the root-zone depth in the produce-growing area ($Cs_{root\text{-}zone\_produce}$), as shown in Equation 3-6. The RCF relates the chemical concentration in the plant on a wet-weight basis to the average chemical concentration in the root-zone soil ($Cs_{root\text{-}zone\_produce}$) on a dry-weight basis. Belowground produce (i.e., tubers or root vegetables) are protected from the deposition and vapor transfer by being covered by soil. Therefore, root uptake of chemicals is the primary mechanism through which belowground produce becomes contaminated.

**Equation 3-6. Chemical Concentration in Belowground Produce: Nonionic Organic Chemicals**

$$C_{\text{BG-produce-WW}} = \frac{Cs_{root-zone\_produce} \times RCF \times VG_{rootveg}}{Kds \times UCF}$$

where:

$C_{BG\text{-}produce\text{-}WW}$ = Concentration of chemical in belowground (BG) produce (i.e., tuber or root vegetable) on a wet-weight (WW) basis (mg chemical/kg produce WW) *

$Cs_{root\text{-}zone\_produce}$ = Average chemical concentration in soil at root-zone depth in produce-growing area, on a dry-weight (DW) basis (mg chemical/kg soil DW)

$RCF$ = Chemical-specific root concentration factor for tubers and root produce (L soil pore water/kg root WW) *

$VG_{rootveg}$ = Empirical correction factor for belowground produce (i.e., tuber or root vegetable) to account for possible overestimate of the diffusive transfer of chemicals from the outside to the inside of bulky tubers or roots (based on carrots and potatoes) (unitless) *

$Kds$ = Chemical-specific soil/water partition coefficient (L soil pore water/kg soil DW)

$UCF$ = Units conversion factor of 1 kg/L

* Note that there is only one type of BG produce; hence there are no plant-type-specific subscripts

The RCF, as developed by Briggs *et al*. (1982), is the ratio of the chemical concentration in the edible root on a wet-weight basis to its concentration in the soil pore water. RCFs are based on experiments with growth solutions (hydroponic) instead of soils; therefore, it is necessary to divide the soil concentration by the chemical-specific soil/water partition coefficient (*Kds*). There is no conversion of chemical concentrations in belowground produce from DW to WW because the values are already on a WW basis.

For nonionic organic chemicals, it is possible to predict RCF values and *Kds* values (for a specified soil organic carbon content) from an estimate of the chemical's Kow from empirically derived regression models. Those models are shown in HHRAP Appendix A-2, Equations A-2-14 and A-2-15 (*RCF*) and in Equations A-29 and A-2-10 (*Kds*). The RCF and Kds values so calculated for many of the chemicals in HHRAP are included in the MIRC database (including the values for PAHs and dioxins).

#### 3.1.1.2.2 Inorganic and Ionic Organic Chemicals

For inorganic chemicals and ionized organic chemicals, it is not possible to predict *RCF* or *Kds* values from Kow. For inorganic chemicals, one must use empirical values for the root/soil bioconcentration factor measured for specific chemicals. The root/soil bioconcentration factor, now specified as $Br_{BG\text{-}produce\text{-}DW}$, must be obtained from the literature for each inorganic chemical on a DW basis. For inorganic chemicals, therefore, Equation 3-7 is used instead of Equation 3-6.

**Equation 3-7. Chemical Concentration in Belowground Produce: Inorganic Chemicals**

$$C_{BG\text{-}produce\text{-}DW} = \frac{Cs_{root-zone\_produce} \times Br_{BG-produce-DW} \times VG_{rootveg}}{1}$$

where:

$C_{BG\text{-}produce\text{-}DW}$ = Concentration of chemical in edible portion of aboveground produce, due to root uptake from soil at root-zone depth in the produce-growing area, on a dry-weight (DW) basis (mg/kg produce DW)

$Cs_{root\text{-}zone\_produce}$ = Average chemical concentration in soil at root-zone depth in produce-growing area (mg/kg soil DW)

$Br_{BG\text{-}produce\text{-}DW}$ = Chemical-specific root/soil chemical bioconcentration factor for edible portion of belowground produce (g soil DW / g produce DW)

$VG_{rootveg}$ = Empirical correction factor for belowground produce (as in Equation 3-6) (unitless)

As for the aboveground produce, the DW estimate of concentration of chemical in the root vegetables must be transformed to a WW estimate, as shown in Equation 3-8.

**Equation 3-8. Conversion of Belowground Produce Chemical Concentration from Dry- to Wet-Weight Basis**

$$C_{BG-produce-WW} = C_{BG-produce-DW} \times \left( \frac{(100 - MAF_{BG})}{100} \right)$$

where:

$C_{BG\text{-}produce\text{-}WW}$ = Chemical concentration in edible portion of belowground produce on a weight-weight (WW) basis (mg/kg produce WW)

$C_{BG\text{-}produce\text{-}DW}$ = Concentration of chemical in edible portion of aboveground produce, due to root uptake from soil at root-zone depth in the produce-growing area, on a dry-weight (DW) basis (mg/kg produce DW)

$MAF_{(BG)}$ = Moisture adjustment factor (as in Equation 3-5, but single value for below ground produce) (percent water)

### *3.1.2 Estimating Chemical Concentrations in Animal Products*

Chemical concentrations in animal products are estimated based on the amount of chemical consumed by each animal group *m* through each plant feed type *i* ($Plant_{Ch\text{-}Intake(i,m)}$) and incidental ingestion of soil for ground-foraging animals ($Soil_{Ch\text{-}Intake(m)}$). Exhibit 3-3 summarizes the pathways by which chemicals are transferred to these home- or farm-raised animal food products. Note that for a general screening-level assessment, all of the pathways can be modeled, as is done for EPA's RTR calculation of screening threshold emission rates for PB-HAPs (EPA 2008b).

The feed options for farm animals in MIRC include forage (plants grown on-site for animal grazing, such as grass), silage (wet forage grasses, fresh-cut hay, or other fresh plant material that has been stored and fermented), and grain products grown on the farm. As seen in Exhibit 3-3, the algorithms in MIRC for chemical intake with plant feeds ($Plant_{Ch\text{-}Intake(i,m)}$) are based on the assumptions that beef and dairy cattle consume all three plant feed products, while pigs consume only silage and grain, and chickens consume only grain.

### Exhibit 3-3. Chemical Transfer Pathways for Animal Products

| Farm Food Media | | Chemical Transfer Pathways |
|---|---|---|
| Animal Products | Beef and total dairy (including milk) | - Ingestion of forage, silage, and grain [a]<br>- Incidental soil ingestion |
| | Pork | - Ingestion of silage and grain [a]<br>- Incidental soil ingestion |
| | Poultry and eggs | - Ingestion of grain [a]<br>- Incidental soil ingestion |

[a] Chemical concentrations in plant feed (i.e., forage, silage, and grain) are estimated via intermediate calculations (see Equations 3-13, 3-14, 3-3, and 3-4).

Forage and silage are exposed to the air and can accumulate chemicals via direct deposition of particle-bound chemical and transfer of vapor-phase chemical, while all animal feed grains are assumed to be protected from the air by a husk or pod (e.g., corn, soybeans). All three animal feed products are assumed to accumulate chemical via root uptake.

Chemical concentrations are estimated for animal feeds using algorithms analogous to those for aboveground farm produce described above. MIRC uses Equation 3-9 to calculate the concentration of chemical in beef, pork, or total dairy and Equation 3-10 to calculate the concentration of chemical in poultry or eggs. The chemical concentration in mammalian farm animals (i.e., beef and pigs) is adjusted using a metabolism factor (*MF*) that accounts for endogenous degradation of the chemical (see Equation 3-9). *MF* is set to 1.0 for chemicals that are not metabolized and for chemicals for which the metabolic degradation rate is unknown. Although other vertebrates, including birds, are likely to have similar metabolic pathways for most chemicals, the health protective assumption is that birds do not metabolize any chemicals; therefore, the *MF* is omitted from Equation 3-10 for poultry and eggs.

### Equation 3-9. Chemical Concentration in Beef, Pork, or Total Dairy

$$C_{mammal(m)} = Ba_{(m)} \times MF \times \left( Soil_{Ch-Intake(m)} + \sum_{i=1}^{n} Plant_{Ch-Intake(i,m)} \right)$$

where:

$C_{mammal(m)}$ = Concentration of chemical in mammalian animal product *m*, where *m* = beef, pork, or total dairy (mg chemical/kg animal product WW)

$Ba_{(m)}$ = Chemical-specific biotransfer factor for chemical in diet to chemical in animal food product *m*, where *m* = beef, pork, or total dairy ([mg chemical/kg animal product WW] / [mg chemical intake/day] or day/kg WW)

$MF$ = Chemical-specific mammalian metabolism factor that accounts for endogenous degradation of the chemical (unitless)

$Soil_{Ch-Intake(m)}$ = Incidental ingestion of chemical in surface soils by livestock type *m* during grazing or consumption of foods placed on the ground (mg/day); see Equation 3-11 below

$Plant_{Ch-Intake(i,m)}$ = For livestock (animal product) type *m*, ingestion of chemical from plant feed type *i* (mg chemical/kg livestock WW); see Equation 3-12 below
(If *m* = beef or total dairy, then *n* = 3 and *i* = forage, silage, and grain;
*m* = pork, then *n* = 2 and *i* = silage and grain;
*m* = poultry, then *n* = 1 and *I* = grain.)

### Equation 3-10. Chemical Concentration in Poultry or Eggs

$$C_{poultry(m)} = Ba_{(m)} \times \left(Soil_{Ch-Intake(m)} + Plant_{Ch-Intake(i,m)}\right)$$

where:

$C_{poultry(m)}$ = Concentration of chemical in food product *m*, where *m* = poultry or eggs (mg chemical/kg animal product WW)

$Ba_{(m)}$ = Chemical-specific biotransfer factor for food product *m*, where *m* = poultry or eggs (day/kg animal product WW)

$Soil_{Ch-Intake(m)}$ = Incidental ingestion of chemical in surface soils by consumption of food on the ground (mg chemical/day) where *m* = poultry; see Equation 3-11

$Plant_{Ch-Intake(i,m)}$ = For poultry (and eggs), animal *m*, ingestion of the chemical in plant feed type *i* (mg chemical/day), which for poultry is limited to grain; see Equation 3-12

In MIRC, the incidental ingestion of the chemical in soils by livestock during grazing or consumption of feed placed on the ground ($Soil_{Ch-Intake(m)}$) is estimated using empirical soil ingestion rates (*Qs*) and a soil bioavailability factor for livestock (*Bs*), as shown in Equation 3-11. At this time, the default value for *Bs* in MIRC for all chemicals is 1.0 (i.e., the chemical in soil is assumed to be 100 percent bioavailable to the animal). This assumption may be reasonably accurate for the soil surface to which airborne chemical is deposited. MIRC allows the user to enter a surface soil concentration for areas where livestock forage, $Cs_{S-livestock}$, that is distinct from the surface soil concentration input for areas where produce may be grown and where humans might incidentally ingest soils (see Section 6.1).

### Equation 3-11. Incidental Ingestion of Chemical in Soil by Livestock

$$Soil_{Ch-Intake(m)} = Qs \times Cs_{s-livestock} \times Bs$$

where:

$Soil_{Ch-Intake(m)}$ = Incidental ingestion of the chemical in surface soils by livestock type *m* during grazing or consumption of foods placed on the ground (mg chemical/day)

$Qs_{(m)}$ = Quantity of soil eaten by animal type *m* each day (kg soil DW/day)

$Cs_{S-livestock}$ = Chemical concentration in surface soil in contaminated area where livestock feed (mg chemical/kg soil DW)

$Bs$ = Soil bioavailability factor for livestock (unitless) (assumed to be the same for birds and mammals)

Animal ingestion of the chemical in feed is calculated for each type of livestock based on their assumed diets. For *m* = beef and dairy cattle, chemical intake is estimated for all three feed types: *i* = forage, silage, and grain. For pork, chemical intake is estimated only for silage and grain. The chemical intake for poultry is based on grain consumption only. The intake of chemical with each feed type, *i*, $Plant_{Ch-Intake(i,m)}$, is calculated separately according to Equation 3-12. Note that the animal feed ingestion rates are on a dry-weight (DW) basis; hence, no DW to wet weight (WW) conversion is needed.

### Equation 3-12. Ingestion of Chemical in Feed by Livestock

$$Plant_{Ch-Intake(i,m)} = F_{(i,m)} \times Qp_{(i,m)} \times C_{feed(i)}$$

where:

$Plant_{Ch\text{-}Intake(i,m)}$ = Ingestion of chemical in plant feed type *i* (mg chemical/day), where *i* = forage, silage, or grain, for livestock type *m*

$F_{(i,m)}$ = Fraction of plant feed type *i* obtained from contaminated area used to grow animal feed, where *I* = forage, silage, or grain (unitless) for livestock type *m*

$Qp_{(i,m)}$ = Quantity of plant feed type *i* consumed per animal per day (kg plant feed DW/day), where *i* = forage, silage, or grain, for livestock type *m*

$C_{feed(i)}$ = Concentration of chemical in ingested plant feed type *i* (mg chemical/kg plant feed DW), where *i* = forage, silage, or grain

The concentrations of chemical in the three different types of plant feeds for livestock are calculated according to Equation 3-13. The equation is the same as that for aboveground produce in Equation 3-1, with the exception that the concentrations are for plants used as animal feeds (not produce consumed by humans) and all types of plant feed (i.e., forage, silage, and grain) are aboveground.

### Equation 3-13. Chemical Concentration in Livestock Feed (All Aboveground)

$$C_{feed(i)} = \mathrm{P}r_{feed(i)} + \mathrm{Pd}_{(i)} + \mathrm{Pv}_{(i)}$$

where:

$C_{feed(i)}$ = Concentration of chemical in plant feed type *i* on a dry-weight (DW) basis (mg chemical/kg plant feed DW), where *i* = forage, silage, or grain

$Pr_{feed(i)}$ = Concentration of chemical in plant feed type *i* due to root uptake from soil (mg/kg DW), where *i* = forage, silage, or grain; see Equation 3-14 below

$Pd_{(i)}$ = Concentration of chemical in plant feed type *i* due to wet and dry deposition of particle-phase chemical (mg/kg DW), where *i* = forage, silage, or grain; when *i* = grain, the *Pd* term equals zero

$Pv_{(i)}$ = Concentration of chemical in plant feed type *i* due to air-to-plant transfer of vapor-phase chemical (µg/g [or mg/kg] DW) where *i* = forage, silage, or grain; when *i* = grain, the *Pd* term equals zero

MIRC calculates the chemical concentration in animal feed due to root uptake from the soil using Equation 3-14. The equation is the same as Equation 3-2, except that a *Br* value appropriate to grasses is used and MIRC allows for different soil concentrations in the area used to grow animal feed than in the area used to grow produce for human consumption (see Section 6.1, user inputs). Note that for feed type *i* = grains, the *Pd* and *Pv* terms do not apply (are set to zero), because the feed products (i.e., corn kernels, soy beans) are protected from the air (i.e., by husks, pods).

**Equation 3-14. Chemical Concentration in Livestock Feed Due to Root Uptake**

$$Pr_{feed(i)} = Cs_{root-zone\_feed(i)} \times Br_{feed(i)}$$

where:

$Pr_{feed(i)}$ = Concentration of chemical in plant feed type *i* due to root uptake from soil on a dry-weight (DW) basis (mg chemical/kg plant feed DW), where *i* = forage, silage, or grain

$Cs_{root-zone\_feed(i)}$ = Average chemical concentration in soil at root-zone depth in area used to grow plant feed type *i* (mg chemical/kg soil DW), where *i* = forage, silage, or grain

$Br_{feed(i)}$ = Chemical-specific plant-soil bioconcentration factor for plant feed type *i* (kg soil DW/kg plant feed DW), where *i* = forage, silage, or grain

The algorithms used to calculate $Pd_{(i)}$ and $Pv_{(i)}$ when plant feed type *i* = forage and silage are identical to those used to calculate $Pd_{(i)}$ and $Pv_{(i)}$ for aboveground exposed produce (i.e., Equations 3-3 and 3-4, respectively).

There are no conversions of DW feed to WW feed, because all feed ingestion rates for livestock are based on DW feed.

## 3.2 Chemical Intake Calculations for Adults and Non-Infant Children

MIRC calculates human chemical intake rates from the ingestion of home-grown foods as average daily doses (ADDs) normalized to body weight for each age group, chemical, and food type separately. ADDs, calculated using Equation 3-15, are expressed in milligrams of chemical per kilogram of receptor body weight per day (mg/kg-day).

**Equation 3-15. Average Daily Dose for Specified Age Group and Food Type**

$$ADD_{(y,i)} = \left( \frac{C_{(i)} \times IR_{(y,i)} \times FC_{(i)} \times ED_{(y)}}{BW_{(y)} \times AT_{(y)}} \right) \left( \frac{EF_{(y)}}{365 \text{ days}} \right)$$

where:

$ADD_{(y,i)}$ = Average daily dose for age group *y* from food type or ingestion medium *i* (mg chemical/kg body weight-day)

$C_{(i)}$ = Concentration of chemical in food type *i* harvested from the contaminated area (mg chemical/kg food or mg food/L water)

$IR_{(y,i)}$ = Ingestion rate for age group *y* of food type *i* (kg/day or L/day)

$FC_{(i)}$ = Fraction of food type *i* that was harvested from contaminated area (unitless)

$ED_{(y)}$ = Exposure duration for age group *y* (years)

$BW_{(y)}$ = Body weight for age group *y* (kg)

$AT_{(y)}$ = Averaging time for calculation of daily dose (years) for age group *y*, set equal to ED in MIRC

$EF_{(y)}$ = Annual exposure frequency for age group *y* (days)

Equation 3-15 takes into account the chemical concentration in each food type *i* (or in water), the quantity of food brought into the home for consumption, the loss of some of the mass of the foods due to preparation and cooking, how much of the food is consumed per year, the amount of the food obtained from contaminated areas, and the consumer's body weight (EPA 2011, 2003a). In MIRC, ADDs are calculated separately for each chemical, home-grown food type, and consumer age group.

ADD values, expressed as intakes, not absorbed doses, are appropriate for comparison with RfDs and for use with cancer slope factors (CSFs) to estimate risk, as discussed in Section 5. An exception is for the breast-milk exposure pathway, where the dose absorbed by the mother is relevant to calculating the dose available to and absorbed by her nursing infant, as discussed in Section 3.4.

MIRC evaluates only one contaminated area (set of environmental concentrations), or exposure scenario, at a time. For screening level assessments, all components of this equation are assumed to remain constant for consumers in a given age group over time (e.g., seasonal and annual variations in diet are not explicitly taken into account). To calculate an $ADD_{(y,i)}$ from the contaminated area for food group *i* over an entire lifetime of exposure, age-group-specific ingestion rates and body weights are used for the age groups described in Section 2.3. In MIRC, the averaging time used to calculate the daily dose for an age group ($AT_y$) is equal to the exposure duration for that group ($ED_y$); therefore these variables drop out of Equation 3-15.

For each chemical included in a screening scenario, total average daily exposure for age group *y* ($ADD_{(y)}$) is estimated as the sum of chemical intake from all ingestion pathways combined:

- Incidental soil ingestion;
- Ingestion of fish;
- Ingestion of homegrown fruits (exposed and protected);
- Ingestion of homegrown vegetables (exposed, protected, and root);
- Ingestion of animal products from home-raised animals:
    - Milk and other dairy products from cows,
    - Beef products,
    - Pork products, and
    - Poultry and eggs;
- Ingestion of drinking water from specified source; and
- Ingestion of breast milk by infants.

Note that the last exposure pathway is limited to infants.

The algorithms for the first six exposure pathways listed above are described in Sections 3.2.1 through 3.2.6. The algorithms for the breast-milk ingestion pathway are described in Section 3.4.

### 3.2.1 Chemical Intake from Soil Ingestion

Equation 3-16 shows the equation used to estimate chemical intake through incidental ingestion of soil.

**Equation 3-16. Chemical Intake from Soil Ingestion**

$$ADD_{Soil\,(y)} = \left( \frac{C_{Soil} \times IR_{Soil(y)} \times FC_{Soil} \times 0.001\ \frac{mg}{\mu g}}{BW_{(y)}} \right) \left( \frac{EF}{365\ \text{days}} \right)$$

where:

$ADD_{Soil(y)}$ = Average daily chemical intake from incidental ingestion of soil or ingestion by child in age group *y* (mg chemical/kg body weight-day)

$C_{Soil}$ = Concentration of chemical in soil from contaminated area on a dry-weight (DW) basis (µg/g soil DW)

$IR_{Soil(y)}$ = Soil ingestion rate for age group *y* (g DW/day)

$FC_{Soil}$ = Fraction of soil ingested that is from contaminated area (unitless)

$BW_{(y)}$ = Body weight for age group *y* (kg)

$EF$ = Exposure frequency; number of days per year of exposure for family(ies) as specified for scenario (≤ 365 days)

Note: MIRC saves soil ingestion rates in units of mg/day (not g/day); therefore, there is an additional 0.001 g/mg conversion unit in the actual MIRC algorithm than shown here.

### 3.2.2 Chemical Intake from Fish Ingestion

Ingestion of locally caught fish is included as a possible exposure pathway in MIRC (Equation 3-17). Two types of fish are included in the exposure algorithm: trophic level 3 (T3) fish, equivalent to small “pan” fish such as bluegill, and trophic level 4 (T4) fish, equivalent to game fish such as trout and walleye. The chemical concentration in fish in Equation 3-17 is estimated as the consumption-weighted chemical concentration using Equation 3-18.

### Equation 3-17. Chemical Intake from Fish Ingestion

$$ADD_{Fish(y)} = \left(1 - L1_{Fish}\right) \times \left(1 - L2_{Fish}\right) \times \frac{\left(C_{Fish} \times IR_{Fish(y)} \times 0.001\frac{\text{kg}}{\text{g}} \times FC_{Fish}\right)}{BW_{(y)}} \times \left(\frac{EF}{365 \text{ days}}\right)$$

### Equation 3-18. Consumption-weighted Chemical Concentration in Fish

$$C_{Fish} = \left(C_{FishT3} \times F_{T3}\right) + \left(C_{FishT4} \times F_{T4}\right)$$

where:

$ADD_{Fish(y)}$ = Average daily chemical intake from ingestion of local fish for age group *y* (mg/kg-day)

$L1_{Fish}$* = Weight of fish brought into home that is discarded during preparation (e.g., head, bones, liver, other viscera, belly fat, skin with fat) (unitless)

$L2_{Fish}$* = Loss of weight during cooking, such as evaporation and loss of fluids into pan (unitless)

$C_{FishT3}$ = Chemical concentration in whole fish for trophic level 3 (T3) fish on a wet-weight (WW) basis (mg/kg WW)

$C_{FishT4}$ = Chemical concentration in whole fish for trophic level 4 (T4) fish on a wet-weight (WW) basis (mg/kg WW)

$F_{T3}$ = Fraction of fish intake that is from T3 (unitless)

$F_{T4}$ = Fraction of fish intake that is from T4 (unitless)

$C_{Fish}$ = Consumption-weighted mean chemical concentration in total fish (i.e., as specified by Equation 3-18) (mg/kg WW)

$FC_{Fish}$ = Fraction of local fish consumed derived from contaminated area (unitless)

$BW_{(y)}$ = Body weight for age *y* (kg)

$IR_{Fish(y)}$* = Local fish ingestion rate for age *y* (g WW/day)

$EF$ = Exposure frequency; number of days per year of exposure for family(ies) as specified for scenario (≤ 365 days)

* Parameter values must be internally consistent. In contrast to the tables included in MIRC for ingestion rate options for homegrown food products, which are based on the products as brought into the home from the field (see Section 6.3.3), the tables of fish ingestion rate options included in MIRC are from CSFII data (see Section 6.3.4) and, therefore, are on an "as consumed" basis (i.e., after preparation and cooking losses), and L1 and L2 therefore are set equal to zero. If the user wishes to enter local fish ingestion rates on an "as harvested" basis, the user also should enter L1 and L2 values as specified in Section 6.4.3.

When whole fish are prepared for cooking, it is usual for the viscera, head, and fins to be removed, particularly for larger fish. Many persons also remove (or do not eat) the skin, bones, and belly fat. EPA has, therefore, estimated the proportion of the weight of whole fish that tends to be lost during preparation and cooking across a variety of fish species (EFH, EPA 2011) and included those losses in its HHRAP algorithms for chemical intake from fish ($L1_{Fish}$ and $L2_{Fish}$ in Equation 3-17).

### 3.2.3 Chemical Intake from Fruit Ingestion

Average daily doses of a chemical from homegrown exposed fruits are calculated separately for exposed and protected fruits (Equations 3-19 and 3-20, respectively).

**Equation 3-19. Chemical Intake from Consumption of Exposed Fruits**

$$ADD_{ExpFruit(y)} = \left(1 - L1_{ExpFruit}\right) \times \left(1 - L2_{ExpFruit}\right) \times \left(C_{ExpFruit} \times IR_{ExpFruit(y)} \times 0.001\frac{\text{kg}}{\text{g}} \times FC_{ExpFruit}\right) \times \left(\frac{EF}{365\text{ days}}\right)$$

**Equation 3-20. Chemical Intake from Consumption of Protected Fruits**

$$ADD_{ProFruit(y)} = \left(1 - L1_{ProFruit}\right) \times \left(C_{ProFruit} \times IR_{ProFruit(y)} \times 0.001\frac{\text{kg}}{\text{g}} \times FC_{ProFruit}\right) \times \left(\frac{EF}{365\text{ days}}\right)$$

where:

$ADD_{ExpFruit(y)}$ $ADD_{ProFruit(y)}$ = Average daily chemical intake from ingestion of exposed fruit or protected fruit (depending on subscript) (mg chemical/kg body weight-day)

$L1_{ExpFruit}$ = Mean reduction in fruit weight resulting from removal of skin or peel, core or pit, stems or caps, seeds and defects, and from draining liquids from canned or frozen forms (unitless)

$L1_{ProFruit}$ = Mean reduction in fruit weight that results from paring or other preparation techniques for protected fruits (unitless)

$L2_{ExpFruit}$ = Mean reduction in fruit weight that results from draining liquids from cooked forms of the fruit (unitless)

$C_{ExpFruit}$ $C_{ProFruit}$ = Chemical concentration in whole exposed fruits or whole protected fruits (depending on subscript) on a wet-weight (WW) basis (mg chemical/kg exposed fruit WW)

$EF$ = Exposure frequency; number of days per year of exposure for family(ies) as specified for scenario ($\leq$ 365 days)

$FC_{ExpFruit}$ $FC_{ProFruit}$ = Fraction of exposed fruits or protected fruits (depending on subscript) obtained from contaminated area (unitless)

$IR_{ExpFruit(y)}$ $IR_{ProFruit(y)}$ = Ingestion rate of home-grown exposed fruits or protected fruits (depending on subscript) for age *y* (g WW/kg body weight-day)

Fruit ingestion rates in the survey were based on weights of unprepared fruits (e.g., one apple; one pear) or the weight of a can of fruit (e.g., 8 oz can). The weight of the fruit ingested is less than the initial weight owing to common preparation actions ($L1_{ExpFruit}$ and $L1_{ProFruit}$; e.g., coring apples and pears; peeling apples; pitting cherries). Cooking of exposed fruit (e.g., berries, apples, peaches) often results in further weight loss that results from liquids lost during cooking and drained from the cooking vessel ($L2_{ExpFruit}$). EPA has assumed that cooking of protected fruit results in no loss of weight for the fruit.

### 3.2.4 Chemical Intake from Vegetable Ingestion

MIRC includes three separate algorithms for homegrown vegetables adapted from EPA's HHRAP Modeling System (EPA 2005a): one for exposed vegetables such as asparagus, broccoli, lettuce, and tomatoes (although they are actually a fruit); one for protected vegetables such as corn, cabbage, soybeans, and peas; and one for root vegetables such as carrots, beets, and potatoes (see Equations 3-21, 3-22, and 3-23, respectively).

### Equation 3-21. Chemical Intake from Exposed Vegetables

$$ADD_{ExpVeg(y)} = \left(1 - L1_{ExpVeg}\right) \times \left( C_{ExpVeg} \times IR_{ExpVeg(y)} \times 0.001 \frac{\text{kg}}{\text{g}} \times FC_{ExpVeg} \right) \times \left( \frac{EF}{365 \text{ days}} \right)$$

### Equation 3-22. Chemical Intake from Protected Vegetables

$$ADD_{ProVeg(y)} = \left(1 - L1_{ProVeg}\right) \times \left( C_{ProVeg} \times IR_{ProVeg(y)} \times 0.001 \frac{\text{kg}}{\text{g}} \times FC_{ProVeg} \right) \times \left( \frac{EF}{365 \text{ days}} \right)$$

### Equation 3-23. Chemical Intake from Root Vegetables

$$ADD_{RootVeg(y)} = \left(1 - L1_{RootVeg}\right) \times \left(1 - L2_{RootVeg}\right) \times \left( C_{RootVeg} \times IR_{RootVeg(y)} \times 0.001 \frac{\text{kg}}{\text{g}} \times FC_{RootVeg} \right) \times \left( \frac{EF}{365 \text{ days}} \right)$$

where:

$ADD_{ExpVeg(y)}$, $ADD_{ProVeg(y)}$, $ADD_{RootVeg(y)}$ = Average chemical intake from ingestion of exposed vegetables, protected vegetables, or root vegetables (depending on subscript) for age group *y* (mg chemical/kg body weight-day)

$L1_{ExpVeg}$ = Mean net preparation and cooking weight loss for exposed vegetables (unitless); includes removing stalks, paring skins, discarding damaged leaves

$L1_{ProVeg}$ = Mean net cooking weight loss for protected vegetables (unitless); includes removing husks, discarding pods of beans and peas, removal of outer leaves

$L1_{RootVeg}$ = Mean net cooking weight loss for root vegetables (unitless); includes losses from removal of tops and paring skins

$L2_{RootVeg}$ = Mean net post cooking weight loss for root vegetables from draining cooking liquids and removal of skin after cooking (unitless)

$C_{ExpVeg}$, $C_{ProVeg}$, $C_{RootVeg}$ = Chemical concentration in exposed vegetables, protected vegetables, or root vegetables (depending on subscript) on a wet-weight (WW) basis (mg chemical/kg vegetable WW)

$EF$ = Exposure frequency; number of days per year of exposure for family(ies) as specified for scenario (≤ 365 days)

$FC_{ExpVeg}$, $FC_{ProVeg}$, $FC_{RootVeg}$ = Fraction of exposed vegetables, protected vegetables, or root vegetables (depending on subscript) obtained from contaminated area (unitless)

$IR_{ExpVeg(y)}$, $IR_{ProVeg(y)}$, $IR_{RootVeg(y)}$ = Ingestion rate of exposed vegetables, protected vegetables, or root vegetables (depending on subscript) for age group *y* (g vegetable WW/kg body weight-day)

### 3.2.5 Chemical Intake from Animal Product Ingestion

Calculations of chemical intake from the consumption of farm animals and related food products are provided below in Equations 3-24 through 3-28 for homegrown beef, dairy (milk), pork, poultry, and eggs, respectively.

**Equation 3-24. Chemical Intake from Ingestion of Beef**

$$ADD_{Beef(y)} = \left(1 - L1_{Beef}\right) \times \left(1 - L2_{Beef}\right) \times \left(C_{Beef} \times IR_{Beef(y)} \times 0.001\frac{\text{kg}}{\text{g}} \times FC_{Beef}\right) \times \left(\frac{EF}{365\text{ days}}\right)$$

where:

$ADD_{Beef(y)}$ = Average daily chemical intake from ingestion of beef for age group y (mg/kg-day)

$L1_{Beef}$ = Mean net cooking loss for beef (unitless)

$L2_{Beef}$ = Mean net post cooking loss for beef (unitless)

$C_{Beef}$ = Concentration of contaminant in beef (mg/kg WW))

$EF$ = Exposure frequency; number of days per year of exposure for family(ies) as specified for scenario (≤ 365 days)

$IR_{Beef(y)}$ = Ingestion rate of contaminated beef for age group y (g WW/kg-day)

$FC_{Beef}$ = Fraction of beef consumed raised on contaminated area or fed contaminated silage and grains (unitless)

**Equation 3-25. Chemical Intake from Dairy Ingestion**

$$ADD_{Dairy(y)} = \left(C_{Dairy} \times IR_{Dairy(y)} \times 0.001\frac{\text{kg}}{\text{g}} \times FC_{Dairy}\right) \times \left(\frac{EF}{365\text{ days}}\right)$$

where:

$ADD_{Dairy(y)}$ = Average daily chemical intake from ingestion of total dairy for age group *y* (mg/kg-day)

$C_{Dairy}$ = Average concentration of contaminant in total dairy (mg/kg WW)

$EF$ = Exposure frequency; number of days per year of exposure for family(ies) as specified for scenario (≤ 365 days)

$IR_{Dairy(y)}$ = Ingestion rate of contaminated total dairy for age group *y* (g WW/kg-day)

$FC_{Dairy}$ = Fraction of total dairy products from contaminated area (unitless)

### Equation 3-26. Chemical Intake from Pork Ingestion

$$ADD_{Pork(y)} = \left(1 - L1_{Pork}\right) \times \left(1 - L2_{Pork}\right) \times \left(C_{Pork} \times IR_{Pork(y)} \times 0.001\frac{\text{kg}}{\text{g}} \times FC_{Pork}\right) \times \left(\frac{EF}{365\text{ days}}\right)$$

where:

$ADD_{Pork(y)}$ = Average daily chemical intake from ingestion of pork for age group *y* (mg/kg-day)

$L1_{Pork}$ = Mean net cooking loss for pork (unitless); includes dripping and volatile losses during cooking; averaged over various cuts and preparation methods

$L2_{Pork}$ = Mean net post cooking loss for pork (unitless); includes losses from cutting, shrinkage, excess fat, bones, scraps, and juices; averaged over various cuts and preparation methods

$C_{Pork}$ = Concentration of contaminant in pork (mg/kg WW)

$EF$ = Exposure frequency; number of days per year of exposure for family(ies) as specified for scenario (≤ 365 days)

$IR_{Pork(y)}$ = Ingestion rate of contaminated pork for age *y* (g WW/kg-day)

$FC_{Pork}$ = Fraction of pork obtained from contaminated area (unitless)

The reduction in the weight of pork during and after cooking may correlate with an increase or decrease in the concentration of the chemical in the pork as consumed depending on the chemical and depending on the cooking method.

### Equation 3-27. Chemical Intake from Poultry Ingestion

$$ADD_{Poultry(y)} = \left(1 - L1_{Poultry}\right) \times \left(1 - L2_{Poultry}\right) \times \left(C_{Poultry} \times IR_{Poultry(y)} \times 0.001\frac{\text{kg}}{\text{g}} \times FC_{Poultry}\right) \times \left(\frac{EF}{365\text{ days}}\right)$$

where:

$ADD_{Poultry(y)}$ = Average daily dose (chemical intake) from ingestion of poultry (mg/kg-day)

$L1_{Poultry}$ = Mean net cooking loss for poultry (unitless)

$L2_{Poultry}$ = Mean net post cooking loss for poultry (unitless)

$C_{Poultry}$ = Concentration of chemical in poultry (mg/kg WW)

$EF$ = Exposure frequency; number of days per year of exposure for family(ies) as specified for scenario (≤ 365 days)

$IR_{Poultry(y)}$ = Ingestion rate of poultry for age group *y* (g WW/kg-day)

$FC_{Poultry}$ = Fraction of poultry from contaminated area or fed contaminated grains (unitless)

**Equation 3-28. Chemical Intake from Egg Ingestion**

$$ADD_{Egg(y)} = \left( C_{Egg} \times IR_{Egg(y)} \times 0.001\frac{\text{kg}}{\text{g}} \times FC_{Egg} \right) \times \left( \frac{EF}{365\text{ days}} \right)$$

where:

$ADD_{Egg(y)}$ = Average daily chemical intake from ingestion of eggs for age group *y* (mg/kg-day)

$C_{Egg}$ = Concentration of contaminant in eggs (mg/kg WW)

$EF$ = Exposure frequency; number of days per year of exposure for family(ies) as specified for scenario (≤ 365 days)

$IR_{Egg(y)}$ = Ingestion rate of contaminated eggs for age group *y* (g WW/kg-day)

$FC_{Egg}$ = Fraction of eggs obtained from contaminated area (unitless)

### *3.2.6 Chemical Intake from Drinking Water Ingestion*

If the user chooses to evaluate chemical ingestion via drinking water, the user specifies a chemical concentration in g/L (equivalent to mg/mL) based on their particular scenario. The chemical concentration could represent water from groundwater wells, community water, nearby surface waters, or other source. For this exposure pathway, ingestion rates are in units of milliliters of water per day (mL/day).

**Equation 3-29. Chemical Intake from Drinking Water Ingestion**

$$ADD_{DW(y)} = \left( \frac{C_{DW} \times IR_{DW(y)} \times FC_{DW}}{BW_{(y)}} \right) \times \left( \frac{EF}{365\text{ days}} \right)$$

where:

$ADD_{DW(y)}$ = Average daily chemical intake from ingestion of drinking water from local residential water source for age group *y* (mg/kg-day)

$C_{DW}$ = Concentration of contaminant in drinking water (g/L)

$IR_{DW(y)}$ = Drinking water ingestion rate for age group *y* (mL/day)

$FC_{DW}$ = Fraction of drinking water obtained from contaminated area (unitless)

$BW_{(y)}$ = Body weight of age group *y* (kg)

$EF$ = Exposure frequency; number of days per year of exposure for family(ies) as specified for scenario (≤ 365 days)

## 3.3 Total Chemical Intake

To estimate the total ADD, or intake of a chemical from all of the exposure media that a single individual in each age group is expected to contact (e.g., soil, local fish, five types of home-grown produce, and five types of home-raised animals or animal products), the media-specific chemical intakes are summed for each age group. Total average daily exposure for a particular age group *y* ($ADD_{(y)}$) is estimated as the sum of chemical intake from all ingestion pathways combined, as illustrated in Equations 3-30 through 3-35 below.

### Equations 3-30 to 3-35. Total Average Daily Dose of a Chemical for Different Age Groups

**Equation 3-30.** $$ADD_{(<1)} = ADD_{breastmilk}$$

**Equation 3-31.** $$ADD_{(1-2)} = \sum_{i=1}^{n} ADD_{(1-2,i)}$$

**Equation 3-32.** $$ADD_{(3-5)} = \sum_{i=1}^{n} ADD_{(3-5,i)}$$

**Equation 3-33.** $$ADD_{(6-11)} = \sum_{i=1}^{n} ADD_{(6-11,i)}$$

**Equation 3-34.** $$ADD_{(12-19)} = \sum_{i=1}^{n} ADD_{(12-19,i)}$$

**Equation 3-35.** $$ADD_{(adult)} = \sum_{i=1}^{n} ADD_{(adult,i)}$$

where *i* represents the $i^{th}$ food type or ingestion medium and *n* equals the total number of food types or ingestion media, and *ADD* parameters are defined below:

$ADD_{(<1)}$ = Total average daily dose of chemical for infants less than one year from ingestion of breast milk (mg/kg-day)
$ADD_{(1-2)}$ = Total average daily dose of chemical from all ingestion sources for children ages 1 through 2 years (mg/kg-day)
$ADD_{(3-5)}$ = Total average daily dose for children ages 3 through 5 years (mg/kg-day)
$ADD_{(6-11)}$ = Total average daily dose for children ages 6 through 11 years (mg/kg-day)
$ADD_{(12-19)}$ = Total average daily dose for children ages 12 through 19 years (mg/kg-day)
$ADD_{(adult)}$ = Total average daily dose for adult age 20 up to 70 years (mg/kg-day)

The lifetime average daily dose (*LADD*) is calculated as the time-weight average of the *ADD* values for each age group (Equation 3-36).

### Equation 3-36. Lifetime Average Daily Dose (LADD)

$$LADD = ADD_{(<1)}\left(\frac{1}{70}\right) + ADD_{(1-2)}\left(\frac{2}{70}\right) + ADD_{(3-5)}\left(\frac{3}{70}\right) + ADD_{(6-11)}\left(\frac{6}{70}\right) + ADD_{(12-19)}\left(\frac{8}{70}\right) + ADD_{(adult)}\left(\frac{50}{70}\right)$$

The time-weighting factors simply equal the duration of exposure for the specified age category in years divided by the total lifespan, assumed to be 70 years. For risk assessments for chemicals with a subchronic RfD or for developmental effects in children, $ADD_{(y)}$ values for the child age groups are compared with the RfD (see Section 5).

## 3.4 Chemical Intake Calculations for Nursing Infants

The scientific literature indicates that infants can be exposed to some chemicals via their mothers' breast milk. The magnitude of the exposure can be estimated from information on the mother's exposure, data on the partitioning of the chemical into various compartments of the mother's body and into breast milk, and information on the infant's consumption of milk and absorption of the chemical. To add this exposure pathway to the MIRC application, we adapted exposure algorithms and default assumptions from EPA's *Methodology for Assessing Health Risks Associated with Multiple Pathways of Exposure to Combustor Emissions* (EPA 1998), hereafter referred to as MPE, as explained below.

Note that this pathway generally is of most concern for *lipophilic* bioaccumulative chemicals (e.g., dioxins) that can cause developmental effects. The period of concern for the more *hydrophilic* chemicals that cause developmental effects generally is earlier, that is, from conception to birth. Hydrophilic chemicals generally exchange well between the maternal and fetal blood supplies at the placenta.

### 3.4.1 Infant Average Daily Absorbed Dose

The average daily dose of chemical *absorbed* by the infant ($DAI_{inf}$) is estimated in MIRC with Equation 3-37. This basic exposure equation relies on the concentration of the chemical in the breast milk, the infant's breast-milk ingestion rate ($IR_{milk}$), the absorption efficiency of the chemical by the oral route of exposure ($AE_{inf}$), the bodyweight of the infant ($BW_{inf}$), and the duration of breast feeding ($ED$). Equation 3-37 is EPA's (EPA 1998) modification of an average daily dose for the infant model first published by Smith (1987) and includes variables for both the concentration of the chemical in the breast milk fat ($C_{milkfat}$) and the concentration of the chemical in the aqueous phase of breast milk ($C_{aqueous}$). The remainder of the $DAI_{inf}$-associated equations assume that most chemicals of concern will partition *either* to the lipid phase *or* to the aqueous phase of breast milk, although some chemicals may partition significantly to both phases of milk. Thus, the remaining equations in MIRC assume that either $C_{milkfat}$ or $C_{aqueous}$ is equal to zero and hence drops out of the equation.

For the parameters in Equation 3-37 (and the equations that follow) that are not calculated from another equation, an EPA default value and options for other values available in MIRC for the infant breast-milk-exposure pathway are described in Section 6.4. The user also can overwrite those parameter values with a different value from the literature as appropriate.

**Equation 3-37. Average Daily Dose of Chemical to the Nursing Infant**

$$DAI_{inf} = \frac{\left[\left(C_{milkfat} \times f_{mbm}\right) + \left(C_{aqueous} \times \left(1 - f_{mbm}\right)\right)\right] \times IR_{milk} \times AE_{inf} \times ED}{BW_{inf} \times AT}$$

where:

$DAI_{inf}$ = Average daily dose of chemical absorbed by infant (mg chemical/kg body weight-day)

$C_{milkfat}$ = Concentration of chemical in lipid phase of maternal milk (mg chemical/kg milk lipid; calculated using Equation 3-38)

$f_{mbm}$ = Fraction of fat in breast milk (unitless)

$C_{aqueous}$ = Concentration of chemical in aqueous phase of maternal milk (mg chemical/kg aqueous phase milk; calculated using Equation 3-42)

$IR_{milk}$ = Infant milk ingestion rate over the duration of nursing (kg milk/day)

$AE_{inf}$ = Absorption efficiency of the chemical by the oral route of exposure (i.e., chemical-specific fraction of ingested chemical that is absorbed by the infant) (unitless)

$ED$ = Exposure duration, i.e., duration of breast feeding (days)

$BW_{inf}$ = Body weight of infant averaged over the duration of nursing (kg)

$AT$ = Averaging time associated with exposure of interest; equal to ED (days)

As mentioned above, Equation 3-37 includes terms for the chemical in both the lipid- and non-lipid phases of milk. The remaining equations, however, assume that a chemical of concern will partition to the lipid or aqueous phase of breast milk. Different models are used to estimate $C_{milkfat}$ (described in Section 3.4.2) and $C_{aqueous}$ (described in Section 3.4.3).

### *3.4.2 Chemical Concentration in Breast Milk Fat*

When developing the Methodology for Assessing Health Risks Associated with Multiple Pathways of Exposure to Combustor Emissions (MPE) (U.S. EPA 1998), EPA reviewed three first-order kinetics models for estimating chemical concentration in breast milk fat. The model selected for use in MPE is the model used in MIRC. It is a changing-concentration model that EPA adapted from a model by Sullivan *et al*. (1991). The model, shown in Equation 3-38, estimates the average chemical concentration in the breast milk over the entire period of breast feeding by reference to a maximum theoretical steady-state concentration. Studies of lipophilic chemicals such as dioxins suggest that concentrations in the maternal milk are highest during the first few weeks of breast feeding and then decrease over time (ATSDR 1998). Equation 3-38 accounts for the changing concentration in breast milk fat, but estimates one average value to represent the concentration over the entire duration of breast feeding. The model is dependent on the maternal body burden of the chemical and assumes that the chemical concentration in breast milk fat is the same as the concentration in general maternal body fat. According to reviewers of the model, this assumption warrants further investigation because milk fat appears to be synthesized in the mammary glands and may have lower chemical concentrations than general body fat stores (EPA 2001a).

### Equation 3-38. Chemical Concentration in Breast Milk Fat

$$C_{milkfat} = \frac{DAI_{mat} \times f_f}{k_{elim} \times f_{fm}} \times \left[ \frac{k_{elim}}{k_{fat\_elac}} + \frac{1}{k_{fat\_elac} \times t_{bf}} \left( 1 - e^{-k_{elim} t_{pn}} - \frac{k_{elim}}{k_{fat\_elac}} \right) \left( 1 - e^{-k_{fat\_elac} t_{bf}} \right) \right]$$

where:

$C_{milkfat}$ = Concentration of chemical in lipid phase of maternal milk (mg chemical/kg lipid)

$DAI_{mat}$ = Daily absorbed maternal chemical dose (mg chemical/kg maternal body weight-day; calculated using Equation 3-39)

$f_f$ = Fraction of total maternal body burden of chemical that is stored in maternal fat (mg chemical in body fat / mg total chemical in whole body; value from literature or EPA default - see Section 6.5)

$k_{elim}$ = Chemical-specific total elimination rate constant for elimination of the chemical by non-lactating women (per day; e.g., via urine, bile to feces, exhalation; value from literature or calculated using Equation 3-40)

$f_{fm}$ = Fraction of maternal body weight that is fat stores (unitless)

$k_{fat\_elac}$ = Chemical-specific rate constant for total elimination of chemical in the lipid phase of milk during nursing (per day; value from literature or calculated using Equation 3-41)

$t_{bf}$ = Duration of breast feeding (days)

$t_{pn}$ = Duration of mother's exposure prior to parturition and initiation of breast feeding (days)

Equation 3-38 relies on the daily maternal absorbed intake ($DAI_{mat}$) to determine the concentration of the chemical in the breast milk fat. $DAI_{mat}$ is multiplied by the fraction of the chemical that is stored in maternal fat ($f_f$) to determine the amount (i.e., mass) of chemical in the fat. This product, divided by the chemical-specific elimination rate constant ($k_{elim}$) for non-lactating adult women and the fraction of the mother's weight that is fat ($f_{fm}$), represents the maximum theoretical steady-state concentration of the chemical in an adult woman. If used alone to estimate the chemical concentration in breast milk fat, the equation as explained thus far is likely to overestimate the chemical concentration in milk fat because it does not account for losses due to breast feeding. Alone, this term ($DAI_{mat} f_f / k_{elim} f_{fm}$) also assumes that the biological half-life of the chemical in the mother's breast milk fat is small relative to the duration of the mother's exposure. However, for chemicals with half-lives that are longer than the exposure duration, which are the chemicals of concern in the applications of MIRC to date, an additional term is needed to determine the average concentration in the milk fat over the duration of her exposure.

To account for breast feeding losses and longer chemical half-lives in the mother than the exposure duration, an additional term is included in Equation 3-38. This term includes a fraction dependent on two rate constants, $k_{elim}$ and the elimination constant for a lipophilic chemical in lactating women via the lipid phase of breast milk ($k_{fat\_elac}$), the duration of the mother's chemical exposure prior to nursing ($t_{pn}$), and the duration of breast feeding ($t_{bf}$). The whole body concentration ($DAI_{mat} f_f / k_{elim} f_{fm}$), the maximum theoretical steady-state concentration, is multiplied by the rate of elimination averaged over the duration of the mother's exposure, including her exposure prior to and during lactation. To review the derivation of Equation 3-38, see Appendix B of MPE (EPA 1998).

To estimate an average daily dose *absorbed* by an infant's mother, or $DAI_{mat}$, the average daily dose (*ADD*) (in mg/kg-day) for the chemical from all sources that MIRC calculates for adults ($ADD_{(adult)}$, described in Section 3.3, Equation 3-35), is multiplied by an absorption efficiency ($AE_{mat}$) or fraction of the chemical absorbed by the oral route of exposure, as shown in Equation 3-39. The value for $AE_{mat}$ can be estimated from absorption efficiencies for adults in general. Available data for some chemicals, in particular some inorganic compounds, indicate AE values for ingestion exposures of substantially less than 100 percent. For a few of these chemicals, data also indicate lower AEs for the chemical when ingested in food or in soil than when ingested in water (e.g., cadmium). For a screening level assessment, however, it is reasonable to either assume 100 percent for the $AE_{mat}$ or to use the higher $AE_{mat}$ of the food and water $AE_{mat}$ values if available; hence, a single $AE_{mat}$ parameter is included in Equation 3-39.

### Equation 3-39. Daily Maternal Absorbed Intake

$$DAI_{mat} = ADD_{(adult)} \times AE_{mat}$$

where:

$DAI_{mat}$ = Daily maternal dose of chemical absorbed from medium *i* (mg/kg-day)

$ADD_{(adult)}$ = Average daily dose to the mother (mg/kg-day) (calculated by MIRC – see Section 3.3, Equation 3-35)

$AE_{mat}$ = Absorption efficiency of the chemical by the oral route of exposure (i.e., chemical-specific fraction of ingested chemical that is absorbed) by the mother (unitless) (value from literature or EPA default – see Section 6.4)

Equation 3-35, used to calculate $ADD_{(adult)}$, is based on many medium-specific ingestion rates that are normalized to body weight. The adult body weights to which the homegrown food ingestion rates are normalized are the body weights of the consumers in the original USDA survey (see Section 6.3.3), which included both males and females. An assumption in the breast-milk exposure pathway is that those ingestion rates also are applicable to nursing mothers. The original data for ingestion rates for soil, drinking water, and fish are on a per person basis for males and females combined. MIRC divides those chemical intakes by an adult body weight for males and females combined as specified by the user (e.g., 71.4 kg mean value) to estimate the ADD normalized to body weight from those sources. If the user finds that those exposure media contribute the majority of the chemical intake for the risk scenario under consideration, the user may use alternative ingestion rates for those media and alternative body weights for nursing women, as described in Section 6.5.

Elimination rates for chemicals often are reported as the half-life of the chemical in the body following a known dose of chemical. Many chemicals exhibit a two-phase elimination process, the first being more rapid than the second. For screening risks for persistent and bioaccumulative chemicals, the half-life of the slower phase of elimination, presumably from non-blood compartments of the body, is the more important of the two. Assuming first-order kinetics, Equation 3-40 is used to convert a measured half-life for elimination of a chemical for adults or non-lactating women to an elimination rate constant (EPA 1998). The equation can be used to estimate any kind of chemical loss rate constant from a measured chemical half-life.

### Equation 3-40. Biological Elimination Rate Constant for Chemicals for Non-lactating Women

$$k_{elim} = \frac{\ln 2}{h}$$

where:

$k_{elim}$ = Chemical-specific elimination rate constant for elimination of the chemical for non-lactating women (per day; e.g., via urine, bile to feces, exhalation)

$ln2$ = Natural log of 2 (unitless constant)

$h$ = Chemical-specific biological half-life of chemical for non-lactating women (days)

For chemicals transferred from the body of lactating women to breast milk, the rate of chemical elimination is augmented by the rate of chemical loss via the milk. The total elimination rate for lactating women sometimes is measured directly and reported in the literature. Where direct measurements are not available, and for chemicals that partition predominantly to the lipid-phase of milk, EPA has used Equation 3-41 to estimate the total chemical elimination rate for lactating women, $k_{fat\_elac}$ (EPA 1998).

### Equation 3-41. Biological Elimination Constant for Lipophilic Chemicals for Lactating Women

$$k_{fat\_elac} = k_{elim} + \frac{IR_{milk} \times f_f \times f_{mbm}}{f_{fm} \times BW_{mat}}$$

where:

$k_{fat\_elac}$ = Rate constant for total elimination of chemical during nursing (per day); accounts for both elimination by adults in general and the additional chemical elimination via the lipid phase of milk in nursing women

$k_{elim}$ = Elimination rate constant for chemical from adults, including non-lactating women (per day; e.g., via urine, bile to feces, exhalation; chemical-specific; value from literature or calculated from half-life using Equation 3-40)

$IR_{milk}$ = Infant milk ingestion rate over the duration of nursing (kg/d)

$f_f$ = Fraction of total maternal body burden of chemical that is stored in maternal fat (mg chemical in body fat / mg chemical total in body; value from literature or EPA default)

$f_{mbm}$ = Fraction of fat in breast milk (unitless)

$f_{fm}$ = Fraction of maternal body weight that is fat stores (unitless)

$BW_{mat}$ = Maternal body weight over the entire duration of the mother's exposure to the chemical including during pregnancy and lactation (kg)

Equation 3-41 is based on a model from Smith (1987) and accounts for the additional elimination pathway for lipophilic chemicals via the breast milk fat. The term $K_{fat\_elac}$ is estimated by adding an estimate of the first-order elimination constant for breast feeding losses to $k_{elim}$, which is the chemical-specific total elimination rate constant for non-lactating women. The breast feeding losses are estimated from the infant's intake rate of breast milk ($IR_{milk}$), the fraction of the total maternal body burden of the chemical that is stored in maternal body fat ($f_f$), the fraction of the mother's breast milk that consists of fat (lipids) ($f_{mbm}$), the mother's body weight ($BW_{mat}$), and the fraction of the mother's weight that is body fat ($f_{fm}$). In Equation 3-41, the value for the mother's body weight should be specific to women of child-bearing age, as opposed to a body weight value for both males and females that is used to estimate an adult average daily dose and the mother's absorbed daily intake in Equation 3-39. Body weight values for the mother are described in Section 6.5. Smith's (1987) model assumes that the chemical partitions to the lipid-phase of breast milk to the same degree that it partitions into the mother's body fat. For highly lipophilic compounds, losses from breast feeding can be larger than losses by all other pathways (EPA 1998).

### *3.4.3 Chemical Concentration in Aqueous Phase of Breast Milk*

When developing MPE (EPA 1998), EPA also considered models to estimate chemical concentrations in the aqueous phase of breast milk ($C_{aqueous}$). EPA adapted Smith's (1987) steady state concentration model for estimating $C_{milkfat}$ and developed the $C_{aqueous}$ model shown in Equation 3-42 (EPA 1998). Chemicals that would partition to the aqueous phase of human milk include water-soluble chemicals, such as salts of metals, and other hydrophilic chemicals that may be in equilibrium with bound forms of the chemical in different tissues. The $C_{aqueous}$ equation assumes that the chemical concentration in the aqueous phase of milk is directly proportional to the chemical concentration in the mother's blood plasma. The portion of chemical sequestered in red blood cells (e.g., bound to RBC proteins) is assumed to be unavailable for direct transfer to breast milk.

**Equation 3-42. Chemical Concentration in Aqueous Phase of Breast Milk**

$$C_{aqueous} = \frac{DAI_{mat} \times f_{pl} \times Pc_{bm}}{k_{aq\_elac} \times f_{pm}}$$

where:

$C_{aqueous}$ = Concentration of chemical in aqueous phase of maternal milk (mg/kg)

$DAI_{mat}$ = Daily absorbed maternal chemical dose (mg/kg-day; calculated by Equation 3-39)

$f_{pl}$ = Fraction of chemical in the body (based on absorbed intake) that is in the blood plasma compartment (unitless; value from literature or calculated by Equation 3-43)

$Pc_{bm}$ = Partition coefficient for chemical between the plasma and breast milk in the aqueous phase (unitless); assumed to equal 1.0

$k_{aq\_elac}$ = Chemical-specific rate constant for total elimination of chemical in the aqueous phase of milk during nursing (per day; value from literature or calculated in Equation 3-44)

$f_{pm}$ = Fraction of maternal weight that is blood plasma (unitless)

Equation 3-42 is a steady-state concentration model that, like the Equation 3-38 for $C_{milkfat}$, is dependent on the maternal absorbed daily intake ($DAI_{mat}$). In Equation 3-42, $DAI_{mat}$ is multiplied by the fraction of the absorbed chemical that is circulating in the blood plasma compartment ($f_{pl}$) and a partitioning coefficient for the chemical between plasma and the aqueous phase of breast milk ($Pc_{bm}$). For highly water-soluble chemicals that are not transported via special carrier molecules, the chemical is assumed to diffuse passively from the mother's blood serum to the aqueous phase of her milk, in which case $Pc_{bm}$ would equal 1.0. The denominator includes the biological elimination constant for the chemical in the aqueous phase of breast milk in lactating women ($k_{aq\_elac}$) and the fraction of the mother's weight that is plasma ($f_{pl}$). Because the model assumes steady-state, it does not account for chemical species with long half-lives in the body or for body burden losses due to lactation. These factors are important for highly lipophilic chemicals and for non-lipophilic chemicals such as methyl mercury, lead, and cadmium that partition into body compartments such as red blood cells and bone. While these latter chemicals or forms of these chemicals are water-soluble when free, they have relatively long half-lives because they are in equilibrium with the chemical bound to macromolecules in some tissue compartments. Lead is of particular concern because it can be released from the bone into the blood during lactation, and thus into the breast milk (EPA 2001a). Due to this limitation, the model may over- or underestimate exposure to the infant.

Because Equation 3-42 is based on the relationship between the chemical concentrations in the aqueous phase of breast milk and the blood plasma, a value for the fraction of the chemical in the mother's blood plasma ($f_{pl}$) is required. Ideally, an empirical value for $f_{pl}$ should be used. If empirical values are not available, $f_{pl}$ can be estimated from Equation 3-43, provided that an empirical value can be found for the fraction of the chemical in the body that is in the mother's whole blood compartment ($f_{bl}$; EPA 1998).

### Equation 3-43. Fraction of Total Chemical in Body in the Blood Plasma Compartment

$$f_{pl} = \frac{f_{bl} \times f_{bp}}{f_{bp} + Pc_{RBC}\left(1 - f_{bp}\right)}$$

where:

$f_{pl}$ = Fraction of chemical in body (based on absorbed intake) that is in the blood plasma compartment (unitless); chemical-specific

$f_{bl}$ = Fraction of chemical in body (based on absorbed intake) in the whole blood compartment (unitless); chemical-specific

$f_{bp}$ = Fraction of whole blood that is plasma (unitless)

$Pc_{RBC}$ = Partition coefficient for chemical between red blood cells and plasma (unitless); chemical-specific

If the fraction of the total chemical in the body that is in the whole blood compartment ($f_{bl}$) is known for a given chemical, then the fraction of that chemical that is in blood plasma depends only on the partition coefficient for the chemical between the red blood cells and the plasma ($Pc_{RBC}$) and the fraction of whole blood that is plasma ($f_{bp}$).

Another parameter for which a value is needed to solve Equation 3-42 is the total chemical elimination rate for lactating women for hydrophilic chemicals, $k_{aq\_elac}$. As for $k_{fat\_elac}$ for lipophilic chemicals, $k_{aq\_elac}$ for hydrophilic chemicals would be equal to $k_{elim}$ plus the loss rate for the chemical in the aqueous phase of breast-milk during lactation. In the case of hydrophilic chemicals, EPA has yet to propose a term for the additional elimination of a chemical in the aqueous phase of milk from breast feeding. Given basic physiological mechanisms, we assume that chemical loss rates via urine are likely to be significantly higher than loss rates from nursing, however. This is because the counter-current anatomy of kidney tubules allows substantial concentration of chemicals in the tubules for elimination in urine compared with the concentration in circulating blood and because of active secretion of some chemicals into urine. Therefore, the best estimation of elimination of hydrophilic chemicals by lactating women is simply $k_{elim}$, the elimination of the chemical from a non-lactating woman, as shown in Equation

3-40. The extent to which $k_{elim}$ is an underestimate of $k_{aq\_elac}$ for a given chemical will determine the extent of health protective bias in $k_{aq\_elac}$.

**Equation 3-44. Biological Elimination Rate Constant for Hydrophilic Chemicals**

$$k_{aq\_elac} = k_{elim}$$

where:

$k_{aq\_elac}$ = Chemical-specific rate constant for total elimination of chemical by lactating women for hydrophilic chemicals (per day)

$k_{elim}$ = Chemical-specific rate constant for total elimination of chemical by non-lactating women (per day; e.g., via urine, bile to feces, exhalation; value from literature or calculated from half-life using Equation 3-40)

### *3.4.4 Alternative Model for Infant Intake of Methyl Mercury*

In this version of MIRC, we were unable to fully parameterize the aqueous model for mercury. In particular, no empirical value could be found for the steady-state fraction of total hydrophilic chemical body burden in the mother that is in the blood plasma ($f_{pl}$, see Exhibit 6-20). This parameter could be estimated using Equation 3-43 if a suitable chemical-specific fraction of chemical in the body that is in the whole blood ($f_{bl}$) could be found. However, the value found for $f_{bl}$ is based on a single-dose study and is not considered reliable for use in chronic exposure calculations.

We therefore conducted a literature search to identify existing physiologically based toxicokinetic (PBTK) models of lactational transfer of methylmercury (MeHg) in humans. Most PBTK models that we identified focused on gestational transfer of mercury between mother and fetus, including a PBTK dynamic compartmental model for gestational transfer of MeHg in humans developed by Gearhart *et al*. (1995, 1996), and reparameterized by Clewell *et al*. (1999).

We did find, however, that Byckowski and Lipscomb (2001) had added a lactational transfer module to the Clewell *et al*. (1999) model. Byckowski and Lipscomb compared their model's predictions to epidemiological data from mother-nursing-infant pairs obtained following an accidental high-dose poisoning in Iraq (Amin-Zaki *et al*. 1976) and from 34 mother-nursing-infant pairs examined in a low-dose, chronic exposure environment (Fujita and Takabatake 1977). Using data from the Iraq incident, Byckowski and Lipscomb (2001) found good agreement between their model's predictions and the clinical data relating MeHg concentrations in breast milk to MeHg concentrations in infant's blood with time following the poisoning. To compare their model's predictions to data from chronic exposure to low doses of MeHg, Byckowski and Lipscomb (2001) simulated MeHg intake for 500 days prior to conception, continued through gestation, and 6.5 months (200 days) of lactation. Their model's predictions were consistent with Fujita and Takabatake's (1977) study, although use of hair/blood partition coefficients based on the results of the 1977 study precluded use of this comparison as model validation. Both the model predictions and the mean values from the 1977 data indicated that the concentration of MeHg in the blood of nursing infants was close to the MeHg concentration in their mothers' blood (approximately 0.025 to 0.027 mg/L, Figure 4 of report). At those blood concentrations, the PBTK model estimated the average maternal intake of MeHg to be 0.68 ± 0.33 (SD) µg/kg-day and the average infant intake of MeHg to be 0.80 ± 0.38 µg/kg-day. Therefore, for purposes of MIRC, the $DAI_{inf}$ of MeHg is estimated to be the same as the maternal intake per unit body weight (Equation 3-42).

### Equation 3-45. Calculation of Infant Average Daily Absorbed Dose of Methyl Mercury

$$DAI_{inf\_MeHg} = DAI_{mat\_MeHg}$$

where:

$DAI_{inf\_MeHg}$ = Average daily dose of MeHg absorbed by infant from breast milk (mg/kg-day)

$DAI_{mat\_MeHg}$ = Average daily dose of methyl mercury absorbed by the mother, predominantly from fish (mg/kg-day)

# 4 Dose-Response Values Used for Assessment

Chemical dose-response values included in MIRC include carcinogenic potency slope factors for ingestion and non-cancer oral reference doses (RfDs) for chronic exposures. The cancer slope factors (CSFs) and RfDs for chemicals used to calculate persistent and bioaccumulative hazardous air pollutant (PB-HAP) emission thresholds are provided in Exhibit 4-1. Dose-response values in MIRC that are used for EPA's Risk and Technology Review (RTR) evaluations are consistent with dose-response data that the Agency's Office of Air Quality Planning and Standards (OAQPS) uses for risk assessments of hazardous air pollutants (HAPs) (EPA 2007a). In general, OAQPS chose these values based on the following hierarchy of sources: EPA's Integrated Risk Information System (IRIS); the Centers for Disease Control's Agency for Toxic Substances and Disease Registry (ATSDR); and the California Environmental Protection Agency's (CalEPA's) Office of Environmental Health Hazard Assessment (OEHHA) Toxicity Criteria Database. For PB-HAPs without dose-response values from these sources, alternative methods for deriving values were used (see Sections 4.3 and 4.4).

**Exhibit 4-1. Oral Dose-response Values for PB-HAP Chemicals Used to Calculate RTR Screening Threshold Emission Rates**

| Chemical | CAS No. | Cancer Slope Factor | | Reference Dose | |
|---|---|---|---|---|---|
| | | Value $(mg/kg\text{-}day)^{-1}$ | Source | Value (mg/kg-day) | Source |
| ***Inorganics*** | | | | | |
| Cadmium compounds in food | 7440439 | not available | | 1.0E-03 | IRIS |
| Mercury (elemental) | 7439976 | NA | | not available | |
| Mercuric chloride | 7487947 | not available | | 3.0E-04 | IRIS |
| Methyl mercury (MeHg) | 22967926 | not available | | 1.0E-04 | IRIS |
| ***Dioxins*** [a] | | | | | |
| 2,3,7,8-TCDD | 1746016 | 1.5E+05 | EPA ORD | 7.0E-10 | IRIS |
| 1,2,3,7,8,9-HexaCDD | 19408743 | 6.2E+03 | IRIS | not available | |
| ***Polycyclic Organic Matter*** | | | | | |
| 2-Methylnaphthalene | 91576 | 5.0E-01 | EPA OAQPS [b] | 5.0E-02 | ATSDR |
| 7,12-Dimethylbenz(a)anthracene | 57976 | 2.5E+02 | CalEPA | not available | |
| Acenaphthene | 83329 | 5.0E-01 | EPA OAQPS [b] | 6.0E-02 | IRIS |
| Acenaphthylene | 208968 | 5.0E-01 | EPA OAQPS [b] | not available | |
| Benz(a)anthracene | 56553 | 1.2E+00 | CalEPA | not available | |
| Benzo(a)pyrene | 50328 | 7.3E+00 | IRIS | not available | |
| Benzo(b)fluoranthene | 205992 | 1.2E+00 | CalEPA | not available | |
| Benzo(g,h,i)fluoranthene | 203123 | 5.0E-01 | EPA OAQPS [b] | not available | |
| Benzo(k)fluoranthene | 207089 | 1.2E+00 | CalEPA | not available | |
| Chrysene | 218019 | 1.2E-01 | CalEPA | not available | |
| Dibenzo(a,h)anthracene | 53703 | 4.1E+00 | CalEPA | not available | |
| Fluoranthene | 206440 | 5.0E-01 | EPA OAQPS [b] | 4.0E-02 | IRIS |

**Exhibit 4 1, continued. Oral Dose-response Values for PB-HAP Chemicals Used to Calculate RTR Screening Threshold Emission Rates**

| Chemical | CAS No. | Cancer Slope Factor | | Reference Dose | |
|---|---|---|---|---|---|
| | | Value $(mg/kg\text{-}day)^{-1}$ | Source | Value (mg/kg-day) | Source |
| Fluorene | 86737 | 5.0E-01 | EPA OAQPS [b] | 4.0E-02 | IRIS |
| Indeno(1,2,3-c,d)pyrene | 193395 | 1.2E+00 | CalEPA | not available | |

ATSDR = Agency for Toxic Substances and Disease Registry
EPA OAQPS = EPA's Office of Air Quality Planning and Standards
EPA ORD = EPA's Office of Research and Development
IRIS = Integrated Risk Information System
CalEPA = California EPA
NA = not applicable

[a] Dose-response values for other dioxin congeners are not available from EPA sources. CSFs for these congeners were derived as discussed in Section 4.3, and the derived CSFs are presented in Exhibit 4-2.

[b] The method to assign oral cancer slope factors to polycyclic organic matter (POM) without CSFs available from other EPA sources is the same as that used in the 1999 National Air Toxics Assessment (EPA 1999b). A complete description of the methodology is available at: http://www.epa.gov/ttn/atw/nata1999/99pdfs/pomapproachjan.pdf and is summarized in Section 4.4.

## 4.1 Cadmium

EPA has developed two chronic RfDs for cadmium (Cd), one for food and one for water, based on data in IRIS indicating a lower absorption efficiency of cadmium from food than from water. The default RfD set in MIRC is the higher RfD for Cd compounds in food (no drinking of water is assumed to occur when calculating screening thresholds). Users of MIRC who assess exposures via drinking water would need to use the RfD for Cd compounds in water (i.e., 5.0E-04 mg/kg-day).

## 4.2 Mercury

EPA's RfD for MeHg of 1.0E-04 mg/kg-day is based on a benchmark dose lower confidence limit (BMDL) on dose-response data from an epidemiological study of neurobehavioral effects in children for which mercury concentrations had been measured in cord blood at birth. The island populations included in the study had been exposed for many years to MeHg in seafood. The RfD applies to the pregnant mother as well as young children. EPA has not specified the minimum exposure duration at the RfD level of exposure that is appropriate to use in characterizing risk; we assume 10 years for women of childbearing age and 1 year for infants.

We note that human exposures to MeHg are primarily through the consumption of fish and shellfish (EPA 2001b). EPA found that, on average, approximately 76 percent of the exposure to MeHg for women of childbearing age could be attributed to ingestion of mercury in freshwater and estuarine fish and shellfish, with the remaining 24 percent derived from marine fish and shellfish. Other sources accounted for less than 0.06 percent of total exposures (EPA 2001b).

## 4.3 Dioxins (2,3,7,8-TCDD)

For chemicals for which the critical health effect is developmental, either *in utero* and/or during the first months or years of life, the exposure duration and timing of exposure for comparison with the RfD (or comparable values) require special consideration. The most sensitive health endpoints for both mercury and 2,3,7,8-TCDD are neurological effects during development that have long-lasting effects on learning and social behaviors. To ensure a protective risk characterization for these chemicals, it is important to use the shortest exposure duration appropriate, at the appropriate life stage, for comparison with the toxicity reference values. This approach avoids "dilution" of an estimated average ADD that would result from averaging the lower daily chemical intake rates normalized to body weight for older children and adults with the potentially higher daily intake rates of infants over a longer exposure averaging period.

The convention for assessing risk from mixtures of dioxins is by application of toxic equivalency factors (TEFs) to dioxin concentrations, which are then expressed as toxic equivalents (TEQs). Of the dioxin congeners, 2,3,7,8-TCDD is the most widely studied and considered to be one of the most toxic congeners. It is therefore assigned a TEF of 1, with the other dioxin congener TEQ concentrations scaled relative to 2,3,7,8-TCDD concentrations on the basis of toxicity. For risk assessment of dioxins for RTR, the World Health Organization (WHO) 2005 TEFs presented in Exhibit 4-2 were used to derive the CSFs for dioxin congeners without available EPA dose response values.

**Exhibit 4-2. WHO 2005 Toxic Equivalency Factors (TEFs) for Dioxin Congeners and Summary of Derived Cancer Slope Factors for RTR**

| Dioxin Congener | CAS No. | WHO 2005 Toxic Equivalency Factor [a] | Cancer Slope Factor for RTR $(mg/kg\text{-}day)^{-1}$ |
|---|---|---|---|
| 1,2,3,4,6,7,8-Heptachlorodibenzofuran | 67562394 | 0.01 | 1.5E+03 |
| 1,2,3,4,7,8,9-Heptachlorodibenzofuran | 55673897 | 0.01 | 1.5E+03 |
| 1,2,3,4,7,8-Hexachlorodibenzofuran | 70648269 | 0.1 | 1.5E+04 |
| 1,2,3,6,7,8-Hexachlorodibenzofuran | 57117449 | 0.1 | 1.5E+04 |
| 1,2,3,7,8,9-Hexachlorodibenzofuran | 72918219 | 0.1 | 1.5E+04 |
| 2,3,4,6,7,8-Hexachlorodibenzofuran | 60851345 | 0.1 | 1.5E+04 |
| 1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin | 39227286 | 0.1 | 1.5E+04 |
| 1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin | 57653857 | 0.1 | 1.5E+04 |
| 1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin | 19408743 | 0.1 | 6.2E+03<br>(see Exhibit 4-1) |
| 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin | 35822469 | 0.01 | 1.5E+03 |
| 1,2,3,4,6,7,8,9-Octachlorodibenzofuran | 39001020 | 0.0003 | 4.5E+01 |
| 1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin | 3268879 | 0.0003 | 4.5E+01 |
| 1,2,3,7,8-Pentachlorodibenzofuran | 57117416 | 0.03 | 4.5E+03 |
| 2,3,4,7,8-Pentachlorodibenzofuran | 57117314 | 0.3 | 4.5E+04 |
| 1,2,3,7,8-Pentachlorodibenzo-p-dioxin | 40321764 | 1 | 1.5E+05 |
| 2,3,7,8-Tetrachlorodibenzofuran | 51207319 | 0.1 | 1.5E+04 |
| 2,3,7,8-Tetrachlorodibenzo-p-dioxin | 1746016 | 1 | 1.5E+05<br>(see Exhibit 4-1) |

[a] Source: van den Berg *et al*. 2006

## 4.4 Polycyclic Organic Matter

Previously, for risk assessment of inhalation exposures to polycyclic organic matter (POM) for EPA's National Air Toxics Assessments (NATA) and for RTR, OAQPS developed an approach for characterizing risks associated with the individual POM species and POM groups reported in the National Emissions Inventory (NEI). Individual POMs were assigned to one of eight POM groups according to cancer potencies derived by EPA for IRIS and by CalEPA, and based on assumptions regarding relative carcinogenicity. OAQPS then estimated an inhalation CSF for each POM group. The same approach was used to derive oral CSFs for POMs for use in multipathway risk assessment for RTR. CSF values for the 14 POM congeners that are included in the screening analysis are provided in Exhibit 4-1. POM groups (with their member POM species reported in NEI) and the corresponding CSFs used for RTR risk assessment are presented in Exhibit 4-3. As shown in Exhibit 4-1, dose-response values for six of the POM species (all in POM group 72002) that are included in the screening analysis were not available from IRIS, ATDSR, or CalEPA; for these, the CSF of 5.0E-01 mg/kg-day$^{-1}$ as derived by OAQPS is provided.

### Exhibit 4-3. Oral Dose-response Values for Polycyclic Organic Matter (POM) Groups

| Individual POM or POM Group | CAS No. | Cancer Slope Factor [a] (mg/kg-day)$^{-1}$ |
|---|---|---|
| ***POM Group 71002*** | | |
| Benz(a)anthracene/chrysene (7-PAH) | 103 | 0.5 |
| Total PAH | 234 | |
| Polycyclic organic matter | 246 | |
| 16-PAH | 40 | |
| 16-PAH–7-PAH | 75040 | |
| ***POM Group 72002*** | | |
| Anthracene | 120127 | 0.5 |
| Pyrene | 129000 | |
| Benzo(g,h,i) perylene | 191242 | |
| Benzo(e)pyrene | 192972 | |
| Benzo(c)phenanthrene | 195197 | |
| Perylene | 198550 | |
| Benzo(g,h,i)fluoranthene | 203123 | |
| Benzo(a)fluoranthene | 203338 | |
| Fluoranthene | 206440 | |
| Acenaphthylene | 208968 | |
| 1-Methylpyrene | 2381217 | |
| 12-Methylbenz(a)anthracene | 2422794 | |
| Methylbenzopyrenes | 247 | |
| Methylchrysene | 248 | |
| Methylanthracene | 26914181 | |
| Benzofluoranthenes | 56832736 | |
| 9-Methylbenz(a)anthracene | 779022 | |
| 1-Methylphenanthrene | 832699 | |
| Acenaphthene | 83329 | |
| Phenanthrene | 85018 | |
| Fluorene | 86737 | |
| 2-Methylnaphthalene | 91576 | |
| 2-Chloronaphthalene | 91587 | |

## Exhibit 4-3, continued. Oral Dose-response Values for Polycyclic Organic Matter (POM) Groups

| Individual POM or POM Group | CAS No. | Cancer Slope Factor [a] (mg/kg-day)$^{-1}$ |
|---|---|---|
| ***POM Group 73002*** | | |
| 7,12-Dimethylbenz(a)anthracene | 57976 | 1000 |
| ***POM Group 74002*** | | |
| Dibenzo(a,i)pyrene | 189559 | 100 |
| Dibenzo(a,h)pyrene | 189640 | |
| ***POM Group 75002*** | | |
| 3-Methylcholanthrene | 56495 | 10 |
| Dibenzo(a,e)pyrene | 192654 | |
| 5-Methylchrysene | 3697243 | |
| **Benzo(a)pyrene** | **50328** | |
| Dibenzo(a,h)anthracene | 53703 | |
| ***POM Group 76002*** | | |
| Benzo(b+k)fluoranthene | 102 | 1 |
| Indeno(1,2,3-c,d)pyrene | 193395 | |
| Benzo(j)fluoranthene | 205823 | |
| Benzo(b)fluoranthene | 205992 | |
| Benzo(k)fluoranthene | 207089 | |
| Dibenzo(a,j)acridine | 224420 | |
| Benz(a)anthracene | 56553 | |
| ***POM Group 77002*** | | |
| Chrysene | 218019 | 0.1 |
| ***POM Group 78002*** | | |
| 7-PAH | 75 | 0.5 |

[a] The method to assign oral cancer slope factors to POM groups was the same as that used in the 1999 National Air Toxics Assessment (EPA 1999b). A complete description of the methodology is available at: http://www.epa.gov/ttn/atw/nata1999/99pdfs/pomapproachjan.pdf.

# 5 Risk Estimation

For persistent and bioaccumulative hazardous air pollutants (BP-HAPs), risks from inhalation of a chemical directly from air generally will be negligible compared with risks from ingestion of the chemical with foodstuffs grown in an area subject to air deposition of the chemical. For other (non-PB) HAPs, inhalation risks can be estimated separately and compared with risks associated with ingestion exposure to determine the focus of subsequent tiers of the risk assessment. Risk characterization for carcinogens with a linear mode of action at low doses is described in Section 5.1. Risk characterization for chemicals likely to exhibit a threshold for response (e.g., non-cancer hazards) is described in Section 5.2.

## 5.1 Cancer Risks

The estimated risk of developing cancer from exposure to a chemical from a specified source is characterized as the excess lifetime cancer risk (ELCR). The ELCR represents the incremental probability of an individual developing cancer over a lifetime as a result of lifetime exposure to the chemical. For a known or suspected carcinogen with a low-dose linear mode of action, the estimated ELCR is calculated as the product of the lifetime average daily dose (LADD) and the cancer slope factor (CSF):

**Equation 5-1. Calculation of Excess Lifetime Cancer Risk**

$$ELCR = LADD \times CSF$$

where:

$ELCR$ = Estimated excess lifetime cancer risk from a chemical summed across all exposure pathways and media (unitless)

$LADD$ = Lifetime average total daily dose from all exposure pathways and media (mg/kg-day)

$CSF$ = Oral carcinogenic potency slope factor for chemical (per mg/kg-day)

As described in Section 3.3, the *LADD* (in mg/kg-day) for a chemical is calculated to reflect age-related differences in exposure rates that are experienced by a hypothetical individual throughout his or her lifetime of exposure. The total chemical intake is normalized to a lifetime, which for the purposes of this assessment is assumed to be 70 years.

EPA considers the possibility that children might be more sensitive than adults to toxic chemicals, including chemical carcinogens (EPA 2005b,c). Where data allow, EPA recommends development of lifestage-specific cancer potency CSFs. To date, EPA has developed a separate slope factor for early lifestage exposure for only one chemical (i.e., 1,1,1-trichloroethane; EPA 2007b), and current data availability for most chemicals preclude this approach. EPA has, therefore, examined options for default adjustments of the CSF to protect children. To date, the only mode of action (MOA) for carcinogenesis for which EPA has adequate data to develop a reasonable quantitative default approach is mutagenesis (EPA 2005b,c). For carcinogens with a mutagenic MOA for cancer, EPA concluded that the carcinogenic potency of a chemical may be approximately tenfold greater for the first 2 years of life (i.e., birth up to second birthday) and threefold greater for the next 14 years of life (i.e., ages 2 through 15) than for adults (EPA 2005c). These conclusions are represented by age-dependent adjustment factors (ADAFs) of 10, 3, and 1 for the first two lifestages and for adults, respectively.

These three lifestages do not match the age categories for the home-grown food ingestion rates, the age categories in MIRC. As a consequence, ADAFs for the age groups in MIRC are adapted as time-weighted average values as follows:

$$ADAF_{(<1)} = 10 \qquad ADAF_{(6\text{-}11)} = 3$$

$$ADAF_{(1\text{-}2)} = \frac{(10 \times 1\,\text{yr}) + (3 \times 1\,\text{yr})}{2} = 6.5 \qquad ADAF_{(12\text{-}19)} = \frac{(3 \times 4\ \text{yrs}) + (1 \times 4\ \text{yrs})}{8} = 2$$

$$ADAF_{(3\text{-}5)} = 3 \qquad ADAF_{(adult)} = 1$$

To estimate total lifetime risk from a lifetime of exposure to such a chemical, EPA recommends estimating the cancer risk for each of the three lifestages separately and then adding the risks for $i$ = 1 to 6 age groups.

**Equations 5-2 to 5-8. Lifetime Cancer Risk: Chemicals with a Mutagenic MOA for Cancer**

**Equation 5-2.** $Risk_{(<1)} = ADD_{(0\text{-}<1)} \times 10 \times CSF \times (1\ \text{yr}/70\ \text{yr})$

**Equation 5-3.** $Risk_{(1\text{-}2)} = ADD_{(1\text{-}2)} \times 6.5 \times CSF \times (2\ \text{yr}/70\ \text{yr})$

**Equation 5-4.** $Risk_{(3\text{-}5)} = ADD_{(3\text{-}5)} \times 3 \times CSF \times (3\ \text{yr}/70\ \text{yr})$

**Equation 5-5.** $Risk_{(6\text{-}11)} = ADD_{(6\text{-}11)} \times 3 \times CSF \times (6\ \text{yr}/70\ \text{yr})$

**Equation 5-6.** $Risk_{(12\text{-}19)} = ADD_{(12\text{-}19)} \times 2 \times CSF \times (8\ \text{yr}/70\ \text{yr})$

**Equation 5-7.** $Risk_{(adult)} = ADD_{(adult)} \times 1 \times CSF \times (50\ \text{yr}/70\ \text{yr})$

**Equation 5-8.** $ELCR = \sum_{i=1}^{n} Risk_{(i)}$

In other words, Equation 5-8 indicates that the total extra lifetime cancer risk (ELCR) equals the sum of the age-group-specific risks estimated by Equations 5-2 through 5-7, where:

$Risk_{(<1)}$ = Risk from chemical ingestion in first year of life
$Risk_{(1\text{-}2)}$ = Risk from chemical ingestion from first birthday through age 2 years
$Risk_{(3\text{-}5)}$ = Risk from chemical ingestion from age 3 through 5 years of age
$Risk_{(6\text{-}11)}$ = Risk from chemical ingestion from age 6 through 11 years of age
$Risk_{(12\text{-}19)}$ = Risk from chemical ingestion from age 12 through 19 years of age
$Risk_{(adult)}$ = Risk from chemical ingestion from age 20 to 70 years age
$ADD_{(<1)}$ = Average daily dose for infants under one year of age (mg/kg-day)
$ADD_{(1\text{-}2)}$ = Average daily dose from first birthday through age 2 years of age (mg/kg-day)
$ADD_{(3\text{-}5)}$ = Average daily dose from age 3 through 5 years of age (mg/kg-day)
$ADD_{(6\text{-}11)}$ = Average daily dose from age 6 through 11 years of age (mg/kg-day)
$ADD_{(12\text{-}19)}$ = Average daily dose from age 12 through 19 years of age (mg/kg-day)
$ADD_{(adult)}$ = Average daily dose for adults age 20 to 70 years of age (mg/kg-day)
$CSF$ = Oral carcinogenic potency slope factor for chemical (per mg/kg-day)
$Risk_{(i)}$ = Risk from chemical ingestion for the $i^{th}$ age group
$ELCR$ = Total extra lifetime cancer risk (incremental or extra risk)
$n$ = Number of age groups (i.e., 6)

## 5.2 Non-cancer Hazard Quotients

Non-cancer risks are presented as hazard quotients (HQs), that is, the ratio of the estimated daily intake (i.e., ADD) to the reference dose (e.g., chronic RfD). If the HQ for a chemical is equal to or less than 1, EPA believes that there is no appreciable risk that non-cancer health effects will occur. If the HQ is greater than 1, however, EPA cautions that adverse health effects are possible, although an HQ above 1 does not indicate an effect will definitely occur. This is because of the margin of safety inherent in the derivation of all RfD values. The larger the HQ value, the more likely it is that an adverse effect may occur.

### *5.2.1 Hazard Quotients for Chemicals with a Chronic RfD*

For chemicals with a chronic RfD, MIRC calculates an HQ for each age group separately using Equation 5-9 to indicate the potential for adverse health effects associated with chronic exposure via ingestion pathways. The HQ is the ratio of a long-term, daily average exposure normalized to the receptor's body weight (i.e., ADD) to the RfD for that chemical.

**Equation 5-9. Hazard Quotient for Chemicals with a Chronic RfD**

$$HQ = \frac{ADD}{RfD}$$

where:

$HQ$ = Hazard quotient for chemical (unitless)

$ADD$ = Average daily ingested dose of chemical (mg/kg-day) from all food types and ingested media for the age group

$RfD$ = Chronic oral reference dose for chemical (mg/kg-day)

### *5.2.2 Hazard Quotients for Chemicals with RfD Based on Developmental Effects*

For chemicals for which the toxicity reference value is an RfD based on developmental effects in infants, children, or young animals, a shorter exposure duration (ED) and averaging time (AT) may be required. For this type of chemical (e.g., methylmercury, 2,3,7,8-TCDD), the appropriate ED/AT and sensitive lifestage for exposure may need to be estimated from the information provided in the critical developmental study(ies) from which the RfD was derived (e.g., in consultation with the RfD documentation in EPA's IRIS or in a toxicological profile developed for the chemical). For screening-level risk assessments, however, a health protective approach is to compare the highest ADD from among the child age categories provided in MIRC to the RfD.

### *5.2.3 Hazard Index for Chemicals with RfDs*

When conducting screening-level assessments for multiple chemicals, it can be informative to calculate a hazard index (HI) for toxicologically similar chemicals (EPA 2000). The HI is the sum of HQs across chemicals as shown in Equation 5-12. As with the HQ, if the HI value is less than 1, adverse health effects are not expected for that suite of chemicals. If the screening level HI exceeds 1, however, the risk assessor is advised to evaluate the assumptions of the screening-level assessment to determine if more realistic local values are available for parameters that drive risk. In addition, the risk assessor may need to examine the mode of action (MOA) and target organ(s) for the chemicals with the highest HQs to develop an appropriate approach to assessing their potential joint action.

**Equation 5-10. Hazard Index Calculation**

$$HI = HQ_1 + HQ_2 \ldots\ HQ_n$$

where:

$HI$ = Hazard index (unitless)
$HQ_1$ = Hazard Quotient for chemical 1 (unitless)
$HQ_2$ = Hazard Quotient for chemical 2 (unitless)
$HQ_n$ = Hazard Quotient for chemical $n$ (unitless)

The HI approach can be appropriate for chemicals with the same MOA and same target organ; however, MOA often is difficult to determine. An HI usually is “developed for each exposure route of interest, and for a single toxic effect or for toxicity to a single target organ” (EPA 2000; p 79). If a receptor is exposed to multiple chemicals that affect different target organs or that operate by different MOAs, and if more than one HQ is close to 1, the risk assessor is advised to perform a follow-on evaluation of assumptions and to consider whether chemical interactions may play a role in chemical toxicity (EPA 2000). Exposures to more than one chemical can result in a greater or lesser toxic response than might be predicted on the basis of one or the other chemical acting alone (toxicologically independent) or acting in concert (toxicologically similar chemicals). Users are referred to EPA’s *Supplementary Guidance for Conducting Health Risk Assessment of Chemical Mixtures* for approaches to assessing the potential for adverse health effects from exposure to multiple chemicals (EPA 2000).

*Note that users of MIRC are responsible for determining how to interpret HQs for multiple chemicals.*

# 6 Model Input Options

This section describes the input options currently included in MIRC. Required user inputs for environmental media concentrations and air deposition rates, such as those predicted by (output of) TRIM.FaTE, are described in Section 6.1. Values for farm-food-chain (FFC) parameters for specific types of produce and animal products are discussed in Section 6.2. Options for parameterizing receptor characteristics are described in Section 6.3, including age-group-specific values for body weight, water ingestion, and food ingestion by food type. Options for other exposure parameter values in MIRC, such as exposure frequency and loss of chemical during food preparation and cooking, are provided in Section 6.4.

Where values for chemical-specific parameters are presented, values are presented only for PB-HAP chemicals currently evaluated using the TRIM-based RTR screening scenario. The database included with MIRC contains chemical-specific parameter values for a large number of chemicals, because all of the chemical-specific input data compiled by EPA for use in HHRAP were uploaded into MIRC. However, only chemicals that are PB-HAPs evaluated for RTR are discussed in this document, and the HHRAP inputs provided for other chemicals have not been evaluated. The data presented in this chapter were reviewed and used to develop the set of modeling defaults used to calculate screening threshold emission rates for RTR. Note that the default values used to estimate RTR screening thresholds, and the justification for selecting a specific value from the data sets described in this chapter, are discussed in Chapter 7.

## 6.1 Environmental Concentrations

As noted in Section 2, MIRC is intended to estimate exposures and risks to self-sufficient farming and fishing families from airborne chemicals. The tool analyzes one exposure scenario at a time; therefore, it is best used to evaluate a maximally exposed individual (MEI) or family when MIRC is used to screen for possible risks.

The following values specific to the air pollutant of concern are required inputs to MIRC:

- a single air concentration (in $g/m^3$);
- the fraction of chemical in the air that is in the vapor phase;
- air-to-surface deposition rates for both vapor- and particle-phase chemical in the air (in $g/m^2$-yr);
- two fish tissue concentrations, one each for forage and game fish (i.e., fish in TL 3 and TL 4) (in mg/kg wet weight);
- concentrations in drinking water (in g/L); and
- four chemical concentrations in soil (in µg/g dry weight), one each for:
    1. surface soil in produce growing area,
    2. surface soil where livestock feed,
    3. root-zone soil in produce growing area, and
    4. root-zone soil in livestock feed growing area.

The MIRC software is configured to estimate ingestion exposures via drinking water for a specified chemical concentration in the drinking water source (e.g., groundwater well).

The user must provide the inputs listed above; no default values are included for these parameters in MIRC. Media concentrations output by TRIM.FaTE can be entered into the tool manually from model output files or can be imported. For RTR evaluations, a tool to facilitate this process was developed using a Microsoft Excel routine written in Visual Basic.

## 6.2 Farm-Food-Chain Parameter Values

Using the chemical information specified in Section 6.1 above as inputs, MIRC calculates chemical concentrations in foods that are commonly grown or raised on family farms: exposed and protected fruits; exposed and protected vegetables; root vegetables; beef; total dairy products; pork; and poultry and eggs.

### *6.2.1 List of Farm-Food-Chain (FFC) Parameters*

MIRC estimates chemical concentrations in the produce identified above using algorithms from HHRAP (EPA 2005a) as described in Section 3.2. Parameter values required for these HHRAP algorithms, including chemical-specific media transfer factors (e.g., soil-to-plant transfer coefficients) and plant- and animal-specific properties (e.g., plant interception fraction, quantity of forage consumed by cattle), are included in tables in MIRC. As described in Section 7, the HHRAP-recommended parameter values are the default values in MIRC; however, these and other inputs in MIRC can be edited as needed. Exhibit 6-1 describes the parameters that are included in the algorithms used to estimate chemical concentrations in the farm food categories. The parameter names and symbols are referenced in this section for plants/produce and animal products.

**Exhibit 6-1. MIRC Parameters Used to Estimate Chemical Concentrations in Farm Foods**

| Parameter | Description | Units |
|---|---|---|
| ***Plants/Produce*** | | |
| $Br_{AG\text{-}produce\text{-}DW(i)}$ | Chemical-specific plant/soil chemical bioconcentration factor for edible portion of aboveground produce type *i, exposed or protected* | Unitless (g soil DW / g produce DW) |
| $Bv_{AG(i)}$ | Chemical-specific air-to-plant biotransfer factor for aboveground produce type *i* for vapor-phase chemical in air | Unitless ([mg chemical / g DW plant] / [mg chemical / g air]) |
| *Fw* | Fraction of wet deposition that adheres to plant surfaces; 0.2 for anions, 0.6 for cations and most organics | Unitless |
| *Kds* | Chemical-specific soil/water partition coefficient | L soil pore water / kg soil DW |
| $kp_{(i)}$ | Plant-specific surface loss coefficient for aboveground exposed produce and animal forage and silage | $yr^{-1}$ |
| $MAF_{(i)}$ | Moisture adjustment factor for aboveground produce type *i* to convert the chemical concentration estimated for dry-weight produce to the corresponding chemical concentration for full-weight fresh produce | Percent water |
| *RCF* | Chemical-specific root concentration factor for tubers and root produce on a wet-weight (WW) basis | L soil pore water/ kg root WW |
| $Rp_{(i)}$ | Plant-specific interception fraction for the edible portion of aboveground exposed produce or animal forage and silage | Unitless |
| $Tp_{(i)}$ | Length of plant exposure to deposition per harvest of the edible portion of aboveground exposed produce or animal forage and silage | Year |
| $VG_{AG(i)}$ | Empirical correction factor for aboveground *exposed* produce type *i* to address possible overestimate of the diffusive transfer of chemical from the outside to the inside of bulky produce, such as fruit | Unitless |

**Exhibit 6-1, continued. MIRC Parameters Used to Estimate Chemical Concentrations in Farm Foods**

| Parameter | Description | Units |
|---|---|---|
| $VG_{rootveg}$ | Empirical correction factor for belowground produce (i.e., tuber or root vegetable) to account for possible overestimate of the diffusive transfer of chemicals from the outside to the inside of bulky tubers or roots (based on carrots and potatoes) | Unitless |
| $Yp_{(i)}$ | Plant-specific yield or standing crop biomass of the edible portion of produce or animal feed | kg produce DW/m$^2$ |
| ***Animal Products*** | | |
| $Bs$ | Soil bioavailability factor for livestock | Unitless |
| $MF$ | Chemical-specific mammalian metabolism factor that accounts for endogenous degradation of the chemical | Unitless |
| $Ba_{(beef)}$ | Chemical-specific biotransfer factor for chemical in diet of cow to chemical in beef on a fresh-wet (FW; equivalent to WW) basis | mg chemical/kg FW tissue/mg chemical/day *or* day/kg FW tissue |
| $Ba_{(dairy)}$ | Biotransfer factor in dairy | day/kg FW tissue |
| $Ba_{(pork)}$ | Biotransfer factor in pork | day/kg FW tissue |
| $Ba_{(poultry)}$ | Biotransfer factor in poultry | day/kg FW tissue |
| $Ba_{(eggs)}$ | Biotransfer factor in eggs | day/kg FW tissue |
| $Qs_{(m)}$ | Quantity of soil eaten by animal type *m* each day | kg/day |
| $Qp_{(i,m)}$ | Quantity of plant feed type *i* consumed per animal type *m* each day | kg/day |

Source: EPA Source: EPA 2005a
DW = dry weight; FW = fresh weight; WW = wet weight

### 6.2.2 Produce Parameter Values

Exhibit 6-4 and Exhibit 6-6 provide the chemical-specific input values that are the current defaults for produce FFC food types in MIRC. Exhibit 6-10 presents additional non-chemical-specific input values for parameters used in the algorithms that calculate chemical concentrations in produce. Unless otherwise noted, the default parameter values were obtained from HHRAP. Options for other parameter values are not included in MIRC at this time; however, the user can overwrite values if appropriate. Refer to HHRAP (EPA 2005a, Chapter 5 and associated appendices) for detailed descriptions of these parameters and documentation of input values.

## Exhibit 6-2. Chemical-Specific Inputs for Produce Parameters for Chemicals Included in MIRC

| Chemical | Fraction of Wet Deposition (*Fw*) (unitless)[a] | Root Concentration Factor (*RCF*) (belowground) (L/kg)[b] | Soil-Water Partition Coefficient (*Kds*) (L/kg)[c] | Chemical Air-to-Plant Biotransfer Factor ($Bv_{AG(i)}$) (unitless)[d] |
|---|---|---|---|---|
| ***Inorganics*** | | | | |
| Cadmium compounds | 0.6 | NA | 7.5E+01 | NA [e] |
| Mercury (elemental) | 0.6 | NA | 1.0E+03 | 0 [f] |
| Mercuric chloride | 0.6 | NA | 5.8E+04 | 1.8E+03 |
| Methyl mercury | 0.6 | NA | 7.0E+03 | 0 [f] |
| ***PAHs*** | | | | |
| 2-Methylnaphthalene | 0.6 | 2.2E+02 | 5.0E+01 | 1.4E+00 |
| 7,12-Dimethylbenz(a)anthracene | 0.6 | 6.8E+03 | 4.0E+03 | 4.2E+04 |
| Acenaphthene | 0.6 | 2.4E+02 | 3.9E+01 | 4.6E+00 |
| Acenaphthylene | 0.6 | 2.8E+02 | 6.8E+01 | 8.1E+00 |
| Benz(a)anthracene | 0.6 | 6.7E+03 | 2.9E+03 | 6.8E+03 |
| Benzo(a)pyrene | 0.6 | 9.2E+03 | 7.8E+03 | 1.7E+05 |
| Benzo(b)fluoranthene | 0.6 | 6.6E+03 | 3.8E+03 | 1.7E+05 |
| Benzo(g,h,i)perylene | 0.6 | 3.0E+04 | 2.6E+04 | 2.3E+06 |
| Benzo(k)fluoranthene | 0.6 | 8.7E+03 | 5.5E+03 | 2.8E+05 |
| Chrysene | 0.6 | 6.0E+03 | 3.4E+03 | 1.4E+04 |
| Dibenz(a,h)anthracene | 0.6 | 2.3E+04 | 1.4E+04 | 6.2E+06 |
| Fluoranthene | 0.6 | 2.2E+03 | 3.9E+02 | 9.0E+02 |
| Fluorene | 0.6 | 3.8E+02 | 6.2E+01 | 1.6E+01 |
| Indeno(1,2,3-cd)pyrene | 0.6 | 3.5E+04 | 3.2E+04 | 2.8E+06 |
| ***Dioxins*** | | | | |
| OctaCDD, 1,2,3,4,6,7,8,9- | 0.6 | 4.8E+05 | 7.8E+05 | 2.4E+06 |
| OctaCDF, 1,2,3,4,6,7,8,9- | 0.6 | 3.4E+05 | 4.9E+05 | 2.3E+06 |
| HeptaCDD, 1,2,3,4,6,7,8- | 0.6 | 3.4E+05 | 4.9E+05 | 9.1E+05 |
| HeptaCDF, 1,2,3,4,6,7,8- | 0.6 | 1.2E+05 | 1.2E+05 | 8.3E+05 |
| HeptaCDF, 1,2,3,4,7,8,9- | 0.6 | 4.8E+04 | 3.9E+04 | 8.3E+05 |
| HexaCDD, 1,2,3,4,7,8- | 0.6 | 2.4E+05 | 3.1E+05 | 5.2E+05 |
| HexaCDF, 1,2,3,4,7,8- | 0.6 | 5.7E+04 | 4.9E+04 | 1.6E+05 |
| HexaCDD, 1,2,3,6,7,8- | 0.6 | 4.9E+05 | 8.0E+05 | 5.2E+05 |
| HexaCDF, 1,2,3,6,7,8- | 0.6 | 2.9E+05 | 4.1E+05 | 1.6E+05 |
| HexaCDD, 1,2,3,7,8,9 - | 0.6 | 4.9E+05 | 8.0E+05 | 5.2E+05 |
| HexaCDF, 1,2,3,7,8,9- | 0.6 | 1.6E+05 | 1.9E+05 | 1.6E+05 |
| HexaCDF, 2,3,4,6,7,8- | 0.6 | 2.9E+05 | 4.1E+05 | 1.6E+05 |

## Exhibit 6-2. Chemical-Specific Inputs for Produce Parameters for Chemicals Included in MIRC

| Chemical | Fraction of Wet Deposition (*Fw*) (unitless)[a] | Root Concentration Factor (*RCF*) (belowground) (L/kg)[b] | Soil-Water Partition Coefficient (*Kds*) (L/kg)[c] | Chemical Air-to-Plant Biotransfer Factor ($Bv_{AG(i)}$) (unitless)[d] |
|---|---|---|---|---|
| PentaCDD, 1,2,3,7,8- | 0.6 | 9.2E+04 | 9.2E+04 | 2.4E+05 |
| PentaCDF, 1,2,3,7,8- | 0.6 | 3.9E+04 | 3.0E+04 | 9.8E+04 |
| PentaCDF, 2,3,4,7,8- | 0.6 | 2.3E+04 | 1.6E+04 | 9.8E+04 |
| TetraCDD, 2,3,7,8- | 0.6 | 4.0E+04 | 3.1E+04 | 6.6E+04 |
| TetraCDF, 2,3,7,8- | 0.6 | 1.2E+04 | 6.2E+03 | 4.6E+04 |

Source: EPA 2005a. NA = not applicable.

[a] 6E-01 is the value for cations and most organic chemicals. As described in HHRAP (EPA 2005a), Appendix B (available at http://www.epa.gov/osw/hazard/tsd/td/combust/finalmact/ssra/05hhrapapb.pdf), EPA estimated this value (EPA 1994a, 1995a) from a study by Hoffman et al. (1992) in which soluble gamma-emitting radionuclides and insoluble particles tagged with gamma-emitting radionuclides were deposited onto pasture grass via simulated rain. Note that the values developed experimentally for pasture grass may not accurately represent all aboveground produce-specific values. Also note that values based on the behavior of insoluble particles tagged with radionuclides may not accurately represent the behavior of organic compounds under site-specific conditions.

[b] For nonionic organic chemicals, as described in HHRAP (EPA 2005a), Appendix A (available at http://www.epa.gov/osw/hazard/tsd/td/combust/finalmact/ssra/05hhrapapa.pdf ), *RCF* is used to calculate the below-ground transfer of contaminants from soil to a root vegetable on a wet-weight basis as shown in Equation 3-6. EPA estimated chemical-specific values for *RCF* from empirical regression equations developed by Briggs et al. (1982) based on their experiments measuring uptake of compounds into barley roots from growth solution. Briggs' regression equations allow calculation of *RCF* values from log $K_{ow}$. For metals and mercuric compounds, empirical values for soil to root vegetable transfer on a dry-weight basis are available in the literature, thus the RCF was not needed.

[c] As discussed in HHRAP (EPA 2005a), Appendix A, *Kds* describes the partitioning of a compound between soil pore-water and soil particles and strongly influences the release and movement of a compound into the subsurface soils and underlying aquifer. *Kds* values for mercuric compounds were obtained from EPA (1997b). *Kds* for cadmium compounds were obtained from U.S. EPA 1996. For all PAHs and dioxins, *Kds* was calculated by multiplying *Koc* times the screening scenario's fraction organic carbon content (0.008). Empirical information for *Koc* was available for acenaphthene, benz(a)anthracene, benzo(a)pyrene, dibenz(a,h)anthracene, fluoranthene, and fluorene in USEAP 1996. For all other organic compounds, the *Koc* was calculated using the correlation equations presented in USEAP 2005a.

[d] As discussed in HHRAP (EPA 2005a), Appendix A, the value for mercuric chloride was obtained from EPA 1997b. $Bv_{AG(i)}$ values for PAHs were calculated using the correlation equation derived for azalea leaves as cited in Bacci et al. (1992), then reducing this value by a factor of 100, as suggested by Lorber (1995), who concluded that the Bacci factor reduced by a factor of 100 was similar to his own observations in various studies. The values for dioxins were obtained from Lorber and Pinsky (2000).

[e] It is assumed that metals, with the exception of vapor-phase elemental mercury, do not transfer significantly from air into leaves.

[f] Speciation and fate and transport of mercury from emissions suggest that $Bv_{AG(i)}$ values for elemental and methyl mercury are likely to be zero (EPA 2005a).

## Exhibit 6-3. Chemical-Specific Inputs by Plant Type for Chemicals in MIRC

| Compound Name | Plant Part | Plant-Soil Bio-Concentration Factor ($Br_{AG\text{-}produce\text{-}DW(i)}$) (unitless) [a] | Empirical Correction Factor- Belowground Produce ($VG_{rootveg}$) (unitless) [b] | Empirical Correction Factor- Aboveground Produce ($VG_{AG(i)}$) (unitless) [c] |
|---|---|---|---|---|
| ***Inorganics*** | | | | |
| Cadmium compounds | Exp. Fruit | 1.3E-01 | - | 1.0E+00 |
| | Exp. Veg. | 1.3E-01 | - | 1.0E+00 |
| | Forage | 3.6E-01 | - | 1.0E+00 |
| | Grain | 6.2E-02 | - | - |
| | Prot. Fruit | 1.3E-01 | - | - |
| | Prot. Veg. | 1.3E-01 | - | - |
| | Root | 6.4E-02 | 1.0E+00 | - |
| | Silage | 3.6E-01 | - | 5.0E-01 |
| Mercury (elemental) | Exp. Fruit | - | - | 1.0E+00 |
| | Exp. Veg. | - | - | 1.0E+00 |
| | Forage | - | - | 1.0E+00 |
| | Grain | - | - | - |
| | Prot. Fruit | - | - | - |
| | Prot. Veg. | - | - | - |
| | Root | - | 1.0E+00 | - |
| | Silage | - | - | 5.0E-01 |
| Mercuric chloride | Exp. Fruit | 1.5E-02 | - | 1.0E+00 |
| | Exp. Veg. | 1.5E-02 | - | 1.0E+00 |
| | Forage | 0.0E+00 | - | 1.0E+00 |
| | Grain | 9.3E-03 | - | - |
| | Prot. Fruit | 1.5E-02 | - | - |
| | Prot. Veg. | 1.5E-02 | - | - |
| | Root | 3.6E-02 | 1.0E+00 | - |
| | Silage | 0.0E+00 | - | 5.0E-01 |
| Methyl mercury | Exp. Fruit | 2.9E-02 | - | 1.0E-02 |
| | Exp. Veg. | 2.9E-02 | - | 1.0E-02 |
| | Forage | 0.0E+00 | - | 1.0E+00 |
| | Grain | 1.9E-02 | - | - |
| | Prot. Fruit | 2.9E-02 | - | - |
| | Prot. Veg. | 2.9E-02 | - | - |
| | Root | 9.9E-02 | 1.0E-02 | - |
| | Silage | 0.0E+00 | - | 5.0E-01 |
| ***PAHs*** | | | | |
| 2-Methylnaphthalene | Exp. Fruit | 2.3E-01 | - | 1.0E+00 |
| | Exp. Veg. | 2.3E-01 | - | 1.0E+00 |
| | Forage | 2.3E-01 | - | 1.0E+00 |
| | Grain | 2.3E-01 | - | - |
| | Prot. Fruit | 2.3E-01 | - | - |
| | Prot. Veg. | 2.3E-01 | - | - |
| | Root | 4.4E+00 | 1.0E+00 | - |

## Exhibit 6-3. Chemical-Specific Inputs by Plant Type for Chemicals in MIRC

| Compound Name | Plant Part | Plant-Soil Bio-Concentration Factor ($Br_{AG\text{-}produce\text{-}DW(i)}$) (unitless) [a] | Empirical Correction Factor- Belowground Produce ($VG_{rootveg}$) (unitless) [b] | Empirical Correction Factor- Aboveground Produce ($VG_{AG(i)}$) (unitless) [c] |
|---|---|---|---|---|
| | Silage | 2.3E-01 | - | 5.0E-01 |
| 7,12-Dimethylbenz(a)anthracene | Exp. Fruit | 1.7E-02 | - | 1.0E-02 |
| | Exp. Veg. | 1.7E-02 | - | 1.0E-02 |
| | Forage | 1.7E-02 | - | 1.0E+00 |
| | Grain | 1.7E-02 | - | - |
| | Prot. Fruit | 1.7E-02 | - | - |
| | Prot. Veg. | 1.7E-02 | - | - |
| | Root | 1.7E+00 | 1.0E-02 | - |
| | Silage | 1.7E-02 | - | 5.0E-01 |
| Acenaphthene | Exp. Fruit | 2.1E-01 | - | 1.0E+00 |
| | Exp. Veg. | 2.1E-01 | - | 1.0E+00 |
| | Forage | 2.1E-01 | - | 1.0E+00 |
| | Grain | 2.1E-01 | - | - |
| | Prot. Fruit | 2.1E-01 | - | - |
| | Prot. Veg. | 2.1E-01 | - | - |
| | Root | 6.2E+00 | 1.0E+00 | - |
| | Silage | 2.1E-01 | - | 5.0E-01 |
| Acenaphthylene | Exp. Fruit | 1.9E-01 | - | 1.0E-02 |
| | Exp. Veg. | 1.9E-01 | - | 1.0E-02 |
| | Forage | 1.9E-01 | - | 1.0E+00 |
| | Grain | 1.9E-01 | - | - |
| | Prot. Fruit | 1.9E-01 | - | - |
| | Prot. Veg. | 1.9E-01 | - | - |
| | Root | 4.1E+00 | 1.0E-02 | - |
| | Silage | 1.9E-01 | - | 5.0E-01 |
| Benz(a)anthracene | Exp. Fruit | 1.7E-02 | - | 1.0E-02 |
| | Exp. Veg. | 1.7E-02 | - | 1.0E-02 |
| | Forage | 1.7E-02 | - | 1.0E+00 |
| | Grain | 1.7E-02 | - | - |
| | Prot. Fruit | 1.7E-02 | - | - |
| | Prot. Veg. | 1.7E-02 | - | - |
| | Root | 2.3E+00 | 1.0E-02 | - |
| | Silage | 1.7E-02 | - | 5.0E-01 |
| Benzo(a)pyrene | Exp. Fruit | 1.4E-02 | - | 1.0E-02 |
| | Exp. Veg. | 1.4E-02 | - | 1.0E-02 |
| | Forage | 1.4E-02 | - | 1.0E+00 |
| | Grain | 1.4E-02 | - | - |
| | Prot. Fruit | 1.4E-02 | - | - |
| | Prot. Veg. | 1.4E-02 | - | - |
| | Root | 1.2E+00 | 1.0E-02 | - |
| | Silage | 1.4E-02 | - | 5.0E-01 |

## Exhibit 6-3. Chemical-Specific Inputs by Plant Type for Chemicals in MIRC

| Compound Name | Plant Part | Plant-Soil Bio-Concentration Factor ($Br_{AG\text{-}produce\text{-}DW(i)}$) (unitless) [a] | Empirical Correction Factor- Belowground Produce ($VG_{rootveg}$) (unitless) [b] | Empirical Correction Factor- Aboveground Produce ($VG_{AG(i)}$) (unitless) [c] |
|---|---|---|---|---|
| Benzo(b)fluoranthene | Exp. Fruit | 1.8E-02 | - | 1.0E-02 |
| | Exp. Veg. | 1.8E-02 | - | 1.0E-02 |
| | Forage | 1.8E-02 | - | 1.0E+00 |
| | Grain | 1.8E-02 | - | - |
| | Prot. Fruit | 1.8E-02 | - | - |
| | Prot. Veg. | 1.8E-02 | - | - |
| | Root | 1.7E+00 | 1.0E-02 | - |
| | Silage | 1.8E-02 | - | 5.0E-01 |
| Benzo(g,h,i)perylene | Exp. Fruit | 5.7E-03 | - | 1.0E-02 |
| | Exp. Veg. | 5.7E-03 | - | 1.0E-02 |
| | Forage | 5.7E-03 | - | 1.0E+00 |
| | Grain | 5.7E-03 | - | - |
| | Prot. Fruit | 5.7E-03 | - | - |
| | Prot. Veg. | 5.7E-03 | - | - |
| | Root | 1.1E+00 | 1.0E-02 | - |
| | Silage | 5.7E-03 | - | 5.0E-01 |
| Benzo(k)fluoranthene | Exp. Fruit | 1.4E-02 | - | 1.0E-02 |
| | Exp. Veg. | 1.4E-02 | - | 1.0E-02 |
| | Forage | 1.4E-02 | - | 1.0E+00 |
| | Grain | 1.4E-02 | - | - |
| | Prot. Fruit | 1.4E-02 | - | - |
| | Prot. Veg. | 1.4E-02 | - | - |
| | Root | 1.6E+00 | 1.0E-02 | - |
| | Silage | 1.4E-02 | - | 5.0E-01 |
| Chrysene | Exp. Fruit | 1.9E-02 | - | 1.0E-02 |
| | Exp. Veg. | 1.9E-02 | - | 1.0E-02 |
| | Forage | 1.9E-02 | - | 1.0E+00 |
| | Grain | 1.9E-02 | - | - |
| | Prot. Fruit | 1.9E-02 | - | - |
| | Prot. Veg. | 1.9E-02 | - | - |
| | Root | 1.7E+00 | 1.0E-02 | - |
| | Silage | 1.9E-02 | - | 5.0E-01 |
| Dibenz(a,h)anthracene | Exp. Fruit | 6.8E-03 | - | 1.0E-02 |
| | Exp. Veg. | 6.8E-03 | - | 1.0E-02 |
| | Forage | 6.8E-03 | - | 1.0E+00 |
| | Grain | 6.8E-03 | - | - |
| | Prot. Fruit | 6.8E-03 | - | - |
| | Prot. Veg. | 6.8E-03 | - | - |
| | Root | 1.6E+00 | 1.0E-02 | - |
| | Silage | 6.8E-03 | - | 5.0E-01 |
| Fluoranthene | Exp. Fruit | 4.0E-02 | - | 1.0E-02 |

## Exhibit 6-3. Chemical-Specific Inputs by Plant Type for Chemicals in MIRC

| Compound Name | Plant Part | Plant-Soil Bio-Concentration Factor ($Br_{AG\text{-}produce\text{-}DW(i)}$) (unitless) [a] | Empirical Correction Factor- Belowground Produce ($VG_{rootveg}$) (unitless) [b] | Empirical Correction Factor- Aboveground Produce ($VG_{AG(i)}$) (unitless) [c] |
|---|---|---|---|---|
| | Exp. Veg. | 4.0E-02 | - | 1.0E-02 |
| | Forage | 4.0E-02 | - | 1.0E+00 |
| | Grain | 4.0E-02 | - | - |
| | Prot. Fruit | 4.0E-02 | - | - |
| | Prot. Veg. | 4.0E-02 | - | - |
| | Root | 5.6E+00 | 1.0E-02 | - |
| | Silage | 4.0E-02 | - | 5.0E-01 |
| Fluorene | Exp. Fruit | 1.5E-01 | - | 1.0E-02 |
| | Exp. Veg. | 1.5E-01 | - | 1.0E-02 |
| | Forage | 1.5E-01 | - | 1.0E+00 |
| | Grain | 1.5E-01 | - | - |
| | Prot. Fruit | 1.5E-01 | - | - |
| | Prot. Veg. | 1.5E-01 | - | - |
| | Root | 6.2E+00 | 1.0E-02 | - |
| | Silage | 1.5E-01 | - | 5.0E-01 |
| Indeno(1,2,3-cd)pyrene | Exp. Fruit | 5.1E-03 | - | 1.0E-02 |
| | Exp. Veg. | 5.1E-03 | - | 1.0E-02 |
| | Forage | 5.1E-03 | - | 1.0E+00 |
| | Grain | 5.1E-03 | - | - |
| | Prot. Fruit | 5.1E-03 | - | - |
| | Prot. Veg. | 5.1E-03 | - | - |
| | Root | 1.1E+00 | 1.0E-02 | - |
| | Silage | 5.1E-03 | - | 5.0E-01 |
| ***Dioxins*** | | | | |
| OctaCDD, 1,2,3,4,6,7,8,9- | Exp. Fruit | 7.1E-04 | - | 1.0E-02 |
| | Exp. Veg. | 7.1E-04 | - | 1.0E-02 |
| | Forage | 7.1E-04 | - | 1.0E+00 |
| | Grain | 7.1E-04 | - | - |
| | Prot. Fruit | 7.1E-04 | - | - |
| | Prot. Veg. | 7.1E-04 | - | - |
| | Root | 6.1E-01 | 1.0E-02 | - |
| | Silage | 7.1E-04 | - | 5.0E-01 |
| OctaCDF, 1,2,3,4,6,7,8,9- | Exp. Fruit | 9.2E-04 | - | 1.0E-02 |
| | Exp. Veg. | 9.2E-04 | - | 1.0E-02 |
| | Forage | 9.2E-04 | - | 1.0E+00 |
| | Grain | 9.2E-04 | - | - |
| | Prot. Fruit | 9.2E-04 | - | - |
| | Prot. Veg. | 9.2E-04 | - | - |
| | Root | 6.8E-01 | 1.0E-02 | - |
| | Silage | 9.2E-04 | - | 5.0E-01 |
| HeptaCDD, 1,2,3,4,6,7,8- | Exp. Fruit | 9.2E-04 | - | 1.0E-02 |

## Exhibit 6-3. Chemical-Specific Inputs by Plant Type for Chemicals in MIRC

| Compound Name | Plant Part | Plant-Soil Bio-Concentration Factor ($Br_{AG\text{-}produce\text{-}DW(i)}$) (unitless) [a] | Empirical Correction Factor- Belowground Produce ($VG_{rootveg}$) (unitless) [b] | Empirical Correction Factor- Aboveground Produce ($VG_{AG(i)}$) (unitless) [c] |
|---|---|---|---|---|
| | Exp. Veg. | 9.2E-04 | - | 1.0E-02 |
| | Forage | 9.2E-04 | - | 1.0E+00 |
| | Grain | 9.2E-04 | - | - |
| | Prot. Fruit | 9.2E-04 | - | - |
| | Prot. Veg. | 9.2E-04 | - | - |
| | Root | 6.8E-01 | 1.0E-02 | - |
| | Silage | 9.2E-04 | - | 5.0E-01 |
| HeptaCDF, 1,2,3,4,6,7,8- | Exp. Fruit | 2.0E-03 | - | 1.0E-02 |
| | Exp. Veg. | 2.0E-03 | - | 1.0E-02 |
| | Forage | 2.0E-03 | - | 1.0E+00 |
| | Grain | 2.0E-03 | - | - |
| | Prot. Fruit | 2.0E-03 | - | - |
| | Prot. Veg. | 2.0E-03 | - | - |
| | Root | 9.4E-01 | 1.0E-02 | - |
| | Silage | 2.0E-03 | - | 5.0E-01 |
| HeptaCDF, 1,2,3,4,7,8,9- | Exp. Fruit | 4.0E-03 | - | 1.0E-02 |
| | Exp. Veg. | 4.0E-03 | - | 1.0E-02 |
| | Forage | 4.0E-03 | - | 1.0E+00 |
| | Grain | 4.0E-03 | - | - |
| | Prot. Fruit | 4.0E-03 | - | - |
| | Prot. Veg. | 4.0E-03 | - | - |
| | Root | 1.2E+00 | 1.0E-02 | - |
| | Silage | 4.0E-03 | - | 5.0E-01 |
| HexaCDD, 1,2,3,4,7,8- | Exp. Fruit | 1.2E-03 | - | 1.0E-02 |
| | Exp. Veg. | 1.2E-03 | - | 1.0E-02 |
| | Forage | 1.2E-03 | - | 1.0E+00 |
| | Grain | 1.2E-03 | - | - |
| | Prot. Fruit | 1.2E-03 | - | - |
| | Prot. Veg. | 1.2E-03 | - | - |
| | Root | 7.6E-01 | 1.0E-02 | - |
| | Silage | 1.2E-03 | - | 5.0E-01 |
| HexaCDF, 1,2,3,4,7,8- | Exp. Fruit | 3.5E-03 | - | 1.0E-02 |
| | Exp. Veg. | 3.5E-03 | - | 1.0E-02 |
| | Forage | 3.5E-03 | - | 1.0E+00 |
| | Grain | 3.5E-03 | - | - |
| | Prot. Fruit | 3.5E-03 | - | - |
| | Prot. Veg. | 3.5E-03 | - | - |
| | Root | 1.2E+00 | 1.0E-02 | - |
| | Silage | 3.5E-03 | - | 5.0E-01 |
| HexaCDD, 1,2,3,6,7,8- | Exp. Fruit | 7.0E-04 | - | 1.0E-02 |
| | Exp. Veg. | 7.0E-04 | - | 1.0E-02 |

## Exhibit 6-3. Chemical-Specific Inputs by Plant Type for Chemicals in MIRC

| Compound Name | Plant Part | Plant-Soil Bio-Concentration Factor ($Br_{AG\text{-}produce\text{-}DW(i)}$) (unitless) [a] | Empirical Correction Factor- Belowground Produce ($VG_{rootveg}$) (unitless) [b] | Empirical Correction Factor- Aboveground Produce ($VG_{AG(i)}$) (unitless) [c] |
|---|---|---|---|---|
| | Forage | 7.0E-04 | - | 1.0E+00 |
| | Grain | 7.0E-04 | - | - |
| | Prot. Fruit | 7.0E-04 | - | - |
| | Prot. Veg. | 7.0E-04 | - | - |
| | Root | 6.1E-01 | 1.0E-02 | - |
| | Silage | 7.0E-04 | - | 5.0E-01 |
| HexaCDF, 1,2,3,6,7,8- | Exp. Fruit | 1.0E-03 | - | 1.0E-02 |
| | Exp. Veg. | 1.0E-03 | - | 1.0E-02 |
| | Forage | 1.0E-03 | - | 1.0E+00 |
| | Grain | 1.0E-03 | - | - |
| | Prot. Fruit | 1.0E-03 | - | - |
| | Prot. Veg. | 1.0E-03 | - | - |
| | Root | 7.1E-01 | 1.0E-02 | - |
| | Silage | 1.0E-03 | - | 5.0E-01 |
| HexaCDD, 1,2,3,7,8,9 - | Exp. Fruit | 7.0E-04 | - | 1.0E-02 |
| | Exp. Veg. | 7.0E-04 | - | 1.0E-02 |
| | Forage | 7.0E-04 | - | 1.0E+00 |
| | Grain | 7.0E-04 | - | - |
| | Prot. Fruit | 7.0E-04 | - | - |
| | Prot. Veg. | 7.0E-04 | - | - |
| | Root | 6.1E-01 | 1.0E-02 | - |
| | Silage | 7.0E-04 | - | 5.0E-01 |
| HexaCDF, 1,2,3,7,8,9- | Exp. Fruit | 1.6E-03 | - | 1.0E-02 |
| | Exp. Veg. | 1.6E-03 | - | 1.0E-02 |
| | Forage | 1.6E-03 | - | 1.0E+00 |
| | Grain | 1.6E-03 | - | - |
| | Prot. Fruit | 1.6E-03 | - | - |
| | Prot. Veg. | 1.6E-03 | - | - |
| | Root | 8.5E-01 | 1.0E-02 | - |
| | Silage | 1.6E-03 | - | 5.0E-01 |
| HexaCDF, 2,3,4,6,7,8- | Exp. Fruit | 1.0E-03 | - | 1.0E-02 |
| | Exp. Veg. | 1.0E-03 | - | 1.0E-02 |
| | Forage | 1.0E-03 | - | 1.0E+00 |
| | Grain | 1.0E-03 | - | - |
| | Prot. Fruit | 1.0E-03 | - | - |
| | Prot. Veg. | 1.0E-03 | - | - |
| | Root | 7.1E-01 | 1.0E-02 | - |
| | Silage | 1.0E-03 | - | 5.0E-01 |
| PentaCDD, 1,2,3,7,8- | Exp. Fruit | 2.4E-03 | - | 1.0E-02 |
| | Exp. Veg. | 2.4E-03 | - | 1.0E-02 |
| | Forage | 2.4E-03 | - | 1.0E+00 |

## Exhibit 6-3. Chemical-Specific Inputs by Plant Type for Chemicals in MIRC

| Compound Name | Plant Part | Plant-Soil Bio-Concentration Factor ($Br_{AG\text{-}produce\text{-}DW(i)}$) (unitless) [a] | Empirical Correction Factor- Belowground Produce ($VG_{rootveg}$) (unitless) [b] | Empirical Correction Factor- Aboveground Produce ($VG_{AG(i)}$) (unitless) [c] |
|---|---|---|---|---|
| | Grain | 2.4E-03 | - | - |
| | Prot. Fruit | 2.4E-03 | - | - |
| | Prot. Veg. | 2.4E-03 | - | - |
| | Root | 1.0E+00 | 1.0E-02 | - |
| | Silage | 2.4E-03 | - | 5.0E-01 |
| PentaCDF, 1,2,3,7,8- | Exp. Fruit | 4.6E-03 | - | 1.0E-02 |
| | Exp. Veg. | 4.6E-03 | - | 1.0E-02 |
| | Forage | 4.6E-03 | - | 1.0E+00 |
| | Grain | 4.6E-03 | - | - |
| | Prot. Fruit | 4.6E-03 | - | - |
| | Prot. Veg. | 4.6E-03 | - | - |
| | Root | 1.3E+00 | 1.0E-02 | - |
| | Silage | 4.6E-03 | - | 5.0E-01 |
| PentaCDF, 2,3,4,7,8- | Exp. Fruit | 6.8E-03 | - | 1.0E-02 |
| | Exp. Veg. | 6.8E-03 | - | 1.0E-02 |
| | Forage | 6.8E-03 | - | 1.0E+00 |
| | Grain | 6.8E-03 | - | - |
| | Prot. Fruit | 6.8E-03 | - | - |
| | Prot. Veg. | 6.8E-03 | - | - |
| | Root | 1.5E+00 | 1.0E-02 | - |
| | Silage | 6.8E-03 | - | 5.0E-01 |
| TetraCDD, 2,3,7,8- | Exp. Fruit | 4.5E-03 | - | 1.0E-02 |
| | Exp. Veg. | 4.5E-03 | - | 1.0E-02 |
| | Forage | 4.5E-03 | - | 1.0E+00 |
| | Grain | 4.5E-03 | - | - |
| | Prot. Fruit | 4.5E-03 | - | - |
| | Prot. Veg. | 4.5E-03 | - | - |
| | Root | 1.3E+00 | 1.0E-02 | - |
| | Silage | 4.5E-03 | - | 5.0E-01 |
| TetraCDF, 2,3,7,8- | Exp. Fruit | 1.2E-02 | - | 1.0E-02 |
| | Exp. Veg. | 1.2E-02 | - | 1.0E-02 |
| | Forage | 1.2E-02 | - | 1.0E+00 |
| | Grain | 1.2E-02 | - | - |
| | Prot. Fruit | 1.2E-02 | - | - |
| | Prot. Veg. | 1.2E-02 | - | - |
| | Root | 1.9E+00 | 1.0E-02 | - |
| | Silage | 1.2E-02 | - | 5.0E-01 |

[a] As discussed in HHRAP (EPA 2005a), the $Br_{AG\text{-}produce\text{-}DW(i)}$ for aboveground produce and forage accounts for the uptake from soil and the subsequent transport of contaminants through the roots to the aboveground plant parts. For organics, correlation equations to calculate values for *Br* on a dry weight basis were obtained from Travis and Arms (1988). For cadmium, *Br* values were derived from uptake slope factors provided in EPA 1992. Uptake slope is the ratio of contaminant concentration in dry weight plant tissue to the mass of contaminant applied per hectare soil. *Br*

## Exhibit 6-3. Chemical-Specific Inputs by Plant Type for Chemicals in MIRC

| Compound Name | Plant Part | Plant-Soil Bio-Concentration Factor ($Br_{AG\text{-}produce\text{-}DW(i)}$) (unitless) [a] | Empirical Correction Factor- Belowground Produce ($VG_{rootveg}$) (unitless) [b] | Empirical Correction Factor- Aboveground Produce ($VG_{AG(i)}$) (unitless) [c] |
|---|---|---|---|---|

aboveground values for mercuric chloride and methyl mercury were calculated using methodology and data from Baes, et al. (1984). *Br* forage values for mercuric chloride and methyl mercury (on a dry weight basis) were obtained from EPA 1997b. The HHRAP methodology assumes that elemental mercury doesn't deposit onto soils. Therefore, it's assumed that there is no plant uptake through the soil.

[b] As discussed in HHRAP (EPA 2005a), Appendix B, $VG_{rootveg}$ represents an empirical correction factor that reduces produce concentration. Because of the protective outer skin, size, and shape of bulky produce, transfer of lipophilic chemicals (i.e., log Kow greater than 4) to the center of the produce is not likely. In addition, typical preparation techniques, such as washing, peeling, and cooking, further reduce the concentration of the chemical in the vegetable as consumed by removing the high concentration of chemical on and in the outer skin, leaving the flesh with a lower concentration than would be the case if the entire vegetable were pureed without washing. For belowground produce, HHRAP (EPA 2005a) recommends using a $VG_{rootveg}$ value of 0.01 for PB-HAP with a log Kow greater than 4 and a value of 1.0 for PB-HAP with a log Kow less than 4 based on information provided in EPA 1994b. In developing these values, EPA (1994b) assumed that the density of the skin and the whole vegetable are equal (potentially overestimating the concentration of PB-HAP in belowground produce due to root uptake).

[c] As discussed in HHRAP (EPA 2005a), Appendix B, $VG_{ag}$ represents an empirical correction factor that reduces aboveground produce concentration and was developed to estimate the transfer of PB-HAP into leafy vegetation versus bulkier aboveground produce (e.g., apples). Because of the protective outer skin, size, and shape of bulky produce, transfer of lipophilic PB-HAP (log Kow greater than 4) to the center of the produce is not likely. In addition, typical preparation techniques, such as washing, peeling, and cooking, further reduces residues. For aboveground produce, HHRAP (EPA 2005a) recommends using a $VG_{ag}$ value of 0.01 for PB-HAP with a log Kow greater than 4 and a value of 1.0 for PB-HAP with a log Kow less than 4 based on information provided in EPA 1994b. In developing these values, EPA (1994b) assumed the following: (1) translocation of compounds deposited on the surface of aboveground vegetation to inner parts of aboveground produce would be insignificant (potentially underestimating the concentration of PB-HAP in aboveground produce due to air-to-plant transfer); (2) the density of the skin and the whole vegetable are equal (potentially overestimating the concentration of PB-HAP in aboveground produce due to air-to-plant transfer); and (3) the thickness of vegetable skin and broadleaf tree skin are equal (effects on the concentration of PB-HAP in aboveground produce due to air-toplant transfer unknown).
For forage, HHRAP recommends a $VG_{ag}$ value of 1.0, also based on information provided in EPA 1994b.
A $VG_{ag}$ value for silage is not provided in EPA 1994b; the VGag value for silage of 0.5 was obtained from NC DEHNR (1997); however, NC DEHNR does not present a specific rationale for this recommendation. Depending on the composition of the site-specific silage, this value may under- or overestimate the actual value.

**Exhibit 6-4. Non-Chemical-Specific Produce Inputs**

| Plant Part | Interception Fraction ($Rp_{(i)}$) (unitless) [a] | Plant Surface Loss Coefficient ($kp_{(i)}$) (1/year) [b] | Length of Plant Exposure to Deposition ($Tp_{(i)}$) (year) [c] | Yield or Standing Crop Biomass ($Yp_{(i)}$) (kg/m$^2$) [d] | Plant Tissue-Specific Moisture Adjustment Factor ($MAF_{(i)}$) (percent) [e] |
|---|---|---|---|---|---|
| Exposed Vegetable | 0.982 | 18 | 0.16 | 5.66 | 92 |
| Protected Fruit | NA | NA | NA | NA | 90 |
| Protected Vegetable | NA | NA | NA | NA | 80 |
| Forage (animal feed) | 0.5 | 18 | 0.12 | 0.24 | 92 |
| Exposed Fruit | 0.053 | 18 | 0.16 | 0.25 | 85 |
| Root Vegetables | NA | NA | NA | NA | 87 |
| Silage (animal feed) | 0.46 | 18 | 0.16 | 0.8 | 92 |
| Grain (animal feed) | NA | NA | NA | NA | 90 |

Source: EPA 2005a. NA = not applicable.

[a] Baes *et al*. (1984) used an empirical relationship developed by Chamberlain (1970) to identify a correlation between initial Rp values and pasture grass productivity (standing crop biomass [*Yp*]) to calculate *Rp* values for exposed vegetables, exposed fruits, forage, and silage. Two key uncertainties are associated with using these values for *Rp*: (1) Chamberlain's (1970) empirical relationship developed for pasture grass may not accurately represent aboveground produce. (2) The empirical constants developed by Baes *et al*. (1984) for use in the empirical relationship developed by Chamberlain (1970) may not accurately represent the site-specific mixes of aboveground produce consumed by humans or the site-specific mixes of forage or silage consumed by livestock.

[b] The term *kp* is a measure of the amount of chemical that is lost to natural physical processes (e.g., wind, water) over time. The HHRAP-recommended value of 18 $yr^{-1}$ (also recommended by EPA 1994a and 1998) represents the midpoint of a range of values reported by Miller and Hoffman (1983). There are two key uncertainties associated with using these values for *kp*: (1) The recommended equation for calculating *kp* includes a health protective bias in that it does not consider chemical degradation processes. (2) Given the reported range of *kp* values from 7.44 to 90.36 $yr^{-1}$, plant concentrations could range from about 1.8 times higher to about 5 times lower than the plant concentrations estimated in FFC media using the midpoint *kp* value of 18.

[c] HHRAP (EPA 2005a) recommends using a *Tp* value of 0.16 years for aboveground produce and cattle silage. This is consistent with earlier reports by EPA (1994a, 1998) and NC DEHNR (1997), which recommended treating *Tp* as a constant based on the average period between successive hay harvests. Belcher and Travis (1989) estimated this period at 60 days. *Tp* is calculated as 60 days ÷ 365 days/year = 0.16 years. For forage, the average of the average period between successive hay harvests (60 days) and the average period between successive grazing (30 days) is used (that is, 45 days), and *Tp* is calculated as (60 days + 30 days)/ 2 ÷ 365 days/yr = 0.12 yr. Two key uncertainties are associated with use of these values for *Tp*: (1) The average period between successive hay harvests (60 days) may not reflect the length of the growing season or the length between successive harvests for site-specific aboveground produce crops. The concentration of chemical in aboveground produce due to direct (wet and dry) deposition (*Pd*) will be underestimated if the site-specific value of *Tp* is less than 60 days, or overestimated if the site-specific value of *Tp* is more than 60 days.

[d] *Yp* values for aboveground produce and forage were calculated using an equation presented in Baes *et al*. (1984) and Shor *et al*. (1982): $Yp = Y_{hi} / A_{hi}$, where $Y_{hi}$ = Harvest yield of $i^{th}$ crop (kg DW) and $A_{hi}$ = Area planted to $i^{th}$ crop (m2), and using values for $Y_h$ and $A_h$ from USDA (1994b and 1994c). A production-weighted U.S. average *Yp* of 0.8 kg DW/m2 for silage was obtained from Shor *et al*. 1982.

[e] *MAF* represents the plant tissue-specific moisture adjustment factor to convert dry-weight concentrations into wet-weight concentrations (which are lower owing to the dilution by water compared with dry-weight concentrations). Values obtained from Chapter 10 of EPA's 2003 SAB Review materials for 3MRA Modeling System, Volume II, "Farm Food Chain and Terrestrial Food Web Data" (EPA 2003a), which references EPA 1997c. Note that the value for grain used as animal feed is based on corn and soybeans, not seed grains such as barley, oats, or wheat.

### *6.2.3 Animal Product Parameter Values*

MIRC also requires chemical-specific inputs for many of the animal product algorithms. The relevant values are shown in Exhibit 6-5 for the chemicals included in MIRC to date. The HHRAP algorithms require additional inputs for the animal products calculations that are not specific to PB-HAPs, but are specific to the animal and animal product type. The soil and plant ingestion rates recommended in HHRAP for beef cattle, dairy cattle, swine, and chicken are provided in Exhibit 6-6.

**Exhibit 6-5. Animal Product Chemical-specific Inputs for Chemicals Included in MIRC**

| **Compound Name** | **Soil Bio-Availability Factor (*Bs*) (unitless)** | **Biotransfer Factors ($Ba_m$) (day/kg FW tissue) [a] and Metabolism Factors (MF) (unitless) [b]** | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **Mammal** | | | | **Non-mammal** | | |
| | | **Beef ($Ba_{beef}$)** | **Dairy ($Ba_{dairy}$)** | **Pork ($Ba_{pork}$)** | ***MF*** | **Eggs ($Ba_{eggs}$)** | **Poultry ($Ba_{poultry}$)** | ***MF*** |
| ***Inorgaincs*** | | | | | | | | |
| Cadmium compounds | 1 | 1.2E-04 | 6.5E-06 | 1.9E-04 | 1 | 2.5E-03 | 1.1E-01 | NA |
| Mercury (elemental) | 1 | 0 | 0 | 0 | 1 | 0 | 0 | NA |
| Mercuric chloride | 1 | 1.1E-04 | 1.4E-06 | 3.4E-05 | 1 | 2.4E-02 | 2.4E-02 | NA |
| Methyl mercury | 1 | 1.2E-03 | 1.7E-05 | 5.1E-06 | 1 | 3.6E-03 | 3.6E-03 | NA |
| ***PAHs*** | | | | | | | | |
| 2-Methylnaphthalene | 1 | 2.4E-02 | 5.0E-03 | 2.9E-02 | 0.01 | 1.0E-02 | 1.7E-02 | NA |
| 7,12-Dimethylbenz(a)anthracene | 1 | 3.9E-02 | 8.3E-03 | 4.8E-02 | 0.01 | 1.7E-02 | 2.9E-02 | NA |
| Acenaphthene | 1 | 2.5E-02 | 5.2E-03 | 3.0E-02 | 0.01 | 1.0E-02 | 1.8E-02 | NA |
| Acenaphthylene | 1 | 2.6E-02 | 5.5E-03 | 3.1E-02 | 0.01 | 1.1E-02 | 1.9E-02 | NA |
| Benz(a)anthracene | 1 | 3.9E-02 | 8.3E-03 | 4.8E-02 | 0.01 | 1.7E-02 | 2.9E-02 | NA |
| Benzo(a)pyrene | 1 | 3.8E-02 | 8.0E-03 | 4.6E-02 | 0.01 | 1.6E-02 | 2.8E-02 | NA |
| Benzo(b)fluoranthene | 1 | 3.9E-02 | 8.3E-03 | 4.8E-02 | 0.01 | 1.7E-02 | 2.9E-02 | NA |
| Benzo(g,h,i)perylene | 1 | 2.9E-02 | 6.1E-03 | 3.5E-02 | 0.01 | 1.2E-02 | 2.1E-02 | NA |
| Benzo(k)fluoranthene | 1 | 3.8E-02 | 8.0E-03 | 4.6E-02 | 0.01 | 1.6E-02 | 2.8E-02 | NA |
| Chrysene | 1 | 4.0E-02 | 8.4E-03 | 4.8E-02 | 0.01 | 1.7E-02 | 2.9E-02 | NA |
| Dibenz(a,h)anthracene | 1 | 3.1E-02 | 6.5E-03 | 3.8E-02 | 0.01 | 1.3E-02 | 2.3E-02 | NA |
| Fluoranthene | 1 | 4.0E-02 | 8.5E-03 | 4.9E-02 | 0.01 | 1.7E-02 | 3.0E-02 | NA |
| Fluorene | 1 | 2.9E-02 | 6.1E-03 | 3.5E-02 | 0.01 | 1.2E-02 | 2.1E-02 | NA |
| Indeno(1,2,3-cd)pyrene | 1 | 2.7E-02 | 5.8E-03 | 3.3E-02 | 0.01 | 1.2E-02 | 2.0E-02 | NA |
| ***Dioxins*** | | | | | | | | |
| OctaCDD, 1,2,3,4,6,7,8,9- | 1 | 6.9E-03 | 1.4E-03 | 8.3E-03 | 1 | 2.9E-03 | 5.1E-03 | NA |
| OctaCDF, 1,2,3,4,6,7,8,9- | 1 | 8.8E-03 | 1.8E-03 | 1.1E-02 | 1 | 3.7E-03 | 6.5E-03 | NA |
| HeptaCDD, 1,2,3,4,6,7,8- | 1 | 8.8E-03 | 1.8E-03 | 1.1E-02 | 1 | 3.7E-03 | 6.5E-03 | NA |
| HeptaCDF, 1,2,3,4,6,7,8- | 1 | 1.6E-02 | 3.5E-03 | 2.0E-02 | 1 | 6.9E-03 | 1.2E-02 | NA |
| HeptaCDF, 1,2,3,4,7,8,9- | 1 | 2.4E-02 | 5.1E-03 | 3.0E-02 | 1 | 1.0E-02 | 1.8E-02 | NA |
| HexaCDD, 1,2,3,4,7,8- | 1 | 1.1E-02 | 2.3E-03 | 1.3E-02 | 1 | 4.6E-03 | 8.1E-03 | NA |
| HexaCDF, 1,2,3,4,7,8- | 1 | 2.3E-02 | 4.8E-03 | 2.8E-02 | 1 | 9.6E-03 | 1.7E-02 | NA |
| HexaCDD, 1,2,3,6,7,8- | 1 | 6.8E-03 | 1.4E-03 | 8.2E-03 | 1 | 2.9E-03 | 5.0E-03 | NA |
| HexaCDF, 1,2,3,6,7,8- | 1 | 9.7E-03 | 2.0E-03 | 1.2E-02 | 1 | 4.1E-03 | 7.1E-03 | NA |
| HexaCDD, 1,2,3,7,8,9 - | 1 | 6.8E-03 | 1.4E-03 | 8.2E-03 | 1 | 2.9E-03 | 5.0E-03 | NA |

**Exhibit 6-5. Animal Product Chemical-specific Inputs for Chemicals Included in MIRC**

| Compound Name | Soil Bio-Availability Factor (*Bs*) (unitless) | Biotransfer Factors ($Ba_m$) (day/kg FW tissue) [a] and Metabolism Factors (MF) (unitless) [b] | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **Mammal** | | | | **Non-mammal** | | |
| | | **Beef ($Ba_{beef}$)** | **Dairy ($Ba_{dairy}$)** | **Pork ($Ba_{pork}$)** | ***MF*** | **Eggs ($Ba_{eggs}$)** | **Poultry ($Ba_{poultry}$)** | ***MF*** |
| HexaCDF, 1,2,3,7,8,9- | 1 | 1.4E-02 | 2.9E-03 | 1.7E-02 | 1 | 5.8E-03 | 1.0E-02 | NA |
| HexaCDF, 2,3,4,6,7,8- | 1 | 9.6E-03 | 2.0E-03 | 1.2E-02 | 1 | 4.1E-03 | 7.1E-03 | NA |
| PentaCDD, 1,2,3,7,8- | 1 | 1.8E-02 | 3.9E-03 | 2.2E-02 | 1 | 7.8E-03 | 1.4E-02 | NA |
| PentaCDF, 1,2,3,7,8- | 1 | 2.6E-02 | 5.5E-03 | 3.2E-02 | 1 | 1.1E-02 | 1.9E-02 | NA |
| PentaCDF, 2,3,4,7,8- | 1 | 3.1E-02 | 6.5E-03 | 3.8E-02 | 1 | 1.3E-02 | 2.3E-02 | NA |
| TetraCDD, 2,3,7,8- | 1 | 2.6E-02 | 5.5E-03 | 3.2E-02 | 1 | 1.1E-02 | 1.9E-02 | NA |
| TetraCDF, 2,3,7,8- | 1 | 3.6E-02 | 7.7E-03 | 4.4E-02 | 1 | 1.5E-02 | 2.7E-02 | NA |

Source: EPA 2005a, unless otherwise indicated. NA = not applicable.

[a] As discussed in HHRAP (EPA 2005a), Appendix A, biotransfer factors for mercury compounds were obtained from EPA 1997b. Considering speciation, fate, and transport of mercury from emission sources, elemental mercury is assumed to be vapor-phase and hence is assumed not to deposit to soil or transfer into aboveground plant parts. As a consequence, there is no transfer of elemental mercury into animal tissues. Biotransfer factors for cadmium compounds were obtained from EPA 1995b. Biotransfer factors for dioxins and PAHs were calculated from chemical octanol-water partitioning coefficients (Kow values) using the correlation equation from RTI (2005) and assuming the following fat contents: milk - 4%; beef - 19%; pork - 23%; poultry -14%; and eggs - 8%.

[b] As discussed in HHRAP (EPA 2005a), EPA (1995c) recommends using a metabolism factor (*MF*) to account for metabolism of PAHs by mammals to offset the amount of bioaccumulation suggested by biotransfer factors. EPA has recommended an *MF* of 0.01 for bis(2-ethylhexyl)phthalate (BEHP) and 1.0 for all other chemicals (EPA 1995d). For MIRC, an *MF* of 0.01 is also used to calculate concentrations of PAHs in food products from mammalian species based on the work of Hofelt et al. (2001). This factor takes into account the P450-mediated metabolism of PAHs in mammals; applying this factor in our approach reduced the concentrations of chemicals in beef, pork, and dairy by two orders of magnitude.

## Exhibit 6-6. Soil and Plant Ingestion Rates for Animals

| Animal | Soil Ingestion Rate – $Qs_{(m)}$ (kg/day) [a] | Plant Part Consumed by Animal | Plant Ingestion Rate – $Qp_{(l,m)}$ (kg/day) |
|---|---|---|---|
| Beef cattle [b] | 0.5 | Silage | 2.5 |
| | | Forage | 8.8 |
| | | Grain | 0.47 |
| Dairy cattle [c] | 0.4 | Silage | 4.1 |
| | | Forage | 13.2 |
| | | Grain | 3.0 |
| Swine [d] | 0.37 | Silage | 1.4 |
| | | Grain | 3.3 |
| Chicken (eggs) [e] | 0.022 | Grain | 0.2 |

Source: EPA 2005a HHRAP (Chapter 5).

[a] Beef cattle: NC DEHNR (1997) and EPA (1994b) recommended a soil ingestion rate for subsistence beef cattle of 0.5 kg/day based on Fries (1994) and NAS (1987). As discussed in HHRAP, Fries (1994) reported soil ingestion to be 4 percent of the total dry matter intake. NAS (1987) cited an average beef cattle weight of 590 kg, and a daily dry matter intake rate (non-lactating cows) of 2 percent of body weight. This results in a daily dry matter intake rate of 11.8 kg DW/day and a daily soil ingestion rate of about 0.5 kg/day.
Dairy cattle: NC DEHNR (1997) and EPA (1994b) recommended a soil ingestion rate for dairy cattle of 0.4 kg/day based on Fries (1994) and NAS (1987). As discussed in HHRAP, Fries (1994) reported soil ingestion to be 2 percent of the total dry matter intake. NAS (1987) cited an average beef cattle weight of 630 kg and a daily dry matter intake rate (non-lactating cows) of 3.2 percent of body weight. This resulted in a daily dry matter intake rate of 20 kg/day DW, and a daily soil ingestion rate of approximately 0.4 kg/day. Uncertainties associated with Qs include the lack of current empirical data to support soil ingestion rates for dairy cattle and the assumption of uniform contamination of soil ingested by cattle.
Swine: NC DEHNR (1997) recommended a soil ingestion rate for swine of 0.37, estimated by assuming a soil intake that is 8% of the plant ingestion rate of 4.3 kg DW/day. Uncertainties include the lack of current empirical data to support soil ingestion rates and the assumption of uniform contamination of the soil ingested by swine.
Chicken: HHRAP (EPA 2005a) assumes that chickens consume 10 percent of their total diet (which is approximately 0.2 kg/day grain) as soil, a percentage that is consistent with the study from Stephens *et al*. (1995). Uncertainties include the lack of current empirical data to support soil ingestion rates for chicken and the assumption of uniform contamination of soil ingested by chicken.

[b] The beef cattle ingestion rates of forage, silage, and grain are based on the total daily intake rate of about 12 kg DW/day (based on NAS [1987] reporting a daily dry matter intake that is 2 percent of an average beef cattle body weight of 590 kg) and are supported by NC DEHNR (1997), EPA (1994b and 1990), and Boone *et al*. (1981). The principal uncertainty associated with these *Qp* values is the variability between forage, silage, and grain ingestion rates for cattle.

[c] The dairy cattle ingestion rates of forage, silage, and grain are based on the total daily intake rate of about 20 kg DW/day (NAS 1987; EPA 1992) as recommended by NC DEHNR (1997). Uncertainties include the proportion of each food type in the diet, which varies from location to location. Assuming uniform contamination of plant materials consumed by cattle also introduces uncertainty.

[d] Swine are not grazing animals and are assumed not to eat forage (EPA 1998). EPA (1994b and 1998) and NC DEHNR (1997) recommended including only silage and grains in the diet of swine. EPA (1995c) recommended an ingestion rate of 4.7 kg DW/day for a swine, referencing NAS (1987). Assuming a diet of 70 percent grain and 30 percent silage (EPA 1990), HHRAP estimated ingestion rates of 3.3 kg DW/day (grain) and 1.4 kg DW/day (silage). Uncertainties associated with *Qp* include variability of the proportion of grain and silage in the diet, which varies from location to location.

[e] Chickens consume grain provided by the farmer. The daily quantity of grain feed consumed by chicken is assumed to be 0.2 kg/day (Ensminger (1980), Fries (1982), and NAS (1987). Uncertainties associated with this variable include the variability of actual grain ingestion rates from site to site. In addition, assuming uniform contamination of plant materials consumed by chicken introduces some uncertainty.

## 6.3 Adult and Non-Infant Exposure Parameter Values

The exposure parameters included in MIRC and their default and other value options are summarized in the following subsections. The default values were selected to result in a highly health protective screening scenario. Parameter value options were primarily obtained or estimated from EPA's *Exposure Factors Handbook* (EFH; EPA 2011) and *Child-Specific Exposure Factors Handbook* (CSEFH; EPA 2008a). Where values were reported for age groupings other than those used in MIRC (see Section 2.3 above for MIRC age groups), time-weighted average values were estimated for the MIRC age groups from the available data.

In MIRC, ingestion rates for home-produced farm food items are included for exposed fruit, protected fruit, exposed vegetables, protected vegetables, root vegetables, beef, total dairy, pork, poultry, and eggs. Those ingestion rates are already normalized to body weight (i.e., $g_{wet\ weight}$/kg-day), as presented in the original data analysis (EPA 2011). The body weight parameter values presented in Exhibit 6-7, therefore, are not applied in the chemical intake (ADD) equations for these food types.

In MIRC, ingestion rates also are included for drinking water (mL/day), soil (mg/day), and fish (g/day). These ingestion rates, however, are on a per person basis (i.e., not normalized for body weight). The body weight parameter values presented in Exhibit 6-7, therefore, are applied in the chemical intake (ADD) equations for these media.

### *6.3.1 Body Weights*

Body weight (BW) options included in MIRC include mean, 5th, 10th, 50th, 90th, and 95th percentiles for adults and the five children's age groups. For its default screening assessment, EPA uses the mean BW for each age group. The BWs currently in the MIRC database are listed in Exhibit 6-7. For adults, BW represents the weighted average of male and female mean body weights for all races, ages 18-74 years, from EPA's 1997 EFH (EPA 1997a; Tables 7-4 and 7-5). We considered updating the body weight for use in the RTR assessment to the revised body weights in the 2011 Exposure Factors Handbook (EPA 2011). However, the 2011 EFH warns that assessors should consider if the dose estimate (for which the body weight is used to calculate) will be used to estimate risk by combining it with a dose-response that was derived assuming a body weight of 70 kg, and that if such an inconsistency exists, an adjustment may be necessary. Because a 70 kg body weight commonly is used to develop IRIS dose-response values, using an 80 kg body weight could result in this inconsistency. Given these issues, we have retained the use of an adult body weight of 71.4 kg.

In general, BW values for the five children's age groups were calculated from the summary data provided in Table 8-3 of EPA's 2008 CSEFH. For purposes of comparison, alternative BW values for children ages 12 through 19 years also were estimated using data from Portier *et al*. (2007). These values are listed in the last row of Exhibit 6-7, but are not included in MIRC. The means calculated using the two methods for children ages 12 through 19 years were essentially identical at 64 kg. The other percentile values differed by approximately 10 percent or less.

## Exhibit 6-7. Mean and Percentile Body Weight Estimates for Adults and Children

| Lifestage (years) | Duration (years) | Body Weight (kg) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Mean | 5th | 10th | 50th | 90th | 95th |
| Adult [a] (20-70) | 50 | 71.4 | 52.9 | 56 | 69.3 | 89.7 | 97.6 |
| Child < 1 [b] | 1 | 7.83 | 6.03 | 6.38 | 7.76 | 9.24 | 9.66 |
| Child 1-2 [c] | 2 | 12.6 | 9.9 | 10.4 | 12.5 | 14.9 | 15.6 |
| Child 3-5 [d] | 3 | 18.6 | 13.5 | 14.4 | 17.8 | 23.6 | 26.2 |
| Child 6-11 [e] | 6 | 36.0 | 22.1 | 24.0 | 33.5 | 51.2 | 58.6 |
| Child 12-19 [f] | 8 | 64.2 | 39.5 | 45 | 64.2 | 83.5 | 89 |
| *[Child 12-19* [g] | *8* | *64.3* | *41.1* | *44.6* | *60.9* | *88.5* | *98.4]* |

[a] BW represents the sample-size weighted average of male and female mean body weights (all races, 18-74 years) from EPA's 1997 EFH (Tables 7-4 for males and 7-5 for females). Note that these weights include the weight of clothing, estimated to range from 0.09 to 0.28 kg. Although the 18 to 74 year age category in EPA's EFH does not match exactly the age 20 to 70 year categorization of adults in MIRC, the magnitude of error in the mean and percentile body weights is likely to be very small (i.e., less than 1%). We considered updating the body weight for use in the RTR assessment to the revised body weights in the 2011 Exposure Factors Handbook. However, the 2011 EFH warns that assessors should consider if the dose estimate (for which the body weight is used to calculate) will be used to estimate risk by combining it with a dose-response that was derived assuming a body weight of 70 kg, and that if such an inconsistency exists, an adjustment may be necessary. Because a 70 kg body weight commonly is used to develop IRIS dose-response values, using an 80 kg body weight could result in this inconsistency. Given these issues, we have retained the use of an adult body weight of 71.4 kg.

[b] Each BW represents a time-weighted average of body weights for age groups birth to <1 month, 1 to <3 months, 3 to <6 months, and 6 to <12 months from Table 8-3 of the 2008 CSEFH. Original sample sizes for each of these age groups can also be found in Table 8-3.

[c] Each BW represents a time-weighted average of body weights for age groups 1 to <2 years and 2 to <3 years from Table 8-3 of the 2008 CSEFH. Original sample sizes for each of these age groups can also be found in Table 8-3.

[d] BWs obtained directly from Table 8-3 of the 2008 CSEFH (age group 3 to <6 years).

[e] Each BW represents a time-weighted average of body weights for age groups 6 to <11 years and 11 to <16 years from Table 8-3 of the 2008 CSEFH. Original sample sizes for each of these age groups can also be found in Table 8-3.

[f] Mean BW estimated using Table 8-22 of the 2008 CSEFH, which is based on NHANES IV data as presented in Portier et al. (2007). This estimate was calculated as the average of the 8 single-year age groups from 12 to 13 years through 19 to 20 years. Values for the other percentiles were estimated using Portier et al., 2007.

[g] Each BW represents a time-weighted average of body weights for age groups 11 to <16 years and 16 to <21 years from Table 8-3 of the 2008 CSEFH. Note that estimated values include 11-year-olds and individuals through age 20, which contributes to uncertainty in the estimates for 12 to 19 years. Those values are provided for comparison purposes only and are not included in MIRC.

### *6.3.2 Water Ingestion Rates*

MIRC also includes the option of calculating chemical ingestion via drinking water obtained from surface-water sources or from wells (i.e., from groundwater) in the contaminated area. Users have the option in MIRC to set drinking water ingestion rates to zero or to revise the drinking water ingestion rates in MIRC to better reflect site-specific water uses. The 2008 CSEFH recommends values for drinking water ingestion rates for children based on a study reported by Kahn and Stralka (2008). Table 3-4 of the CSEFH provides *per capita* estimates of community water ingestion rates by age categories. Community water ingestion includes both direct and indirect ingestion of water from the tap. *Direct ingestion* is defined as direct consumption of water as a beverage, while *indirect ingestion* includes water added during food or beverage preparation. The source of these data is the 1994-1996 and 1998 U.S. Department of Agriculture's (USDA's) *Continuing Survey of Food Intakes by Individuals* (CSFII) (USDA 2000). Exhibit 6-8 includes the drinking water ingestion rates for children that are included in MIRC.

Mean and percentile adult drinking water ingestion rates were obtained from EPA (2004b), which presents estimated *per capita* water ingestion rates for various age categories based on data collected by the USDA's 1994–1996 and 1998 CSFII (USDA 2000). Adult ingestion rates, presented in Exhibit 6-8, represent community water ingestion, both direct and indirect as defined above, for males and females combined, ages 20 years and older.

**Exhibit 6-8. Estimated Daily Per Capita Mean and Percentile Water Ingestion Rates for Children and Adults [a]**

| Lifestage (years) | Ingestion Rates, Community Water (mL/day) | | | | |
|---|---|---|---|---|---|
| | Mean | 50th | 90th | 95th | 99th |
| Child <1 [b] | 504 | 482 | 969 | 1113 | 1440 |
| Child 1-2 [c] | 332 | 255 | 687 | 903 | 1318 |
| Child 3-5 [d] | 382 | 316 | 778 | 999 | 1592 |
| Child 6-11 [e] | 532 | 417 | 1149 | 1499 | 2274 |
| Child 12-19 [f] | 698 | 473 | 1641 | 2163 | 3467 |
| Adult [g] | 1219 | 981 | 2534 | 3087 | 4567 |

Sources: EPA 2004b, 2008a

* The sample size does not meet minimum reporting requirements as described in EPA 2008a. For some of these MIRC age groupings, the values are based on the time-weighted average value for 2 or more age ranges from CSEFH Table 3-4. One or more age ranges within the group may not meet the minimum reporting requirements, but not necessarily all of them fall within this category.

[a] Source is Kahn and Stralka 2008, also presented in the CSEFH (EPA 2008a).

[b] Each IR represents a time-weighted average of ingestion rates for age groups birth to <1 month, 1 to <3 months, 3 to <6 months, and 6 to <12 months from Table 3-4 of the 2008 CSEFH.

[c] Each IR represents a time-weighted average of ingestion rates for age groups 1 to <2 years and 2 to <3 years from Table 3-4 of the 2008 CSEFH.

[d] Each IR represents the ingestion rate for age group 3 to <6 years from Table 3-4 of the 2008 CSEFH.

[e] Each IR represents the ingestion rate for age group 6 to <11 years from Table 3-4 of the 2008 CSEFH. This value represents a health protective (i.e., slightly low) estimate of IR for ages 6 through 11 years since 11-year olds are not included in this CSEFH age group.

[f] Each IR represents a time-weighted average of ingestion rates for age groups 11 to <16 years, 16 to <18, and 18 to <21 years from Table 3-4 of the 2008 CSEFH. Note that estimated values include 11-year-olds and individuals through age 20, which contributes to uncertainty in the estimates for 12 to 19 years.

[g] Adult drinking water ingestion rates were obtained from EPA (2004b), Appendix E, Part I, Table A1 for community water, both sexes (ages 20+), direct plus indirect water ingestion.

### *6.3.3 Local Food Ingestion Rates*

MIRC includes mean, median, 90th, 95th, and 99th percentile food-specific ingestion rates (IRs) for consumers-only of farm food chain (FFC) media for adults and children. The mean and percentile values are from EPA's analysis of data from the USDA's 1987 to 1988 *Nationwide Food Consumption Survey* (NFCS) (USDA 1993), as presented in Chapter 13 of the Agency's *Exposure Factors Handbook* (i.e., Intake Rates for Various Home Produced Food Items) (EPA 2011). Consumers-only means that individuals who did not report eating a specified type of food during the three-day period covered by the food ingestion part of the survey were not included in the analysis of ingestion rates for that food type. The questionnaire included the options for a household to self-identify in one or more of five categories: as a household that gardens, raises animals, hunts, fishes, or farms. As of September, 2008, that survey was the most recent NFCS available (EPA 2008a, CSEFH), and we are not aware of any that might be more recent.[3]

For the adult age group in MIRC, data were compiled on food-specific IRs separately for two types of households as indicated in the "Response to Questionnaire" (EPA 2000, Chapter 13): (1) households that farm (F) and (2) households that garden or raise animals (HG for homegrown). This division reflects EPA's data analysis. EPA tabulated IRs for fruits and vegetables for households that that farm and for households that garden. EPA tabulated IRs for animals and animal products for households that farm and for households that raise animals. Thus, the first type of household, F, represents farmers who may both grow crops and raise animals and who are likely to consume more home grown/raised foods than the second type of household. The second type of household, HG, represents the non-farming households that may consume lower amounts of home-grown or raised foods (i.e., HG encompasses both households that garden and households that raise animals).

The food-specific ingestion rates are based on the amount of each food type that households that farm (F) or households that garden and raise animals (HG) produced and brought into their homes for consumption and the number of persons consuming the food. EPA averaged the actual consumption rate for home-grown foods over the 1-week survey period.

The default food-specific ingestion rates in MIRC for adults are those for farming households (F) in Exhibit 6-9. The user can specify use of the non-farming household (HG) ingestion rates if they are more appropriate for the user's exposure scenario (second column of IR values under Adults in Exhibit 6-9).

**Exhibit 6-9. Summary of Age-Group Specific Food Ingestion Rates for Farm Food Items**

| Product | Child (age in yr) | | | | | Adult (20–70 yrs) |
|---|---|---|---|---|---|---|
| | <1 | 1–2 | 3–5 | 6–11 | 12–19 | |
| ***Mean ingestion rates*** | | | | | | |
| Beef[a] | N/A | 4.14 | 4.00 | 3.77 | 1.72 | 1.93 |
| Dairy[b] | N/A | 91.6 | 50.9 | 27.4 | 13.6 | 2.96 |
| Eggs[a] | N/A | 2.46 | 1.42 | 0.86 | 0.588 | 0.606 |
| Exposed Fruit[a] | N/A | 6.14 | 2.60 | 2.52 | 1.33 | 1.19 |
| Exposed Vegetable[a] | N/A | 3.48 | 1.74 | 1.39 | 1.07 | 1.38 |
| Pork[a] | N/A | 2.23 | 2.15 | 1.50 | 1.28 | 1.10 |
| Poultry[a] | N/A | 3.57 | 3.35 | 2.14 | 1.50 | 1.37 |
| Protected Fruit[a] | N/A | 16.6 | 12.4 | 8.50 | 2.96 | 5.19 |
| Protected Vegetable[a] | N/A | 2.46 | 1.30 | 1.10 | 0.78 | 0.862 |
| Root Vegetable[a] | N/A | 2.52 | 1.28 | 1.32 | 0.94 | 1.03 |

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*[3] Note that EPA's 2008 CSEFH does not distinguish between exposed and protected fruits and vegetables when recommending food ingestion rates based on the same data set for the same age categories. EPA's 1997 analysis for its EFH therefore remains the most appropriate data source for use in MIRC.*

## Exhibit 6-9. Summary of Age-Group Specific Food Ingestion Rates for Farm Food Items

| Product | Child (age in yr) | | | | | Adult (20–70 yrs) |
|---|---|---|---|---|---|---|
| | <1 | 1–2 | 3–5 | 6–11 | 12–19 | |
| Water (mL/day)[c] | N/A | 332 | 382 | 532 | 698 | 1218 |
| ***Median ingestion rates*** | | | | | | |
| Beef[a] | N/A | 2.51 | 2.49 | 2.11 | 1.51 | 1.55 |
| Dairy[b] | N/A | 125 | 66.0 | 34.4 | 15.5 | 2.58 |
| Eggs[a] | N/A | 1.51 | 0.83 | 0.561 | 0.435 | 0.474 |
| Exposed Fruit[a] | N/A | 1.82 | 1.11 | 0.61 | 0.62 | 0.593 |
| Exposed Vegetable[a] | N/A | 1.89 | 1.16 | 0.64 | 0.66 | 0.812 |
| Pork[a] | N/A | 1.80 | 1.49 | 1.04 | 0.89 | 0.802 |
| Poultry[a] | N/A | 3.01 | 2.90 | 1.48 | 1.30 | 0.922 |
| Protected Fruit[a] | N/A | 7.59 | 5.94 | 3.63 | 1.23 | 2.08 |
| Protected Vegetable[a] | N/A | 1.94 | 1.04 | 0.79 | 0.58 | 0.564 |
| Root Vegetable[a] | N/A | 0.46 | 0.52 | 0.57 | 0.56 | 0.59 |
| Water (mL/day)[c] | N/A | 255 | 316 | 417 | 473 | 981 |
| ***90th percentile ingestion rates*** [d] | | | | | | |
| Beef[a] | N/A | 9.49 | 8.83 | 11.4 | 3.53 | 4.41 |
| Dairy[b] | N/A | 185 | 92.5 | 57.4 | 30.9 | 6.16 |
| Eggs[a] | N/A | 4.90 | 3.06 | 1.90 | 1.30 | 1.31 |
| Exposed Fruit[a] | N/A | 12.7 | 5.41 | 6.98 | 3.41 | 2.37 |
| Exposed Vegetable[a] | N/A | 10.7 | 3.47 | 3.22 | 2.35 | 3.09 |
| Pork[a] | N/A | 4.90 | 4.83 | 3.72 | 3.69 | 2.23 |
| Poultry[a] | N/A | 7.17 | 6.52 | 4.51 | 3.13 | 2.69 |
| Protected Fruit[a] | N/A | 44.8 | 32.0 | 23.3 | 7.44 | 15.1 |
| Protected Vegetable[a] | N/A | 3.88 | 2.51 | 2.14 | 1.85 | 1.81 |
| Root Vegetable[a] | N/A | 7.25 | 4.26 | 3.83 | 2.26 | 2.49 |
| Water (mL/day)[c] | N/A | 687 | 778 | 1149 | 1640 | 2534 |
| ***95th percentile ingestion rates*** | | | | | | |
| Beef[a] | N/A | 12.9 | 12.5 | 12.5 | 3.57 | 5.83 |
| Dairy[b] | N/A | 167 | 89.9 | 56.0 | 32.3 | 7.80 |
| Eggs[a] | N/A | 5.38 | 3.62 | 2.37 | 1.43 | 1.59 |
| Exposed Fruit[a] | N/A | 14.6 | 6.07 | 11.7 | 4.78 | 3.38 |
| Exposed Vegetable[a] | N/A | 11.9 | 6.29 | 5.47 | 3.78 | 4.46 |
| Pork[a] | N/A | 6.52 | 6.12 | 4.73 | 6.39 | 2.60 |
| Poultry[a] | N/A | 8.10 | 7.06 | 5.07 | 3.51 | 3.93 |
| Protected Fruit[a] | N/A | 48.3 | 35.1 | 26.9 | 11.4 | 19.2 |
| Protected Vegetable[a] | N/A | 9.42 | 5.10 | 3.12 | 2.20 | 2.83 |

## Exhibit 6-9. Summary of Age-Group Specific Food Ingestion Rates for Farm Food Items

| Product | Child (age in yr) | | | | | Adult (20–70 yrs) |
|---|---|---|---|---|---|---|
| | <1 | 1–2 | 3–5 | 6–11 | 12–19 | |
| Root Vegetable[a] | N/A | 10.4 | 4.73 | 5.59 | 3.32 | 3.37 |
| Water (mL/day)[c] | N/A | 903 | 999 | 1499 | 2163 | 3087 |
| ***99th percentile ingestion rates*** | | | | | | |
| Beef[a] | N/A | 20.9 | 19.8 | 13.3 | 4.28 | 6.84 |
| Dairy[b] | N/A | 180 | 87.2 | 54.8 | 34.7 | 9.20 |
| Eggs[a] | N/A | 16.2 | 11.2 | 8.19 | 4.77 | 1.83 |
| Exposed Fruit[a] | N/A | 25.2 | 32.5 | 15.7 | 5.9 | 13.0 |
| Exposed Vegetable[a] | N/A | 12.1 | 7.36 | 13.3 | 5.67 | 8.42 |
| Pork[a] | N/A | 8.71 | 9.74 | 6.61 | 4.29 | 3.87 |
| Poultry[a] | N/A | 9.63 | 10.24 | 6.12 | 4.60 | 4.93 |
| Protected Fruit[a] | N/A | 109 | 71.2 | 58.2 | 19.1 | 34.4 |
| Protected Vegetable[a] | N/A | 9.42 | 5.31 | 5.40 | 2.69 | 5.56 |
| Root Vegetable[a] | N/A | 10.4 | 4.73 | 7.47 | 5.13 | 7.57 |
| Water (mL/day)[c] | N/A | 1318 | 1592 | 2274 | 3467 | 4567 |

[a] Primary source for values was the 1987–1988 NFCS survey; compiled results are presented in Chapter 13 of 2011 Exposure Factors Handbook (EPA, 2011). When data were unavailable for a particular age group, intake rate for all age groups was used multiplied by the age-specific ratio of intake based on national population intake rates from CSFII.

[b] Primary source for values was 1987–1988 NFCS survey, compiled results presented in Chapter 13 of 2011 Exposure Factors Handbook (EPA, 2011). When data were unavailable for a particular age group, intake rate for all age groups was used multiplied by the age-specific ratio of intake based on national population intake rates from an NHANES 2003–2006 analysis in Chapter 11 of the Exposure Factors Handbook.

[c] Primary source for children less than 3 years of age was a Khan et al.(2008) analysis of CSFII data, and from EPA's analysis of NHANES 2003–2006 data for children and adults greater than three. All data tables that were used and justifications for data sources are presented in Chapter 3 of the 2011 Exposure Factors' Handbook.

[d] Default ingestion rate percentile used in MIRC for Tier 1 assessments and chemical threshold calculations

For children, EPA estimated food-specific IRs for four age categories (EPA 2011): 1 to 2 years, 3 to 5 years, 6 to 11 years, and 12 to 19 years. Sample sizes were insufficient to distinguish IRs for children in different types of households; hence, for children, a single IR value represents both F and HG households for a given food type and age category (Exhibit 6-9). For some food types and age categories, there were insufficient data for EPA to provide consumer-only intake rates (i.e., data set for the subpopulation consisted of fewer than 20 observations). The HHRAP methodology, Section 6.2.2.2, recommends a method by which to calculate the "missing" age-specific consumer-only ingestion rates, as explained below. Food-specific intake rates (IRs) for those child age groups and food items not included in Chapter 13 of the 2011 EFH, that is $IR_{age\_group\_x}$, were derived using the following information:

- Mean or percentile-specific *consumer-only* intake of the farm food item, as brought into the home, for the <u>total</u> NFCS survey population (from EFH Chapter 13) – $IR_{CO\_total}$;
- Mean or percentile-specific *per capita* intake of the food type from all sources, as consumed, for the specific child age group, from Chapter 3 of the *CSFII Analysis of Food Intake Distributions* (EPA 2003c) – $IR_{PC,\ age\_group\_x}$; and
- Mean or percentile-specific *per capita* intake of the farm food item for the <u>total</u> CSFII survey population (from Chapter 3 of EPA 2003c) – $IR_{PC\_total}$.

The ratio of $IR_{PC,\ age\_group\_x}$ to $IR_{PC\_total}$ from the CSFII data shows the consumption rate of a particular food type by a specific age group relative to the consumption rate for that food type for the population as a whole. The ratio of $IR_{CO,\ age\_group\_x}$ to $IR_{CO\_total}$, that is the consumption rate of a particular food type by a specific age group (consumers only) relative to the consumption rate for that food type for the NFCS survey population as a whole (consumers only), should be approximately the same. Given the assumption that the two ratios are equal, Equation 6-2 was used to calculate the "missing" age-specific consumer-only *IRs*:

**Equation 6-1. Calculation of Age-Group-Specific and Food-Specific Ingestion Rates**

$$IR_{CO,\ age\_group\_x} = \frac{IR_{CO\_total} \times IR_{PC,\ age\_group\_x}}{IR_{PC\_total}}$$

where:

$IR_{CO,\ age\_group\_x}$ = Mean or percentile-specific *consumer-only* intake of the food type from all sources, as consumed, for the specific child age group X

$IR_{CO\_total}$ = Mean or percentile-specific *consumer-only* intake of the farm food item, as brought into the home, for the <u>total</u> NFCS survey population

$IR_{PC,\ age\_group\_x}$ = Mean or percentile-specific *per capita* intake of the food type from all sources, as consumed, for the specific child age group X from the CSFII

$IR_{PC\_total}$ = Mean or percentile-specific *per capita* intake of the farm food item for the <u>total</u> CSFII survey population

In this discussion, *per capita* (as opposed to *consumer-only*) indicates the intake rates are based on the entire population rather than the subset of the population that ingests the particular food category (i.e., consumers). Here, the use of *per capita* ingestion rates are recommended by the HHRAP methodology because no consumer-only percentile-specific intakes are provided for the different age groups.

The above calculation implicitly assumes that the distribution of the consumption rate for a food type for a specific age group (consumers only) has the same shape as the distribution of the consumption rate for a food type for a specific age group in the general population (*per capita*). Otherwise, the separate calculation of each percentile might yield intake estimates that decrease as the percentile increases. This calculation artifact could occur if the shapes of the two distributions differ in the upper percentiles (or "tails") of the distributions.

In the instances where the above calculations were used to fill data gaps in the above exhibit, only the dairy child-specific age group intake estimates are not strictly increasing with increasing percentile. The distributions likely track better (and thus the above assumption of equal ratios is more reasonable) for lower percentiles, with deviations occurring due to outlier ingestion rates based on only a few respondents in the tails of the distributions. The MIRC defaults use the 90th percentile ingestion estimates, which are likely more reliable than the 95th or 99th percentile estimates in this particular calculation.

### 6.3.4 Local Fish Ingestion Rates

The USDA's 1987 to 1988 Nationwide Food Consumption Survey (NFCS) (USDA 1993, 1994a), as presented in Chapter 13 of the Agency's Exposure Factors Handbook (i.e., Intake Rates for Various Home Produced Food Items) (EPA 2011), includes family-caught fish ingestion rates by age category. There are several disadvantages, however, to using that data source to estimate fish ingestion rates. First, due to inadequate sample sizes, EPA did not report fish IRs for children less than 6 years of age. Second, the NFCS data were collected approximately two decades ago. Third, the reported fish IRs are for ages 6 to 11 and 12 to 19 and are based on 29 and 21 individuals in each age category, respectively (EPA 2011, Table 13-20). Finally, the IRs from NFCS data are based on total weight of fish as brought into the home, and do not include losses from preparation of the fish (i.e., removal of inedible parts and, possibly, the skin). Estimates of preparation losses for fish intended to apply to the NFCS fish IR data are very uncertain and are based on a wide variety of freshwater, estuarine, and marine fish, and squid (EPA 2011, Table 13-69). Therefore, a more recent survey was sought that included larger sample sizes, data for children younger than six years, and IRs for the parts of fish actually consumed.

EPA's (2002) analysis freshwater and estuarine fish consumption from the USDA's Continuing Survey of Food Intake by Individuals (CSFII) for 1994-96 and 1998 was chosen to provide *per capita* fish IR options by age category in MIRC. Although the fish consumption rates reported in the CSFII include all sources, commercial and self-caught, for purposes of screening level risk assessments, it was assumed that all freshwater and estuarine fish consumed are self-caught. The inclusion of commercially obtained and estuarine fish will overestimate locally caught freshwater fish IRs for many rural populations in the United States; however, it also may underestimate locally caught fish IRs for some populations (e.g., Native Americans, Asian and Pacific Island communities, rural African American communities). Because consumption of locally caught fish varies substantially from region to region in the United States and from one population or ethnic group to the next, users of MIRC are encouraged to use more locally relevant data whenever available.

For children ages 3 to 17 years and for adults, MIRC includes values for the mean and the 90th, 95th, and 99th percentile fish ingestion rates (freshwater and estuarine fish only) based on EPA's analysis of 1994-96 and 1998 CSFII data (EPA 2002, 2008a). As shown in EPA's 2008(a) CSEFH, Table 10-7, the 90th percentile *per capita* ingestion rates estimated from the two-day CSFII recall period are zero for some child age groups. Although not presented in CSEFH Table 10-7, median ingestion rates for all child age groups would be zero (considering the "consumer only" sample sizes [CSEFH Table 10-9] relative to the "*per capita*" sample sizes in Table 10-7).

The high percentile fish IRs that are zero result from the short duration of the CSFII survey (two days) compared with the averaging time of interest (a year) and the relatively infrequent consumption of fish (e.g., on the order of once a week to once a month or less) compared with the near daily ingestion of other types of food products (e.g., dairy, produce, meat). Use of zero for fish IRs, however, is not useful in MIRC. As a result, an alternative method was used to estimate fish ingestion rates for children and adults that could provide reasonable, non-zero values for all age groups and percentiles.

The alternative, age-group-specific fish ingestion rates were derived using values for each age group, $y$:

- Mean or other appropriate percentile *consumer-only* fish ingestion rates for age group $y$, $IR_{CO,y}$, from EPA's *Estimated Per Capita Fish Consumption in the United States* (EPA 2002), Section 5.2.1.1, Table 5, for freshwater/estuarine habitat.[4]
- Fraction of the population consuming freshwater/estuarine fish, $F_{PC,y}$, calculated as consumer-only sample size / U.S. population sample for age group $y$. The data to calculate these fractions are available in the 2008 CSEFH and EPA 2002.

Equation 6-2 was used to calculate the alternative, *per capita* fish ingestion rates by age group ($IR_{PC,y}$):

**Equation 6-2. Calculation of Alternative Age-Group-Specific Fish Ingestion Rates**

$$\mathrm{IR}_{\mathrm{PC,y}} = \mathrm{IR}_{\mathrm{CO,y}} \times \mathrm{F}_{\mathrm{PC,y}}$$

where:

$IR_{PC,y}$ = *Per capita* fish ingestion rate for age group $y$ (g/day)

$IR_{CO,y}$ = *Consumer-only* fish ingestion rates for age group $y$ (g/day) (EPA 2002, Section 5.2.1.1, Table 5, for freshwater/estuarine habitat)

$F_{PC,y}$ = Fraction of the population consuming freshwater/estuarine fish, calculated as consumer-only sample size / total U.S. population sample size for age group $y$ (unitless) (2008 CSEFH, EPA 2002)

In the above, *per capita* (as opposed to *consumer-only*) indicates the intake rates are based on the entire population rather than the subset of the population that ingests the particular food category. Here, *per capita* ingestions are recommended by the HHRAP methodology because no consumer-only percentile-specific intakes are provided for the different age groups.

The mean and percentile consumer-only fish ingestion rates for children and adults and the fraction of the population consuming freshwater/estuarine fish used in calculating long-term *per capita* fish ingestion rates by age group are presented in Exhibit 6-10and Exhibit 6-11. The mean and percentile *per capita* fish ingestion rates estimated using this methodology are summarized in Exhibit 6-12 and are available in MIRC. (Note that as detailed in Appendix 5,

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[4] *Most of these data also are provided in Table 10-9 of the CSEFH; the median values, however, are not presented in the CSEFH, and values for the mean and all other percentiles are slightly different due to rounding.*

Exhibit 3-6, in developing the screening threshold emission rates, a health protective fish ingestion rate of 105.5 g/day was used.)

The fish ingestion rates provided in Exhibit 6-12 and included in MIRC are intended to represent the harvest and consumption of fish in surface waters in a hypothetical depositional area. For site-specific application of this tool, users should consider using more localized survey data to estimate more appropriate fish ingestion rates. The fishing season varies substantially across the United States by latitude, and fish consumption patterns also vary by type of water body (e.g., ponds, lakes, rivers, streams, estuaries, coastal marine), cultural heritage, and general geographic area. Therefore, use of more localized information is encouraged.

As noted in Section 6.4.3, if the user overwrites the fish IRs shown in Exhibit 6-12 with fresh-weight as caught values (e.g., values obtained from a local creel survey), the user is advised to set non-zero values for the preparation and cooking loss factors L1 and L2 in Equation 3-15. Suggested values are presented in Section 6.4.3.

**Exhibit 6-10. Daily Mean and Percentile *Consumer-Only* Fish Ingestion Rates for Children and Adults ($IR_{CO,y}$) [a]**

| Lifestage (years) | Ingestion Rates, All Fish (g/day) | | | | |
|---|---|---|---|---|---|
| | Mean | 50th | 90th | 95th | 99th |
| Child <1 | NA | NA | NA | NA | NA |
| Child 1-2 [b] | 27.31 | 15.61 | 64.46 | 87.60 | 138.76 * |
| Child 3-5 [c] | 40.31 | 23.04 | 95.16 | 129.31 | 204.84 * |
| Child 6-11 [d] | 61.49 | 28.46 | 156.86 * | 247.69 * | 385.64 * |
| Child 12-19 [e] | 79.07 | 43.18 | 181.40 * | 211.15 * | 423.38 * |
| Adult [f] | 81.08 | 47.39 | 199.62 * | 278.91 | 505.65 * |

Sources: EPA 2002, 2008a

NA = not applicable; it is assumed that children < 1 year of age do not consume fish.

* Indicates that the sample size does not meet minimum reporting requirements as described in EPA 2002. Owing to the small sample sizes, these upper percentiles values are highly uncertain.

[a] *Per capita* fish ingestion (FI) rates for children by age group are available from Chapter 10 of the CSEFH (EPA 2008a); however, all 50th and some 90th percentile ingestion rates are zero. *Per capita* FI rates were therefore estimated as described in Equation 6-2 to provide reasonable, non-zero values for all age groups and percentiles.

[b] A fish IR for ages 1-2 years was not available. The value represents the consumer-only fish ingestion rate for ages 3 to 5 from EPA (2002) (Section 5.2.1.1 Table 5 [freshwater/estuarine habitat]), scaled down by the ratio of the mean Child 1-2 body weight to the mean Child 3-5 body weight.

[c] These values represent the consumer-only fish ingestion rate for ages 3 to 5 from EPA (2002), Section 5.2.1.1 Table 5 (freshwater/estuarine habitat). Sample size = 442.

[d] These values represent the consumer-only fish ingestion rate for ages 6 to 10 from EPA (2002), Section 5.2.1.1 Table 5 (freshwater/estuarine habitat). Sample size = 147.

[e] These values represent the time-weighted average *per capita* fish ingestion rate for ages 11 to 15 and 16 to 17 years from EPA (2002), Section 5.1.1.1 Table 5 (freshwater/estuarine habitat); the value may underestimate ingestion rate for ages 12 to 19 years. Sample size = 135.

[f] These values represent the consumer-only fish ingestion rate for individuals 18 years and older from EPA (2002), Section 5.2.1.1 Table 4 (freshwater/estuarine habitat). Sample size = 1,633.

### Exhibit 6-11. Fraction of Population Consuming Freshwater/Estuarine Fish on a Single Day ($F_{PC,y}$)

| Lifestage (years) | Fraction Consuming Fish |
|---|---|
| Child 3-5 | 0.0503 [a] |
| Child 6-11 | 0.0440 [b] |
| Child 12-19 | 0.0493 [c] |
| Adult | 0.08509[d] |

Sources: EPA 2002, 2008a

[a] This value was calculated using the ages 3 to 5 sample size for consumers only divided by the sample size for the U.S. population divided by 2 to represent the proportion consuming fish on a single day (the consumers-only group includes individuals who consumed fish on at least one of two survey days) to match the one-day ingestion rate.

[b] As in footnote a, the value was calculated using the ages 6 to 10 sample size for consumers only divided by the sample size for U.S. population divided by 2.

[c] The value was calculated by summing the ages 11 to 15 and 16 to 17 sample sizes for consumers only and dividing by both by the sum of the sample sizes for U.S. population and by a factor of 2.

[d] The value was calculated using the ages 18 and older sample size for consumers only divided by the sample size for U.S. population from Section 5.1.1.1 Table 4. The result was divided by 2 to represent a one-day sampling period in order to match the one-day ingestion rate.

### Exhibit 6-12. Calculated Long-term Mean and Percentile *Per capita* Fish Ingestion Rates for Children and Adults ($IR_{PC,y}$)

| Lifestage (years) | Ingestion Rates, All Fish (g/day) | | | | |
|---|---|---|---|---|---|
| | Mean | 50th | 90th | 95th | 99th |
| Child <1 | NA | NA | NA | NA | NA |
| Child 1-2 [a] | 1.37 | 0.79 | 3.24 | 4.41 | 6.98 |
| Child 3-5 [b] | 2.03 | 1.16 | 4.79 | 6.51 | 10.3 |
| Child 6-11[c] | 2.71 | 1.25 | 6.90 | 10.9 | 17.0 |
| Child 12-19 [d] | 3.90 | 2.13 | 8.95 | 10.4 | 20.9 |
| Adult [e] | 6.90 | 4.03 | 16.99 | 23.73 | 43.02 |

Sources: EPA 2002, 2008a

NA = not applicable; it is assumed that children < 1 year of age do not consume fish.

[a] Values were calculated as (consumer-only IR for Child 1-2) x (fraction of population consuming fish for Child 3-5).

[b] Values were calculated as (consumer-only IR for Child 3-5) x (fraction of population consuming fish for Child 3-5).

[c] Values were calculated as (consumer-only IR for Child 6-11) x (fraction of population consuming fish for Child 6-11).

[d] Values were calculated as (consumer-only IR estimated for Child 12-19) x (fraction of population estimated to consume fish for Child 12-19).

[e] Values were calculated as (consumer-only IR for Adults) x (fraction of population consuming fish for Adults).

MIRC also includes values for the mean and the 90th percentile fish ingestion rates for recreational anglers, black and female recreational anglers, and anglers of Hispanic, Laotian, and Vietnamese descent which are shown in Exhibit 6-13 These populations are culturally or economically disposed to higher rates of fish ingestion than the general population. Recreational angler values are the EFH (EPA, 2011.) Black and female recreational anglers ingestion rates are presented in Burger *et al*. (2010.) The fish ingestion rates for Hispanic, Laotian, and Vietnamese populations were derived from a study by Shilling *et al*. (2010) of contaminated fish consumption in California's Central Valley Delta. Shilling *et al*. (2010) reported mean and 95th percentile ingestion rates for each subpopulation. In part due to the low sample size (n of 30 to 45), 95th percentile values were believed to be unrealistically high. The 90th percentile ingestion rate estimates presented in Exhibit 6-13 were derived by EPA using information from Shilling *et al*. (2010; EPA, 2010).

**Exhibit 6-13. Calculated Mean and 90th Percentile Per capita Fish Ingestion Rates for Populations of Recreational Fishers ($IR_{PC,y}$)**

| | | Subpopulation | | | | | |
|---|---|---|---|---|---|---|---|
| **Percentile** | **Units** | **Recreational Fisher [a]** | **Female Recreational Fisher [b]** | **Black Recreational Fisher [b]** | **Hispanic Recreational Fisher [c]** | **Laotian Recreational Fisher [c]** | **Vietnamese Recreational Fisher [c]** |
| ***Ingestion of Fish*** | | | | | | | |
| Mean | g/day | 8 | 39.1 | 171 | 25.8 | 47.2 | 27.1 |
| 90th % | g/day | 11 | 123 | 446 | 98 | 144.8 | 99.1 |

[a] 1997 Exposure Factors Handbook (USEPA, 1997)
[b] Burger *et al.,* 2010, weights reported are post-cooking for locally caught fish
[c] Shilling, F., A. White, L. Lippert, and M. Lubell. 2010. Contaminated fish consumption in California's Central Valley Delta. Environmental Research 110: 334-344., weights reported are post-cooking for locally caught fish Burger *et al*., 2010

Applications to date of MIRC have used whole fish concentrations estimated by TRIM.FaTE. The proportion lipid in TL3 and TL4 fish in TRIM.FaTE is assumed to be 5.7 percent (by weight) for the whole fish, based on information provided by Thomann (1989). The lipid content of the part(s) of the fish normally consumed is likely to be less than 5.7 percent. For example, EPA estimated a consumption-weighted mean lipid value for fillets of fish from TL3 to be 2.6 percent and from TL4 to be 3.0 percent (Table 6-9 in EPA 2003b). If a user of MIRC wishes to account for reduced chemical concentration in fillet compared with whole fish for lipophilic chemicals, the user can specify a "preparation" loss of chemical (see Section 6.4).

For lipophilic chemicals (e.g., log Kow greater than 4), which partition primarily into the fatty tissues of fish, much of the higher concentration tissues might be stripped from the fish during preparation (e.g., belly fat, viscera which includes fat in liver, etc, fat under skin). The degree to which the concentration of chemical in a fillet is less than the average total concentration in the whole fish is chemical specific. Assuming that the chemical concentration in the fillet is the same as in the whole fish may result in a health protective bias for highly lipophilic chemicals. For persons who prefer to consume fillets with the skin on and do not discard belly fat, assuming the same concentration of chemical in the fish consumed as in the whole fish is protective.

### 6.3.5 Soil Ingestion Rates

Adult gardeners may incidentally ingest soils from gardening activities, and gardening and farming families might ingest soil particles that adhere to exposed fruits and exposed and belowground vegetables. Soils that are re-suspended in the air by wind can resettle on exposed fruits and vegetables. Children may incidentally ingest soils in those ways, but in addition, children playing outdoors may ingest soils directly or by hand-to-mouth activities during play. MIRC includes soil ingestion rate options by age group for these types of exposures. MIRC does not include options for children who may exhibit pica, or the recurrent ingestion of unusually high amounts of soil (i.e., on the order of 1,000 - 5,000 mg/day or more) (EPA 2008a).

Data on soil ingestion rates are sparse; the soil ingestion rates listed in Exhibit 6-14 and included in MIRC are based on very limited data, as is evident from the values listed. The studies evaluated by EPA for children generally focused on children between the ages of 1 and

3 to 6 years and were not specific to families that garden or farm. The default ingestion rates in MIRC are the 90th percentile values, as for other ingestion rate parameters.

**Exhibit 6-14. Daily Mean and Percentile Soil Ingestion Rates for Children and Adults**

| Age Group<br>(years) | Soil Ingestion Rate (mg/day) | | | | |
|---|---|---|---|---|---|
| | Mean [a] | 50th [a] | 90th | 95th | 99th |
| Child < 1 | NA | | | | |
| Child 1-2 | 50 | 50 | 200 [b] | 200 [b] | 200 [b] |
| Child 3-5 | 50 | 50 | 200 [b] | 200 [b] | 200 [b] |
| Child 6-11 | 50 | 50 | 201 [c] | 331 [d] | 331 [d] |
| Child 12-19 | 50 | 50 | 201 [c] | 331 [d] | 331 [d] |
| Adult 20-70 | 20 | 20 | 201 [c] | 331 [d] | 331 [d] |

Sources: EPA 2008, EPA 2011

[a] For the mean and 50th percentile soil ingestion rates for children, value represents a "central tendency" estimate from EPA's 2008 CSEFH, Table 5-1. For adults, value is the recommended mean value for adults from EPA's 2011 EFH, Chapter 5, Table 5-1.

[b] These values are the recommended "upper percentile" value for children from EPA's 2011 EFH, Chapter 4, Table 4-23. The 2008 CSEFH and 2011 ESH included a high-end value associated with pica only, but this value has not been used.

[c] These values are 90th percentile adult ingestion rates calculated in Stanek et al. 1997, and they are used to represent older children and adults.

[d] These values are 95th percentile adult ingestion rates calculated in Stanek et al. 1997, and they are used to represent older children and adults.

### *6.3.6 Total Food Ingestion Rates*

Although not included in MIRC for deterministic screening-level exposure and risk assessments, total food ingestion rates would be included in any probabilistic module developed for MIRC. The total food ingestion rates presented in Exhibit 6-15 will be used to normalize or to truncate the sum of food-specific ingestion rates to reasonable values. This procedure is particularly important when chemical intake from multiple upper-percentile food ingestion rates for different types of food are added together. Individuals representing the upper percentile ingestion rate for one food category might not be the same individuals who reported high percentile ingestion rates for one or any of the other food categories.

**Exhibit 6-15. Daily Mean and Percentile *Per Capita* Total Food Intake for Children and Adults**

| Lifestage (years) | Percent of Group Consuming Food | Mean | 50th | 90th | 95th | 99th |
|---|---|---|---|---|---|---|
| ***Total Food Intake (g/day, as consumed)*** | | | | | | |
| Child < 1 [a] | 67.0% - 99.7% [h] | 322 | 270 | 599 | 779 | 1152 |
| Child 1-2 [b] | 100% | 1,032 | 996 | 1537 | 1703 | 2143 |
| Child 3-5 [c] | 100% | 1,066 | 1,020 | 1,548 | 1,746 | 2,168 |
| Child 6-11 [d] | 100% | 1,118 | 1,052 | 1,642 | 1,825 | 2,218 |
| Child 12-19 [e] | 100% | 1,197 | 1,093 | 1,872 | 2,231 | 2,975 |
| Adult [f] | 100% | 1,100 | 1,034 | 1,738 | 2,002 | 2,736 |
| ***Total Food Intake (g/kg-day, as consumed)*** | | | | | | |
| Child < 1 [a] | 67.0% - 99.7% [h] | 39 | 34 | 72 | 95 | 147 |
| Child 1-2 [b] | 100% | 82 | 79 | 125 | 144 | 177 |
| Child 3-5 [c] | 100% | 61 | 57 | 91 | 102 | 132 |
| Child 6-11 [d] | 100% | 40 | 38 | 61 | 70 | 88 |
| Child 12-19 [e] | 100% | 21 | 19 | 34 | 40 | 51 |
| Adult [g] | 100% | 14.8 | 13.9 | 23.7 | 27.6 | 35.5 |

Sources: EPA 2005e, 2008a

[a] These values represent a time-weighted average for age groups birth to <1 month (N=88), 1 to <3 months (N=245), 3 to <6 months (N=411), and 6 to <12 months (N=678) from Table 14-3 of the 2008 CSEFH.

[b] These values represent a time-weighted average for age groups 1 to <2 years (N=1,002) and 2 to <3 years (N=994) from Table 14-3 of the 2008 CSEFH.

[c] These values were obtained from Table 14-3 of the 2008 CSEFH (age group 3 to <6 years, N=4,112).

[d] These values were obtained from Table 14-3 of the 2008 CSEFH (age group 6 to <11 years, N=1,553). These values represents a health protective (i.e., slightly low) estimate for ages 6 through 11 years since 11-year olds are not included in this CSEFH age group.

[e] These values represent a time-weighted average for age groups 11 to <16 years (N=975) and 16 to <21 (N=743) years from Table 14-3 of the 2008 CSEFH. Note that estimated values include 11-year-olds and individuals through age 20, which contributes to uncertainty in the estimates.

[f] These values represent a time-weighted average for age groups 20 to 39 years (N=2,950) and 40 to 69 years (N=4,818) from Table 5B of the 2005 EPA analysis of CSFII.

[g] These values represent a time-weighted average for age groups 20 to 39 years (N=2,950) and 40 to 69 years (N=4,818) from Table 5A of the 2005 EPA analysis of CSFII.

[h] Percents consuming foods from Table 14-3 of the 2008 CSEFH include: 67.0% (birth to <1 month); 74.7% (1 to <3 months); 93.7% (3 to <6 months); and 99.7% (6 to <12 months). Infants under the age of 1 that consume breast milk are classified as "non-consumers" of food.

## 6.4 Other Exposure Factor Values

The other exposure parameters included in the MIRC algorithms are exposure frequency (Section 6.4.1), fraction of the food type obtained from the contaminated area (Section 6.4.2), and reduction in the weight of the food types during preparation and cooking (Section 6.4.3). For the breast milk ingestion pathway, additional exposure parameters are included in the FFC algorithms (Section 6.5).

### *6.4.1 Exposure Frequency*

The exposure frequency (EF) represents the number of days per year that an individual consumes home-produced food items that are contaminated with the chemical being evaluated. In MIRC, the default value for EF is 365 days/year for all exposure sources and all potential receptors. This assumption is consistent with the food ingestion rates used in MIRC (i.e., daily intake rates equivalent to annual totals divided by 365 days) and does not imply that residents necessarily consume home-produced food products every day of the year.

If the user wishes to evaluate daily intake rates based on shorter averaging times, the user can overwrite both the food-specific ingestion rates and the EF for each home-grown food product. Users of MIRC might want to specify a lower EF values for various food types where residents obtain some of their diet from commercial sources and where consumption of home grown produce is seasonal.

### *6.4.2 Fraction Contaminated*

The fraction contaminated (FC) represents the fraction of each food product consumed that is contaminated by the chemical at a level consistent with environmental concentrations in the area of concern (e.g., area with maximum deposition rates). Obviously, the most health protective assumption is that all food products consumed (i.e., 100 percent) are from the location represented by the chemical concentrations input into MIRC.

For non-infant children and the adult age cohorts, MIRC includes the default FC of 1, assuming that 100 percent of the food product consumed is produced by households that farm, garden, or raise animals. The user can vary this default FC value for individual food products to tailor the assessment to a particular exposure scenario.

### *6.4.3 Preparation and Cooking Losses*

Food preparation and cooking losses are included in the FFC exposure calculations to account for the amount of a food product as brought into the home that is not ingested due to loss during preparation, cooking, or post-cooking. These losses need to be accounted for in the ADD equations because the food ingestion rates calculated from the USDA 1987 to 1988 NFCS are based on the weight of home grown produce and animal products brought from the field into the house prior to any type of preparation. Not all of the produce or products were eventually ingested. In general, some parts of the produce and products are discarded during preparation while other parts might not be consumed even after cooking (e.g., bones). Thus, the actual food ingested is generally less than the amount brought into the home.

Three distinct types of preparation and cooking losses are included in the ingestion exposure algorithms in MIRC: (1) loss of parts of the food type from paring (i.e., removing the skin from vegetables and fruits) or other types of preparation (e.g., removing pits, coring, deboning), (2) additional loss of weight for the food type during cooking (e.g., evaporation of water), and (3) post-cooking losses (e.g., non-consumption of bones, draining cooking liquid [e.g., spinach]). MIRC includes mean values for these three types of preparation and cooking losses for exposed fruit, protected fruit, exposed vegetables, protected vegetables, root vegetables, beef, pork, poultry, and fish. Different types of losses apply to different types of foods. Therefore, the losses can be represented by only two parameters, *L1* and *L2*, the definitions of which vary according to the food type as explained in the endnotes in Exhibit 6-16. All preparation and cooking loss parameter values were estimated as specified in the Exhibit's endnotes from data presented in Chapter 13 of the EPA's 1997 and 2011 EFH (EPA 1997a and 2011).

### Exhibit 6-16. Fraction Weight Losses from Preparation of Various Foods

| Product | Mean Cooking, Paring, or Preparation Loss (Cooking Loss Type 1 [L1]) (unitless) [a] | Mean Net Post Cooking (Cooking Loss Type 2 [L2]) (unitless) [b] |
|---|---|---|
| Exposed Fruit [c] | 0.244 | 0.305 |
| Exposed Vegetable | 0.162 [d] | NA |
| Protected Fruit | 0.29 [e] | NA |
| Protected Vegetable | 0.088 [f] | NA |
| Root Vegetable [g] | 0.075 | 0.22 |
| Beef | 0.27 | 0.24 |
| Pork | 0.28 | 0.36 |
| Poultry | 0.32 | 0.295 [h] |
| Fish [i] | 0.0 | 0.0 or 1.5[j] |

Source: EPA 1997a and 2011

NA = Not Available

[a] For *fruits*, includes losses from draining cooked forms. For *vegetables*, includes losses due to paring, trimming, flowering the stalk, thawing, draining, scraping, shelling, slicing, husking, chopping, and dicing and gains from the addition of water, fat, or other ingredients. For *meats*, includes dripping and volatile losses during cooking.

[b] For *fruits*, includes losses from removal of skin or peel, core or pit, stems or caps, seeds and defects; may also include losses from removal of drained liquids from canned or frozen forms. For *vegetables*, includes losses from draining or removal of skin. For *meats*, includes losses from cutting, shrinkage, excess fat, bones, scraps, and juices.

[c] These values represent averages of means for all fruits with available data (except oranges) (Table 13-6).

[d] This value represents an average of means for all exposed vegetables with available data (Table 13-7). Exposed vegetables include asparagus, broccoli, cabbage, cucumber, lettuce, okra, peppers, snap beans, and tomatoes.

[e] This value was set equal to the value for oranges (Table 13-6).

[f] This value represents an average of means for all protected vegetables with available data (Table 13-7). Protected vegetables include pumpkin, corn, peas, and lima beans.

[g] These values represent averages of means for all root vegetables with available data (Table 13-7). Root vegetables include beets, carrots, onions, and potatoes.

[h] This value represents an average of means for chicken and turkey (Table 13-5).

[i] If the user changes fish ingestion rates to match a survey of the whole weight of fish brought into the home from the field (divided by the consumers of the fish), an appropriate value for L1 would be 0.31 (EPA 2011, Table 13-5). For volatile or water soluble chemicals, a non-zero value for L2 also may be appropriate. Although EPA (2011) recommended 0.11 for L2, it varies substantially by chemical.

[J] Cooking loss accounts for the difference between ingestion rates for cooked fish and calculated Hg concentrations in whole fish. Cooking fish tends to reduce the overall weight of fish, and volatilization of mercury is unlikely to occur during cooking, increasing the concentration of mercury by a factor of roughly 1.5 (Morgan, Berry, and Graves, 1997).[5]

There are substantial uncertainties associated with the L1 and L2 parameters, including the wide variation in values across produce types that were averaged together to recommend a central tendency value for each. For example, the L2 factor does not distinguish between weight loss during cooking by water evaporation, which might leave the chemical in the fruit, and pouring the cooking liquid down the drain (chemical lost) or using the liquid to create a sauce (chemical not lost). In addition, the concentration of chemical might be highest in the skin, which often is discarded, and lower in the consumed portion of many bulky fruits and vegetables. Finally, the data EPA used to evaluate L1 included negative losses (i.e., weight

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[5] Morgan, J.N., M.R. Berry, and R.L. Graves. 1997. “Effects of Commonly Used Cooking Practices on Total Mercury Concentration in Fish and Their Impact on Exposure Assessments.” Journal of Exposure Analysis and Environmental Epidemiology 7(1):119-133.

gains) due to hydration of dried vegetables (e.g., peas and lima beans), which increases the range of L1 values across different vegetables.

Note that the default L1 and L2 values for fish are set to zero with the exception of methyl mercury. That is because the data source for the fish ingestion rates is not the USDA's 1987 to 1988 NFCS (USDA 1993, 1994) as reported in EPA's EFH, which reported food as brought into the home, as is the case for the other food categories. Instead, the fish IR data included in MIRC are from a more recent and larger survey, EPA's (2002) analysis of freshwater and estuarine fish consumption from the USDA's 1994-96 and 1998 CSFII. That survey reports ingestion rates of fish parts actually consumed, and so no loss processes for preparation are needed. The zero value for L2 assumes that no chemical is lost by volatilization and that pan juices are consumed. The user may reset that value where chemical-specific data are available. In the case of methyl mercury, the chemical is not lost by volatilization during cooking, but liquid from the fish is lost. This lowers the mass of fish consumed, thereby increasing the methyl mercury concentration. As such, L2 is set at 1.5 as detailed by Burger *et al* (2010).[6] (Note that due to uncertainties associated with the cooking conversion factor of 1.5 for methyl mercury, it was not used in the multipathway screening assessment. However, this is an area that should be investigated further for potential use in the future.)

If the user manually changes fish ingestion rates to match a local survey of the whole weight of fish brought into the home from the field (divided by number of persons consuming the fish), the user should also set the L1 and L2 parameter to non-zero values. An appropriate value for L1 would be 0.3 (EPA 2011, Table 13-69). For volatile or water soluble chemicals, a non-zero value for L2 also may be appropriate. Although EPA recommended 0.11 for L2, it varies substantially by chemical.

## 6.5 Breast-Milk Infant Exposure Pathway Parameter Values

Values used for parameters in the breast-milk exposure pathway algorithms (Section 3.4) can be scenario-specific, receptor-specific, and/or chemical-specific and might be empirically derived or estimated by an appropriate model. For parameters that are scenario-specific or for which empirical values are required, the default values provided in MIRC are listed. For parameters for which MIRC calculates values, the appropriate equation is listed. Scenario- and receptor-specific parameters are discussed in Section 6.5.1 and chemical-specific parameters are discussed in Section 6.5.2.

### *6.5.1 Receptor-specific Parameters*

Receptor-specific values are needed for parameters that describe the characteristics or activities of the exposed individual. In this context, there are two relevant receptors: the mother and the infant. Exhibit 6-17 lists the parameters and their default values. The text that follows describes the input value or value options for each exposure parameter required by MIRC to calculate the infant absorbed chemical intake rate, or $DAI_{inf}$. For parameter values that can be estimated when empirical values are not available, see the equation description in Section 3.4.

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[6] Burger J. 2010. Daily consumption of wild fish and game: Exposures of high end recreationalists. Environmental Health Research 12(4): 343-354.

### Exhibit 6-17. Scenario- and Receptor-Specific Input Parameter Values Used to Estimate Infant Exposures via Breast Milk

| Parameter | Description | Default Value |
|---|---|---|
| $AT$ | Averaging time for infant's exposure via breast milk, i.e., duration of nursing (days) | =ED |
| $BW_{inf}$ | Body weight of infant (kg) averaged over duration of nursing exposure | 7.8 |
| $BW_{mat}$ | Body weight of mother (kg) averaged over duration of mother's exposure | 66 |
| $DAI_{mat}$ | Daily absorbed intake of chemical by mother (mg/kg-day) | Equation 3-36 |
| $ED$ | Exposure duration for infant, i.e., duration of breast feeding (days) | =AT |
| $AT/ED$ | Averaging time divided by exposure duration | 1.0 |
| $f_{bp}$ | Fraction of mother's whole blood that is plasma (unitless) | 0.65 |
| $f_{fm}$ | Fraction of mother's body weight that is fat (unitless) | 0.30 |
| $f_{mbm}$ | Fraction of fat in mother's breast milk (unitless) | 0.04 |
| $f_{pm}$ | Fraction of mother's body weight that is plasma (unitless) | 0.046 |
| $IR_{milk}$ | Mean infant milk ingestion rate over duration of nursing (kg/day) | 0.709 |
| $t_{bf}$ | Duration of breast feeding (days) | 365 |
| $t_{pn}$ | Duration of maternal chemical exposure prior to nursing (days) | 3285 |

Averaging time (***AT***) and exposure duration (***ED***). AT refers to the time over which the infant's exposure to the chemical of concern is averaged. *ED* refers to the duration of the infant's exposure. For the exposure scenario considered for this age group, both *AT* and *ED* equal the duration of the nursing period, and they therefore cancel each other out in the infant average daily dose equation.

Infant body weight ($BW_{inf}$). The user selects a value for $BW_{inf}$, the time-weighted average body weight of the infant over the entire duration of breast feeding, based on the age at which the infant stops breast feeding. For example, if the infant breast feeds for one year, the user should select the body weight for an infant that is averaged from birth to the first birthday. Similarly, if an infant breast feeds for 6 months, the user should select the body weight for an infant that is averaged from birth to six months. Because the default breast feeding duration ($t_{bf}$) is one year (i.e., 365 days), the default infant body weight is 7.8 kg, which is the time-weighted average for the mean infant body weight between birth and its first birthday from EPA's (2008) *Child Specific Exposure Factors Handbook* (CSEFH; EPA 2008a). Exhibit 6-18 presents additional values for the infant body weight parameter that the user can select instead of the MIRC default.

### Exhibit 6-18. Average Body Weight for Infants

| Statistic | 0 to < 6 months (kg) | 0 to < 12 months (kg) | 0 to < 18 months (kg) | 0 to < 24 months (kg) |
|---|---|---|---|---|
| Mean | 6.5 | 7.8[a] | 9.0 | 9.6 |
| 5th percentile | 5.0 | 6.0 | 7.0 | 7.5 |
| 10th percentile | 5.3 | 6.4 | 7.4 | 7.8 |
| 15th percentile | 5.5 | 6.7 | 7.7 | 8.2 |
| 25th percentile | 5.8 | 7.0 | 8.1 | 8.7 |
| 50th percentile | 6.4 | 7.8 | 8.9 | 9.5 |

### Exhibit 6-18. Average Body Weight for Infants

| Statistic | 0 to < 6 months (kg) | 0 to < 12 months (kg) | 0 to < 18 months (kg) | 0 to < 24 months (kg) |
|---|---|---|---|---|
| Mean | 6.5 | 7.8[a] | 9.0 | 9.6 |
| 75th percentile | 7.1 | 8.6 | 9.9 | 10.5 |
| 85th percentile | 7.4 | 9.0 | 10.3 | 11.0 |
| 90th percentile | 7.7 | 9.2 | 10.6 | 11.3 |
| 95th percentile | 8.0 | 9.7 | 11.1 | 11.8 |

Source: EPA 2008a; each value is the time-weighted average from the data summaries presented in the CSEFH, Table 8-3.
[a] MIRC default

Maternal body weight (***BW**$_{mat}$*). This parameter represents the body weight of the mother averaged over the entire duration of the mother's exposure to the chemical of concern. The maternal body weight is needed to calculate the biological elimination constant for the lipophilic chemical in lactating women ($k_{fat\_elac}$). MIRC assumes that the mother will be pregnant for 9 months (i.e., 0.75 year) and will be lactating for 1 year. The MIRC default maternal body weight also assumes that the mother has been exposed for 10 years total. For 8.25 years, she is not pregnant or lactating, for 0.75 year she is pregnant, and for 1 year she is lactating. The MIRC default $BW_{mat}$ of 66 kg is based on CSFII data compiled by EPA for non-lactating and non-pregnant women between the ages of 15 and 44 (i.e., women of child-bearing age), lactating women, and pregnant women (EPA 2004b). Exhibit 6-19 presents additional values for the maternal body weight parameter which the user may choose to use instead of the MIRC default. The $BW_{mat}$ value is *not* the value that MIRC uses to estimate the mother's absorbed daily intake ($DAI_{mat}$). The daily ingestion rates for home-grown/raised food products in MIRC are for men and women combined, with the rates normalized to body weight. The ingestion rates for soil, water, and fish included in MIRC are not normalized to body weight but are based on both men and women. For those ingestion rates, MIRC uses an average body weight value for males and females to estimate the average daily dose (intake) of the chemical in mg/kg-day. These values are subject to the assumption that the body-weight normalized ingestion rates and resulting ADD values are applicable to nursing mothers.

### Exhibit 6-19. Time-weighted Average Body Weight for Mothers

| Statistic | Weight (kg) |
|---|---|
| Mean | 66.0[a] |
| 5th | 47.1 |
| 10th | 50.2 |
| 25th | 54.3 |
| 50th | 62.0 |
| 75th | 72.0 |
| 90th | 85.7 |
| 95th | 97.0 |

Source: EPA 2004b
[a] MIRC default value

Exposure duration (*ED*). See discussion of *AT* and *ED* above.

Fraction of mother's whole blood that is plasma (***f**$_{bp}$*). Steinbeck (1954) reported that plasma volume accounts for approximately 60 percent of the total blood volume in non-lactating human females (EPA 1998). Harrison (1967) and Ueland (1976) reported plasma volumes between 63 to 70 percent in postpartum women (EPA 1998). The default value in MIRC of 65 percent (0.65) is the value recommended by EPA in its *Methodology for Assessing Health Risks Associated with Multiple Pathways of Exposure to Combustor Emissions* (MPE, EPA 1998).

Fraction of mother's body weight that is fat ($\boldsymbol{f_{fm}}$). A limitation of using a steady-state, instead of a dynamic partitioning, model for lactational transfer of chemicals is that several key parameters change over the course of exposure. For example, Equation 3-38, used to estimate the concentration of a lipophilic chemical in breast milk fat, assumes that the mother's body fat will remain constant over the entire duration of breast feeding ($t_{bf}$), which is unlikely to be true (EPA 2001a). Another limitation of the single analytic model is that chemical transfer rates from blood to milk are unlikely to be the same as the rate of mobilization of the chemical from fat stores to the blood (EPA 2001a). Studies cited in ATSDR's toxicological profile for chlorinated dibenzo-p-dioxins show a correlation between percent body fat and the elimination rate of dioxins, with longer half-lives for dioxins in individuals with a higher proportion of fat in their bodies (ATSDR 1998). In the context of a screening model, however, EPA recommends a default value for the fraction of a mother's body comprised of fat of 0.3 based on data and discussions presented by Smith (1987) and Sullivan *et al*. (1991) (EPA 1998). A fraction of 0.3 indicates that 30 percent of the mother's body weight is fat, which is a health protective value (EPA 2001a). To establish a health protective screening scenario, the MIRC default value for $f_{fm}$ is 0.30**.**

Fraction of fat in mother's breast milk ($\boldsymbol{f_{mbm}}$). The $C_{milkfat}$ model (Equation 3-38) assumes that a constant fraction of breast milk is fat, even though there is evidence that indicates variation in the fat content of breast milk throughout lactation (Sim and McNeil 1992). Different studies suggest a fat content of breast milk in humans of between 1 and 5 percent (Jensen 1987, Schecter *et al*. 1994, Hong *et al*. 1994, McLachlan 1993, Bates *et al*. 1994, NAS 1991, Butte *et al*. 1984, Maxwell and Burmaster 1993, EPA 2011, Smith 1987, Sullivan *et al*. 1991). The MIRC default value for $f_{mbm}$ of 0.04 (i.e., 4 percent) is the value EPA recommended for MPE (EPA 1998).

Fraction of maternal weight that is plasma ($\boldsymbol{f_{pm}}$). Altmann and Dittmer (1964) estimated that plasma volume for adult women ranged from 37 to 60 mL/kg of body weight and averaged about 45 mL/kg. Ueland (1976) observed that the average plasma volume of women 6 weeks postpartum was 45 mL/kg of body weight. Using a value of 1.026 for the specific gravity of plasma from Conley (1974), EPA estimated a value of 0.046 for the fraction of maternal weight that is plasma (EPA 1998). The MIRC default for $f_{pm}$ therefore is 0.046.

Infant breast milk ingestion rate ($\boldsymbol{IR_{milk}}$). Milk ingestion rates vary with several factors, including the age and size of the infant and use of other foods such as formula. Based on its review of a several studies, EPA recommended time-weighted average and upper percentile milk ingestion rates for infants that nurse for six and for twelve months (EPA 2011, Table 15-3). To estimate an "average" value, EPA first estimated study-sample-size weighted average values for 1 through 12 months of age and then developed time-weighted average milk ingestion rates from those (EPA 2011). EPA estimated an upper percentile (upper bound) value as the mean plus two standard deviations. MIRC converts the ingestion rates measured volumetrically (mL/day) to mass-based estimates (kg/day) assuming the density of human milk to be 1.03 g/mL (reported by NAS 1991 and recommended by EPA 2011). The resulting values are shown in the first two rows of Exhibit 6-20. The MIRC screening-level default of 980 mL/day is an upper-bound estimate based on a one-year nursing period.

Exhibit 6-20 also includes the recommended values for four non-overlapping age categories from the CSEFH (U.S. EPA 2008a, Table 15-1). The values demonstrate that although infants grow substantially from birth to one year of age, the "upper bound" estimates of their milk ingestion rates are very close to 1 liter per day at all stages of development in the first year.

**Exhibit 6-20. Infant Breast Milk Intake Rates**

| Age Category | Average (mL/d) | Average (kg/d) | "Upper Bound" (mL/d) | "Upper Bound" (kg/d) | Reference |
|---|---|---|---|---|---|
| 1 to 6 months | 742 | 0.764 | 1,033 | 1.064 | EPA 2011[†] |
| 0 to < 12 months | 688 | 0.709 | 980[a] | 1.01[a] | EPA 2011[†] |
| 0 to < 1 month | 510 | 0.525 | 950 | 0.979 | EPA 2008[††] |
| 1 to < 3 months | 690 | 0.711 | 980 | 1.01 | EPA 2008[†] |
| 3 to < 6 months | 770 | 0.793 | 1,000 | 1.03 | EPA 2008[†] |
| 6 to < 12 months | 620 | 0.639 | 1,000 | 1.03 | EPA 2008[†] |

[a] MIRC default; [†] Based on review of multiple studies; [††] Based on a single study

Duration of breast feeding ($t_{bf}$). This parameter is equal to the infant's exposure duration (*ED*) and the infant's averaging time (*AT*). In its MPE Methodology, EPA asserts a health protective value for the duration of breast feeding of 1 year (i.e., 365 days) and a central tendency estimate of 6 months (180 days) (EPA 1998). Reviewers of MPE noted that 365 days may be overly health protective, given that only 20 percent of infants are breast fed for 6 months, at which point alternative foods are introduced, at least in addition to breast milk (EPA 2001a). Nonetheless, to establish a health protective screening scenario, the MIRC default for $t_{bf}$ is 365 days.

Duration of the mother's exposure to the chemical of concern prior to nursing ($t_{pn}$). The model shown as Equation 3-38 includes this parameter to reduce the over-estimate of chemical concentration in milk fat that occurs if the model is applied to a chemical with a long biological half-life (e.g., many years). The factor is needed for applications of the model to scenarios with a brief exposure duration (e.g., beginning a few months prior to the start of nursing) relative to the chemical half life. As the duration of an exposure scenario increases to meet and exceed the chemical half life, however, the overestimate that occurs without this parameter is reduced. For example, assume a chemical biological half-life of 8 years and a nursing period of 1 year. If exposure of the mother starts at the beginning of nursing, using Equation 3-38 without the $t_{pn}$ term results in an over-estimate of the concentration of the chemical in breast milk by a factor of 28.1 compared with the prediction using Equation 3-38 with the $t_{pn}$ term (EPA 1998, Table 9-6). However, at longer pre-natal exposures of the mother, the magnitude of the over-estimate is reduced: for a 10-year exposure, the magnitude of the overestimate without the $t_{pn}$ term is 2.28, and for a 30-year exposure, the overestimate is reduced to 1.39.

For purposes of the screening-level of assessment for dioxins, we assume an exposure duration equal to the half-life of the chemical, or 10 years. Only 3285 days of that period are pre-natal (i.e., 3650 minus 365 days, assuming 1 year lactation period). Although longer exposure periods are possible for the screening scenario, there is sufficient uncertainty in the model to merit accepting a health protective bias for this parameter value.

### 6.5.2 Chemical-Specific Parameter Values

The chemical-specific parameters in the breast-milk pathway in MIRC are listed in Exhibit 6-21. Note that the parameters for which values are needed are different for the lipophilic chemicals (i.e., dioxins), for which lactational transfer is assumed to occur via milk fat, and inorganic chemicals, for which the transfer is assumed to occur via the aqueous phase of breast milk (i.e., mercury). All dioxin congeners were assumed to manifest identical values as TCDD in regard to breast milk-related parameters.

Absorption efficiency of the chemical by the oral route of exposure for the infant (**$AE_{inf}$**). The models included in MIRC assume that the $AE_{inf}$ from the lipid phase of breast milk is equal to the $AE_{inf}$ from the aqueous phase of the milk. Reviewers of the model stated that this assumption may not be valid and that ideally, the equation $DAI_{inf}$ would include variables for the $AE_{inf}$ from the breast milk fat and the $AE_{inf}$ from the aqueous phase of breast milk (EPA 2001a). However, since the MIRC assumption is that chemicals will partition to either the lipid or aqueous phase of milk, it is not necessary at this time to have multiple $AE_{inf}$ values for a given chemical. If data on the AE from the mother or an adult but not for the infant are available, data for the adult may be used for $AE_{inf}$. Reviewers also recommended that chemical-specific values come from studies that account for absorption of the chemical from milk, because absorption from other matrices (e.g., solid foods) may not be relevant (EPA 2001a). If chemical-specific data are not available for adults or infants, a health protective default value for $AE_{inf}$ for a screening level assessment is 1.0, which assumes 100 percent absorption (EPA 1998).

The default value for $AE_{inf}$ in MIRC for both MeHg and dioxin is 1.0. For ingested lipophilic chemicals, it is reasonable to assume that absorption will be high (EPA 2004c). ATSDR (1998) reported that dioxins are well absorbed by the oral route of exposure, with one human experiment indicating more than 86 percent absorption. It is EPA policy to assume 100 percent absorption for chemicals with reported *AEs* of 50 percent or higher (EPA 2004c). MeHg also is well absorbed, with measured values as high as 95 percent, and so a value of 100 percent is used in MIRC (EPA 2001b).

**Exhibit 6-21. Chemical-specific Input Parameter Values for Breast Milk Exposure Pathway**

| Parameter and Description | | 2,3,7,8-TCDD | MeHg |
|---|---|---|---|
| $AE_{inf}$ | Infant absorption efficiency of the chemical by the oral route of exposure (i.e., fraction of ingested chemical that is absorbed by the infant; unitless) | 1.0 (default) | 1.0 (default) |
| $AE_{mat}$ | Maternal absorption efficiency of the chemical by the oral route of exposure (i.e., fraction of ingested chemical that is absorbed by the mother; unitless) | 1.0 (default) | 1.0 (default) |
| $f_{bl}$ | Fraction of steady-state total body burden of hydrophilic chemical in mother that is in the mother's whole blood compartment (unitless) | NA | 0.059 (Kershaw *et al*. 1980) [a] |
| $f_f$ | Fraction of steady-state lipophilic chemical body burden in mother that is stored in body fat (unitless) | ≥ 0.90 (ATSDR 1992) | NA |
| $f_{pl}$ | Fraction of steady-state total hydrophilic chemical body burden in mother that is in the blood plasma compartment (unitless) | NA | Not yet identified [b] |
| $h$ | Biological half-life for chemical in non-lactating women (days) | 3650 (EPA 1994c) | 50 (Sherlock *et al*. 1984) |
| $k_{aq\_elac}$ | Rate constant for total elimination of hydrophilic chemicals by lactating women (per day) | NA | = $k_{elim}$ |

| | | | |
|---|---|---|---|
| $k_{elim}$ | Rate constant for elimination of chemical for non-lactating women (per day; related to chemical half-life) | 1.9E-04[b] | 1.4E-02 [c] |
| $k_{fat\_elac}$ | Rate constant for total elimination of lipophilic chemicals by lactating women (per day) | Est. using Equation 3-41 | NA |
| $Pc_{bm}$ | Partition coefficient for hydrophilic chemical between maternal *blood plasma* and aqueous phase of breast milk (g milk/g plasma; model assumption) | NA | 1.0 (model assumption) |
| $Pc_{RBC}$ | Partition coefficient for hydrophilic or protein-bound chemical between *red blood cells* (RBC) and *plasma* in maternal blood (mL whole blood/mL RBC) | NA | 40 (Hollins *et al.* 1975) |

NA = not applicable. ND = not yet determined from literature.

[a] This value is based on a single-dose study and may not be appropriate for a chronic exposure model.

[b] An empirical value for this variable is currently missing for application of model.

[c] This value was calculated from biological half-life (*h*) using Equation 3-40.

Note that *AE* values for some inorganic compounds are substantially less than 1.0. For cadmium, for example, *AEs* for adults of 0.025 to 0.05 have been reported (EPA 2004c, Exhibit B-4).

Absorption efficiency of the chemical by the oral route of exposure for the mother ($\boldsymbol{AE_{mat}}$). The default value for both dioxins and MeHg is 1.0, as described in the previous paragraph.

Fraction of total maternal chemical body burden that is in the whole blood ($\boldsymbol{f_{bl}}$). The default value for MeHg in MIRC, 0.059, is from Kershaw *et al.* (1980), which reported kinetics of blood deposition and clearance of MeHg in humans. Individuals consumed one meal of fish that contained between 18 and 22 µg Hg/kg body weight. The fraction of the dose deposited in the blood volume after mercury was fully distributed in tissues was 5.9 percent or 0.059. This study used a single-dose and thus may not be appropriate for a chronic exposure analysis.

Fraction of total maternal chemical body burden that is in body fat ($\boldsymbol{f_f}$). Based on ATSDR's *Toxicological Profile for Selected PCBs* (ATSDR 1992) and Sullivan *et al.* (1991), EPA concluded that the "fraction of ingested contaminant stored in fat may be >90%" for lipophilic chemicals such as PCBs and dioxins (EPA 1998). This statement was interpreted to mean that 90 percent of the maternal body burden of chemical at "steady state" is located in body fat for dioxins at steady state.

Fraction of total maternal chemical body burden that is in blood plasma ($\boldsymbol{f_{pl}}$). For hydrophilic chemicals, this parameter represents the steady-state fraction of the total chemical in the body that is circulating in the blood plasma. Values for $f_{pl}$ may be available for some chemicals in the scientific literature. No value for this parameter for methyl mercury has been identified from the literature at this time. A value can be calculated using Equation 3-43. However, this equation requires a reliable value for $f_{bl}$, and the value found for mercury may not be appropriate for a chronic exposure analysis (see above).

Chemical half-life in non-lactating women (***h***). In general, highly lipophilic chemicals tend to have relatively long biological half-lives. EPA estimates that the half-life for dioxins is between 7 and 10 years (EPA 1994a). ATSDR estimates that the half-life for 2,3,7,8-TCDD in particular may be as long as 12 years (ATSDR 1998). To establish a health protective screening scenario, the MIRC default half-life for dioxins is set to 10 years or 3650 days.

The half-life for methylmercury is on the order of weeks, not years. Greenwood *et al*. (1978) measured blood clearance rates for MeHg in lactating Iraqi women exposed accidentally to MeHg via bread prepared from wheat treated with a fungicide that contained MeHg. The data indicated a mean half-life for MeHg of approximately 42 days. Sherlock *et al*. (1984) reported an average measured half-life for MeHg of 50 days with a range of 42-70 days. The MIRC default for MeHg is set to the longer average half life of 50 days.

<u>Chemical elimination rate constant for lactating women – aqueous ($\boldsymbol{k_{aq\_elac}}$).</u> The parameter $k_{aq\_elac}$ is equal to $k_{elim}$ plus the loss rate for the chemical in the aqueous phase of breast-milk during lactation. EPA has yet to propose a term for the additional elimination of a chemical in the aqueous phase of milk from breast feeding. In the absence of empirical values, a reasonable assumption for water soluble chemicals is that $k_{aq\_elac}$ is equal to $k_{elim}$ as discussed for Equation 3-43. The extent to which $k_{elim}$ is an underestimate of $k_{aq\_elac}$ for a given chemical will determine the extent of health protective bias in $k_{aq\_elac}$.

<u>Chemical elimination rate constant for non-lactating women ($\boldsymbol{k_{elim}}$).</u> Although values for this parameter often are reported directly in the literature, MIRC estimates $k_{elim}$ from chemical half-life assuming first-order kinetics as shown in Equation 3-40. For example, for a biological half-life of 3,650 days for dioxins, $k_{elim}$ is estimated to be 1.9E-04 per day. Assuming a biological half-life of 50 days for MeHg, the value for $k_{elim}$ is estimated to be 0.014 per day.

<u>Rate constant for total elimination of lipophilic chemicals by lactating women ($\boldsymbol{k_{fat\_elac}}$).</u> Although values for this parameter might be found in the scientific literature for some chemicals, in MIRC, $k_{fat\_elac}$ for dioxins is calculated from Equation 3-41. When the parameters in that equation are set to the default values in MIRC for dioxins, MIRC estimates a value of 0.0015 per day for $k_{fat\_elac}$.

<u>Partition coefficient for chemical between maternal blood plasma and aqueous phase of breast milk ($\boldsymbol{Pc_{bm}}$).</u> The aqueous model, presented in Equation 3-42, assumes that the concentrations in the plasma and aqueous phase of breast milk are directly proportional (EPA 1998). Therefore, the default value for this parameter for MeHg in MIRC is 1.0.

<u>Partition coefficient for chemical between red blood cells and plasma in maternal blood ($\boldsymbol{Pc_{RBC}}$).</u> Chemical-specific values for this parameter should be located in the scientific literature. If chemical-specific values are unavailable and it is assumed that there is equal distribution of the chemical in the plasma and red blood cells, EPA suggests a default value of 1.0 (EPA 1998). For MeHg, MIRC includes a value of 40 based on Hollins *et al*. (1975) study of cats exposed to MeHg, which reported a ratio of radio-labeled mercury in red blood cells to plasma of 97.7 to 2.3 (i.e., ratio of 42.5).

# 7 Summary of MIRC Default Exposure Parameter Settings

The default settings included in MIRC are intended to be characteristic of a health protective (but plausible) exposure scenario that results in a negligible or extremely low chance of underestimating risk to farming households in an area with chemical concentrations and air deposition rates as specified by the user. These default parameter values were used to derive the screening threshold emission rates used for screening emissions of PB-HAPs from sources included in RTR risk assessments. These values are the default, or initial setting, for parameter values in MIRC as described in Section 6. This section summarizes the default parameter values used to calculate screening thresholds.

This chapter is organized to present the chemical- and scenario-specific inputs to MIRC by data type. The screening-level analysis uses 90th percentile ingestion rates, presented in Section 7.1, and population-specific characteristic assumptions, presented in Section 7.2, that are generally health protective in nature. Screening thresholds were derived for five RTR chemical species: benzo(a)pyrene, cadmium, mercuric chloride, methyl mercury, and 2,3,7,8-TCDD; Section 7.3 presents chemical-specific parameter inputs for these five chemicals. Finally, Section 7.4 presents default parameter values for the nursing infant exposure scenario, which applied only to dioxin and methyl mercury.

## 7.1 Default Ingestion Rates

The screening-level (or default) values for ingestion rates for soil, fish, breast milk, and for each farm food type are equal to the 90th percentile of the distribution of national data for that ingestion medium (Exhibit 7-1). The default settings also assume that all food types are obtained from the area of chemical deposition specified by the user (i.e., fraction of food from contaminated area = 1.0).

For estimates of screening threshold emission rates for PB-HAPS, environmental concentrations and air deposition rates were estimated using TRIM.FaTE for the area of maximal deposition in the vicinity of a hypothetical facility, and thus represent risks estimated for a maximally exposed individual/farm/family.

Exhibit 7-1 also includes a sum of the 90th percentile ingestion rates for homegrown food categories and fish ingestion (preceding rows) to show the implied total food ingestion rate associated with setting multiple food-type-specific ingestion rates at a 90th percentile. Because the 90th percentiles for each farm food category are likely to reflect different individuals, it is likely that addition of multiple 90th percentile intake values will exceed the total food ingestion rates likely for the general population.

The final row in Exhibit 7-1 lists the likely magnitude of the overestimates by age category. The preceding row includes the 90th percentile of the distribution of *individual total food ingestion rates* from the USDA's 1994-96 and 1998 *Continuing Survey of Food Intakes by Individuals* (CSFII) (USDA 2000) data sets, as analyzed by EPA (EPA 2005e). The total ingestion rate for the farming households takes into account the cooking losses typical of each food category to provide a better comparison with the 90th percentile individual total food ingestion rates (which are based on consumption of prepared foods).

## Exhibit 7-1. Farm Food Category Ingestion Rates for Health protective Screening Scenario for Farming Households

| Product | 90th Percentile Consumer Ingestion Rate | | | | | | Units |
|---|---|---|---|---|---|---|---|
| | Infants < 1 yr | Child 1-2 yrs | Child 3-5 yrs | Child 6-11 yrs | Child 12-19 yrs | Adult | |
| ***Farm Food Item*** | | | | | | | |
| Beef[a] | N/A | 9.49 | 8.83 | 11.4 | 3.53 | 4.41 | g/kg-day |
| Dairy[b] | N/A | 185 | 92.5 | 57.4 | 30.9 | 6.16 | g/kg-day |
| Eggs[a] | N/A | 4.90 | 3.06 | 1.90 | 1.30 | 1.31 | g/kg-day |
| Exposed Fruit[a] | N/A | 12.7 | 5.41 | 6.98 | 3.41 | 2.37 | g/kg-day |
| Exposed Vegetable[a] | N/A | 10.7 | 3.47 | 3.22 | 2.35 | 3.09 | g/kg-day |
| Pork[a] | N/A | 4.90 | 4.83 | 3.72 | 3.69 | 2.23 | g/kg-day |
| Poultry[a] | N/A | 7.17 | 6.52 | 4.51 | 3.13 | 2.69 | g/kg-day |
| Protected Fruit[a] | N/A | 44.8 | 32.0 | 23.3 | 7.44 | 15.1 | g/kg-day |
| Protected Vegetable[a] | N/A | 3.88 | 2.51 | 2.14 | 1.85 | 1.81 | g/kg-day |
| Root Vegetable[a] | N/A | 7.25 | 4.26 | 3.83 | 2.26 | 2.49 | g/kg-day |
| ***Other*** | | | | | | | |
| Breast milk[c] | 1.01 | NA | NA | NA | NA | NA | kg/day |
| Soil (dry) | NA | 200[d] | 200[d] | 201 [e] | 201 [e] | 201 [e] | mg/day |
| Fish (per individual) [f] | NA | 26.23 | 38.72 | 57.09 | 82.66 | 105.47 | g/day |
| Fish (per kg BW) [g] | NA | 2.08 | 2.08 | 1.59 | 1.29 | 1.48 | g/kg-day |
| ***Total Food Ingestion Rates for Comparison Only (not in MIRC; excludes soil and water)*** | | | | | | | |
| Total Food: Homegrown only [h] | NA | 260 | 143 | 100 | 52 | 32 | g/kg-day |
| Total Food: All Sources [i] | NA | 125 | 91 | 61 | 34 | 23.7 | g/kg-day |
| Overestimate (ratio of Homegrown/Total) | NA | 2.1 | 1.6 | 1.6 | 1.5 | 1.3 | (unitless) |

Sources: EPA 2011, EPA 2008, unless otherwise noted.

NA = not applicable

[a] Primary source for values was the 1987–1988 NFCS survey; compiled results are presented in Chapter 13 of the 2011 Exposure Factors Handbook (EPA, 2011). When data were unavailable for a particular age group, the intake rate for all age groups was multiplied by the age-specific ratio of intake based on national population intake rates from CSFII.

[b] Primary source for values was 1987–1988 NFCS survey, compiled results are presented in Chapter 13 of the 2011 Exposure Factors Handbook (EPA, 2011). When data were unavailable for a particular age group, the intake rate for all age groups was multiplied by the age-specific ratio of intake based on national population intake rates from an NHANES 2003–2006 analysis in Chapter 11 of the Exposure Factors Handbook.

[c] Infants are assumed to consume only breast milk for one year.

[d] These values are the recommended "upper percentile" value for children from EPA's 2011 EFH, Chapter 4, Table 4-23. The 2008 CSEFH and 2011 EFH included a high-end value associated with pica only, but this value has not been used.

[e] These values are 90th percentile adult ingestion rates calculated in Stanek et al. 1997, and they are used to represent older children and adults.

[f] Based on data from U.S. EPA 2002, adjusted to be "as prepared"

[g] Fish ingestion rates, original data in g/day, have been normalized to body weight in this table to allow addition into total food estimate using the mean body weight for each age category.

[h] Sum of 90th percentile post-cooking food ingestion rates. This estimate is calculated by multiplying the food ingestion rates on previous rows (excluding soil and water) by $(1-L_1)x(1-L_2)$, where $L_1$ and $L_2$ are the loss rates from Exhibit 6-16. The rows are then summed to get the total post-cooking ingestion rate.

[i] 90th percentile total food intake rates from EPA 2008a and 2005e based on CSFII data 1994-96 and 1998; see Exhibit 6-15 of this document.

The final row of Exhibit 7-1 is the ratio of the two preceding rows. The values in this row demonstrates the potential for overestimating intake by using upper percentile values for all food groups. This bias may be considered when evaluating the cancer risks and noncancer hazard quotients estimated by MIRC.

## 7.2 Default Screening-Level Population-Specific Parameter Values

The screening-level values for body weights (BWs) for the RTR screening threshold analysis, which serve as the default values in MIRC, are mean values and are presented in Exhibit 7-2. As stated in Section 6, EPA recommends using the mean BW for each age group when using upper (90th) percentile values for medium ingestion rates. Use of the mean body weights introduces no bias toward over- or underestimating risk.

**Exhibit 7-2. Mean Body Weight Estimates for Adults and Children [a]**

| Lifestage (years) | Duration (years) | Mean Body Weight (kg) |
|---|---|---|
| Adult [b] (20-70) | 50 | 71.4 |
| Child < 1 [c] | 1 | 7.83 |
| Child 1-2 [c] | 2 | 12.6 |
| Child 3-5 [d] | 3 | 18.6 |
| Child 6-11 [e] | 6 | 36.0 |
| Child 12-19 [f] | 8 | 64.2 |

[a] Sources: EPA 1997, 2008a

[b] BW represents the sample-size weighted average of male and female mean body weights (all races, 18-74 years) from EPA's 1997 EFH (Tables 7-4 for males and 7-5 for females). Note that these weights include the weight of clothing, estimated to range from 0.09 to 0.28 kg. Although the 18 to 74 year age category in EPA's EFH does not match exactly the age 20 to 70 year categorization of adults in MIRC, the magnitude of error in the mean and percentile body weights is likely to be very small (i.e., less than 1%). We considered updating the body weight for use in the RTR assessment to the revised body weights in the 2011 Exposure Factors Handbook. However, the 2011 EFH warns that assessors should consider if the dose estimate (for which the body weight is used to calculate) will be used to estimate risk by combining it with a dose-response that was derived assuming a body weight of 70 kg, and that if such an inconsistency exists, an adjustment may be necessary. Because a 70 kg body weight commonly is used to develop IRIS dose-response values, using an 80 kg body weight could result in this inconsistency. Given these issues, we have retained the use of an adult body weight of 71.4 kg.

[c] These values were calculated as time-weighted average body weight (BW) from data presented in Table 8-3 of EPA's (2008a) *Child-Specific Exposure Factors Handbook* (CSEFH).

[d] These values were obtained directly from Table 8-3 of the 2008 CSEFH.

[e] Each BW represents a time-weighted average of BWs for age groups 6 to <11 years and 11 to <16 years from Table 8-3 of the 2008 CSEFH. Original sample sizes for each of these age groups can also be found in Table 8-3.

[f] These values were calculated as time-weighted average BW for age groups 11 to <16 years and 16 to <21 years from Table 8-3 of the 2008 CSEFH. The direction of the possible bias is unknown. The values match the estimate based on Table 8-22 of the NHANES IV data as presented by Portier et al. (2007).

## 7.3 Default Chemical-Specific Parameter Values for Screening Analysis

Exhibit 7-3 presents chemical-specific parameter values for input to MIRC for the screening-level analysis. Values for bioavailability when ingested in soil (*Bs*), mammalian metabolism factors (*MF*), correction factors for belowground produce ($VG_{rootveg}$), wet deposition fractions (*Fw*), air to plant transfer factors ($Bv_{AG}$), root concentration factors (*RCF*), and soil-water partition coefficient (*Kds*) are presented in Exhibit 7-3.

### Exhibit 7-3. Chemical-Specific Parameter Values for Input to MIRC[a]

| Parameter | Description | Benzo(a)-pyrene | Cadmium | Mercuric chloride | Methyl mercury | 2,3,7,8-TCDD | Units |
|---|---|---|---|---|---|---|---|
| *Bs* | Soil bioavailability factor for livestock | 1 | 1 | 1 | 1 | 1 | unitless |
| *MF* | Mammalian metabolism factor | 0.01 | 1 | 1 | 1 | 1 | unitless |
| $VG_{rootveg}$ | Empirical correction factor for belowground produce, i.e., tuber or root vegetable, to account for possible overestimate of the transfer of chemicals from the outside to the inside of bulky tubers or roots (based on carrots and potatoes) | 0.01 | 1 | 1 | 0.01 | 0.01 | unitless |
| *Fw* | Fraction of wet deposition that adheres to plant surfaces; 0.2 for anions, 0.6 for cations and most organics | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | unitless |
| $Bv_{AG}$ | Air-to-plant biotransfer factor for aboveground produce for vapor-phase chemical in air | 124,742 | 0 | 1,800 | 0 | 65,500 | [mg/g produce DW] / [mg/g air] |
| *RCF* | Chemical-specific root concentration factor for tubers and root produce | 9,684 | 0 | 0 | 0 | 39,999 | L soil pore water/kg root WW |
| *Kds* | Chemical-specific soil/water partition coefficient | 160,000 | 75 | 58,000 | 7,000 | 38,904.51 | L soil pore water/kg soil DW |

[a] Values presented in this exhibit are also presented in previous exhibits; however exact values used in the analysis are presented here, rather than values restricted by significant figures. In addition, only values for those chemicals that are specifically used in the screening analysis are provided here.

Only single estimates were developed for each of these parameters for HHRAP (EPA 2005a), and the potential direction and magnitude of bias toward over- or underestimating risks were not investigated in this analysis. The inputs that are both chemical-specific and plant-type-specific, as presented in Exhibit 6-3, are *not* repeated here. Again, only single estimates were developed for these parameters and the potential direction and magnitude of bias toward over- or underestimating risks were not investigated. Finally, Exhibit 7-4 presents biotransfer factors for each of the chemicals and animal types for which screening threshold emissions were calculated.

**Exhibit 7-4. Chemical and Animal-Type Specific Biotransfer Factor (Ba) values for Input to MIRC**

([mg chemical/kg WW tissue or dairy] / [mg chemical intake/day] = day/kg WW tissue or dairy)

| Chemical | Beef | Dairy | Pork | Eggs | Poultry |
|---|---|---|---|---|---|
| Benzo(a)pyrene | 3.8E-02 | 8.0E-03 | 4.6E-02 | 1.6E-02 | 2.8E-02 |
| Cadmium | 1.2E-04 | 6.5E-06 | 1.9E-04 | 2.5E-03 | 1.1E-01 |
| Mercuric chloride | 1.1E-04 | 1.4E-06 | 3.4E-05 | 2.4E-02 | 2.4E-02 |
| Methyl mercury | 1.2E-03 | 1.7E-05 | 5.1E-06 | 3.6E-03 | 3.6E-03 |
| 2,3,7,8-TCDD | 3.6E-02 | 7.7E-03 | 4.4E-02 | 1.5E-02 | 2.7E-02 |

## 7.4 Screening-Level Parameter Values for Nursing Infant Exposure

EPA also included an assessment of risk to nursing infants exposed to dioxins and to methylmercury (MeHg) in their mother's milk for a family farming and catching fish in the area of maximal air deposition of chemical. Input values were summarized in Section 6.5.

### *7.4.1 Dioxins*

For dioxins, chemical intake via breast milk by nursing infants was estimated using the model presented in EPA's *Methodology for Assessing Health Risks Associated with Multiple Pathways of Exposure to Combustor Emissions* (MPE, EPA 1998a). The assumption that lactational transfer of dioxins to the infant occurs via the lipid-phase of milk appears reasonable. The following screening-level assumptions used in that model should bias the results toward some overestimate of risks.

- Duration of nursing is a full year and no other foods or liquids are consumed by the infant; a more "typical" value would be six months.
- Absorption efficiency of dioxin in food or milk by mother and infant are 100 percent; this assumption might overestimate absorption but probably by no more than 15 percent.
- The fat content of human milk is assumed to be 4 percent, a value toward the high end of the reported range of values (1 to 5 percent).
- The maternal chemical intake is estimated using 90th percentile ingestion rates for the different homegrown foods (see discussion for Exhibit 7-1); this assumption might overestimate total ingestion of homegrown foods by a factor of more than 3.
- If the fraction of the maternal body burden of dioxin that is in the body fat compartment is greater than 90 percent, as suggested by ATSDR (1998), then actual exposures of the infant may be less than estimated.

There also are parameter values and model assumptions for the lipid-phase breast-milk pathway for which possible bias is unknown.

- The accuracy of the model is unknown; it has not been verified or validated with empirical data.
- Using a half-life of 10 years for dioxins may over- or under-estimate risks.

Finally, there is one assumption that might possibly introduce some bias toward underestimating risks. The model results are sensitive to the biological half-life of the chemical in the mother relative to the length of her exposure prior to the lactation period. Using an exposure duration for the mother equal to the assumed half-life for dioxins, 10 years, may underestimate the duration of exposure of the mother.

### 7.4.2 Methyl Mercury

For MeHg, empirical data from a single human study (Fujita and Takabatake 1977) was used in conjunction with a physiologically based pharmacokinetic (PBPK) model of lactational transfer of MeHg developed and partially validated by Byckowski and Lipscomb (2001) to support a very simple predictive model. Both the human data and the PBPK model indicated that for relatively low MeHg exposures, the concentration of MeHg in the nursing infant's blood is similar to its concentration in the mother's blood. The PBPK model suggested in addition that the average daily dose of MeHg absorbed from milk by the nursing infant ($DAI_{inf}$) is indistinguishable from the dose of MeHg absorbed by its mother from her food ($DAI_{mat}$). The data are limited, and the model includes various assumptions; however, there is no known directional bias in the estimates.

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## Technical Support Document for TRIM-Based Multipathway Tiered Screening Methodology for RTR

# ADDENDUM 3: Dermal Risk Screening

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# Dermal Risk Screening

Non-inhalation exposure to PB-HAPs can occur by way of the dermal pathway through contact with PB-HAP-contaminated soil and water. However, dermal absorption of chemicals that are originally airborne is generally a relatively minor pathway of exposure compared to other exposure pathways (U.S. EPA 2006, Cal/EPA 2000). This section demonstrates that for the conservative screening scenario developed for RTR multipathway evaluation, the dermal exposure route is not a significant risk pathway when compared to the ingestion pathway. In general, the assessment followed the protocol for evaluating a reasonable maximum exposure as described in EPA's *Risk Assessment Guidance for Superfund (RAGS), Volume I: Human Health Evaluation Model, Part E, Supplemental Guidance for Dermal Risk Assessment* (U.S. EPA 2004c).

## 1 Hazard Identification and Dose Response Assessment

To assess the potential contribution of dermal exposure to non-inhalation exposure, we evaluated the potential for cancer and chronic non-cancer effects for the four PB-HAPs currently assessed in the multipathway screening evaluation for RTR: cadmium, divalent mercury, 2,3,7,8-TCDD, and benzo(a)pyrene. EPA has not developed carcinogenic potency slope factors (CSFs) and non-cancer reference doses (RfDs) specifically for evaluating potential human health concerns associated with dermal exposure to PB-HAPs. Instead, dermal toxicity values can be derived from oral toxicity values via route-to-route extrapolation by adjusting for gastrointestinal (GI) absorption. EPA recommends making this adjustment only when GI absorption of the chemical is significantly less than 100% (i.e., less than 50 percent). Otherwise, a default value of complete (100 percent) oral absorption is assumed, and no adjustment is made (U.S. EPA 2004c).

The absorbed cancer slope factor ($CSF_{ABS}$) is based on the oral cancer slope factor ($CSF_O$) and the fraction of the contaminant absorbed in the gastrointestinal track ($ABS_{GI}$), as follows:

$$CSF_{ABS} = \frac{CSF_o}{ABS_{GI}}$$

where:

$CSF_{ABS}$ = Absorbed slope factor $(mg/kg\text{-}day)^{-1}$

$CSF_o$ = Oral slope factor $(mg/kg\text{-}day)^{-1}$

$ABS_{GI}$ = Fraction of chemical absorbed in gastrointestinal tract (unitless)

The absorbed reference dose ($RfD_{ABS}$) is based on the oral reference dose ($RFD_O$) and the fraction of the contaminant absorbed in the gastrointestinal track ($ABS_{GI}$), as shown below.

$$RfD_{ABS} = RfD_o \times ABS_{GI}$$

where:

$RfD_{ABS}$ = Absorbed reference dose (mg/kg-day)

$RfD_o$ = Oral reference dose (mg/kg-day)

$ABSGI$ = Fraction of chemical absorbed in gastrointestinal tract (unitless)

GI absorptions for 2,3,7,8-TCDD and all polycyclic aromatic hydrocarbons (PAHs) (which includes benzo[a]pyrene) were estimated to be greater than 50 percent. Therefore, as shown in Exhibit 1-1, no adjustments to the available oral CSFs were required. Similarly, no adjustment to the oral RfD for 2,3,7,8-

TCDD was required.  For cadmium and divalent mercury, adjustments were made based on absorption data provided in RAGS Part E, Exhibit 4-1.  The RfDs for dermal exposure to cadmium and divalent mercury are also shown in Exhibit 1-1.

**Exhibit 1-1.  Cancer Slope Factors and Reference Doses Based on Absorbed Dose**

| PB-HAP | $ABS_{GI}$ (unitless) | $CSF_{ABS}$ [a] $(mg/kg\text{-}day)^{-1}$ | $RfD_{ABS}$ [a] (mg/kg-day) |
|---|---|---|---|
| Cadmium Compounds | 0.05 | NA | 2.5E-05 |
| Divalent Mercury | 0.07 | NA | 2.1E-05 |
| 2,3,7,8-TCDD | No adjustment required [b] | 1.5E+05 | 1.0E-09 |
| Benzo[a]pyrene | No adjustment required [b] | 1.0E+01 | NA |

NA = Not applicable

[a] Oral dose response values are presented in Appendix 2.  Only the resulting adjusted dose response values are presented in this table.

[b] According to RAGS Part E, Exhibit 4-1, GI absorption is expected to be greater than 50%.

# 2 Dermal Exposure Estimation

Dermal exposures and risks resulting from absorption of the chemical through the skin from contact with contaminated water and soil were evaluated for the RTR screening scenario.  Individuals were assumed to be exposed on a fraction of their bodies (i.e., their head, forearms, hands, lower legs, and feet) to contaminated soil from the TRIM.FaTE surface soil parcel with the highest concentration (N1) on a daily basis.  For the water evaluation, individuals were assumed to be exposed to contaminated surface water with the same PB-HAP concentration as the TRIM.FaTE screening scenario lake over their entire bodies on a daily basis.

## 2.1 Equations for Estimating Dermal Exposure

The general equation used to estimate dermal absorbed dose (DAD) for water or soil is shown below, and is expressed in milligrams of PB-HAP per kilogram of receptor body weight per day (mg/kg-day).  DAD is calculated separately for the water and soil pathways.

$$DAD = \frac{DA_{event} \times EV \times ED \times EF \times SA}{BW \times AT}$$

where:

$DA_{event}$ = Absorbed dose per event; chemical-specific; equation for $DA_{event}$ also differs depending on water or soil contact ($mg/cm^2$-event)

$EV$ = Event frequency (events/day)

$ED$ = Exposure duration (years)

$EF$ = Exposure frequency (days/year)

$SA$ = Skin surface area available for contact ($cm^2$)

$BW$ = Body weight (kg)

$AT$ = Averaging time; for non-cancer effects, equals ED x 365 days/year; for cancer effects, equals 70 years x 365 days/year (days)

$DA_{event}$ is estimated to be the total dose absorbed through the skin at the end of exposure and the equation for calculation is different for organic and inorganic chemicals in water and for soil. The equations for calculating these chemical-specific $DA_{event}$ values for water contact are provided in RAGS Part E, Chapter 3 (see Equations 3.2 – 3.4). For soil, the equation for calculating these chemical-specific $DA_{event}$ values is provided in RAGS Part E, Chapter 3 (see Equation 3.12).

Water – Organic Chemicals: $$DA_{event} = C_w \times 2 \times FA \times K_p \sqrt{\frac{6 \times \tau_{event} \times t_{event}}{\pi}}$$

Water – Inorganic Chemicals: $$DA_{event} = C_w \times K_p \times t_{event}$$

Soil – All Chemicals: $$DA_{event} = C_s \times AF \times ABS \times CF$$

where:

$DA_{event}$ = Absorbed dose per event (mg/cm$^2$-event)

$C_w$ $C_s$ = Chemical concentration in water (mg/cm$^3$) or soil (mg/kg)

$K_p$ = Chemical-specific dermal permeability coefficient of compound in water (cm/hr)

$FA$ = Chemical-specific fraction absorbed; accounts for loss due to the regular shedding of skin cells of some chemical originally dissolved into skin (unitless)

$\tau_{event}$ = Chemical-specific lag time per event (hr/event)

$t_{event}$ = Receptor-specific event duration (hr/event)

$AF$ = Receptor- and activity-specific adherence factor of soil to skin (mg/cm$^2$-event)

$ABS$ = Chemical-specific dermal absorption fraction (unitless)

$CF$ = Conversion factor ($10^{-6}$ kg/mg)

## 2.2 Exposure Factors and Assumptions

The exposure parameters included in this assessment and their default and other value options are summarized in this subsection. Default values were selected to result in a highly conservative estimated of exposure (i.e., exposures are likely overestimated). Parameter values were primarily obtained or estimated from RAGS Part E (EPA 2004c) and the CSEFH (EPA 2008). Receptor-and scenario-specific exposure assumptions are discussed first, and a discussion of chemical-specific parameters values follows. Estimated water and soil exposure concentrations are presented at the end of this subsection.

## 2.3 Receptor-Specific Parameters

Dermal exposures and risks were estimated for the same age groups used in the ingestion exposure assessment: adults (ages 20 to 70 years) and five child age groups: <1 year; 1 to 2 years; 3 to 5 years; 6 to 11 years; and 12 to 19 years. The body weight values used in the ingestion exposure assessment were used in the dermal exposure assessment.

Body surface areas for water and soil exposures for adults were calculated using Appendix C, Exhibit C-1, of RAGS Part E. For children, SAs for water and soil exposures for the five children's age groups were estimated using Tables 7-1 and 7-2 of the CSEFH, respectively. For SA (water), individuals were assumed to shower or bathe in the water with 100 percent of their body exposed. For SA (soil), it was assumed that individuals were exposed on a fraction of their total body, specifically their head, forearms, hands, lower legs, and feet. Based on information provided in RAGS Part E, the SA for forearms was calculated using the SA for arms and assuming a forearm-to-arm ratio of 0.45, and the SA for lower legs was estimated using the SA for legs and assuming a lower leg-to-leg ratio of 0.4.

Values for body SA by age group are summarized in Exhibit 2-1.

**Exhibit 2-1. Receptor-Specific Body Surface Area Assumed to be Exposed to Chemicals**

| Age Group [a] (years) | Surface Area for Water Exposure ($cm^2$) | Surface Area for Soil Exposure ($cm^2$) |
|---|---|---|
| Adult 20-70 | 18,150 [g] | 6,878 [h] |
| Child <1 [b] | 3,992 | 1,772 |
| Child 1-2 [c] | 5,700 | 2,405 |
| Child 3-5 [d] | 7,600 | 3,354 |
| Child 6-11 [e] | 10,800 | 4,501 |
| Child 12-19 [f] | 17,150 | 6,906 |

[a] Sources for the child groups included Table 7-1 (total body surface area for SA-Water), and Table 7-2 (fraction of total body surface area for SA-Soil) of the 2008 CSEFH.
[b] Represents a time-weighted average for age groups birth to <1 month, 1 to <3 months, 3 to <6 months, and 6 to <12 months.
[c] Represents a time-weighted average for age groups 1 to <2 years and 2 to <3 years.
[d] Values for age group 3 to <6 years in the 2008 CSEFH.
[e] Values for age group 6 to <11 years in the 2008 CSEFH. Represents a conservative (i.e., slightly low) estimate for ages 6 through 11 years since 11-year olds are not included in this CSEFH age group.
[f] Represents a time-weighted average for age groups 11 to <16 years and 16 to <21 years. Note that estimated values include 11-year-olds and individuals through age 20, which contributes to uncertainty in the estimates for 12 to 19 years.
[g] Represents the average total surface area of adults from Table C-1 of RAGS Part E.
[h] Represents the average surface area of adults for head, forearms, hands, lower legs, and feet from Table C-1 of RAGS Part E.

## 2.4 Scenario-Specific Parameters

Exhibit 2-2 summarizes the exposure values related to frequency and duration of contact. In general, these are the recommended defaults for calculating a reasonable maximum exposure (RME) for a residential scenario as proposed by EPA in RAGS Part E, Chapter 3.

**Exhibit 2-2. Scenario-Specific Exposure Values for Water and Soil Contact**

| Exposure Parameter | Receptor | Value | Source |
|---|---|---|---|
| ***Water Contact*** | | | |
| *Event Duration ($t_{event}$) (hr/event)* | Child | 1 | Reasonable maximum exposure scenario for showering/bathing from RAGS Part E, Exhibit 3-2 |
| | Adult | 0.58 | |
| ***Soil Contact*** | | | |
| Soil Adherence Factor (AF) ($mg/cm^2$) | Child | 0.2 | For children, value is geometric mean value for children playing (wet soil) and for adults, value is geometric mean value for an adult farmer from RAGS Part E, Exhibit 3-3 |
| | Adult | 0.1 | |
| ***Both Media*** | | | |
| Event Frequency (EV) (events/day) | All | 1 | Reasonable maximum exposure scenario from RAGS Part E, Exhibits 3-2 & 3-5. |
| Exposure Frequency (EF) (days/year) | All | 350 | |
| Exposure Duration (ED) (years) | Child <1 | 1 | Represents the number of years included in the age group; also used in ingestion exposure |
| | Child 1-2 | 2 | |
| | Child 3-5 | 3 | |

**Exhibit 2-2. Scenario-Specific Exposure Values for Water and Soil Contact**

| Exposure Parameter | Receptor | Value | Source |
|---|---|---|---|
| | Child 6-11 | 6 | calculations. |
| | Child 12-19 | 8 | |
| | Adult 20-70 | 50 | |
| Averaging Time (AT) (days) | For cancer assessment, an AT equal to a lifetime (70 years) x 365 days/year is used. Same value used in ingestion exposure calculations.<br>For non-cancer assessment, an AT equal to the exposure duration (ED) x 365 days/year is used, so AT will vary by receptor group. Same value used in ingestion exposure calculations. | | |

## 2.5 Chemical-Specific Parameters

The chemical-specific parameters required to quantitatively evaluate dermal pathway exposures are listed in Exhibit 2-3. For the water concentration in the dermal analysis, the modeled TRIM.FaTE chemical concentration in the screening scenario pond at the screening threshold emission rate was used. For the soil concentration, the modeled TRIM.FaTE chemical concentration in surface soil in parcel N1 of the screening scenario at threshold emission rate was used. This same soil concentration was also used in ingestion exposure calculations for soil ingestion.

Dermal absorption of chemicals in water is based on the use of a dermal permeability coefficient ($K_p$), which measures the rate that a chemical penetrates the skin. Dermal absorption of soil-bound chemicals is based on the use of a dermal absorption fraction (ABS), which is a measure of how much of a chemical the skin absorbs through contact with soil.

**Exhibit 2-3. Chemical-Specific Dermal Exposure Values for Water and Soil Contact**

| PB-HAP | Cadmium | Divalent Mercury | 2,3,7,8-TCDD | Benzo[a] pyrene | Source |
|---|---|---|---|---|---|
| Chemical concentration in Water (Cw) (mg/cm3) | 2.4E-08 | 1.9E-09 | 2.6E-18 | 2.1E-13 | TRIM.FaTE modeled concentration in screening scenario pond |
| Chemical concentration in Soil (Cs) (mg/kg) | 6.9E-02 | 6.3E-02 | 2.2E-10 | 1.4E-04 | TRIM.FaTE modeled concentration in surface soil in parcel N1 in screening scenario |
| Permeability coefficient in water (Kp) (cm/hour) | 0.001 | 0.001 | 0.81 | 0.7 | Values from RAGS Part E, Exhibits B-3 (organics) and B-4 (inorganics) |
| Fraction absorbed water (FA) (unitless) | NA | NA | 0.5 | 1.00 | Values from RAGS Part E, Exhibits B-3; only used for organic chemicals |
| Lag time per event (τevent) (hr/event) | NA | NA | 6.82 | 2.69 | Values from RAGS Part E, Exhibits B-3; only used for organic chemicals |
| Dermal absorption fraction (ABS) from soil (unitless) | 0.001 | 0.045 [a] | 0.03 | 0.13 | Values from RAGS Part E, Exhibit 3-4, unless otherwise noted |

[a] Value obtained from Bioavailability in Environmental Risk Assessment (Hrudey et al. 1996).

# 3 Screening-Level Cancer Risks and Non-Cancer Hazard Quotients

Toxicity values were used in conjunction with exposure information to evaluate the potential for cancer risks and non-cancer health hazards. Risk estimation methods are presented below.

***Dermal Cancer Risk***

Cancer risk for the dermal route was calculated as the product of the age-specific *DAD*s and the absorbed CSF for each chemical, as follows:

$$Dermal\ Cancer\ Risk = DAD \times CSF_{ABS}$$

where:

$DAD$ = Dermal Absorbed Dose (mg/kg-day)

$CSF_{ABS}$ = Absorbed cancer slope factor $(mg/kg\text{-}day)^{-1}$

Lifetime dermal cancer risks were calculated for 2,3,7,8-TCDD and benzo[a]pyrene. The total risk accounts for dermal exposures that an individual might receive from these PB-HAPs in water plus soil over his or her lifetime (70 years).

***Dermal Hazard Quotient***

Dermal hazard quotient (HQ) was estimated as the ratio of age-specific *DAD*s to the absorbed RfD for each chemical, as shown below:

$$Dermal\ HQ = DAD / RfD_{ABS}$$

where:

$DAD$ = Dermal Absorbed Dose (mg/kg-day)

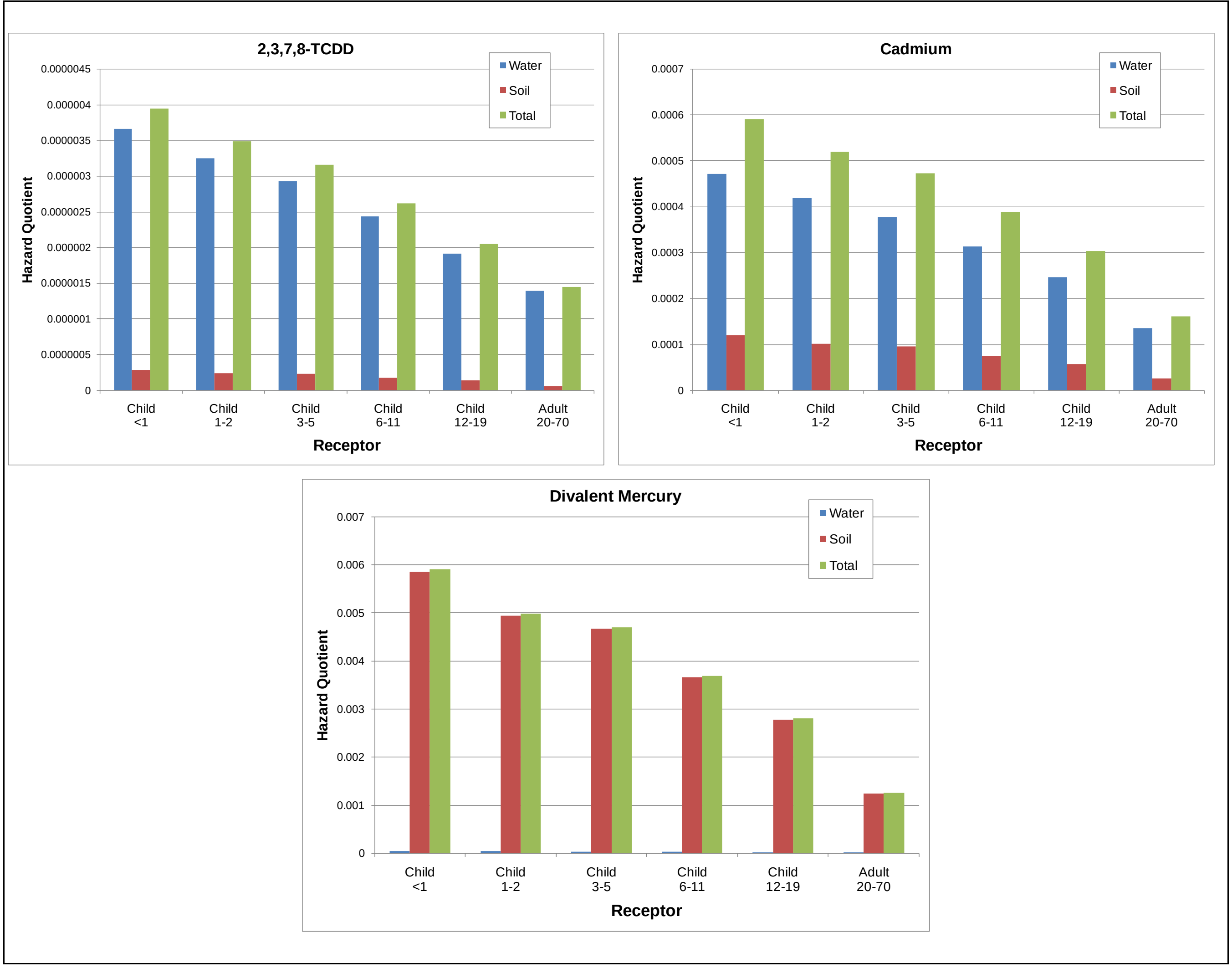
$RfD_{ABS}$ = Absorbed reference dose (mg/kg-day)

The aggregate HQ accounts for exposures that an individual in a receptor group may receive from the PB-HAP in water and soil over the exposure duration. Non-cancer hazard is not additive *across* the age groups evaluated here.

# 4 Dermal Screening Results

Exhibit 4-1 presents a summary of estimated dermal non-cancer hazards by age group. A summary of estimated lifetime dermal cancer risks is provided in Exhibit 4-2. All HQ values were 0.006 (representing divalent mercury exposure for children less than 1 year of age) or less. This is approximately 170 times less than the potential ingestion hazard quotients associated with the screening scenario. The highest estimated individual lifetime cancer risk associated with potential dermal exposures was 4.1E-09 for benzo[a]pyrene; this value is approximately 240 times smaller than the ingestion risk estimated for the same screening threshold emission rate.

## Exhibit 4-1. Summary of Dermal Non-Cancer Hazards



## Exhibit 4-2. Summary of Dermal Cancer Risks

| PB-HAP | Dermal Lifetime Cancer Risk | Magnitude of Difference |
|---|---|---|
| ***2,3,7,8-TCDD*** | | |
| Water | 2.64E-10 | >3,700 |
| Soil | 1.49E-11 | >67,300 |
| Total | 2.79E-10 | >3,500 |
| ***Benzo[a]pyrene*** | | |
| Water | 1.50E-09 | >600 |
| Soil | 2.63E-09 | >300 |
| Total | 4.12E-09 | >200 |

Based on these results and taking into consideration the extremely conservative nature of the dermal exposure calculations, it was assumed that it is not necessary to incorporate dermal exposures in calculating multipathway screening threshold levels.  Specifically, the daily exposure durations of 0.58 hour for adults and 1 hour for children used to calculate dermal exposure from water are highly conservative and assume that the individual is bathing in surface water taken directly from a contaminated lake or is swimming in the lake for 350 days of the year.  The exposure frequency of 350 days and corresponding skin surface area available for contact with contaminated soils (i.e., head, hands, arms, legs, and feet) likely also grossly overestimates dermal exposure to soil.

## References

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## Technical Support Document for the TRIM-Based Multipathway Tiered Screening Methodology for RTR

# Attachment B. Tier 2 Screening Methodology

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# List of Exhibits

# 1 Overview of Approach

The Tier 1 screening scenario is, by design, generic and health-protective. It was constructed for quick application to a large number of facilities in a source category with the least chance of returning false negatives for risk. Once the initial screen is complete, however, the remaining facilities that fail for any PB-HAPs must be scrutinized further to reduce the number of potential false positives for risk.

Based on screening analyses conducted for RTR to date, many facilities could "fail" the Tier 1 screen for some source categories (e.g., 50+ facilities). A full site-specific analysis of all facilities that cannot be screened out in Tier 1 would not be practical. Site-specific values for some influential variables, however, can be determined without intensive effort during the assessment.

The use of these site-specific values instead of the values used in Tier 1 can be used to justify adjusting the screening threshold for a given PB-HAP at that facility, potentially eliminating the facility from concern while maintaining a high degree of confidence that risks of concern have not been overlooked. Specifically, for Tier 2, data on two types of variables are utilized:

- Meteorological characteristics, including the fraction of time the wind blows in the direction of the farm and lake ("wind direction"), the wind speed, the precipitation rate, and the mixing height; and
- Distance from the facility to the nearest fishable lake(s).[1]

These variables affect the PB-HAP concentrations in environmental media estimated by TRIM.FaTE (and thus can be used to justify scaling upwards the emission threshold associated with the risk/HQ level of concern), but they are not related to specific exposure assumptions. The exposure assumptions, such as ingestion rate and fraction of diet derived from the lake and farm, are expected to be variable for the population around any given facility and remain at fixed, health-protective values in Tier 2. In selecting the fate and transport variables to include in Tier 2, a balance was struck between the degree of impact on the risk estimate, the ease of implementation in TRIM.FaTE, and the ease of obtaining relatively certain site-specific values for all facilities that might be evaluated under the RTR program.

To evaluate the impacts these parameters have on exposure and risk, a series of TRIM.FaTE simulations was performed that systematically varied the values used in the screening scenario for the five selected variables (i.e., four meteorological variables and lake location). Four or five alternative values for each variable were selected using statistics on U.S. meteorological data or professional judgment to capture the expected range in the facility data. TRIM.FaTE simulations were performed for every possible combination of these variable values to enable the estimation of appropriate site-specific threshold adjustment factors for scenarios with the corresponding characteristics. Based on the TRIM.FaTE results of these simulations (and the subsequent exposure and risk characterization, conducted using MIRC), a matrix of Tier 2 threshold adjustment factors was calculated, with each element of the matrix corresponding to a unique combination of values from each of the selected variables.

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[1] The lake size was also changed for each new facility lake distance. This change allowed the simulations to maintain a constant ratio between watershed and erosion area compared with the lake area.

The Tier 2 threshold adjustment factors represent the ratio between the risk metric (i.e., cancer risk or HQ) obtained using the baseline Tier 1 screening scenario and the risk metric obtained from the Tier 2 TRIM.FaTE runs. For a given facility, an adjusted Tier 2 emission threshold can be estimated by multiplying the Tier 1 emission threshold by the adjustment factor that best corresponds to the meteorological conditions present at the site and the presence and location of lakes at the site:

$$Tier\ 2\ Threshold = Tier\ 1\ Threshold\ \times Tier\ 2\ Adjustment\ Factor$$

Matrices of threshold adjustment factors were separately developed for the four PB-HAPs that currently have screening emission thresholds in the Tier 1 process: benzo(a)pyrene (BaP, representative of polycyclic aromatic hydrocarbons), cadmium, divalent mercury and 2,3,7,8-tetrachlorodibenzodioxin (TCDD, representative of dioxins). In implementing the Tier 2 process, a risk equivalency approach was used to convert speciated emissions of PAHs and dioxins into BaP and TCDD equivalents, respectively, similar to the Tier 1 screening approach.

To facilitate the implementation of this approach without requiring facility-specific data searches for each new source category evaluated, databases of the relevant U.S. meteorological and lake data were created that could be accessed on the fly during a Tier 2 evaluation. The meteorological database includes annual-average summary statistics on wind direction, wind speed, and precipitation for 1,305 surface stations located throughout the United States. The mixing heights for these stations were estimated using the closest upper air data. The database of fishable lakes includes information on the location and size of all lakes in the United States. To focus on lakes that can support angling of upper trophic level fish, only lakes greater than 25 acres in area are included.

Once the databases are created, one further processing step is necessary before implementing the Tier 2 screening tool. For each facility that will be analyzed in Tier 2, the distance to the closest relevant lake near the facility in each of eight directional "octants" is recorded using GIS software. For the purposes of Tier 2, a "relevant" lake is considered to be one located within a radius of 50 km from the facility and above the size threshold of 25 acres. To access these databases, a Microsoft® Excel tool was created that merges the TRIM.FaTE Tier 2 adjustment factors with the stored lake and meteorology information corresponding by location to an individual facility. In the tool, each facility is matched with the closest meteorological station, and the values for the four relevant parameters at that station are recorded. The distance from the facility to the nearest lakes estimated using GIS are also imported. These five values become the set of facility-specific parameters. The threshold adjustment factor corresponding to this set of site-specific data is then looked up in the matrix of adjustment factors. If a facility variable assumed a value in between two of the computed levels available in the matrix, the more health-protective of the two levels of that variable was selected (i.e., the level that resulted in the smaller adjustment to the baseline Tier 1 exposure). The Tier 1 screening emission threshold is then multiplied by the appropriate adjustment factor to obtain an updated Tier 2 emission threshold for that PB-HAP. Any emissions below the adjusted Tier 2 threshold are assumed to pose no health risk above levels of concern.

# 2 Selection of Site-Specific Characteristics to Include in the Tier 2 Analysis

The screening scenario used to derive Tier 1 thresholds incorporates assumptions regarding meteorological conditions, the spatial configuration of the hypothetical exposure setting, physical parameters of the environment, and chemical-specific parameters that result in generally health-protective results. In Tier 2, selected assumptions used in the fate and transport modeling conducted using TRIM.FaTE are relaxed to reflect site-specific information for the facilities being evaluated.[2] To determine which scenario characteristics should be incorporated into the Tier 2 analysis, the following issues were considered for TRIM.FaTE model parameters:

- How sensitive are the modeled risks to a user-input model parameter?
- Do the plausible values for a variable span a wide spectrum of values at different sites?
- Which site-specific characteristics can be found easily and reliably for facilities with emissions exceeding Tier 1 thresholds? Is the uncertainty in the value matched to each facility high or low?
- How complicated or time-consuming is the incorporation of changes in parameter values into the Tier 1 screening scenario set-up?

Supplement A provides an exhibit showing all the TRIM.FaTE variables considered for the Tier 2 analysis. These variables were evaluated qualitatively using the criteria above to determine whether the variable was of high, medium, or low priority. The following five “high priority” variables were selected for implementation in the current Tier 2 analysis:

- Wind direction (the percent of time the wind blows toward the lake and farm),
- Wind speed,
- Precipitation,
- Mixing height, and
- Distance to the nearest fishable lake.

These parameters were judged to represent a balance between high risk sensitivity, range of potential variability, ease of implementation within the modeling scheme used for RTR, and ease of obtaining site-specific values with a relatively high level of confidence.

## 3 Estimation of Adjustment Factors for Selected Site-Specific Parameters

The purpose of including site-specific detail for a facility evaluated in Tier 2 is to develop a more realistic (and presumably lower) estimate of risk associated with facility emissions. This is implemented within the analysis by generating revised threshold emissions specific to that PB-HAP at the selected facility. However, instead of performing full-fledged model runs for each facility that does not “screen out” in Tier 1, a set of generally applicable threshold adjustment thresholds was developed based on a set of model runs. Specifically, a total of 320 adjustment factors were developed for each PB-HAP corresponding to unique combinations of variable levels for each variable discussed above (with one exception for wind direction, which was adjusted on a linear basis, as explained below). These adjustment factors were based on a set of runs in which the values for the selected variables were varied systematically. The

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[2] Only TRIM.FaTE parameters were considered for inclusion in Tier 2 adjustments because of the difficulty in identifying substantial ***location-related*** differences in values for exposure factors (and other inputs to MIRC). The exposure characteristics used in MIRC are considered to be generally consistent across different locations and facilities.

appropriate adjustment factor is then applied when evaluating a source in Tier 2 based on the facility's location.

The analyses conducted to select the parameters to adjust and derive the threshold adjustment factors are described in this section. Section 3.2 also describes the development of appropriate "bins" for the selected parameters. These bins correspond to the subset of parameter values for which adjustment factors were calculated, based on the anticipated range of plausible values for that parameter for facilities evaluated in RTR.

## 3.1 Selection Values for Variables of Interest

For each site-specific parameter identified in Section 2 other than wind direction, adjustment factors were estimated that correspond to a set of four or five particular values for the parameter. To facilitate this, ICF created bins (i.e., relevant ranges of values) for each parameter of interest, with the exception of wind direction (as described below, representative bins were not necessary for this parameter). The rationale for selecting the range for each bin for each parameter of interest is described below.

**Wind Direction:** Within the context of the hypothetical exposure scenario used in Tier 1 (and presumably under actual conditions), when the frequency with which the wind blows towards the modeled domain increases, greater pollutant deposition is likely to occur over and around the farm and lake. The percentage of time the wind blows toward the farm and lake is therefore expected to be positively correlated with ingestion exposure and risk. In the screening scenario used to estimate Tier 1 thresholds, the wind is assumed to blow toward the modeled domain (i.e., where the hypothetical farm and lake are located) 3 days a week, or 43 percent of the time. This assumption is intended to approximate an unusually consistent long-term wind pattern and is representative of wind direction patterns in Yakima, Washington (where the wind blows eastward approximately 40 percent of the time, based on a review of wind direction data compiled by the National Weather Service).

In the Tier 2 analysis, this factor was changed to 1, 2, and 4 days a week, corresponding to 14 percent, 29 percent, and 57 percent of the time. This spectrum of values was chosen to obtain a good understanding of the impact of wind direction on risk for the range of meteorological conditions likely to be present at real facilities. Review of these results indicated that, within this modeling scenario, estimated ingestion exposure varies directly with percentage of time the wind blows toward the farm and lake. Given the exactly linear nature of the relationship observed in model results obtained from ICF's test runs, the adjustment of the threshold for wind direction in Tier 2 is a direct, linear adjustment using the actual site value rather than an incremental, bin-based approach. In other words, the Tier 2 threshold is adjusted for wind direction in direct proportion to the difference between conditions for the facility location and the wind direction parameters included in the screening scenario (i.e., blowing toward the lake/farm 43 percent of the time on average).

**Wind Speed:** Although the impact of wind speed on non-inhalation risks also is likely to depend on configurational parameters such as the location of farms and lakes, in general it is reasonable to assume that higher wind speeds lead to more rapid chemical transfer out of the modeled domain, allowing less time for chemical deposition and, therefore, less total near-field deposition and a lower exposure and risk. The Tier 1 screening analysis assumed a wind speed of 2.8 m/s, corresponding to the 5th percentile of annual average speed for the contiguous United States (distribution was based on data for 239 stations collected by the National Oceanic and Atmospheric Administration [NOAA], with approximately 50 years of data per station).[3] This value is similar to the annual average wind speeds of the U.S. Deep South.[4] In the Tier 2 analysis, ICF calculated the adjustment to exposure resulting from increasing this factor to 3.5 m/s, 4 m/s, and 5 m/s (the 88th percentile in the NOAA data). Based on these levels, the bins used to classify wind speed are: 2.8–3.5 m/s, 3.5–4 m/s, 4–5 m/s and above 5 m/s. To ensure that the approach is health-protective, a facility was assigned the lower end value of the bin into which it was placed. Facilities with wind speeds less than 2.8 m/s were assumed to have a wind speed of 2.8 m/s.

**Precipitation:** Higher levels of precipitation over the modeled domain are expected to increase non-inhalation risks by increasing particulate and gaseous wet deposition near-field to the source. The screening scenario used in Tier 1 assumed an annual precipitation of 1,500 mm/year. This level of annual precipitation is experienced in parts of the U.S. Deep South and parts of the U.S. Northwest Coast[5] and corresponds to approximately the 95th percentile precipitation in the National Climatic Data Center's (NCDC) 30-year (1981–2010) data for over 9,000 U.S. stations.[6] To estimate adjustment factors in the Tier 2 analysis, model simulations were conducted with the parameter value set to three lower values (i.e., 1,187 mm/year, 924 mm/year and 512 mm/year), corresponding to the 75th, 50th and 25th percentiles, respectively, of the NCDC data. Locations with lower precipitation levels were assumed to have a minimum precipitation of 512 mm/year. Based on these levels, the bins used to classify precipitation were: 0-512 mm/year, 512-924 mm/year, 924-1,187 mm/year, 1,187-1,500 mm/year and above 1,500 mm/year. To be health-protective, a facility was assigned the upper end value of the bin in which it was placed. Facilities with precipitation levels above 1,500 mm/year were assumed to experience precipitation of 1,500 mm/year. In setting up the wind direction runs described earlier, the Tier 2 analysis maintained the same wind direction to frequency of rain characteristics as in the Tier 1 analysis to control for effects of potential interactions between these factors. That is, the Tier 2 analysis maintained the same ratio of the percentage of time precipitation was experienced when the wind was blowing toward the lake and farm as in the Tier 1 analysis.

**Mixing Height:** Greater mixing heights can dilute the concentration of pollutants in air, resulting in lower deposition and other transfers from air to surfaces and consequently also lower ingestion exposures. The Tier 1 screening analysis assumed a mixing height of 710 meters. This value is the 5th percentile of annual average mixing heights for 463 U.S. locations, based on data obtained from EPA's SCRAM Web site.[7] In the Tier 2 analysis, ICF evaluated the effect on exposure of increasing the value for mixing height to 865 m, 1,079 m, and 1,537 m. These values correspond to North Little Rock, Arkansas, Boise, Idaho, and Tucson, Arizona and are intended to encompass the range of annual average mixing heights experienced in different parts of the United States. Based on these levels, the following bins were selected for categorization of mixing height: 710–865 m, 865–1,079 m, 1,079–1,537 m, and above 1,537. To be health-protective, a facility was assigned the lower end value of the bin into which it was placed. Facilities with mixing heights above 1,537 m and those below 710 m were assumed to have mixing heights of 1,537 m and 710 m, respectively.

**Lake Distance:** Moving the lake included in the hypothetical scenario to a location farther from the source in the modeled domain will reduce deposition to the lake and its watershed and consequently reduce exposures associated with the fish consumption pathway, which is an

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[3] http://ols.nndc.noaa.gov/plolstore/plsql/olstore.prodspecific?prodnum=C00095-PUB-A0001#TABLES
[4] National Climatic Data Center CliMaps (NCDC-CliMaps) (2007). http://cdo.ncdc.noaa.gov/cgi-bin/climaps/climaps.pl
[5] National Climatic Data Center Historical Climate Series (NCDC-HCS) (2007).
[6] http://www.ncdc.noaa.gov/oa/climate/normals/usnormals.html
[7] Support Center for Regulatory Atmospheric Modeling; http://www.epa.gov/scram001/tt24.htm

important pathway of exposure for several chemicals (for example, in the case of methyl mercury, it is by far the predominant exposure pathway). For the scenario modeled in Tier 1, the center of the lake was situated approximately 2 km from the source. To estimate "lake distance" adjustment factors for use in Tier 2, ICF completed a series of model runs in which the lake was located 10 km, 20 km, 30 km, and 40 km from the source. Accordingly, the bins used to classify lake distance are: 2–10 km, 10–20 km, 30–40 km, and >40 km. Facilities with lakes situated closer than 2 km or farther than 40 km from the source were assumed to have lakes at 2 km and 40 km, respectively.

In resituating the lake in these alternative configurations, ICF maintained ratios consistent with those included in the screening scenario for (1) lake area to total land area in the modeled domain, (2) runoff watershed area to lake area, and (3) erosion watershed area to lake area. Exhibit 1 provides a diagram of the TRIM.FaTE layout in each of the alternate lake distance simulations. ICF used a "thin" lake shape (i.e., downwind width much smaller than the cross-wind length) that minimized the potential effect of declining deposition with distance from stack that might affect lakes that are long in the downwind direction. By controlling for these potentially confounding effects, ICF could isolate the effect of lake distance on risk appropriately. Moving the lakes to increasing distances from the stack required expansion of the modeled domain. Maintaining the same overall ratio of land area to lake area in each domain resulted in scenarios with increasingly large lakes, with surface area increasing with distance from the source. This approach also was taken for reasons of configurational convenience (i.e., taking into account resource requirements associated with reconfiguring the TRIM.FaTE spatial layout). The changes in lake size between these four runs are not expected to have a substantial independent effect on exposure and risk because the effect of increased lake size is offset by greater total deposition and runoff. Furthermore, the lake depth was not changed, which is a much more important parameter than lake surface area in determining the chemical concentrations in the water column and sediment. As noted above, ICF set up the configurations to ensure that the lakes in the different scenarios received runoff and erosion from equivalent watersheds on a per surface area basis.

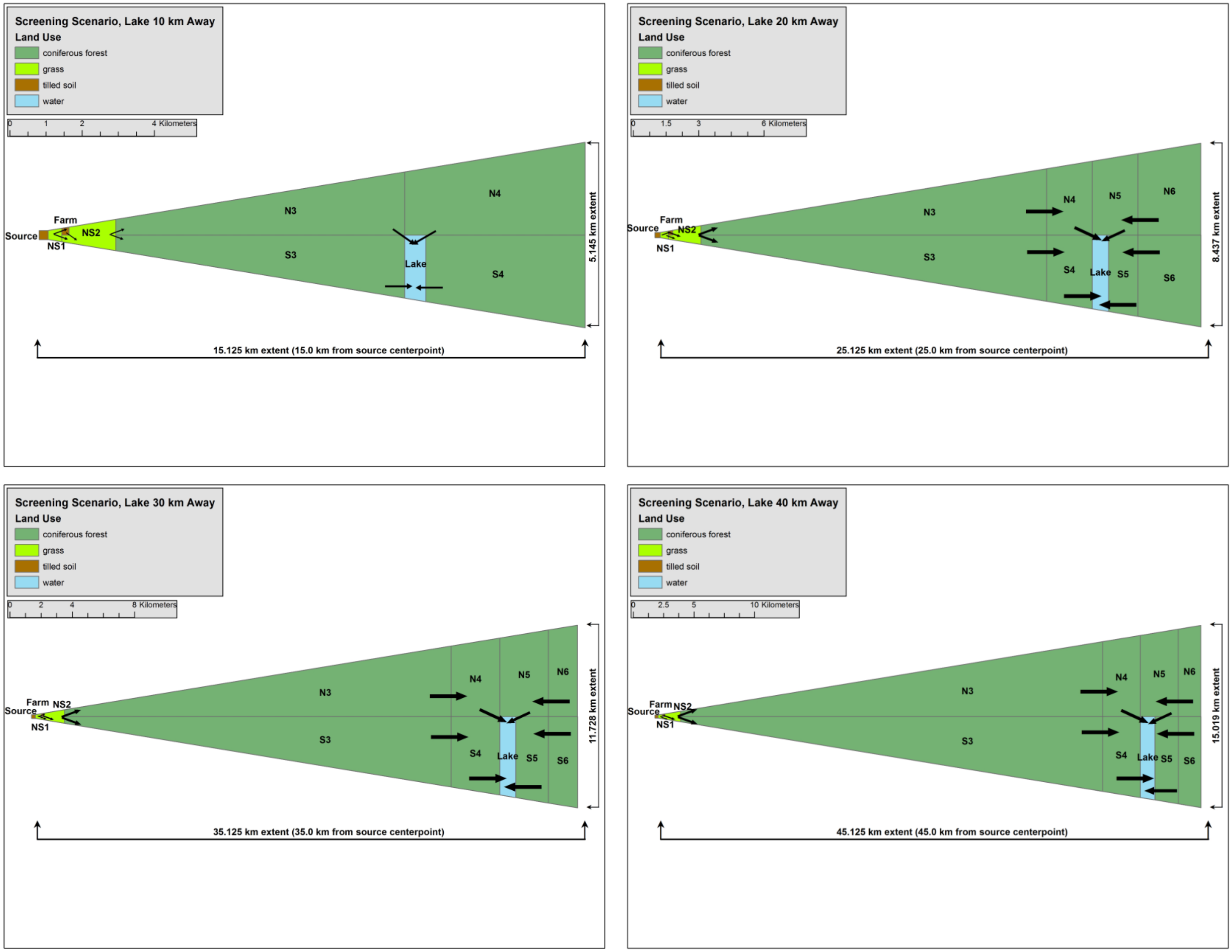
## 3.2 Estimation of Adjustment Factors

Adjustment factors were estimated and applied as multipliers to the Tier 1 emissions thresholds. The resulting Tier 2 emissions thresholds are used to assess whether facilities with corresponding configurations pose greater than acceptable risks. Facilities with emissions exceeding the resulting adjusted emission (Tier 2) thresholds would be deemed to have "failed" the Tier 2 screen (i.e., the potential for health risk of concern cannot be unequivocally ruled out).

### *3.2.1 General Approach*

The core principle in the estimation of adjustment factors is the assumption of direct proportionality of risk and emissions in the modeling approach used for RTR involving TRIM.FaTE and MIRC. Although not strictly present across all variations due to feedback mechanisms and other processes encompassed by the TRIM.FaTE model, a generally linear relationship between risk and emissions has been observed across model simulations conducted for RTR. This suggests that the ratio of total estimated exposures (and consequently risks) obtained for the screening scenario and any alternative configuration could be used as an adjustment factor to scale emissions for that specific alternative configuration. The risk in the alternative configuration following such a scaling of emissions would be equal to the risk in the screening scenario (which in Tier 1 was set at a risk level of 1E−6 incremental lifetime cancer risk or an incremental hazard quotient of 1, depending on the toxic effect of the chemical in question)

## Exhibit 1. Layouts for Tier 2 TRIM.FaTE Simulations Using Alternate Distances Between the Facility and the Fishable Lake



To account for potential interactions between the chosen Tier 2 variables, matrix adjustment factors were estimated by performing TRIM.FaTE runs for each unique combination of the specified variable values (that is, all permutations of the selected values for the wind speed, precipitation, mixing height, and lake distance). Wind direction was handled separately, as explained below. Implementing the approach required 320 runs per chemical. Adjustment factors for each configuration were then estimated as the ratio of risks in the Tier 1 analysis to the estimated risk in the particular TRIM.FaTE configuration. This approach results in a large matrix of adjustment factors and has the advantage of accounting for all possible interaction effects between the variables.

The adjustment factor for wind direction is handled separately. The fraction of the time the wind blows in the direction of the farm and lake was observed to have a directly linear effect on the resulting risk estimates. For this reason, it was not necessary to perform the actual TRIM.FaTE simulations for a set of values. Instead, it is calculated a linear factor that divides the Tier 1 value (0.43, or 43% of the time in the direction of the farm and lake) by the facility value, as follows:

Adjustment Factor $_{\text{Wind Direction}}$ = 0.43 / (fraction of time wind blows towards domain).

The adjustment factor for wind direction is multiplied by the matrix adjustment factor discussed above to obtain a consolidated threshold adjustment factor that accounts for all the five variables considered in Tier 2.

### *3.2.2 Incorporation of the Risk Equivalency Approach*

The adoption of a risk-equivalency approach to convert speciated emissions of PAHs and dioxins to BaP and TCDD equivalents, respectively, in Tier 1 required the development of risk equivalency factors (REFs) for each reported species in these groups. REFs for PAHs and dioxins represent the ratio of the risk posed by a particular species to the risk posed by BaP and TCDD, respectively, at equivalent emissions rates in a given scenario.

REFs can be represented as the product of exposure equivalency factors (EEFs) and toxicity equivalency factors (TEFs). For the PAHs, this can be expressed as:

$$REF_{PAH} = EEF_{PAH} \times TEF_{PAH}$$

EEFs for PAHs and dioxins represent the ratio of the exposure to a particular species to the exposure to BaP and TCDD, respectively, at equivalent emission rates in a given scenario. TEFs for PAHs and dioxins represent the ratio of the cancer slope factor (CSF) for a particular species to the CSF for BaP and TCDD, respectively.

EEFs are scenario-specific and depend on the TRIM.FaTE configuration. For example, the exposure profile (i.e., how ingestion pathways contribute to total exposure and risk) varies differently for each PAH when the lake is moved, owing to a larger or smaller contribution of fish ingestion to risk relative to the contribution of other ingestion pathways, such as consumption of produce and animal products. Thus, EEFs were recomputed for each of the 320 representative scenarios modeled in Tier 2 separately for 29 PAH species (14 based on direct TRIM.FaTE modeling and 15 based on $K_{ow}$-based regression estimates) and 19 dioxin species (17 based on direct TRIM.FaTE modeling and two assumed to behave like TCDD).

The following mathematical formulas demonstrate how the Tier 2 adjustment factors are estimated for the PAH and dioxin species. The formulas presented below are for a representative PAH species, but they can also be applied to dioxin species.

For a given PAH emitted at a rate $E_{PAH}$ at a facility, the risk-equivalent BaP emission level can be expressed as:

$$E_{BAP\ EQIV} = E_{PAH} \times EEF_{PAH} \times TEF_{PAH}$$

Then, the Tier 1 risk ratio is estimated by comparing the risk-equivalent BaP emissions to the BaP emission threshold:

$$Ratio_{TIER\ 1\_PAH} = \frac{E_{BAP\ EQUIV\_TIER\ 1}}{Threshold_{BAP\ TIER\ 1}}$$

If the ratio is less than 1, the facility “screens out” of the Tier 1 analysis. Similarly, for Tier 2, the ratio of risk-equivalent BaP emissions to the Tier 2 BaP threshold may be expressed as:

$$Ratio_{TIER\ 2\_PAH} = \frac{E_{BAP\ EQUIV\_TIER\ 2}}{Threshold_{BAP\ TIER\ 2}}$$

Using the definition of the risk-equivalent BaP emissions, this can be re-expressed for a given PAH species as:

$$Ratio_{Tier\ 2\_PAH} = \frac{E_{PAH} \times EEF_{PAH\_TIER\ 2} \times TEF_{PAH}}{Threshold_{BAP\ TIER\ 2}}$$

This expression may be further reconfigured, after some algebraic rearrangement, in terms of the Tier 1 ratio as:

$$Ratio_{Tier\ 2_{PAH}} = Ratio_{Tier\ 1_{PAH}} \times \frac{Threshold_{BAP\ TIER\ 1}}{Threshold_{BAP\ TIER\ 2}} \times \frac{EEF_{PAH\ TIER\ 2}}{EEF_{PAH\ TIER\ 1}}$$

$$Tier\ 2\ Adjustment\ Factor = \frac{Threshold_{BAP\ TIER\ 1}}{Threshold_{BAP\ TIER\ 2}} \times \frac{EEF_{PAH\ TIER\ 2}}{EEF_{PAH\ TIER\ 1}}$$

These equations simply state that to adjust the Tier 1 threshold to a Tier 2 threshold for a PAH species, the adjustment factor must include the ratio of the BaP Tier 1 and 2 thresholds (as for all chemicals, as discussed above) *and* the ratio of the EEFs for the particular PAH in Tier 2 and Tier 1. This additional EEF factor is needed to account for the fact that the EEFs are different for each Tier 2 TRIM.FaTE configuration.

Finally, the ratio of total BaP equivalents contributed by all PAH species at a given facility to the BaP Tier 2 threshold may be expressed, by summing the above expression, as:

$$Ratio_{Tier\ 2\_PAH\_All} = \sum^{All\ PAHs} Ratio_{Tier\ 1\_PAH} \times \frac{Threshold_{BAP\ TIER\ 1}}{Threshold_{BAP\ TIER\ 2}} \times \frac{EEF_{PAH\ TIER\ 2}}{EEF_{PAH\ TIER\ 1}}$$

If the ratio of total BaP equivalents contributed by all PAH species to the BaP Tier 2 threshold is greater than 1, the facility would be deemed to have failed the Tier 2 screen for the PAH group.

# 4 Preparing National Databases of Lake and Meteorological Data

To facilitate the effective application of the Tier 2 screening procedures, databases were prepared containing national-scale information about lakes (locations and sizes) and meteorological data at available surface stations (including average wind direction, wind speed, precipitation, and estimated mixing height). The development and content of these two databases are discussed in the following sections.

## 4.1 Processing Lake Data for Tier 2 Analysis

The lake database was built using a geospatial file provided by ESRI for their ArcGIS products, the “U.S. Water Bodies” geospatial file in the ESRI Data & Maps 2009 Data Update for ArcGIS version 9.3.1. The water body geospatial data were derived by the United States Geological Survey (USGS), EPA, and ESRI from the USGS National Hydrography Dataset (USGS 2012). Because this geospatial file excluded water bodies in Alaska, Puerto Rico, and the U.S. Virgin Islands, it was augmented with water body information (also from the USGS National Hydrography Dataset) for those other locations. The data represent 2004 and generally have an estimated horizontal accuracy of 50 m. For the Tier 2 analysis, ICF focused on the 432,950 water bodies classified as “Lake/Pond” or “Reservoir” but not designated for disposal, evaporation, or treatment. We refer to these water bodies simply as “lakes” in the remainder of this document. The approximately 99,192 other water bodies (classified as canal/ditch, ice mass, inundation area, playa, stream/river, swamp marsh, or unclassified) were not included. In a more subjective step during the processing of the lake database for a specific source category, the lake names (when provided) are scrutinized manually, and lakes are removed from the analysis when their names suggest industrial or treatment use (e.g., wastewater treatment ponds, sludge ponds, fly ash ponds, paper mill ponds, sewage pools, etc.).

Early in the process of compiling this database, ICF encountered the question: “What size water body qualifies as a ‘lake’ for the purposes of this assessment?” The Tier 2 analysis must focus on lakes large enough to support relatively intensive angling pressure to be compatible with the characteristics inherent to the assumed exposure scenario. To estimate the relationship between fish consumption at a high level, harvest rates, and lake size, the following key assumptions were made. Information and citations to peer-reviewed literature that support these assumptions are provided in Supplement B to this document. Note that in the TRIM.FaTE model screening scenario, trophic level 3 fish (T3) assumed to be consumed by anglers are represented by benthic carnivores (BC) and trophic level 4 fish (T4) assumed to be consumed by anglers are represented by water column carnivores (WCC). Together, these two trophic levels are referred to as piscivorous fish.

1. Piscivorous fish, when present, comprise approximately 21 percent of the standing biomass of fish in an annual average. T3 fish represent 17.5 percent of the standing fish biomass; T4 fish account for 3.5 percent of this total fish biomass. Thus, T4 fish, when present, represent the limiting compartment for angler fish harvesting and consumption.

2. Humans can harvest 10 percent of the T4 biomass without threatening the population due to overharvesting.

3. The minimum viable effective population size for a single T4 species is at least 50 adult fish for a local population to survive over the short term (more than a decade).

4. Only 33 percent of a T4 fish is edible fillet muscle. A 0.33 edible fraction is used to estimate total fish biomass associated with human consumption.

5. A productivity level of 40 g wet weight/m$^2$ represents an approximate upper bound for natural ponds and lakes in the United States.

Using the above assumptions and a series of equations (see Supplement B), the maximum fish ingestion rates as a function of standing biomass and lake size were estimated. Exhibit 2 presents these findings, where the shading in the exhibit provides an indication of where short- and longer term sustainable fishing is expected to occur (see exhibit notes).

The Tier 2 analysis is intended to retain most of the health-protective attributes of the screening scenario used in Tier 1 so that no facilities of potential concern erroneously pass the screen. For a given facility, the smaller the lake size threshold, the greater the number of lakes and the greater the probability that a lake is closer to the facility. Lakes closer to a facility will result in higher fish concentrations compared with lakes farther from the facility. Thus, Exhibit 2 was used to determine the smallest lake size that would support a T4 population. At the assumed upper-limit standing fish biomass of 40 g ww/m$^2$, this corresponds to 25 acres (the first “white” box when moving from smaller to larger lakes). Thus, a lake size threshold of 25 acres was used. The final database included 117,842 lakes with surface areas of at least 25 acres but smaller than 100,000 acres.

The ingestion rate supported by a 25-acre lake is not as high as the adult ingestion rate used in the Tier 1 and Tier 2 analyses for subsistence anglers (i.e., 26 g ww fillet per day in a 25-acre lake compared with 78.13 g ww fillet per day in the Tier 1 analysis). However, because the lake correction will also be used in Tier 3 where a wider range of ingestion rates will be considered, the decision was made to use the smallest lake size that supported an upper trophic level population without explicitly linking the lake size with the subsistence angler ingestion rate.

To place an upper bound on the radial distance from the source up to which lake-derived risks need to be assessed, ICF performed a series of analyses that examined how lake-derived risks declined with lake distance at alternative emission rates. Exhibits 3 through 6 present the results of these analyses. To put these graphs in perspective, ICF superimposed the percentiles corresponding to each emission rate based on actual emissions data from all available source categories. For mercury and cadmium, these analyses suggested that a negligible number of facilities reported emissions at high enough levels that would continue to pose a risk beyond 50 km. For BaP and TCDD, results indicate that lake risks beyond 50 km would continue to be significant for a sizeable number of facilities. However, performing a site-specific Tier 4 analysis beyond 50 km would not be feasible, given the limitations to the accuracy of TRIM.FaTE results beyond this distance. Based on these considerations, ICF limited the lake analysis to an outward radial bound of 50 km from the stack. For facilities with no lakes within 50 km, we used the health-protective approach of assuming a lake at 50 km.

## Exhibit 2. Maximum Fish Ingestion Rate (g/day) Associated with Sustainable Fishing[a]

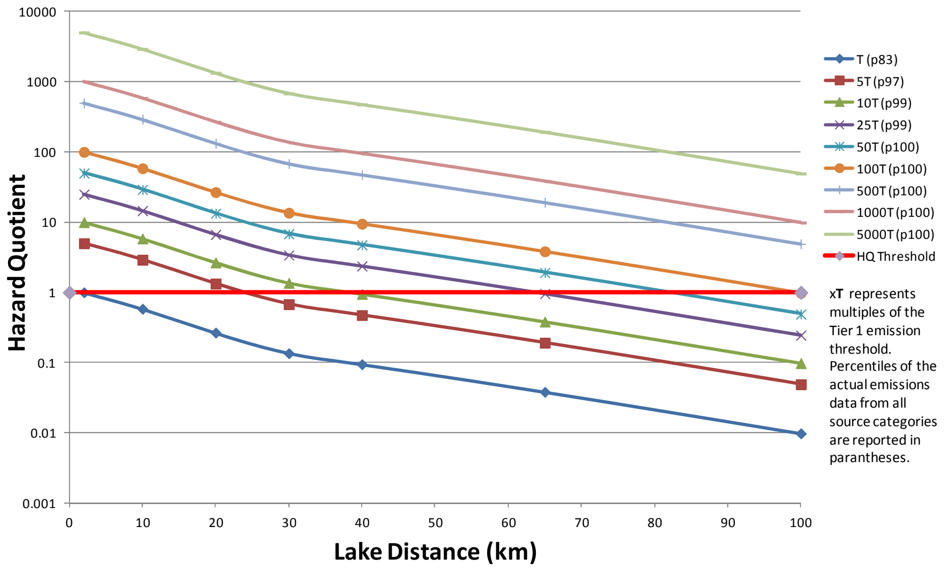
| Standing Biomass (g ww/m$^2$)[b] | Size of Pond or Lake (acres) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 7.5 | 10 | 15 | 25 | 35 | 50 | 75 | 100 | 150 | 200 | 400 |
| 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 2 | 3 | 4 | 5 | 8 | 10 | 20 |
| 3 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 2 | 3 | 4 | 6 | 8 | 12 | 15 | 31 |
| 4 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 2 | 3 | 4 | 5 | 8 | 10 | 15 | 20 | 41 |
| 5.7 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 2 | 4 | 5 | 7 | 11 | 15 | 22 | 29 | 58 |
| 10 | 0 | 1 | 1 | 1 | 1 | 2 | 3 | 4 | 6 | 9 | 13 | 19 | 26 | 38 | 51 | 102 |
| 15 | 0 | 1 | 1 | 2 | 2 | 3 | 4 | 6 | 10 | 13 | 19 | 29 | 38 | 58 | 77 | 154 |
| 20 | 1 | 1 | 2 | 2 | 3 | 4 | 5 | 8 | 13 | 18 | 26 | 38 | 51 | 77 | 102 | 205 |
| 30 | 1 | 2 | 2 | 3 | 4 | 6 | 8 | 12 | 19 | 27 | 38 | 58 | 77 | 115 | 154 | 307 |
| 35 | 1 | 2 | 3 | 4 | 4 | 7 | 9 | 13 | 22 | 31 | 45 | 67 | 90 | 134 | 179 | 359 |
| 40 | 1 | 2 | 3 | 4 | 5 | 8 | 10 | 15 | 26 | 36 | 51 | 77 | 102 | 154 | 205 | 410 |
| 50 | 1 | 3 | 4 | 5 | 6 | 10 | 13 | 19 | 32 | 45 | 64 | 96 | 128 | 192 | 256 | 512 |
| 60 | 2 | 3 | 5 | 6 | 8 | 12 | 15 | 23 | 38 | 54 | 77 | 115 | 154 | 231 | 307 | 615 |
| 70 | 2 | 4 | 5 | 7 | 9 | 13 | 18 | 27 | 45 | 63 | 90 | 134 | 179 | 269 | 359 | 717 |
| 80 | 2 | 4 | 6 | 8 | 10 | 15 | 20 | 31 | 51 | 72 | 102 | 154 | 205 | 307 | 410 | 820 |
| 90 | 2 | 5 | 7 | 9 | 12 | 17 | 23 | 35 | 58 | 81 | 115 | 173 | 231 | 346 | 461 | 922 |
| 100 | 3 | 5 | 8 | 10 | 13 | 19 | 26 | 38 | 64 | 90 | 128 | 192 | 256 | 384 | 512 | 1025 |
| 110 | 3 | 6 | 8 | 11 | 14 | 21 | 28 | 42 | 70 | 99 | 141 | 211 | 282 | 423 | 563 | 1127 |
| 120 | 3 | 6 | 9 | 12 | 15 | 23 | 31 | 46 | 77 | 108 | 154 | 231 | 307 | 461 | 615 | 1229 |
| 130 | 3 | 7 | 10 | 13 | 17 | 25 | 33 | 50 | 83 | 117 | 166 | 250 | 333 | 499 | 666 | 1332 |

[a] Dark gray shading indicates insufficient population size for T4 (WCC) fish (<50 adults) to be sustainable for more than a decade; yellow-shaded cells indicate the likelihood to provide long-term sustainable fish populations with at least 500 T4 adult fish present; white area indicates medium-term sustainability.

[b] Represents the standing biomass of T4 fish. At the upper-limit standing biomass of 40 g ww/m$^2$, a lake that is 25 acres in size would sustain a maximum fish ingestion rate of 26 g/day for a single angler.

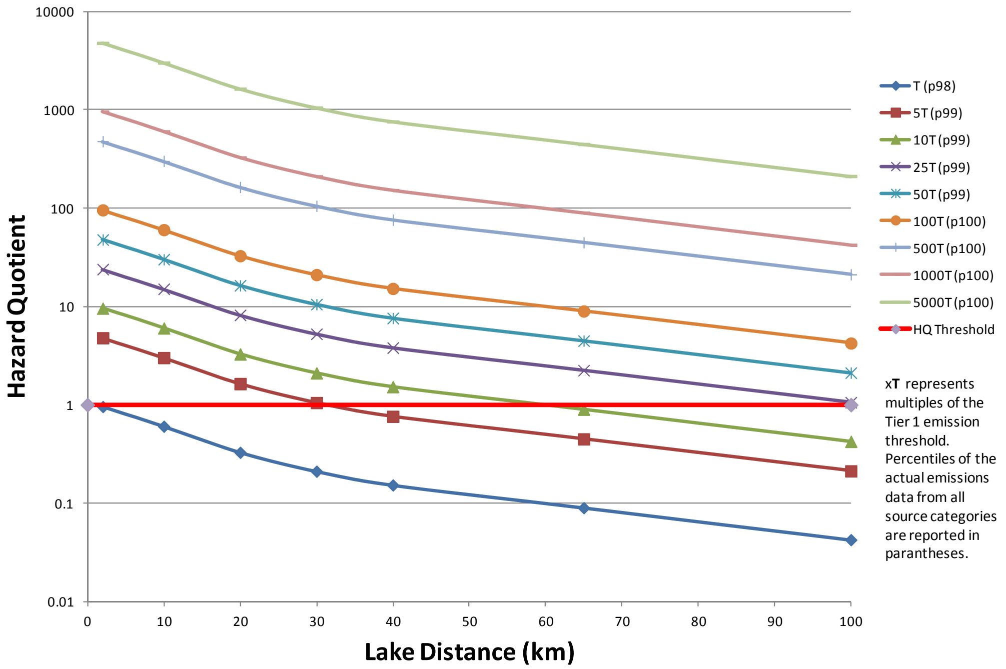
Exhibits 3 through 6 present ICF's lake distance analyses for mercury, cadmium, 2,3,7,8- TCDD and BaP.

### Exhibit 3. Lake Distance – Hazard Relationship for Mercury



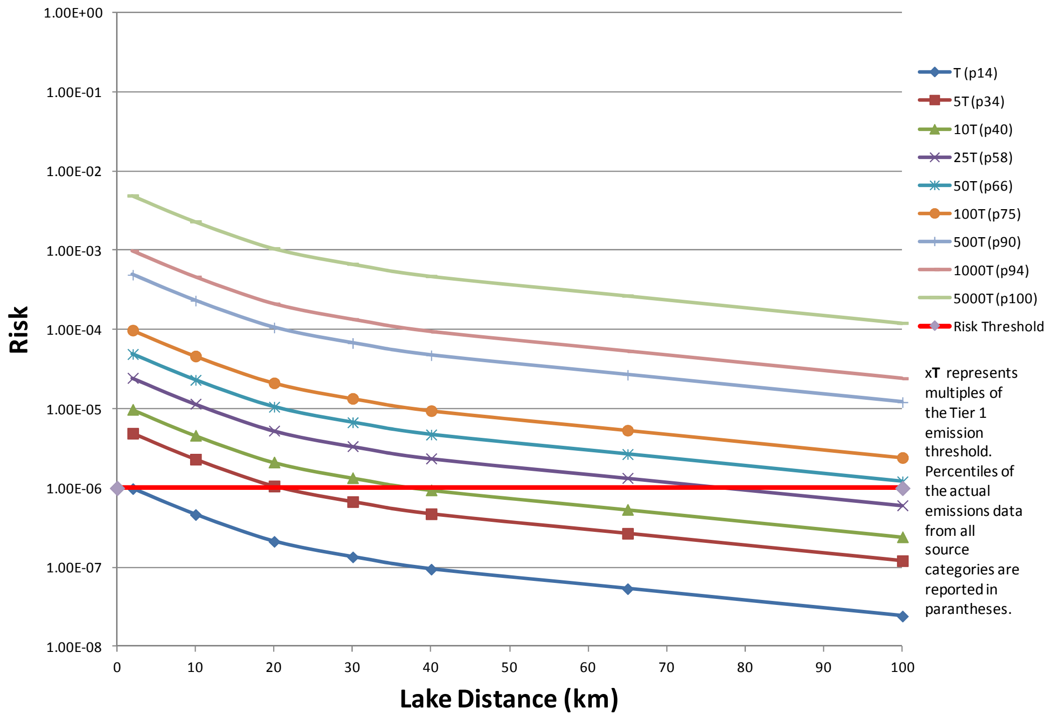
**xT** represents multiples of the Tier 1 emission threshold. Percentiles of the actual emissions data from all source categories are reported in parantheses.

### Exhibit 4. Lake Distance – Hazard Relationship for Cadmium

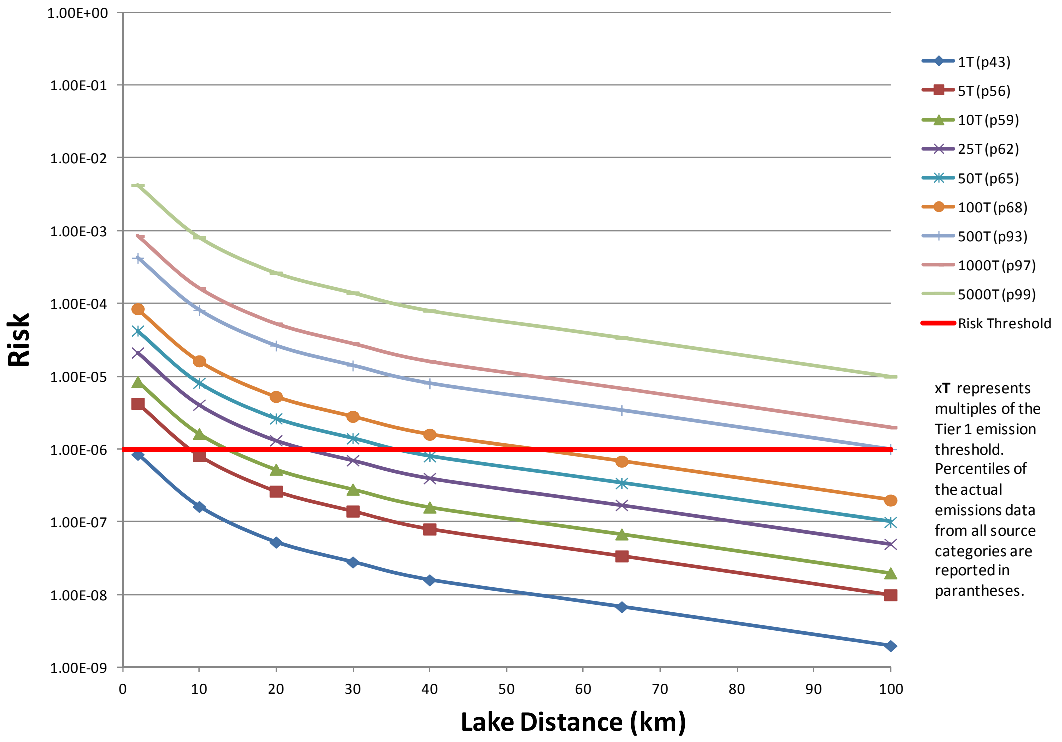


**xT** represents multiples of the Tier 1 emission threshold. Percentiles of the actual emissions data from all source categories are reported in parantheses.

## Exhibit 5.  Lake Distance – Risk Relationship for 2,3,7,8 - TCDD



## Exhibit 6.  Lake Distance – Risk Relationship for Benzo(a)pyrene



## 4.2 Processing Meteorological Data for Tier 2 Analysis

In addition to the lake database, a database of average meteorological data at U.S. surface stations with complete data was created, so that each source category facility can be paired with the closest meteorological station data. This process of pairing dozens or hundreds of facilities with meteorological data is not unprecedented. In their report to the Science Advisory Board (SAB) on the 1996 NATA, EPA described pairing each facility with the closest meteorological station in an inventory of over 350 meteorological stations nationwide, creating an average facility-to-station distance of less than 50 km in the 1996 NATA (EPA 2001b). In a separate 2009 report to the SAB on the RTR program, EPA described using 158 meteorological stations to choose from nationwide, with a standard practice of selecting the station nearest to each facility unless the facility provides onsite meteorological data (EPA 2009). Using 156 petroleum refineries as a sample data set, the average facility-to-station distance was 72 km. In both instances, the SAB accepted this matching as standard practice when modeling large numbers of sources, although they recommended providing high-level siting maps (e.g., meteorological stations overlaid with terrain gradients or regional climate regimes) to qualify some of the uncertainties related to meteorological data in air dispersion modeling (EPA 2001a; EPA 2010a). The current effort builds on this practice but increases the number of available meteorological stations as described below.

### *4.2.1 Sources of Meteorological Data*

To construct a database of average meteorological data for all available surface stations in the United States, EPA obtained surface meteorological data from the Quality Controlled Local Climatological Data (QCLCD), available from the National Climatic Data Center (NCDC 2012). The processing began with the approximately 2,090 stations located in any of the 50 states plus Puerto Rico and the U.S. Virgin Islands with at least some data in the 5-year period of 2006 through 2010. ICF narrowed the stations to consider the 1,709 stations with data at both the beginning and end of the period. In addition, owing to significant amounts of missing data at the end of 2010, ICF discarded this year of data from the analysis. During the processing of these 1,709 stations (described later in this section), ICF removed 329 (19 percent) additional stations because of large amounts of missing wind data during the 4-year period. The criteria for removing these 329 stations are described later in this section.

In the QCLCD data, many stations had unreliable or largely missing precipitation data. The numeric or text flag used to indicate missing data was not consistent, making automated processing of the whole dataset with respect to this one variable difficult. To reduce the uncertainty in the precipitation estimates, ICF used average annual precipitation data from the 1981−2010 National Climatic Data Center 30-year normal dataset wherever possible. ICF matched the 30-year normal precipitation data to 992 of the remaining QCLCD stations. Among the remaining 385 stations without clear matches to the 30-year normal dataset, ICF removed 72 (5 percent of total stations) from processing because they had no precipitation data from QCLCD. The remaining 316 stations used the values estimated from the QCLCD data. The final dataset contained 1,308 surface metrological stations for 2005 through 2009, which is far greater than the 350 and 158 stations, respectively, used in the 1996 NATA report (EPA 2001b) and the 2009 RTR report (EPA 2009).

The QCLCD surface meteorological data alone cannot provide information on mixing heights, which must be estimated from upper air measurements. EPA's Support Center for Regulatory Atmospheric Modeling archived estimated morning and afternoon mixing heights at 76 locations across the 50 states and Puerto Rico corresponding to years 1984 through 1991 where possible

(EPA 2010b). The data in the 4-year period of 1987 through 1990 was averaged into one annual average morning mixing height and one annual average afternoon mixing height for the Tier 2 analysis. Each surface meteorological station was paired with its closest mixing height location, leading to 68 mixing height locations being matched with surface stations (the remaining 8 were not the closest locations to any surface station). At this time, these pairings of surface meteorological stations with mixing height locations were not further scrutinized.

### *4.2.2 Coverage of Meteorological Stations Compared with Facility Locations*

The locations of the 1,308 surface meteorological stations and 68 mixing height locations used in this methodology are shown in Exhibit 7. For illustrative purposes only, the locations of the 65,292 U.S. point source facilities in the 2005 NATA are also shown in Exhibit 7 so that the spatial coverage of the surface meteorological stations used in this methodology can be compared to the spatial coverage of most of the point source facilities that might undergo an RTR multipathway analysis in the future.[8] Generally, the spatial density of the surface meteorological stations in this methodology was similar to the spatial density of the 2005 NATA facilities. That is, the density tends to be greatest in the Great Lakes region, along the East and West Coasts, and in the Southern Plains, and tends to be lowest in the Rockies (except Colorado) and Northern Plains.

Exhibit 8 again shows each of the 65,292 U.S. point source facilities from the 2005 NATA, and the location markers are shaded and sized according to how far the facility is from the closest of the surface meteorological stations used in this methodology. The average and median distances are 21 km and 15 km, respectively, between a facility and its closest surface meteorological station with complete data. This average distance is far smaller than the average distance between the petroleum refining facilities and meteorology stations used in the 2009 RTR report (72 km; EPA 2009) and is likely much smaller than the average distance between all facilities and meteorological stations used in the 1996 NATA (less than 50 km; EPA 2001b). Approximately 32 percent of facilities are less than 10 km from a surface meteorological station, while 29 percent are between 10 and 20 km, 7 percent are farther than 50 km, and less than 1 percent are farther than 100 km.

### *4.2.3 Data Processing*

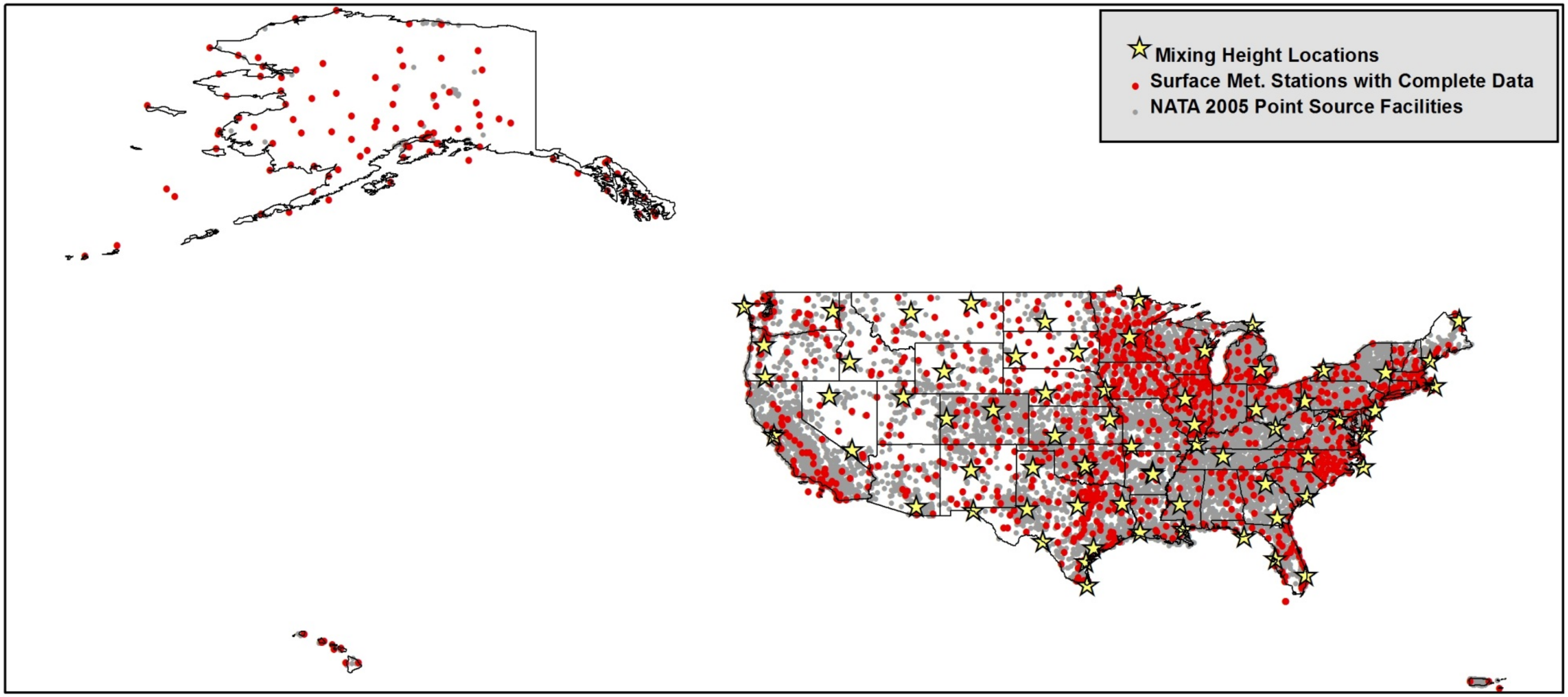
To facilitate application of the meteorological data to the Tier 2 analysis, EPA gathered wind information in directional octants that could be linked to the direction of the closest lake (see Introduction and Section 5). EPA divided the periphery around a meteorological station into eight octants representing the direction toward which the wind was blowing:

N: >337.5 to 22.5 degrees
NE: >22.5 to 67.5 degrees
E: >67.5 to 112.5 degrees
SE: >112.5 to 157.5 degrees
S: >157.5 to 202.5 degrees
SW: >202.5 to 247.5 degrees
W: >247.5 to 292.5 degrees
NW: >292.5 to 337.5 degrees

---

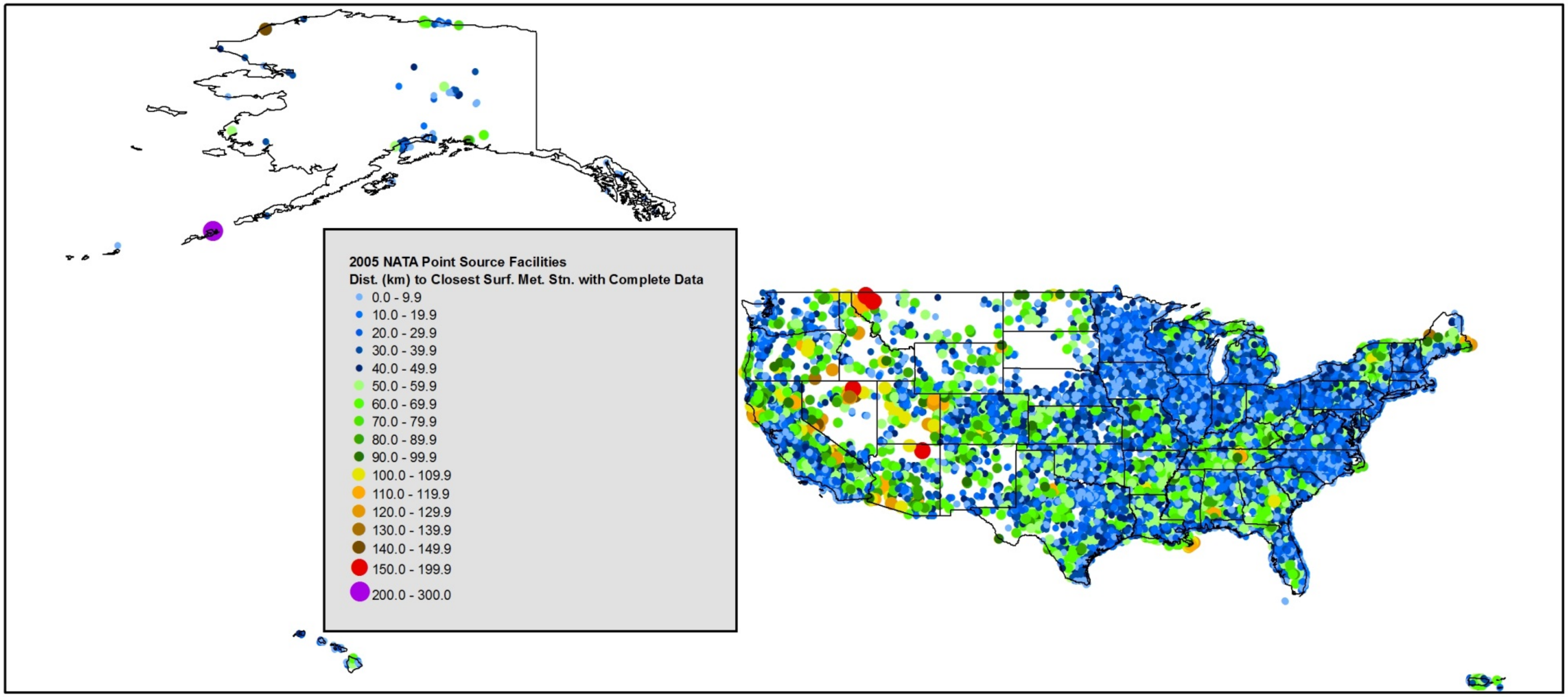
[8] The 2005 NATA was the most recent, comprehensive, finalized dataset of nationwide point source emitters of hazardous air pollutants, and is used here only for illustrative purposes. The 2005 NATA used a meteorological dataset different from the one used in this report.

**Exhibit 7. Locations of Meteorological Stations and Point Source Facilities**[a]



[a]The 2005 NATA was the most recent, comprehensive, finalized dataset of nationwide point source emitters of hazardous air pollutants, and it is used here only for illustrative purposes. The 2005 NATA used a meteorological dataset different from the one used in this report.

**Exhibit 8. Distance Between the Point Source Facilities and the Closest Meteorological Station[a,b]**



[a] The high spatial density of facilities in some areas (e.g., the Great Lakes area) causes some facility dots to be plotted on top of other facility dots. In these areas, most or all stations might appear to have distances of a certain range (e.g., less than 50 km, denoted by blue shades), when in fact some other distance values (e.g., at least 50 km but less than 100 km, denoted by green shades) might also be present but are not visible.

[b] The 2005 NATA was the most recent, comprehensive, finalized dataset of nationwide point source emitters of hazardous air pollutants, and it is used here only for illustrative purposes. The 2005 NATA used a meteorological dataset different from the one used in this report.

Using the data for each of the 1,308 surface meteorological stations (with proximity-matched mixing height data), EPA developed a software program to calculate the following statistics for each station-month combination in the 4-year period of surface meteorological data:

- Number of hourly observations,
- Number of hours with calm winds or missing winds,
- Number of hours the wind was blowing into each directional octant,
- Average wind speed blowing into each octant, and
- Total precipitation (irrespective of wind octant and preferring 30-year normal data if available).

This program then calculated the following statistics for each station's period of record, using the above monthly totals and averages:

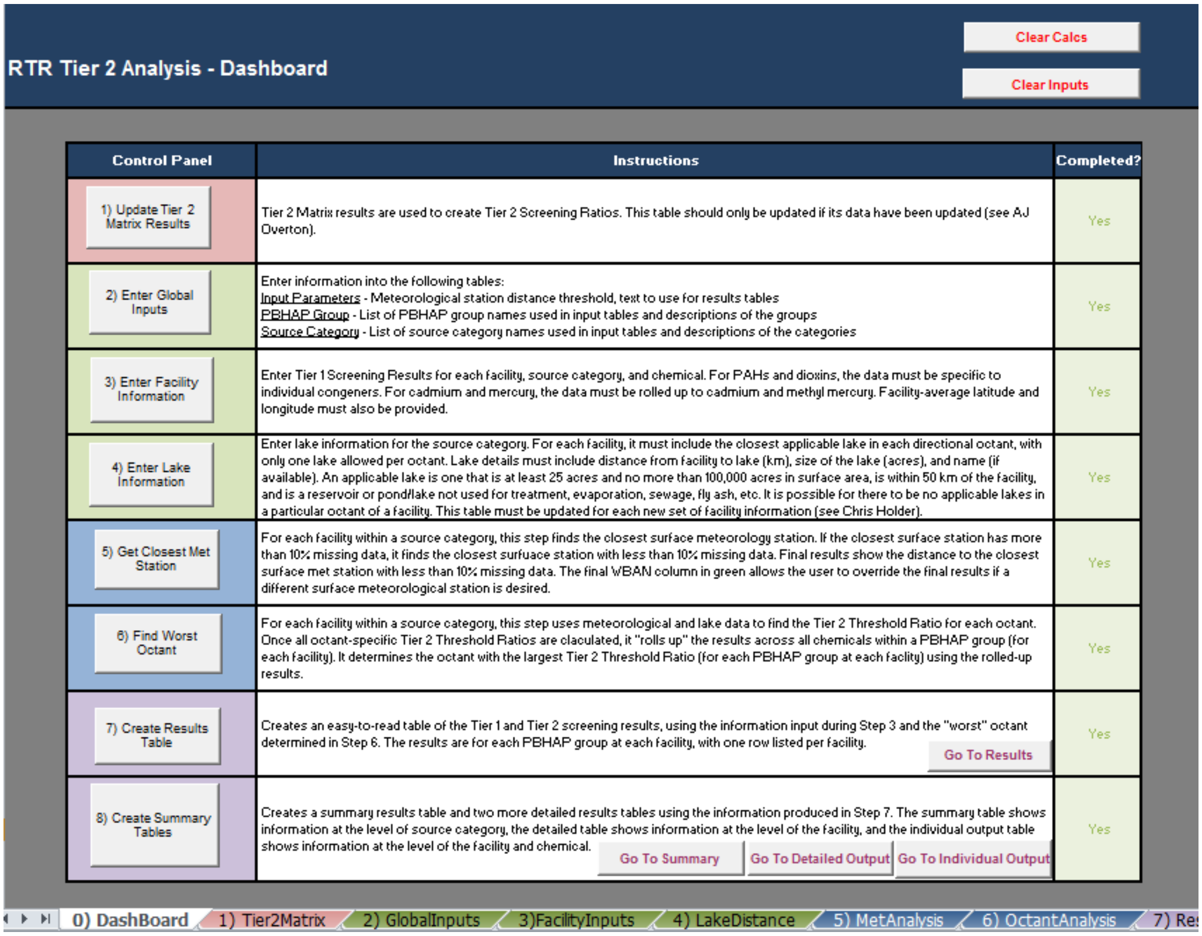
- Number of months with more than 10 percent of hours missing wind data,
- Percentage of time the wind blows into each octant (after excluding missing wind hours),
- Median wind speed when wind was blowing into each octant,
- Average annual precipitation at the station, and
- Average mixing height at the matched upper air station (averaged between morning and afternoon mixing height values).

The program flags a station if its total number of months missing 10 percent or more of QLCLD data is greater than 4 (i.e., greater than 10 percent of the 4-year period of record) or if no annual precipitation data are reported over the 4-year period; that station is not used in Tier 2 analysis. As stated earlier in this section, 401 of the original 1,709 stations were removed because of missing wind or precipitation data.

# 5 Implementation of Tier 2 Analysis

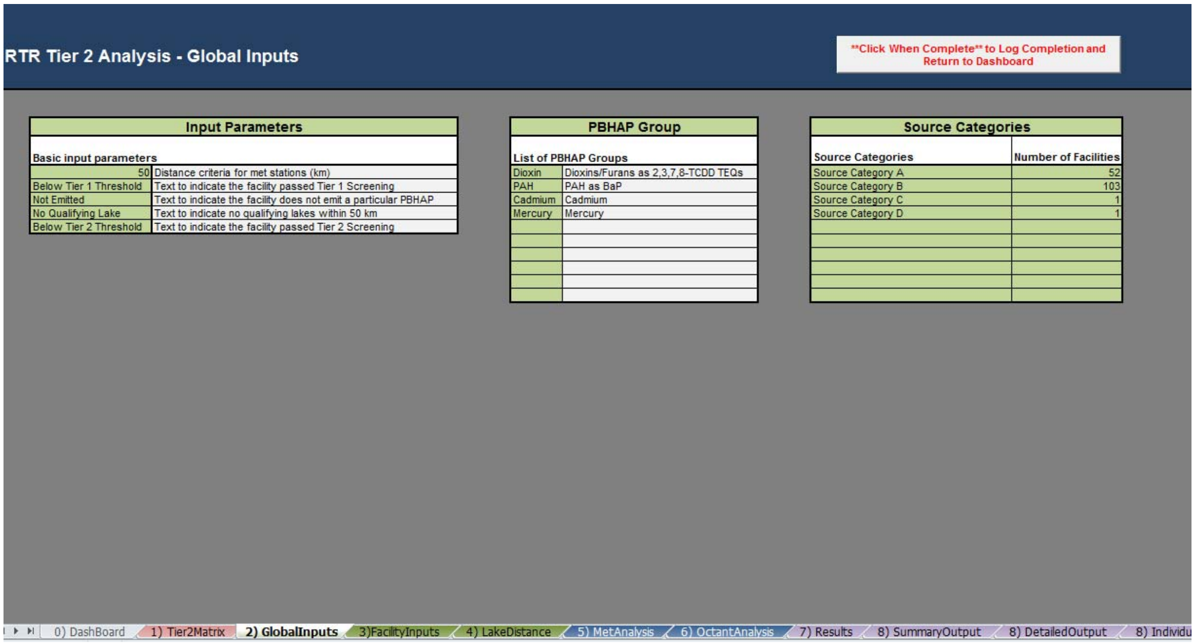
The Tier 2 screening analysis is implemented using a Microsoft ® Excel tool. The tool has two main functions: 1) finding the closest surface meteorological station to a facility, and 2) calculating Tier 2 threshold values. The tool is created so that all facilities in multiple source categories can be screened at once, if desired. The tool is controlled by a dashboard control panel (see Exhibit 9), where each of 8 sequential steps are controlled by a button on the panel. From the dashboard, the user is prompted to enter data on four worksheets. Steps 1 and 2 are user input steps to prepare the tool for the analysis. In Step 1, the user verifies that the Tier 2 matrix results developed using the TRIM.FaTE model are current. In Step 2, the user enters basic 'global inputs' that include the PB-HAP groups and source categories included in the analysis (Exhibit 10). Steps 1 and 2 on the dashboard should be performed prior to the start of any analysis to ensure that the user is using the most current information. Two additional input tables are created using the Tier 1 Microsoft Access screening tool and the ArcGIS ® lake database (see Section 3.1), as described in Sections 5.1 and 5.2 below. Once these tables are created, the user enters the associated data in steps 3 and 4, respectively. After all these input data have been supplied, steps 5 and 6 conduct the Tier 2 analysis and steps 7 and 8 produce output tables that summarize the results, as described in Sections 5.3 and 5.4.

## Exhibit 9.  Example of the Dashboard To Conduct the Tier 2 Analysis



| Control Panel | Instructions | Completed? |
|---|---|---|
| 1) Update Tier 2 Matrix Results | Tier 2 Matrix results are used to create Tier 2 Screening Ratios. This table should only be updated if its data have been updated (see AJ Overton). | Yes |
| 2) Enter Global Inputs | Enter information into the following tables:<br>Input Parameters - Meteorological station distance threshold, text to use for results tables<br>PBHAP Group - List of PBHAP group names used in input tables and descriptions of the groups<br>Source Category - List of source category names used in input tables and descriptions of the categories | Yes |
| 3) Enter Facility Information | Enter Tier 1 Screening Results for each facility, source category, and chemical. For PAHs and dioxins, the data must be specific to individual congeners. For cadmium and mercury, the data must be rolled up to cadmium and methyl mercury. Facility-average latitude and longitude must also be provided. | Yes |
| 4) Enter Lake Information | Enter lake information for the source category. For each facility, it must include the closest applicable lake in each directional octant, with only one lake allowed per octant. Lake details must include distance from facility to lake (km), size of the lake (acres), and name (if available). An applicable lake is one that is at least 25 acres and no more than 100,000 acres in surface area, is within 50 km of the facility, and is a reservoir or pond/lake not used for treatment, evaporation, sewage, fly ash, etc. It is possible for there to be no applicable lakes in a particular octant of a facility. This table must be updated for each new set of facility information (see Chris Holder). | Yes |
| 5) Get Closest Met Station | For each facility within a source category, this step finds the closest surface meteorology station. If the closest surface station has more than 10% missing data, it finds the closest surfuace station with less than 10% missing data. Final results show the distance to the closest surface met station with less than 10% missing data. The final WBAN column in green allows the user to override the final results if a different surface meteorological station is desired. | Yes |
| 6) Find Worst Octant | For each facility within a source category, this step uses meteorological and lake data to find the Tier 2 Threshold Ratio for each octant. Once all octant-specific Tier 2 Threshold Ratios are claculated, it "rolls up" the results across all chemicals within a PBHAP group (for each facility). It determines the octant with the largest Tier 2 Threshold Ratio (for each PBHAP group at each faclity) using the rolled-up results. | Yes |
| 7) Create Results Table | Creates an easy-to-read table of the Tier 1 and Tier 2 screening results, using the information input during Step 3 and the "worst" octant determined in Step 6. The results are for each PBHAP group at each facility, with one row listed per facility. | Yes |
| 8) Create Summary Tables | Creates a summary results table and two more detailed results tables using the information produced in Step 7. The summary table shows information at the level of source category, the detailed table shows information at the level of the facility, and the individual output table shows information at the level of the facility and chemical. | Yes |

## Exhibit 10.  Example of Global Inputs Used in the Tier 2 Analysis



**Input Parameters**

| Basic input parameters | |
|---|---|
| 50 | Distance criteria for met stations (km) |
| Below Tier 1 Threshold | Text to indicate the facility passed Tier 1 Screening |
| Not Emitted | Text to indicate the facility does not emit a particular PBHAP |
| No Qualifying Lake | Text to indicate no qualifying lakes within 50 km |
| Below Tier 2 Threshold | Text to indicate the facility passed Tier 2 Screening |

**PBHAP Group**

| List of PBHAP Groups | |
|---|---|
| Dioxin | Dioxins/Furans as 2,3,7,8-TCDD TEQs |
| PAH | PAH as BaP |
| Cadmium | Cadmium |
| Mercury | Mercury |

**Source Categories**

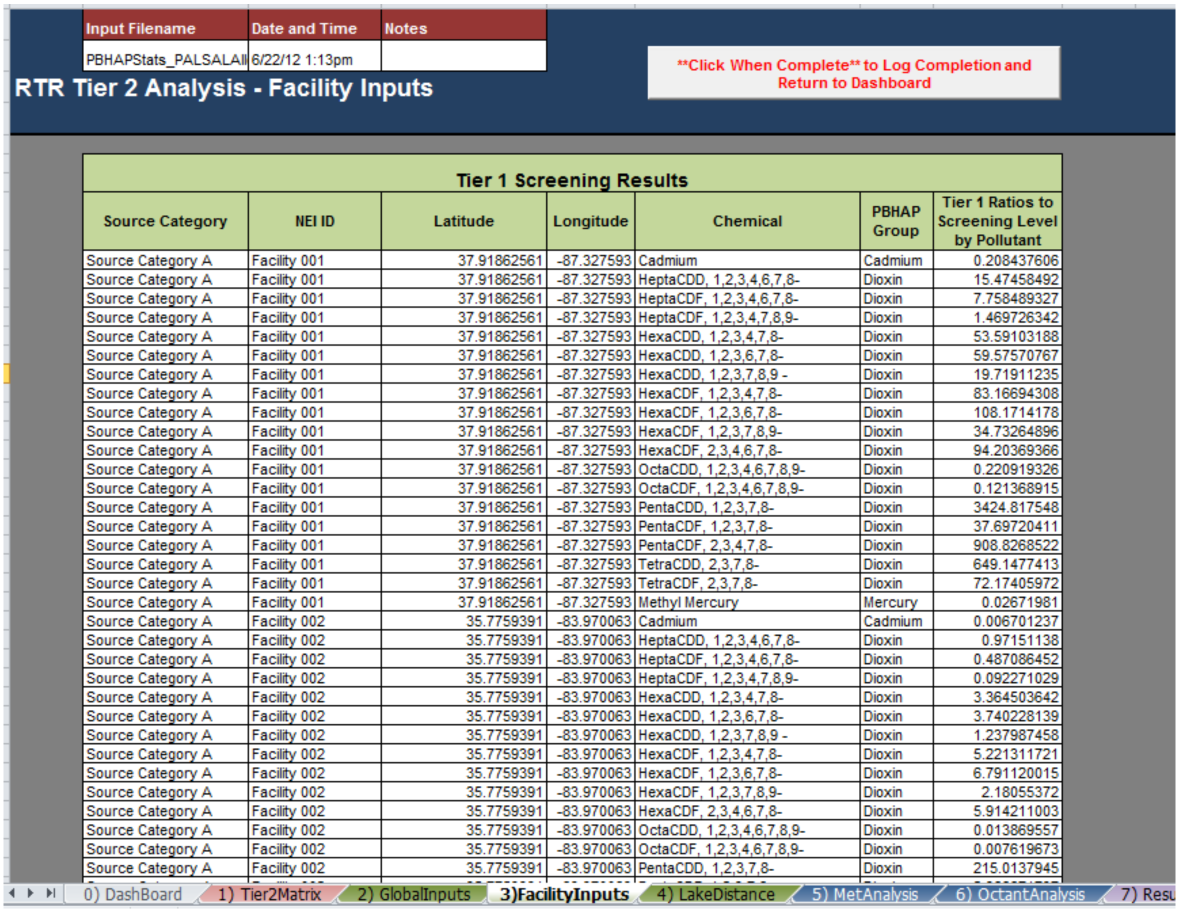
| Source Categories | Number of Facilities |
|---|---|
| Source Category A | 52 |
| Source Category B | 103 |
| Source Category C | 1 |
| Source Category D | 1 |

To facilitate explanation of the Tier 2 analysis implementation, example source categories with hypothetical PB-HAP emissions were run through the tool and screen shots including these results are provided to illustrate the overall 8-step process.

## 5.1 Facility List for Tier 2 Screen (Step 3)

After clicking Button 3 on the dashboard, the user is brought to the facility input sheet to enter a list of all facilities in a source category (or multiple source categories) with emissions above the Tier 1 thresholds for any PB-HAP group. Included in this list are the average latitude and longitude of the emission sources at the facility, the list of chemicals emitted (and their respective PB-HAP groups), and the ratio of the REF-adjusted emission rate to the Tier 1 screening threshold for each chemical within a PB-HAP group. This table is generated using the Tier 1 Microsoft® Access screening tool, and it is pasted into the “3) Facility Inputs” sheet of the Excel tool, as shown in Exhibit 11.

**Exhibit 11. Example of the Facility Input Data Required To Conduct the Tier 2 Analysis**



| Input Filename | Date and Time | Notes |
|---|---|---|
| PBHAPStats_PALSALAll | 6/22/12 1:13pm | |

**RTR Tier 2 Analysis - Facility Inputs**

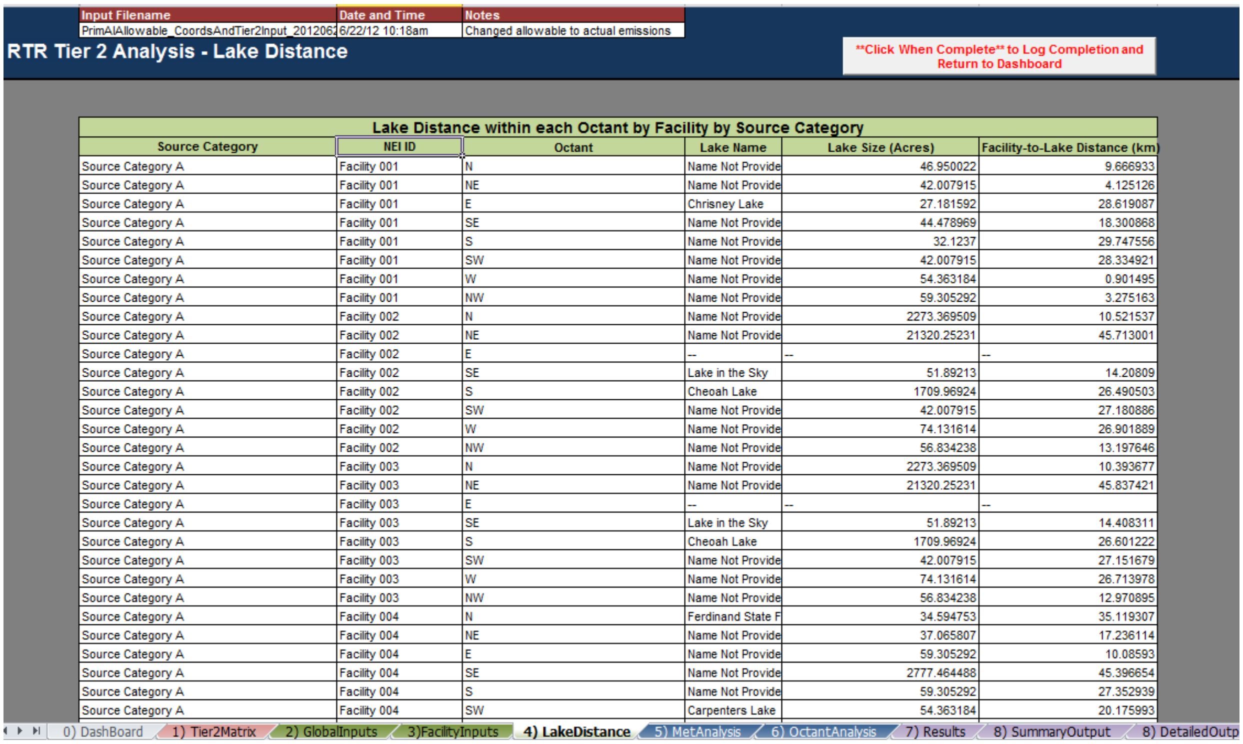
**Tier 1 Screening Results**

| Source Category | NEI ID | Latitude | Longitude | Chemical | PBHAP Group | Tier 1 Ratios to Screening Level by Pollutant |
|---|---|---|---|---|---|---|
| Source Category A | Facility 001 | 37.91862561 | -87.327593 | Cadmium | Cadmium | 0.208437606 |
| Source Category A | Facility 001 | 37.91862561 | -87.327593 | HeptaCDD, 1,2,3,4,6,7,8- | Dioxin | 15.47458492 |
| Source Category A | Facility 001 | 37.91862561 | -87.327593 | HeptaCDF, 1,2,3,4,6,7,8- | Dioxin | 7.758489327 |
| Source Category A | Facility 001 | 37.91862561 | -87.327593 | HeptaCDF, 1,2,3,4,7,8,9- | Dioxin | 1.469726342 |
| Source Category A | Facility 001 | 37.91862561 | -87.327593 | HexaCDD, 1,2,3,4,7,8- | Dioxin | 53.59103188 |
| Source Category A | Facility 001 | 37.91862561 | -87.327593 | HexaCDD, 1,2,3,6,7,8- | Dioxin | 59.57570767 |
| Source Category A | Facility 001 | 37.91862561 | -87.327593 | HexaCDD, 1,2,3,7,8,9 - | Dioxin | 19.71911235 |
| Source Category A | Facility 001 | 37.91862561 | -87.327593 | HexaCDF, 1,2,3,4,7,8- | Dioxin | 83.16694308 |
| Source Category A | Facility 001 | 37.91862561 | -87.327593 | HexaCDF, 1,2,3,6,7,8- | Dioxin | 108.1714178 |
| Source Category A | Facility 001 | 37.91862561 | -87.327593 | HexaCDF, 1,2,3,7,8,9- | Dioxin | 34.73264896 |
| Source Category A | Facility 001 | 37.91862561 | -87.327593 | HexaCDF, 2,3,4,6,7,8- | Dioxin | 94.20369366 |
| Source Category A | Facility 001 | 37.91862561 | -87.327593 | OctaCDD, 1,2,3,4,6,7,8,9- | Dioxin | 0.220919326 |
| Source Category A | Facility 001 | 37.91862561 | -87.327593 | OctaCDF, 1,2,3,4,6,7,8,9- | Dioxin | 0.121368915 |
| Source Category A | Facility 001 | 37.91862561 | -87.327593 | PentaCDD, 1,2,3,7,8- | Dioxin | 3424.817548 |
| Source Category A | Facility 001 | 37.91862561 | -87.327593 | PentaCDF, 1,2,3,7,8- | Dioxin | 37.69720411 |
| Source Category A | Facility 001 | 37.91862561 | -87.327593 | PentaCDF, 2,3,4,7,8- | Dioxin | 908.8268522 |
| Source Category A | Facility 001 | 37.91862561 | -87.327593 | TetraCDD, 2,3,7,8- | Dioxin | 649.1477413 |
| Source Category A | Facility 001 | 37.91862561 | -87.327593 | TetraCDF, 2,3,7,8- | Dioxin | 72.17405972 |
| Source Category A | Facility 001 | 37.91862561 | -87.327593 | Methyl Mercury | Mercury | 0.02671981 |
| Source Category A | Facility 002 | 35.7759391 | -83.970063 | Cadmium | Cadmium | 0.006701237 |
| Source Category A | Facility 002 | 35.7759391 | -83.970063 | HeptaCDD, 1,2,3,4,6,7,8- | Dioxin | 0.97151138 |
| Source Category A | Facility 002 | 35.7759391 | -83.970063 | HeptaCDF, 1,2,3,4,6,7,8- | Dioxin | 0.487086452 |
| Source Category A | Facility 002 | 35.7759391 | -83.970063 | HeptaCDF, 1,2,3,4,7,8,9- | Dioxin | 0.092271029 |
| Source Category A | Facility 002 | 35.7759391 | -83.970063 | HexaCDD, 1,2,3,4,7,8- | Dioxin | 3.364503642 |
| Source Category A | Facility 002 | 35.7759391 | -83.970063 | HexaCDD, 1,2,3,6,7,8- | Dioxin | 3.740228139 |
| Source Category A | Facility 002 | 35.7759391 | -83.970063 | HexaCDD, 1,2,3,7,8,9 - | Dioxin | 1.237987458 |
| Source Category A | Facility 002 | 35.7759391 | -83.970063 | HexaCDF, 1,2,3,4,7,8- | Dioxin | 5.221311721 |
| Source Category A | Facility 002 | 35.7759391 | -83.970063 | HexaCDF, 1,2,3,6,7,8- | Dioxin | 6.791120015 |
| Source Category A | Facility 002 | 35.7759391 | -83.970063 | HexaCDF, 1,2,3,7,8,9- | Dioxin | 2.18055372 |
| Source Category A | Facility 002 | 35.7759391 | -83.970063 | HexaCDF, 2,3,4,6,7,8- | Dioxin | 5.914211003 |
| Source Category A | Facility 002 | 35.7759391 | -83.970063 | OctaCDD, 1,2,3,4,6,7,8,9- | Dioxin | 0.013869557 |
| Source Category A | Facility 002 | 35.7759391 | -83.970063 | OctaCDF, 1,2,3,4,6,7,8,9- | Dioxin | 0.007619673 |
| Source Category A | Facility 002 | 35.7759391 | -83.970063 | PentaCDD, 1,2,3,7,8- | Dioxin | 215.0137945 |

## 5.2 Facility/Lake Distance Table (Step 4)

After clicking Button 4 on the dashboard, the user is brought to the lake distance sheet to enter details on the closest lake to each facility in each of the directional octants (N, NE, E, SE, S, SW, W, and NW). These lake data are assembled outside of this Excel tool using the following steps. First, the location of each facility with emissions above a Tier 1 threshold emission is imported into ArcGIS ®. The lake database (Section 3.1) is used to calculate the inside geographic centroid of each of the 117,842 lakes greater than 25 acres but less than 100,000 acres in the U.S. plus Puerto Rico and the U.S. Virgin Islands. Then, from within the ArcGIS ® software, all lakes with centroids within 50 km of each facility are identified. A table is created that summarizes how far away the nearest lake is and how large that lake is in each of the directional octants within 50 km. If no lake is present within 50 km in a given octant, the table includes dashes to indicate no lake is present within the radius selected. The lake names (where available) are scrutinized to subjectively remove industrial and treatment water bodies, as discussed in Section 3.1. This table is pasting in the “4) lake distance” sheet as shown in Exhibit 12.

**Exhibit 12. Example of the Lake Distance Data Required To Conduct the Tier 2 Analysis**



| Input Filename | Date and Time | Notes |
|---|---|---|
| PrimAlAllowable_CoordsAndTier2Input_201206 | 6/22/12 10:18am | Changed allowable to actual emissions |

RTR Tier 2 Analysis - Lake Distance

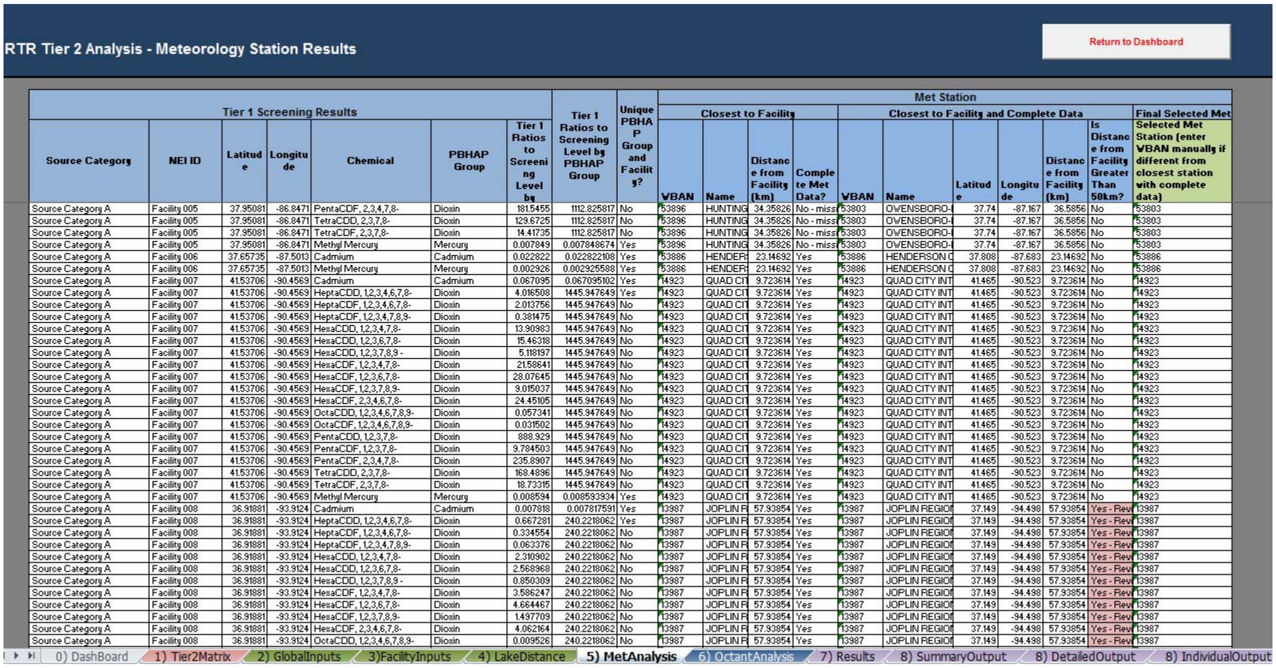
Lake Distance within each Octant by Facility by Source Category

| Source Category | NEI ID | Octant | Lake Name | Lake Size (Acres) | Facility-to-Lake Distance (km) |
|---|---|---|---|---|---|
| Source Category A | Facility 001 | N | Name Not Provide | 46.950022 | 9.666933 |
| Source Category A | Facility 001 | NE | Name Not Provide | 42.007915 | 4.125126 |
| Source Category A | Facility 001 | E | Chrisney Lake | 27.181592 | 28.619087 |
| Source Category A | Facility 001 | SE | Name Not Provide | 44.478969 | 18.300868 |
| Source Category A | Facility 001 | S | Name Not Provide | 32.1237 | 29.747556 |
| Source Category A | Facility 001 | SW | Name Not Provide | 42.007915 | 28.334921 |
| Source Category A | Facility 001 | W | Name Not Provide | 54.363184 | 0.901495 |
| Source Category A | Facility 001 | NW | Name Not Provide | 59.305292 | 3.275163 |
| Source Category A | Facility 002 | N | Name Not Provide | 2273.369509 | 10.521537 |
| Source Category A | Facility 002 | NE | Name Not Provide | 21320.25231 | 45.713001 |
| Source Category A | Facility 002 | E | -- | -- | -- |
| Source Category A | Facility 002 | SE | Lake in the Sky | 51.89213 | 14.20809 |
| Source Category A | Facility 002 | S | Cheoah Lake | 1709.96924 | 26.490503 |
| Source Category A | Facility 002 | SW | Name Not Provide | 42.007915 | 27.180886 |
| Source Category A | Facility 002 | W | Name Not Provide | 74.131614 | 26.901889 |
| Source Category A | Facility 002 | NW | Name Not Provide | 56.834238 | 13.197646 |
| Source Category A | Facility 003 | N | Name Not Provide | 2273.369509 | 10.393677 |
| Source Category A | Facility 003 | NE | Name Not Provide | 21320.25231 | 45.837421 |
| Source Category A | Facility 003 | E | -- | -- | -- |
| Source Category A | Facility 003 | SE | Lake in the Sky | 51.89213 | 14.408311 |
| Source Category A | Facility 003 | S | Cheoah Lake | 1709.96924 | 26.601222 |
| Source Category A | Facility 003 | SW | Name Not Provide | 42.007915 | 27.151679 |
| Source Category A | Facility 003 | W | Name Not Provide | 74.131614 | 26.713978 |
| Source Category A | Facility 003 | NW | Name Not Provide | 56.834238 | 12.970895 |
| Source Category A | Facility 004 | N | Ferdinand State F | 34.594753 | 35.119307 |
| Source Category A | Facility 004 | NE | Name Not Provide | 37.065807 | 17.236114 |
| Source Category A | Facility 004 | E | Name Not Provide | 59.305292 | 10.08593 |
| Source Category A | Facility 004 | SE | Name Not Provide | 2777.464488 | 45.396654 |
| Source Category A | Facility 004 | S | Name Not Provide | 59.305292 | 27.352939 |
| Source Category A | Facility 004 | SW | Carpenters Lake | 54.363184 | 20.175993 |

## 5.3 Finding the Closest Meteorological Station (Step 5)

Now that the user has entered all required input data, clicking Button 5 initiates an analysis that finds the closest surface meteorological station (having complete summary statistics) to each facility in the Facility List using straight-line distance. If the facility and the meteorological station are more than 50 km apart, the tool returns the closest station but flags the match with the text “Review” to alert the user that further scrutiny of the facility/station pair might be necessary. In addition, the tool also alerts the user if the closest station did not have complete summary data and the next closest station was selected instead. The results of the meteorological analysis are shown in the “5) Met Analysis” sheet (an example is shown in Exhibit 13). In the example in Exhibit 13, the closest surface meteorological station to Facility 005 was approximately 34 km away, but the methodology rejected that station because it had too much missing data, choosing instead a different station approximately 37 km away with fewer missing data. For Facility 008, the closest station had acceptably complete data but was located 57 km from the facility, causing the analysis to display a warning about being beyond 50 km away.

**Exhibit 13. Example Results of the Meteorological Station Matching Required To Conduct the Tier 2 Analysis**



RTR Tier 2 Analysis - Meteorology Station Results

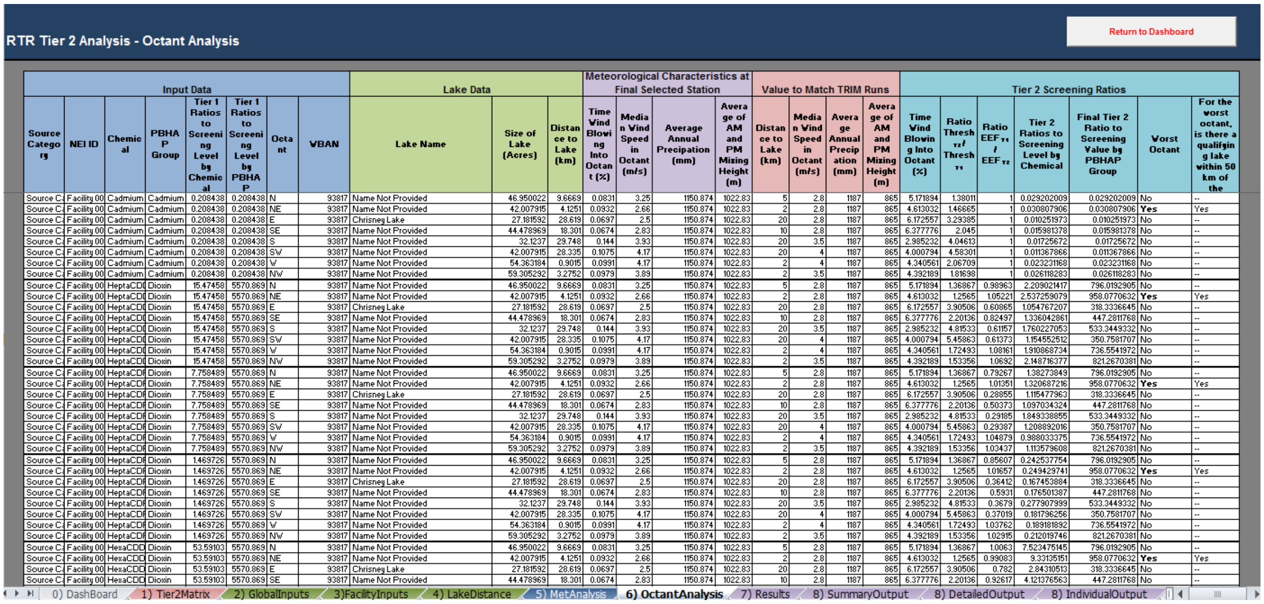
| Tier 1 Screening Results | | | | | | | Tier 1 Ratios to Screening Level by PBHAP Group | Unique PBHAP Group and Facility? | Met Station | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Closest to Facility | | | | Closest to Facility and Complete Data | | | | | | Final Selected Met |
| Source Category | NEI ID | Latitude | Longitude | Chemical | PBHAP Group | Tier 1 Ratios to Screening Level by | | | WBAN | Name | Distance from Facility (km) | Complete Met Data? | WBAN | Name | Latitude | Longitude | Distance from Facility (km) | Is Distance from Facility Greater Than 50km? | Selected Met Station (enter WBAN manually if different from closest station with complete data) |
| Source Category A | Facility 005 | 37.95081 | -86.8471 | PentaCDF, 2,3,4,7,8- | Dioxin | 181.5455 | 1112.825817 | No | 53896 | HUNTING | 34.35826 | No - missi | 53803 | OWENSBORO- | 37.74 | -87.167 | 36.5856 | No | 53803 |
| Source Category A | Facility 005 | 37.95081 | -86.8471 | TetraCDD, 2,3,7,8- | Dioxin | 129.6725 | 1112.825817 | No | 53896 | HUNTING | 34.35826 | No - missi | 53803 | OWENSBORO- | 37.74 | -87.167 | 36.5856 | No | 53803 |
| Source Category A | Facility 005 | 37.95081 | -86.8471 | TetraCDF, 2,3,7,8- | Dioxin | 14.41735 | 1112.825817 | No | 53896 | HUNTING | 34.35826 | No - missi | 53803 | OWENSBORO- | 37.74 | -87.167 | 36.5856 | No | 53803 |
| Source Category A | Facility 005 | 37.95081 | -86.8471 | Methyl Mercury | Mercury | 0.007849 | 0.007848674 | Yes | 53896 | HUNTING | 34.35826 | No - missi | 53803 | OWENSBORO- | 37.74 | -87.167 | 36.5856 | No | 53803 |
| Source Category A | Facility 006 | 37.65735 | -87.5013 | Cadmium | Cadmium | 0.022822 | 0.02282108 | Yes | 53886 | HENDERS | 23.14692 | Yes | 53886 | HENDERSON C | 37.808 | -87.683 | 23.14692 | No | 53886 |
| Source Category A | Facility 006 | 37.65735 | -87.5013 | Methyl Mercury | Mercury | 0.002926 | 0.002925588 | Yes | 53886 | HENDERS | 23.14692 | Yes | 53886 | HENDERSON C | 37.808 | -87.683 | 23.14692 | No | 53886 |
| Source Category A | Facility 007 | 41.53706 | -90.4569 | Cadmium | Cadmium | 0.067095 | 0.067095102 | Yes | 14923 | QUAD CIT | 9.723614 | Yes | 14923 | QUAD CITY INT | 41.465 | -90.523 | 9.723614 | No | 14923 |
| Source Category A | Facility 007 | 41.53706 | -90.4569 | HeptaCDD, 1,2,3,4,6,7,8- | Dioxin | 4.016508 | 1445.947649 | Yes | 14923 | QUAD CIT | 9.723614 | Yes | 14923 | QUAD CITY INT | 41.465 | -90.523 | 9.723614 | No | 14923 |
| Source Category A | Facility 007 | 41.53706 | -90.4569 | HeptaCDF, 1,2,3,4,6,7,8- | Dioxin | 2.013756 | 1445.947649 | No | 14923 | QUAD CIT | 9.723614 | Yes | 14923 | QUAD CITY INT | 41.465 | -90.523 | 9.723614 | No | 14923 |
| Source Category A | Facility 007 | 41.53706 | -90.4569 | HeptaCDF, 1,2,3,4,7,8,9- | Dioxin | 0.381475 | 1445.947649 | No | 14923 | QUAD CIT | 9.723614 | Yes | 14923 | QUAD CITY INT | 41.465 | -90.523 | 9.723614 | No | 14923 |
| Source Category A | Facility 007 | 41.53706 | -90.4569 | HexaCDD, 1,2,3,4,7,8- | Dioxin | 13.90983 | 1445.947649 | No | 14923 | QUAD CIT | 9.723614 | Yes | 14923 | QUAD CITY INT | 41.465 | -90.523 | 9.723614 | No | 14923 |
| Source Category A | Facility 007 | 41.53706 | -90.4569 | HexaCDD, 1,2,3,6,7,8- | Dioxin | 15.46318 | 1445.947649 | No | 14923 | QUAD CIT | 9.723614 | Yes | 14923 | QUAD CITY INT | 41.465 | -90.523 | 9.723614 | No | 14923 |
| Source Category A | Facility 007 | 41.53706 | -90.4569 | HexaCDD, 1,2,3,7,8,9 - | Dioxin | 5.118197 | 1445.947649 | No | 14923 | QUAD CIT | 9.723614 | Yes | 14923 | QUAD CITY INT | 41.465 | -90.523 | 9.723614 | No | 14923 |
| Source Category A | Facility 007 | 41.53706 | -90.4569 | HexaCDF, 1,2,3,4,7,8- | Dioxin | 21.58641 | 1445.947649 | No | 14923 | QUAD CIT | 9.723614 | Yes | 14923 | QUAD CITY INT | 41.465 | -90.523 | 9.723614 | No | 14923 |
| Source Category A | Facility 007 | 41.53706 | -90.4569 | HexaCDF, 1,2,3,6,7,8- | Dioxin | 28.07645 | 1445.947649 | No | 14923 | QUAD CIT | 9.723614 | Yes | 14923 | QUAD CITY INT | 41.465 | -90.523 | 9.723614 | No | 14923 |
| Source Category A | Facility 007 | 41.53706 | -90.4569 | HexaCDF, 1,2,3,7,8,9- | Dioxin | 9.015037 | 1445.947649 | No | 14923 | QUAD CIT | 9.723614 | Yes | 14923 | QUAD CITY INT | 41.465 | -90.523 | 9.723614 | No | 14923 |
| Source Category A | Facility 007 | 41.53706 | -90.4569 | HexaCDF, 2,3,4,6,7,8- | Dioxin | 24.45105 | 1445.947649 | No | 14923 | QUAD CIT | 9.723614 | Yes | 14923 | QUAD CITY INT | 41.465 | -90.523 | 9.723614 | No | 14923 |
| Source Category A | Facility 007 | 41.53706 | -90.4569 | OctaCDD, 1,2,3,4,6,7,8,9- | Dioxin | 0.057341 | 1445.947649 | No | 14923 | QUAD CIT | 9.723614 | Yes | 14923 | QUAD CITY INT | 41.465 | -90.523 | 9.723614 | No | 14923 |
| Source Category A | Facility 007 | 41.53706 | -90.4569 | OctaCDF, 1,2,3,4,6,7,8,9- | Dioxin | 0.031502 | 1445.947649 | No | 14923 | QUAD CIT | 9.723614 | Yes | 14923 | QUAD CITY INT | 41.465 | -90.523 | 9.723614 | No | 14923 |
| Source Category A | Facility 007 | 41.53706 | -90.4569 | PentaCDD, 1,2,3,7,8- | Dioxin | 888.929 | 1445.947649 | No | 14923 | QUAD CIT | 9.723614 | Yes | 14923 | QUAD CITY INT | 41.465 | -90.523 | 9.723614 | No | 14923 |
| Source Category A | Facility 007 | 41.53706 | -90.4569 | PentaCDF, 1,2,3,7,8- | Dioxin | 9.784503 | 1445.947649 | No | 14923 | QUAD CIT | 9.723614 | Yes | 14923 | QUAD CITY INT | 41.465 | -90.523 | 9.723614 | No | 14923 |
| Source Category A | Facility 007 | 41.53706 | -90.4569 | PentaCDF, 2,3,4,7,8- | Dioxin | 235.8907 | 1445.947649 | No | 14923 | QUAD CIT | 9.723614 | Yes | 14923 | QUAD CITY INT | 41.465 | -90.523 | 9.723614 | No | 14923 |
| Source Category A | Facility 007 | 41.53706 | -90.4569 | TetraCDD, 2,3,7,8- | Dioxin | 168.4896 | 1445.947649 | No | 14923 | QUAD CIT | 9.723614 | Yes | 14923 | QUAD CITY INT | 41.465 | -90.523 | 9.723614 | No | 14923 |
| Source Category A | Facility 007 | 41.53706 | -90.4569 | TetraCDF, 2,3,7,8- | Dioxin | 18.73315 | 1445.947649 | No | 14923 | QUAD CIT | 9.723614 | Yes | 14923 | QUAD CITY INT | 41.465 | -90.523 | 9.723614 | No | 14923 |
| Source Category A | Facility 007 | 41.53706 | -90.4569 | Methyl Mercury | Mercury | 0.008594 | 0.008593934 | Yes | 14923 | QUAD CIT | 9.723614 | Yes | 14923 | QUAD CITY INT | 41.465 | -90.523 | 9.723614 | No | 14923 |
| Source Category A | Facility 008 | 36.91881 | -93.9124 | Cadmium | Cadmium | 0.007818 | 0.007817591 | Yes | 13987 | JOPLIN R | 57.93854 | Yes | 13987 | JOPLIN REGIO | 37.149 | -94.498 | 57.93854 | Yes - Rev | 13987 |
| Source Category A | Facility 008 | 36.91881 | -93.9124 | HeptaCDD, 1,2,3,4,6,7,8- | Dioxin | 0.667281 | 240.2218062 | Yes | 13987 | JOPLIN R | 57.93854 | Yes | 13987 | JOPLIN REGIO | 37.149 | -94.498 | 57.93854 | Yes - Rev | 13987 |
| Source Category A | Facility 008 | 36.91881 | -93.9124 | HeptaCDF, 1,2,3,4,6,7,8- | Dioxin | 0.334554 | 240.2218062 | No | 13987 | JOPLIN R | 57.93854 | Yes | 13987 | JOPLIN REGIO | 37.149 | -94.498 | 57.93854 | Yes - Rev | 13987 |
| Source Category A | Facility 008 | 36.91881 | -93.9124 | HeptaCDF, 1,2,3,4,7,8,9- | Dioxin | 0.063376 | 240.2218062 | No | 13987 | JOPLIN R | 57.93854 | Yes | 13987 | JOPLIN REGIO | 37.149 | -94.498 | 57.93854 | Yes - Rev | 13987 |
| Source Category A | Facility 008 | 36.91881 | -93.9124 | HexaCDD, 1,2,3,4,7,8- | Dioxin | 2.310902 | 240.2218062 | No | 13987 | JOPLIN R | 57.93854 | Yes | 13987 | JOPLIN REGIO | 37.149 | -94.498 | 57.93854 | Yes - Rev | 13987 |
| Source Category A | Facility 008 | 36.91881 | -93.9124 | HexaCDD, 1,2,3,6,7,8- | Dioxin | 2.568968 | 240.2218062 | No | 13987 | JOPLIN R | 57.93854 | Yes | 13987 | JOPLIN REGIO | 37.149 | -94.498 | 57.93854 | Yes - Rev | 13987 |
| Source Category A | Facility 008 | 36.91881 | -93.9124 | HexaCDD, 1,2,3,7,8,9 - | Dioxin | 0.850309 | 240.2218062 | No | 13987 | JOPLIN R | 57.93854 | Yes | 13987 | JOPLIN REGIO | 37.149 | -94.498 | 57.93854 | Yes - Rev | 13987 |
| Source Category A | Facility 008 | 36.91881 | -93.9124 | HexaCDF, 1,2,3,4,7,8- | Dioxin | 3.586247 | 240.2218062 | No | 13987 | JOPLIN R | 57.93854 | Yes | 13987 | JOPLIN REGIO | 37.149 | -94.498 | 57.93854 | Yes - Rev | 13987 |
| Source Category A | Facility 008 | 36.91881 | -93.9124 | HexaCDF, 1,2,3,6,7,8- | Dioxin | 4.664467 | 240.2218062 | No | 13987 | JOPLIN R | 57.93854 | Yes | 13987 | JOPLIN REGIO | 37.149 | -94.498 | 57.93854 | Yes - Rev | 13987 |
| Source Category A | Facility 008 | 36.91881 | -93.9124 | HexaCDF, 1,2,3,7,8,9- | Dioxin | 1.497709 | 240.2218062 | No | 13987 | JOPLIN R | 57.93854 | Yes | 13987 | JOPLIN REGIO | 37.149 | -94.498 | 57.93854 | Yes - Rev | 13987 |
| Source Category A | Facility 008 | 36.91881 | -93.9124 | HexaCDF, 2,3,4,6,7,8- | Dioxin | 4.062164 | 240.2218062 | No | 13987 | JOPLIN R | 57.93854 | Yes | 13987 | JOPLIN REGIO | 37.149 | -94.498 | 57.93854 | Yes - Rev | 13987 |
| Source Category A | Facility 008 | 36.91881 | -93.9124 | OctaCDD, 1,2,3,4,6,7,8,9- | Dioxin | 0.009526 | 240.2218062 | No | 13987 | JOPLIN R | 57.93854 | Yes | 13987 | JOPLIN REGIO | 37.149 | -94.498 | 57.93854 | Yes - Rev | 13987 |

## 5.4 Assembling Threshold Adjustment Factors (Step 6)

Next, the tool calculates the facility-specific, octant-specific threshold adjustment factor for each chemical within a PB-HAP group. When Button 6 is clicked, the tool uses the meteorological parameters and lake distances to find the correct adjustment factor bin for each of the Tier 2 characteristics, as discussed in Section 3. See example screen shot in Exhibit 14. The completed analysis is shown in the "6) Octant Analysis" sheet. The analysis uses the distance to the closest lake in each octant, the estimated median wind speed in each octant, the average percentage of the time winds blow into each octant, and the estimated average annual precipitation and annual average daily mixing height for the facility, and the analysis matches these meteorological parameters to the closest TRIM.FaTE run with similar parameters. The TRIM.FaTE runs supply individual adjustment factors for each of the meteorological parameters, as shown in the "1) Tier2Matrix" sheet (see screen shot example in Exhibit 15). The matching to TRIM.FaTE results is done in a health-protective manner, taking note of the direction of the correlation of the variable with risk. For example, larger mixing heights are associated with lower risks. Thus, mixing heights are assigned to bins by selecting the closest TRIM.FaTE value that is *higher* than the estimated facility mixing height.

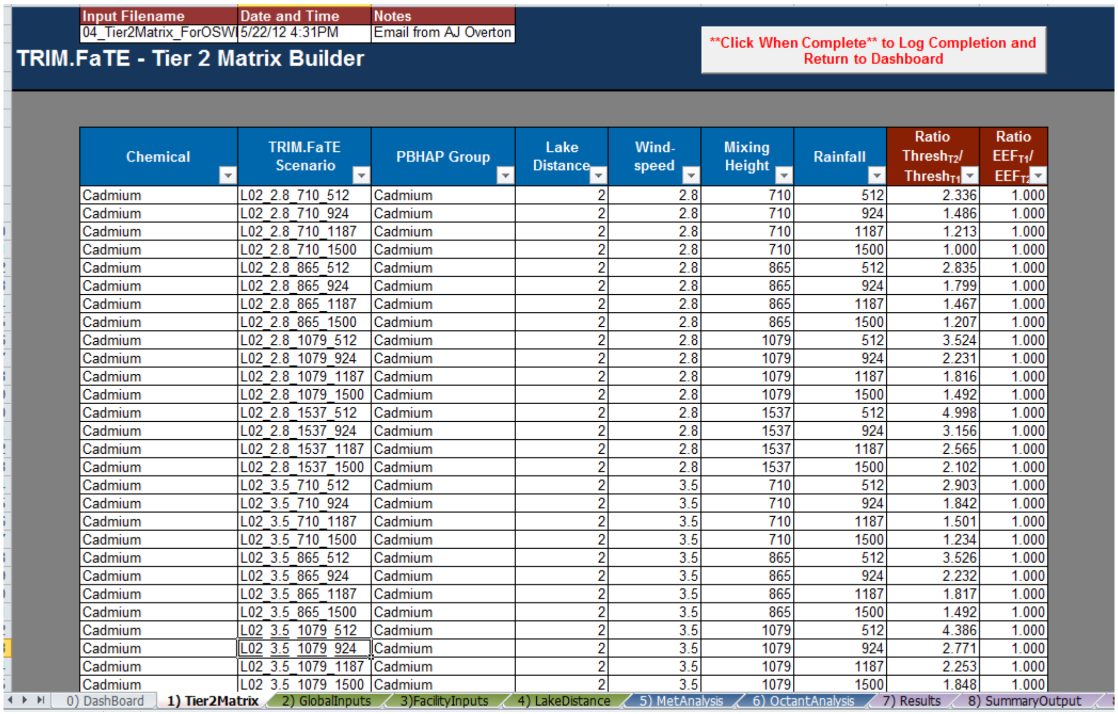
The adjustment factors indicate the ratio of the Tier 2 threshold to the Tier 1 threshold. Thus, larger values indicate a risk reduction in Tier 2 relative to Tier 1. The ratio between the REF-adjusted emissions and the Tier 1 thresholds are divided by the overall Tier 2 threshold adjustment factor for each chemical in each octant of a facility. Within a PB-HAP group, the chemical-specific adjustment factors at a facility are summed for each individual octant, resulting in octant-specific PB-HAP adjustment factors for the facility. To maintain a health-protective focus in the analysis, the octant analysis then identifies the octant with the smallest

## Exhibit 14. Example Results of the Octant Analysis Required To Conduct the Tier 2 Analysis



| Input Data | | | | | | | | Lake Data | | | Meteorological Characteristics at Final Selected Station | | | | Value to Match TRIM Runs | | | | Tier 2 Screening Ratios | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Source Category | NEI ID | Chemical | PBHAP Group | Tier 1 Ratios to Screening Level by Chemical | Tier 1 Ratios to Screening Level by PBHAP | Octant | WBAN | Lake Name | Size of Lake (Acres) | Distance to Lake (km) | Time Wind Blowing Into Octant (%) | Median Wind Speed in Octant (m/s) | Average Annual Precipation (mm) | Average of AM and PM Mixing Height (m) | Distance to Lake (km) | Median Wind Speed in Octant (m/s) | Average Annual Precipation (mm) | Average of AM and PM Mixing Height (m) | Time Wind Blowing Into Octant (%) | Ratio $Thresh_{T2}/Thresh_{T1}$ | Ratio $EEF_{T1}/EEF_{T2}$ | Tier 2 Ratios to Screening Level by Chemical | Final Tier 2 Ratio to Screening Value by PBHAP Group | Worst Octant | For the worst octant, is there a qualifying lake within 50 km of the |
| Source C | Facility 00 | Cadmium | Cadmium | 0.208438 | 0.208438 | N | 93817 | Name Not Provided | 46.950022 | 9.6669 | 0.0831 | 3.25 | 1150.874 | 1022.83 | 5 | 2.8 | 1187 | 865 | 5.171894 | 1.38011 | 1 | 0.029202009 | 0.029202009 | No | -- |
| Source C | Facility 00 | Cadmium | Cadmium | 0.208438 | 0.208438 | NE | 93817 | Name Not Provided | 42.007915 | 4.1251 | 0.0932 | 2.66 | 1150.874 | 1022.83 | 2 | 2.8 | 1187 | 865 | 4.613032 | 1.46665 | 1 | 0.030807906 | 0.030807906 | **Yes** | Yes |
| Source C | Facility 00 | Cadmium | Cadmium | 0.208438 | 0.208438 | E | 93817 | Chrisney Lake | 27.181592 | 28.619 | 0.0697 | 2.5 | 1150.874 | 1022.83 | 20 | 2.8 | 1187 | 865 | 6.172557 | 3.29385 | 1 | 0.010251973 | 0.010251973 | No | -- |
| Source C | Facility 00 | Cadmium | Cadmium | 0.208438 | 0.208438 | SE | 93817 | Name Not Provided | 44.478969 | 18.301 | 0.0674 | 2.83 | 1150.874 | 1022.83 | 10 | 2.8 | 1187 | 865 | 6.377776 | 2.045 | 1 | 0.015981378 | 0.015981378 | No | -- |
| Source C | Facility 00 | Cadmium | Cadmium | 0.208438 | 0.208438 | S | 93817 | Name Not Provided | 32.1237 | 29.748 | 0.144 | 3.93 | 1150.874 | 1022.83 | 20 | 3.5 | 1187 | 865 | 2.985232 | 4.04613 | 1 | 0.01725672 | 0.01725672 | No | -- |
| Source C | Facility 00 | Cadmium | Cadmium | 0.208438 | 0.208438 | SW | 93817 | Name Not Provided | 42.007915 | 28.335 | 0.1075 | 4.17 | 1150.874 | 1022.83 | 20 | 4 | 1187 | 865 | 4.000794 | 4.58301 | 1 | 0.011367866 | 0.011367866 | No | -- |
| Source C | Facility 00 | Cadmium | Cadmium | 0.208438 | 0.208438 | W | 93817 | Name Not Provided | 54.363184 | 0.9015 | 0.0991 | 4.17 | 1150.874 | 1022.83 | 2 | 4 | 1187 | 865 | 4.340561 | 2.06709 | 1 | 0.023231168 | 0.023231168 | No | -- |
| Source C | Facility 00 | Cadmium | Cadmium | 0.208438 | 0.208438 | NW | 93817 | Name Not Provided | 59.305292 | 3.2752 | 0.0979 | 3.89 | 1150.874 | 1022.83 | 2 | 3.5 | 1187 | 865 | 4.392189 | 1.81698 | 1 | 0.026118283 | 0.026118283 | No | -- |
| Source C | Facility 00 | HeptaCDD | Dioxin | 15.47458 | 5570.869 | N | 93817 | Name Not Provided | 46.950022 | 9.6669 | 0.0831 | 3.25 | 1150.874 | 1022.83 | 5 | 2.8 | 1187 | 865 | 5.171894 | 1.36867 | 0.98963 | 2.209021417 | 796.0192905 | No | -- |
| Source C | Facility 00 | HeptaCDD | Dioxin | 15.47458 | 5570.869 | NE | 93817 | Name Not Provided | 42.007915 | 4.1251 | 0.0932 | 2.66 | 1150.874 | 1022.83 | 2 | 2.8 | 1187 | 865 | 4.613032 | 1.2565 | 1.05221 | 2.537259079 | 958.0770632 | **Yes** | Yes |
| Source C | Facility 00 | HeptaCDD | Dioxin | 15.47458 | 5570.869 | E | 93817 | Chrisney Lake | 27.181592 | 28.619 | 0.0697 | 2.5 | 1150.874 | 1022.83 | 20 | 2.8 | 1187 | 865 | 6.172557 | 3.90506 | 0.60865 | 1.054767207 | 318.3336645 | No | -- |
| Source C | Facility 00 | HeptaCDD | Dioxin | 15.47458 | 5570.869 | SE | 93817 | Name Not Provided | 44.478969 | 18.301 | 0.0674 | 2.83 | 1150.874 | 1022.83 | 10 | 2.8 | 1187 | 865 | 6.377776 | 2.20136 | 0.82497 | 1.336042861 | 447.2811768 | No | -- |
| Source C | Facility 00 | HeptaCDD | Dioxin | 15.47458 | 5570.869 | S | 93817 | Name Not Provided | 32.1237 | 29.748 | 0.144 | 3.93 | 1150.874 | 1022.83 | 20 | 3.5 | 1187 | 865 | 2.985232 | 4.81533 | 0.61157 | 1.760227053 | 533.3449332 | No | -- |
| Source C | Facility 00 | HeptaCDD | Dioxin | 15.47458 | 5570.869 | SW | 93817 | Name Not Provided | 42.007915 | 28.335 | 0.1075 | 4.17 | 1150.874 | 1022.83 | 20 | 4 | 1187 | 865 | 4.000794 | 5.45863 | 0.61373 | 1.154552512 | 350.7581707 | No | -- |
| Source C | Facility 00 | HeptaCDD | Dioxin | 15.47458 | 5570.869 | W | 93817 | Name Not Provided | 54.363184 | 0.9015 | 0.0991 | 4.17 | 1150.874 | 1022.83 | 2 | 4 | 1187 | 865 | 4.340561 | 1.72493 | 1.08161 | 1.910868734 | 736.5541972 | No | -- |
| Source C | Facility 00 | HeptaCDD | Dioxin | 15.47458 | 5570.869 | NW | 93817 | Name Not Provided | 59.305292 | 3.2752 | 0.0979 | 3.89 | 1150.874 | 1022.83 | 2 | 3.5 | 1187 | 865 | 4.392189 | 1.53356 | 1.0692 | 2.148716377 | 821.2670381 | No | -- |
| Source C | Facility 00 | HeptaCDF | Dioxin | 7.758489 | 5570.869 | N | 93817 | Name Not Provided | 46.950022 | 9.6669 | 0.0831 | 3.25 | 1150.874 | 1022.83 | 5 | 2.8 | 1187 | 865 | 5.171894 | 1.36867 | 0.79267 | 1.38273849 | 796.0192905 | No | -- |
| Source C | Facility 00 | HeptaCDF | Dioxin | 7.758489 | 5570.869 | NE | 93817 | Name Not Provided | 42.007915 | 4.1251 | 0.0932 | 2.66 | 1150.874 | 1022.83 | 2 | 2.8 | 1187 | 865 | 4.613032 | 1.2565 | 1.01351 | 1.320687216 | 958.0770632 | **Yes** | Yes |
| Source C | Facility 00 | HeptaCDF | Dioxin | 7.758489 | 5570.869 | E | 93817 | Chrisney Lake | 27.181592 | 28.619 | 0.0697 | 2.5 | 1150.874 | 1022.83 | 20 | 2.8 | 1187 | 865 | 6.172557 | 3.90506 | 0.28855 | 1.115477963 | 318.3336645 | No | -- |
| Source C | Facility 00 | HeptaCDF | Dioxin | 7.758489 | 5570.869 | SE | 93817 | Name Not Provided | 44.478969 | 18.301 | 0.0674 | 2.83 | 1150.874 | 1022.83 | 10 | 2.8 | 1187 | 865 | 6.377776 | 2.20136 | 0.50373 | 1.097034324 | 447.2811768 | No | -- |
| Source C | Facility 00 | HeptaCDF | Dioxin | 7.758489 | 5570.869 | S | 93817 | Name Not Provided | 32.1237 | 29.748 | 0.144 | 3.93 | 1150.874 | 1022.83 | 20 | 3.5 | 1187 | 865 | 2.985232 | 4.81533 | 0.29185 | 1.849338855 | 533.3449332 | No | -- |
| Source C | Facility 00 | HeptaCDF | Dioxin | 7.758489 | 5570.869 | SW | 93817 | Name Not Provided | 42.007915 | 28.335 | 0.1075 | 4.17 | 1150.874 | 1022.83 | 20 | 4 | 1187 | 865 | 4.000794 | 5.45863 | 0.29387 | 1.208892016 | 350.7581707 | No | -- |
| Source C | Facility 00 | HeptaCDF | Dioxin | 7.758489 | 5570.869 | W | 93817 | Name Not Provided | 54.363184 | 0.9015 | 0.0991 | 4.17 | 1150.874 | 1022.83 | 2 | 4 | 1187 | 865 | 4.340561 | 1.72493 | 1.04879 | 0.988033375 | 736.5541972 | No | -- |
| Source C | Facility 00 | HeptaCDF | Dioxin | 7.758489 | 5570.869 | NW | 93817 | Name Not Provided | 59.305292 | 3.2752 | 0.0979 | 3.89 | 1150.874 | 1022.83 | 2 | 3.5 | 1187 | 865 | 4.392189 | 1.53356 | 1.03437 | 1.113579608 | 821.2670381 | No | -- |
| Source C | Facility 00 | HeptaCDF | Dioxin | 1.469726 | 5570.869 | N | 93817 | Name Not Provided | 46.950022 | 9.6669 | 0.0831 | 3.25 | 1150.874 | 1022.83 | 5 | 2.8 | 1187 | 865 | 5.171894 | 1.36867 | 0.85607 | 0.242537754 | 796.0192905 | No | -- |
| Source C | Facility 00 | HeptaCDF | Dioxin | 1.469726 | 5570.869 | NE | 93817 | Name Not Provided | 42.007915 | 4.1251 | 0.0932 | 2.66 | 1150.874 | 1022.83 | 2 | 2.8 | 1187 | 865 | 4.613032 | 1.2565 | 1.01657 | 0.249429741 | 958.0770632 | **Yes** | Yes |
| Source C | Facility 00 | HeptaCDF | Dioxin | 1.469726 | 5570.869 | E | 93817 | Chrisney Lake | 27.181592 | 28.619 | 0.0697 | 2.5 | 1150.874 | 1022.83 | 20 | 2.8 | 1187 | 865 | 6.172557 | 3.90506 | 0.36412 | 0.167453884 | 318.3336645 | No | -- |
| Source C | Facility 00 | HeptaCDF | Dioxin | 1.469726 | 5570.869 | SE | 93817 | Name Not Provided | 44.478969 | 18.301 | 0.0674 | 2.83 | 1150.874 | 1022.83 | 10 | 2.8 | 1187 | 865 | 6.377776 | 2.20136 | 0.5931 | 0.176501387 | 447.2811768 | No | -- |
| Source C | Facility 00 | HeptaCDF | Dioxin | 1.469726 | 5570.869 | S | 93817 | Name Not Provided | 32.1237 | 29.748 | 0.144 | 3.93 | 1150.874 | 1022.83 | 20 | 3.5 | 1187 | 865 | 2.985232 | 4.81533 | 0.3679 | 0.277907999 | 533.3449332 | No | -- |
| Source C | Facility 00 | HeptaCDF | Dioxin | 1.469726 | 5570.869 | SW | 93817 | Name Not Provided | 42.007915 | 28.335 | 0.1075 | 4.17 | 1150.874 | 1022.83 | 20 | 4 | 1187 | 865 | 4.000794 | 5.45863 | 0.37019 | 0.181796256 | 350.7581707 | No | -- |
| Source C | Facility 00 | HeptaCDF | Dioxin | 1.469726 | 5570.869 | W | 93817 | Name Not Provided | 54.363184 | 0.9015 | 0.0991 | 4.17 | 1150.874 | 1022.83 | 2 | 4 | 1187 | 865 | 4.340561 | 1.72493 | 1.03762 | 0.189181892 | 736.5541972 | No | -- |
| Source C | Facility 00 | HeptaCDF | Dioxin | 1.469726 | 5570.869 | NW | 93817 | Name Not Provided | 59.305292 | 3.2752 | 0.0979 | 3.89 | 1150.874 | 1022.83 | 2 | 3.5 | 1187 | 865 | 4.392189 | 1.53356 | 1.02915 | 0.212019746 | 821.2670381 | No | -- |
| Source C | Facility 00 | HexaCDD | Dioxin | 53.59103 | 5570.869 | N | 93817 | Name Not Provided | 46.950022 | 9.6669 | 0.0831 | 3.25 | 1150.874 | 1022.83 | 5 | 2.8 | 1187 | 865 | 5.171894 | 1.36867 | 1.0063 | 7.523475145 | 796.0192905 | No | -- |
| Source C | Facility 00 | HexaCDD | Dioxin | 53.59103 | 5570.869 | NE | 93817 | Name Not Provided | 42.007915 | 4.1251 | 0.0932 | 2.66 | 1150.874 | 1022.83 | 2 | 2.8 | 1187 | 865 | 4.613032 | 1.2565 | 0.99083 | 9.33135151 | 958.0770632 | **Yes** | Yes |
| Source C | Facility 00 | HexaCDD | Dioxin | 53.59103 | 5570.869 | E | 93817 | Chrisney Lake | 27.181592 | 28.619 | 0.0697 | 2.5 | 1150.874 | 1022.83 | 20 | 2.8 | 1187 | 865 | 6.172557 | 3.90506 | 0.782 | 2.84310513 | 318.3336645 | No | -- |
| Source C | Facility 00 | HexaCDD | Dioxin | 53.59103 | 5570.869 | SE | 93817 | Name Not Provided | 44.478969 | 18.301 | 0.0674 | 2.83 | 1150.874 | 1022.83 | 10 | 2.8 | 1187 | 865 | 6.377776 | 2.20136 | 0.92617 | 4.121376563 | 447.2811768 | No | -- |

## Exhibit 15. Example of the TRIM.FaTE Matrix Results Required To Conduct the Tier 2 Analysis



| Input Filename | Date and Time | Notes |
|---|---|---|
| 04_Tier2Matrix_ForOSW | 5/22/12 4:31PM | Email from AJ Overton |

TRIM.FaTE - Tier 2 Matrix Builder

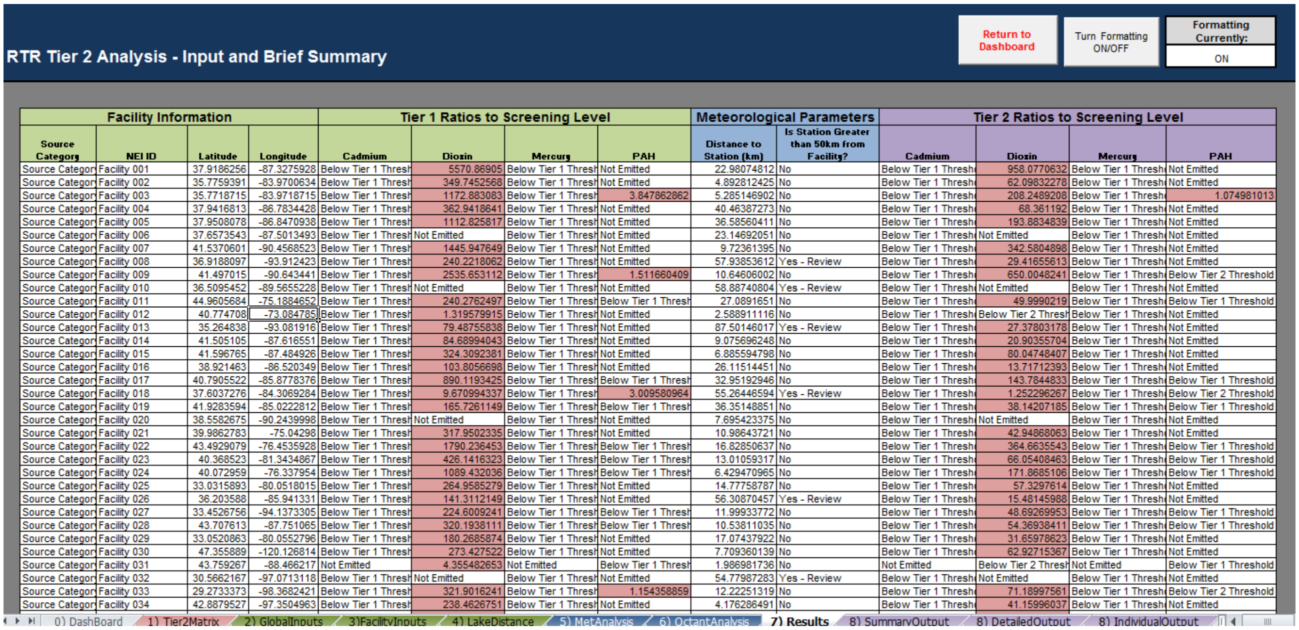
| Chemical | TRIM.FaTE Scenario | PBHAP Group | Lake Distance | Wind-speed | Mixing Height | Rainfall | Ratio $Thresh_{T2}/Thresh_{T1}$ | Ratio $EEF_{T1}/EEF_{T2}$ |
|---|---|---|---|---|---|---|---|---|
| Cadmium | L02_2.8_710_512 | Cadmium | 2 | 2.8 | 710 | 512 | 2.336 | 1.000 |
| Cadmium | L02_2.8_710_924 | Cadmium | 2 | 2.8 | 710 | 924 | 1.486 | 1.000 |
| Cadmium | L02_2.8_710_1187 | Cadmium | 2 | 2.8 | 710 | 1187 | 1.213 | 1.000 |
| Cadmium | L02_2.8_710_1500 | Cadmium | 2 | 2.8 | 710 | 1500 | 1.000 | 1.000 |
| Cadmium | L02_2.8_865_512 | Cadmium | 2 | 2.8 | 865 | 512 | 2.835 | 1.000 |
| Cadmium | L02_2.8_865_924 | Cadmium | 2 | 2.8 | 865 | 924 | 1.799 | 1.000 |
| Cadmium | L02_2.8_865_1187 | Cadmium | 2 | 2.8 | 865 | 1187 | 1.467 | 1.000 |
| Cadmium | L02_2.8_865_1500 | Cadmium | 2 | 2.8 | 865 | 1500 | 1.207 | 1.000 |
| Cadmium | L02_2.8_1079_512 | Cadmium | 2 | 2.8 | 1079 | 512 | 3.524 | 1.000 |
| Cadmium | L02_2.8_1079_924 | Cadmium | 2 | 2.8 | 1079 | 924 | 2.231 | 1.000 |
| Cadmium | L02_2.8_1079_1187 | Cadmium | 2 | 2.8 | 1079 | 1187 | 1.816 | 1.000 |
| Cadmium | L02_2.8_1079_1500 | Cadmium | 2 | 2.8 | 1079 | 1500 | 1.492 | 1.000 |
| Cadmium | L02_2.8_1537_512 | Cadmium | 2 | 2.8 | 1537 | 512 | 4.998 | 1.000 |
| Cadmium | L02_2.8_1537_924 | Cadmium | 2 | 2.8 | 1537 | 924 | 3.156 | 1.000 |
| Cadmium | L02_2.8_1537_1187 | Cadmium | 2 | 2.8 | 1537 | 1187 | 2.565 | 1.000 |
| Cadmium | L02_2.8_1537_1500 | Cadmium | 2 | 2.8 | 1537 | 1500 | 2.102 | 1.000 |
| Cadmium | L02_3.5_710_512 | Cadmium | 2 | 3.5 | 710 | 512 | 2.903 | 1.000 |
| Cadmium | L02_3.5_710_924 | Cadmium | 2 | 3.5 | 710 | 924 | 1.842 | 1.000 |
| Cadmium | L02_3.5_710_1187 | Cadmium | 2 | 3.5 | 710 | 1187 | 1.501 | 1.000 |
| Cadmium | L02_3.5_710_1500 | Cadmium | 2 | 3.5 | 710 | 1500 | 1.234 | 1.000 |
| Cadmium | L02_3.5_865_512 | Cadmium | 2 | 3.5 | 865 | 512 | 3.526 | 1.000 |
| Cadmium | L02_3.5_865_924 | Cadmium | 2 | 3.5 | 865 | 924 | 2.232 | 1.000 |
| Cadmium | L02_3.5_865_1187 | Cadmium | 2 | 3.5 | 865 | 1187 | 1.817 | 1.000 |
| Cadmium | L02_3.5_865_1500 | Cadmium | 2 | 3.5 | 865 | 1500 | 1.492 | 1.000 |
| Cadmium | L02_3.5_1079_512 | Cadmium | 2 | 3.5 | 1079 | 512 | 4.386 | 1.000 |
| Cadmium | L02_3.5_1079_924 | Cadmium | 2 | 3.5 | 1079 | 924 | 2.771 | 1.000 |
| Cadmium | L02_3.5_1079_1187 | Cadmium | 2 | 3.5 | 1079 | 1187 | 2.253 | 1.000 |
| Cadmium | L02_3.5_1079_1500 | Cadmium | 2 | 3.5 | 1079 | 1500 | 1.848 | 1.000 |

adjustment factor for each PB-HAP at each facility. A smaller adjustment factor leads to a smaller Tier 2 threshold and, therefore, a larger ratio of facility REF-adjusted emissions to the Tier 2 threshold (discussed in Section 5.5).

## 5.5 Finalizing Threshold Adjustment Factors and Assembling Screening Results (Step 7)

Clicking Button 7 collects the final Tiers 1 and 2 screening results for each PB-HAP at each facility, using the data from the larger octant analysis table (discussed in Section 5.4). These collected data are displayed in the “7) Results” sheet. Any ratio above 1 can be shaded red (as shown in the example screen shot in Exhibit 16) to easily identify facilities that exceed the Tier 1 threshold or the Tier 2 threshold. If the ratio is less than 1, the value displayed is “Below Tier 1 Threshold” or “Below Tier 2 Threshold”, indicating that the REF-adjusted emissions are lower than the threshold and the facility is deemed not to be of concern. In the example shown in Exhibit 16, many facilities exceeded the Tier 1 threshold and many of those facilities also exceed the Tier 2 threshold.

**Exhibit 16. Example Summarized Results of the Octant Analysis Conducted in the Tier 2 Tool.**



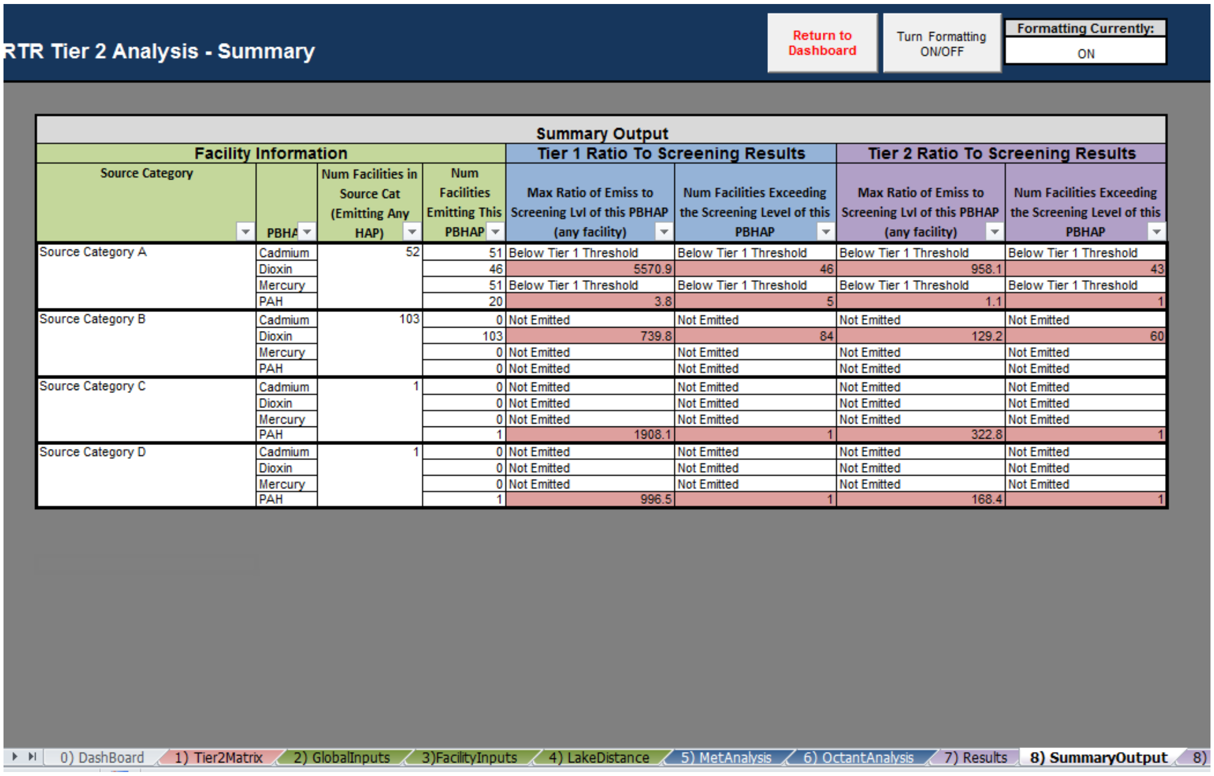
| Facility Information | | | | Tier 1 Ratios to Screening Level | | | | Meteorological Parameters | | Tier 2 Ratios to Screening Level | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Source Category | NEI ID | Latitude | Longitude | Cadmium | Dioxin | Mercury | PAH | Distance to Station (km) | Is Station Greater than 50km from Facility? | Cadmium | Dioxin | Mercury | PAH |
| Source Category | Facility 001 | 37.9186256 | -87.3275928 | Below Tier 1 Thresh | 5570.86905 | Below Tier 1 Thresh | Not Emitted | 22.98074812 | No | Below Tier 1 Thresh | 958.0770632 | Below Tier 1 Thresh | Not Emitted |
| Source Category | Facility 002 | 35.7759391 | -83.9700634 | Below Tier 1 Thresh | 349.7452568 | Below Tier 1 Thresh | Not Emitted | 4.892812425 | No | Below Tier 1 Thresh | 62.09832278 | Below Tier 1 Thresh | Not Emitted |
| Source Category | Facility 003 | 35.7718715 | -83.9718715 | Below Tier 1 Thresh | 1172.883083 | Below Tier 1 Thresh | 3.847862862 | 5.285146902 | No | Below Tier 1 Thresh | 208.2489208 | Below Tier 1 Thresh | 1.074981013 |
| Source Category | Facility 004 | 37.9416813 | -86.7834428 | Below Tier 1 Thresh | 362.9418641 | Below Tier 1 Thresh | Not Emitted | 40.46387273 | No | Below Tier 1 Thresh | 68.361192 | Below Tier 1 Thresh | Not Emitted |
| Source Category | Facility 005 | 37.9508078 | -86.8470938 | Below Tier 1 Thresh | 1112.825817 | Below Tier 1 Thresh | Not Emitted | 36.58560411 | No | Below Tier 1 Thresh | 193.8834839 | Below Tier 1 Thresh | Not Emitted |
| Source Category | Facility 006 | 37.6573543 | -87.5013493 | Below Tier 1 Thresh | Not Emitted | Below Tier 1 Thresh | Not Emitted | 23.14692051 | No | Below Tier 1 Thresh | Not Emitted | Below Tier 1 Thresh | Not Emitted |
| Source Category | Facility 007 | 41.5370601 | -90.4568523 | Below Tier 1 Thresh | 1445.947649 | Below Tier 1 Thresh | Not Emitted | 9.72361395 | No | Below Tier 1 Thresh | 342.5804898 | Below Tier 1 Thresh | Not Emitted |
| Source Category | Facility 008 | 36.9188097 | -93.912423 | Below Tier 1 Thresh | 240.2218062 | Below Tier 1 Thresh | Not Emitted | 57.93853612 | Yes - Review | Below Tier 1 Thresh | 29.41655613 | Below Tier 1 Thresh | Not Emitted |
| Source Category | Facility 009 | 41.497015 | -90.643441 | Below Tier 1 Thresh | 2535.653112 | Below Tier 1 Thresh | 1.511660409 | 10.64606002 | No | Below Tier 1 Thresh | 650.0048241 | Below Tier 1 Thresh | Below Tier 2 Threshold |
| Source Category | Facility 010 | 36.5095452 | -89.5655228 | Below Tier 1 Thresh | Not Emitted | Below Tier 1 Thresh | Not Emitted | 58.88740804 | Yes - Review | Below Tier 1 Thresh | Not Emitted | Below Tier 1 Thresh | Not Emitted |
| Source Category | Facility 011 | 44.9605684 | -75.1884652 | Below Tier 1 Thresh | 240.2762497 | Below Tier 1 Thresh | Below Tier 1 Thresh | 27.0891651 | No | Below Tier 1 Thresh | 49.9990219 | Below Tier 1 Thresh | Below Tier 1 Threshold |
| Source Category | Facility 012 | 40.774708 | -73.084785 | Below Tier 1 Thresh | 1.319579915 | Below Tier 1 Thresh | Not Emitted | 2.588911116 | No | Below Tier 1 Thresh | Below Tier 2 Thresh | Below Tier 1 Thresh | Not Emitted |
| Source Category | Facility 013 | 35.264838 | -93.081916 | Below Tier 1 Thresh | 79.48755838 | Below Tier 1 Thresh | Not Emitted | 87.50146017 | Yes - Review | Below Tier 1 Thresh | 27.37803178 | Below Tier 1 Thresh | Not Emitted |
| Source Category | Facility 014 | 41.505105 | -87.616551 | Below Tier 1 Thresh | 84.68994043 | Below Tier 1 Thresh | Not Emitted | 9.075696248 | No | Below Tier 1 Thresh | 20.90355704 | Below Tier 1 Thresh | Not Emitted |
| Source Category | Facility 015 | 41.596765 | -87.484926 | Below Tier 1 Thresh | 324.3092381 | Below Tier 1 Thresh | Not Emitted | 6.885594798 | No | Below Tier 1 Thresh | 80.04748407 | Below Tier 1 Thresh | Not Emitted |
| Source Category | Facility 016 | 38.921463 | -86.520349 | Below Tier 1 Thresh | 103.8056698 | Below Tier 1 Thresh | Not Emitted | 26.11514451 | No | Below Tier 1 Thresh | 13.71712393 | Below Tier 1 Thresh | Not Emitted |
| Source Category | Facility 017 | 40.7905522 | -85.8778376 | Below Tier 1 Thresh | 890.1193425 | Below Tier 1 Thresh | Below Tier 1 Thresh | 32.95192946 | No | Below Tier 1 Thresh | 143.7844833 | Below Tier 1 Thresh | Below Tier 1 Threshold |
| Source Category | Facility 018 | 37.6037276 | -84.3069284 | Below Tier 1 Thresh | 9.670994337 | Below Tier 1 Thresh | 3.009580964 | 55.26446594 | Yes - Review | Below Tier 1 Thresh | 1.252296267 | Below Tier 1 Thresh | Below Tier 2 Threshold |
| Source Category | Facility 019 | 41.9283594 | -85.0222812 | Below Tier 1 Thresh | 165.7261149 | Below Tier 1 Thresh | Below Tier 1 Thresh | 36.35148851 | No | Below Tier 1 Thresh | 38.14207185 | Below Tier 1 Thresh | Below Tier 1 Threshold |
| Source Category | Facility 020 | 38.5582675 | -90.2439998 | Below Tier 1 Thresh | Not Emitted | Below Tier 1 Thresh | Not Emitted | 7.695423375 | No | Below Tier 1 Thresh | Not Emitted | Below Tier 1 Thresh | Not Emitted |
| Source Category | Facility 021 | 39.9862783 | -75.04298 | Below Tier 1 Thresh | 317.9502335 | Below Tier 1 Thresh | Not Emitted | 10.98643721 | No | Below Tier 1 Thresh | 42.94868063 | Below Tier 1 Thresh | Not Emitted |
| Source Category | Facility 022 | 43.4929079 | -76.4535928 | Below Tier 1 Thresh | 1790.236453 | Below Tier 1 Thresh | Below Tier 1 Thresh | 16.82850637 | No | Below Tier 1 Thresh | 364.6635543 | Below Tier 1 Thresh | Below Tier 1 Threshold |
| Source Category | Facility 023 | 40.368523 | -81.3434867 | Below Tier 1 Thresh | 426.1416323 | Below Tier 1 Thresh | Below Tier 1 Thresh | 13.01059317 | No | Below Tier 1 Thresh | 66.05408463 | Below Tier 1 Thresh | Below Tier 1 Threshold |
| Source Category | Facility 024 | 40.072959 | -76.337954 | Below Tier 1 Thresh | 1089.432036 | Below Tier 1 Thresh | Below Tier 1 Thresh | 6.429470965 | No | Below Tier 1 Thresh | 171.8685106 | Below Tier 1 Thresh | Below Tier 1 Threshold |
| Source Category | Facility 025 | 33.0315893 | -80.0518015 | Below Tier 1 Thresh | 264.9585279 | Below Tier 1 Thresh | Not Emitted | 14.77758787 | No | Below Tier 1 Thresh | 57.3297614 | Below Tier 1 Thresh | Not Emitted |
| Source Category | Facility 026 | 36.203588 | -85.941331 | Below Tier 1 Thresh | 141.3112149 | Below Tier 1 Thresh | Not Emitted | 56.30870457 | Yes - Review | Below Tier 1 Thresh | 15.48145988 | Below Tier 1 Thresh | Not Emitted |
| Source Category | Facility 027 | 33.4526756 | -94.1373305 | Below Tier 1 Thresh | 224.6009241 | Below Tier 1 Thresh | Below Tier 1 Thresh | 11.99933772 | No | Below Tier 1 Thresh | 48.69269953 | Below Tier 1 Thresh | Below Tier 1 Threshold |
| Source Category | Facility 028 | 43.707613 | -87.751065 | Below Tier 1 Thresh | 320.1938111 | Below Tier 1 Thresh | Below Tier 1 Thresh | 10.53811035 | No | Below Tier 1 Thresh | 54.36938411 | Below Tier 1 Thresh | Below Tier 1 Threshold |
| Source Category | Facility 029 | 33.0520863 | -80.0552796 | Below Tier 1 Thresh | 180.2685874 | Below Tier 1 Thresh | Not Emitted | 17.07437922 | No | Below Tier 1 Thresh | 31.65978623 | Below Tier 1 Thresh | Not Emitted |
| Source Category | Facility 030 | 47.355889 | -120.126814 | Below Tier 1 Thresh | 273.427522 | Below Tier 1 Thresh | Not Emitted | 7.709360139 | No | Below Tier 1 Thresh | 62.92715367 | Below Tier 1 Thresh | Not Emitted |
| Source Category | Facility 031 | 43.759267 | -88.466217 | Not Emitted | 4.355482653 | Not Emitted | Below Tier 1 Thresh | 1.986981736 | No | Not Emitted | Below Tier 2 Thresh | Not Emitted | Below Tier 1 Threshold |
| Source Category | Facility 032 | 30.5662167 | -97.0713118 | Below Tier 1 Thresh | Not Emitted | Below Tier 1 Thresh | Not Emitted | 54.77987283 | Yes - Review | Below Tier 1 Thresh | Not Emitted | Below Tier 1 Thresh | Not Emitted |
| Source Category | Facility 033 | 29.2733373 | -98.3682421 | Below Tier 1 Thresh | 321.9016241 | Below Tier 1 Thresh | 1.154358859 | 12.22251319 | No | Below Tier 1 Thresh | 71.18997561 | Below Tier 1 Thresh | Below Tier 2 Threshold |
| Source Category | Facility 034 | 42.8879527 | -97.3504963 | Below Tier 1 Thresh | 238.4626751 | Below Tier 1 Thresh | Not Emitted | 4.176286491 | No | Below Tier 1 Thresh | 41.15996037 | Below Tier 1 Thresh | Not Emitted |

## 5.6 Assembling Results (Step 8)

By clicking Button 8, the Excel tool creates three separate results tables, shown in the sheets “8) SummaryOutput,” “8) DetailedOutput,” and “8) IndividualOutput.”

The summary table shows the Tiers 1 and 2 human health multipathway screening results at the level of source category and PBHAP Group (see example screen shot in Exhibit 17). Cells with red highlighting call attention to cases where facilities exceeded the Tier 1 or Tier 2 thresholds. Using Source Category A as an example – there were 52 facilities in the category, 51 of which emitted cadmium, 46 emitted dioxins, 51 emitted mercury, and 20 emitted PAHs. No facilities in this category emitted cadmium or mercury at levels exceeding the Tier 1 threshold, so the summary table shows “Below Tier 1 Threshold” as the result for these two PBHAP groups. Because they did not exceed the Tier 1 threshold, they by definition did not exceed the Tier 2 threshold. Five of the facilities in the category exceeded the Tier 1 threshold for PAHs, with the maximum-emitting facility exceeding the threshold by a factor of 3.8. The Tier 2 methodology brought 4 of these 5 facilities below the Tier 2 threshold, leaving only 1 exceeding the Tier 2

**Exhibit 17. Example of Summary Output Table Created by the Tier 2 Tool**



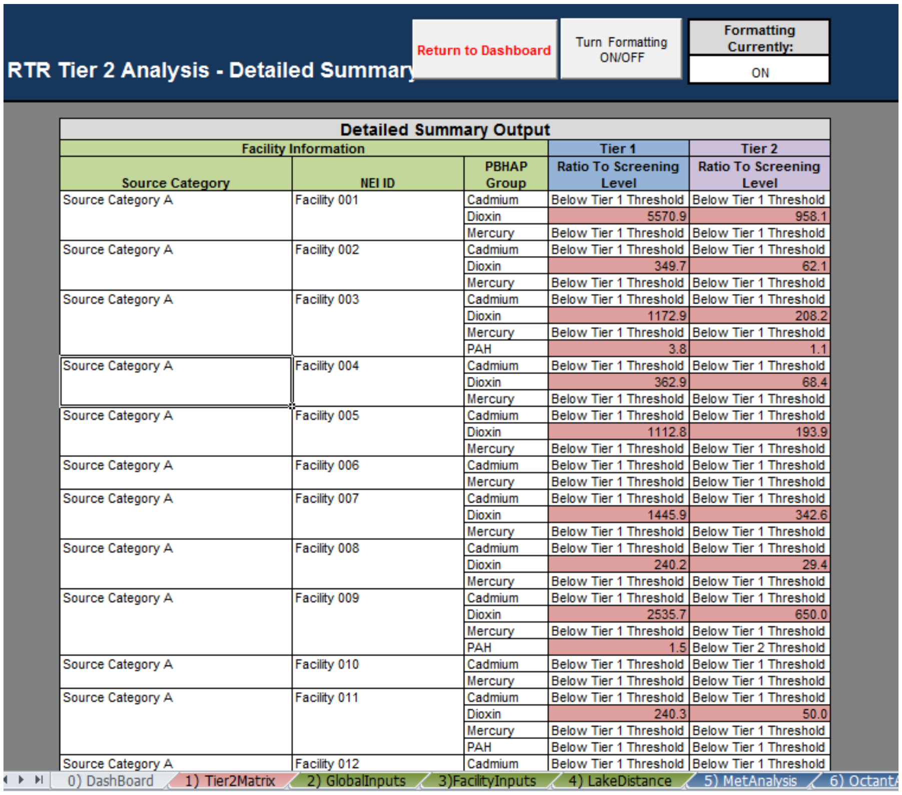
Summary Output

| Facility Information | | | | Tier 1 Ratio To Screening Results | | Tier 2 Ratio To Screening Results | |
|---|---|---|---|---|---|---|---|
| Source Category | PBHAP | Num Facilities in Source Cat (Emitting Any HAP) | Num Facilities Emitting This PBHAP | Max Ratio of Emiss to Screening Lvl of this PBHAP (any facility) | Num Facilities Exceeding the Screening Level of this PBHAP | Max Ratio of Emiss to Screening Lvl of this PBHAP (any facility) | Num Facilities Exceeding the Screening Level of this PBHAP |
| Source Category A | Cadmium | 52 | 51 | Below Tier 1 Threshold | Below Tier 1 Threshold | Below Tier 1 Threshold | Below Tier 1 Threshold |
| | Dioxin | | 46 | 5570.9 | 46 | 958.1 | 43 |
| | Mercury | | 51 | Below Tier 1 Threshold | Below Tier 1 Threshold | Below Tier 1 Threshold | Below Tier 1 Threshold |
| | PAH | | 20 | 3.8 | 5 | 1.1 | 1 |
| Source Category B | Cadmium | 103 | 0 | Not Emitted | Not Emitted | Not Emitted | Not Emitted |
| | Dioxin | | 103 | 739.8 | 84 | 129.2 | 60 |
| | Mercury | | 0 | Not Emitted | Not Emitted | Not Emitted | Not Emitted |
| | PAH | | 0 | Not Emitted | Not Emitted | Not Emitted | Not Emitted |
| Source Category C | Cadmium | 1 | 0 | Not Emitted | Not Emitted | Not Emitted | Not Emitted |
| | Dioxin | | 0 | Not Emitted | Not Emitted | Not Emitted | Not Emitted |
| | Mercury | | 0 | Not Emitted | Not Emitted | Not Emitted | Not Emitted |
| | PAH | | 1 | 1908.1 | 1 | 322.8 | 1 |
| Source Category D | Cadmium | 1 | 0 | Not Emitted | Not Emitted | Not Emitted | Not Emitted |
| | Dioxin | | 0 | Not Emitted | Not Emitted | Not Emitted | Not Emitted |
| | Mercury | | 0 | Not Emitted | Not Emitted | Not Emitted | Not Emitted |
| | PAH | | 1 | 996.5 | 1 | 168.4 | 1 |

threshold (by a factor of 1.1). All 46 dioxin-emitting facilities in the category exceed the Tier 1 dioxin threshold. Three of the 46 facilities did not exceed the Tier 2 threshold, leaving 43 exceeding the Tier 2 threshold but by much smaller amounts compared to Tier 1 (the maximum-emitting facility exceeds the Tier 2 threshold by a factor of 958.1, compared to a factor of 5,570.9 for Tier 1).

The detailed summary table shows much of the same information as the summary table, but the screening results of each facility are shown (see example screen shot in Exhibit 18). This detailed table is helpful because it shows which facilities exceeded the thresholds and by how much. As discussed in the previous paragraph, the summary table shows that 46 and 43 facilities respectively exceeded the Tiers 1 and 2 thresholds for dioxins, with the maximum-emitting facility exceeding Tiers 1 and 2 thresholds by respective factors of 5,570.9 and 958.1. This detailed summary table shows that Facility 001 is that facility emitting the most dioxins after adjusting the emissions for toxicity and exposure. The screen shot in Exhibit 18 shows exceedance factors for dioxins and PAHs for a subset of 8 other facilities in Source Category A (other facilities and source categories are in the table but not shown in the screen shot). The individual summary table is similar to the detailed summary table, but it adds the details of the screening results for each chemical (not just PB-HAP group) and the Tier 2 adjustment factors (see example screen shot in Exhibit 19). The Tier 2 adjustment factors are specific to each chemical and each facility. The ratios to screening level by chemical are summed at the facility level to produce the ratios to screening level by PB-HAP group.

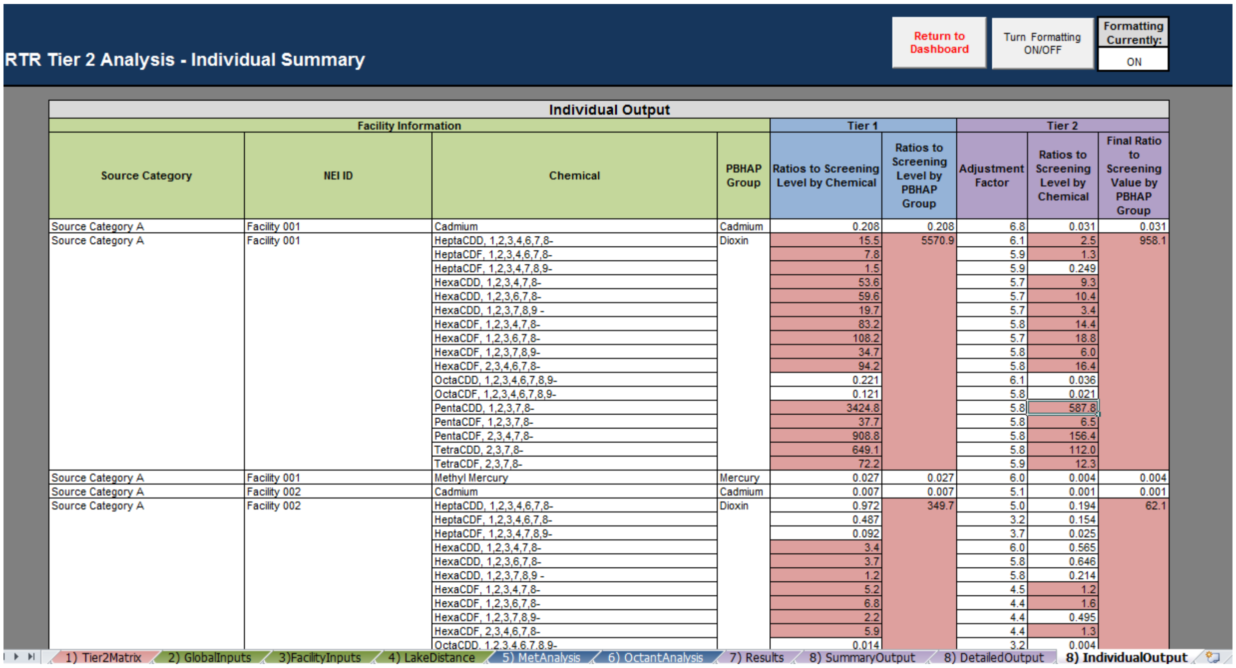
## Exhibit 18. Example of Detailed Output Table Created by the Tier 2 Tool



Detailed Summary Output

| Facility Information | | | Tier 1 | Tier 2 |
|---|---|---|---|---|
| Source Category | NEI ID | PBHAP Group | Ratio To Screening Level | Ratio To Screening Level |
| Source Category A | Facility 001 | Cadmium | Below Tier 1 Threshold | Below Tier 1 Threshold |
| | | Dioxin | 5570.9 | 958.1 |
| | | Mercury | Below Tier 1 Threshold | Below Tier 1 Threshold |
| Source Category A | Facility 002 | Cadmium | Below Tier 1 Threshold | Below Tier 1 Threshold |
| | | Dioxin | 349.7 | 62.1 |
| | | Mercury | Below Tier 1 Threshold | Below Tier 1 Threshold |
| Source Category A | Facility 003 | Cadmium | Below Tier 1 Threshold | Below Tier 1 Threshold |
| | | Dioxin | 1172.9 | 208.2 |
| | | Mercury | Below Tier 1 Threshold | Below Tier 1 Threshold |
| | | PAH | 3.8 | 1.1 |
| Source Category A | Facility 004 | Cadmium | Below Tier 1 Threshold | Below Tier 1 Threshold |
| | | Dioxin | 362.9 | 68.4 |
| | | Mercury | Below Tier 1 Threshold | Below Tier 1 Threshold |
| Source Category A | Facility 005 | Cadmium | Below Tier 1 Threshold | Below Tier 1 Threshold |
| | | Dioxin | 1112.8 | 193.9 |
| | | Mercury | Below Tier 1 Threshold | Below Tier 1 Threshold |
| Source Category A | Facility 006 | Cadmium | Below Tier 1 Threshold | Below Tier 1 Threshold |
| | | Mercury | Below Tier 1 Threshold | Below Tier 1 Threshold |
| Source Category A | Facility 007 | Cadmium | Below Tier 1 Threshold | Below Tier 1 Threshold |
| | | Dioxin | 1445.9 | 342.6 |
| | | Mercury | Below Tier 1 Threshold | Below Tier 1 Threshold |
| Source Category A | Facility 008 | Cadmium | Below Tier 1 Threshold | Below Tier 1 Threshold |
| | | Dioxin | 240.2 | 29.4 |
| | | Mercury | Below Tier 1 Threshold | Below Tier 1 Threshold |
| Source Category A | Facility 009 | Cadmium | Below Tier 1 Threshold | Below Tier 1 Threshold |
| | | Dioxin | 2535.7 | 650.0 |
| | | Mercury | Below Tier 1 Threshold | Below Tier 1 Threshold |
| | | PAH | 1.5 | Below Tier 2 Threshold |
| Source Category A | Facility 010 | Cadmium | Below Tier 1 Threshold | Below Tier 1 Threshold |
| | | Mercury | Below Tier 1 Threshold | Below Tier 1 Threshold |
| Source Category A | Facility 011 | Cadmium | Below Tier 1 Threshold | Below Tier 1 Threshold |
| | | Dioxin | 240.3 | 50.0 |
| | | Mercury | Below Tier 1 Threshold | Below Tier 1 Threshold |
| | | PAH | Below Tier 1 Threshold | Below Tier 1 Threshold |
| Source Category A | Facility 012 | Cadmium | Below Tier 1 Threshold | Below Tier 1 Threshold |

## Exhibit 19. Example of Individual Output Table Created by the Tier 2 Tool



Individual Output

| Facility Information | | | | Tier 1 | | Tier 2 | | |
|---|---|---|---|---|---|---|---|---|
| Source Category | NEI ID | Chemical | PBHAP Group | Ratios to Screening Level by Chemical | Ratios to Screening Level by PBHAP Group | Adjustment Factor | Ratios to Screening Level by Chemical | Final Ratio to Screening Value by PBHAP Group |
| Source Category A | Facility 001 | Cadmium | Cadmium | 0.208 | 0.208 | 6.8 | 0.031 | 0.031 |
| Source Category A | Facility 001 | HeptaCDD, 1,2,3,4,6,7,8- | Dioxin | 15.5 | 5570.9 | 6.1 | 2.5 | 958.1 |
| | | HeptaCDF, 1,2,3,4,6,7,8- | | 7.8 | | 5.9 | 1.3 | |
| | | HeptaCDF, 1,2,3,4,7,8,9- | | 1.5 | | 5.9 | 0.249 | |
| | | HexaCDD, 1,2,3,4,7,8- | | 53.6 | | 5.7 | 9.3 | |
| | | HexaCDD, 1,2,3,6,7,8- | | 59.6 | | 5.7 | 10.4 | |
| | | HexaCDD, 1,2,3,7,8,9 - | | 19.7 | | 5.7 | 3.4 | |
| | | HexaCDF, 1,2,3,4,7,8- | | 83.2 | | 5.8 | 14.4 | |
| | | HexaCDF, 1,2,3,6,7,8- | | 108.2 | | 5.7 | 18.8 | |
| | | HexaCDF, 1,2,3,7,8,9- | | 34.7 | | 5.8 | 6.0 | |
| | | HexaCDF, 2,3,4,6,7,8- | | 94.2 | | 5.8 | 16.4 | |
| | | OctaCDD, 1,2,3,4,6,7,8,9- | | 0.221 | | 6.1 | 0.036 | |
| | | OctaCDF, 1,2,3,4,6,7,8,9- | | 0.121 | | 5.8 | 0.021 | |
| | | PentaCDD, 1,2,3,7,8- | | 3424.8 | | 5.8 | 587.8 | |
| | | PentaCDF, 1,2,3,7,8- | | 37.7 | | 5.8 | 6.5 | |
| | | PentaCDF, 2,3,4,7,8- | | 908.8 | | 5.8 | 156.4 | |
| | | TetraCDD, 2,3,7,8- | | 649.1 | | 5.8 | 112.0 | |
| | | TetraCDF, 2,3,7,8- | | 72.2 | | 5.9 | 12.3 | |
| Source Category A | Facility 001 | Methyl Mercury | Mercury | 0.027 | 0.027 | 6.0 | 0.004 | 0.004 |
| Source Category A | Facility 002 | Cadmium | Cadmium | 0.007 | 0.007 | 5.1 | 0.001 | 0.001 |
| Source Category A | Facility 002 | HeptaCDD, 1,2,3,4,6,7,8- | Dioxin | 0.972 | 349.7 | 5.0 | 0.194 | 62.1 |
| | | HeptaCDF, 1,2,3,4,6,7,8- | | 0.487 | | 3.2 | 0.154 | |
| | | HeptaCDF, 1,2,3,4,7,8,9- | | 0.092 | | 3.7 | 0.025 | |
| | | HexaCDD, 1,2,3,4,7,8- | | 3.4 | | 6.0 | 0.565 | |
| | | HexaCDD, 1,2,3,6,7,8- | | 3.7 | | 5.8 | 0.646 | |
| | | HexaCDD, 1,2,3,7,8,9 - | | 1.2 | | 5.8 | 0.214 | |
| | | HexaCDF, 1,2,3,4,7,8- | | 5.2 | | 4.5 | 1.2 | |
| | | HexaCDF, 1,2,3,6,7,8- | | 6.8 | | 4.4 | 1.6 | |
| | | HexaCDF, 1,2,3,7,8,9- | | 2.2 | | 4.4 | 0.495 | |
| | | HexaCDF, 2,3,4,6,7,8- | | 5.9 | | 4.4 | 1.3 | |
| | | OctaCDD, 1,2,3,4,6,7,8,9- | | 0.014 | | 3.2 | 0.004 | |

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# Supplement A. Summary of TRIM.FaTE Parameters Considered for Inclusion in Tier 2 Analysis

| Parameter | Mechanism of Potential Influence in TRIM | Assessment of Parameter Significance and Ease in Implementation | Uncertainty in Site-Specific Data for Facilities | Priority for Inclusion |
|---|---|---|---|---|
| **Meteorological Parameters** | | | | |
| **Wind direction** (% of time wind blows toward the lake and farm) | In previous runs, direct deposition accounted for the bulk of chemical input onto farms and into lakes. Because wind direction is strongly correlated to direct deposition in a given location, media concentrations are potentially highly sensitive to this parameter. Also, because the percentage of time the prevailing wind blows in the direction of lakes and farms can vary considerably across locations, differences in this parameter might also result in significant changes in important environmental concentrations. | **Highly Significant**: Previous sensitivity analyses have confirmed this to be a very sensitive parameter in the Tier 1 Screening modeling set-up. Changing the fraction of time the wind blows toward the lake and farm by a factor of two corresponds to a change in the risk by a factor of two.<br>**Low Effort to Implement:** This variable is relatively straightforward to vary in the Tier 1 screening scenario. | **Low to Moderate:** The average fraction of time the wind blows in a given direction can be estimated for any surface meteorological station. Then, facilities can be linked to the closest surface meteorological station. | **High** |
| **Wind speed** | Wind speed can affect the location of the "peak" concentration and deposition patterns in a given model configuration, as well as the risk-distance profile. | **Highly Significant**: Previous sensitivity analyses have confirmed this to be a very sensitive parameter. However, wind speed does not vary widely across scenarios, which could reduce its potential influence.<br>**Low Effort to Implement:** This variable is relatively straightforward to vary in the Tier 1 screening scenario. | **Low to Moderate:** The annually-averaged wind speed can be estimated for any surface meteorological station. Then, facilities can be linked to the closest surface meteorological station. | **High** |
| **Precipitation** | Chemicals for which wet vapor or wet particle deposition processes are important are likely to be sensitive to the assumed level of precipitation. | **Highly Significant**: Previous sensitivity analyses have indicated a relatively high sensitivity of risk to precipitation for most PB-HAPs (PAHs, cadmium, and mercury)<br>**Moderate Effort to Implement:** In implementing changes in precipitation in TRIM, care must be taken to also preserve the overall water balance in the model. | **Low to Moderate:** The annually-averaged precipitation rate can be estimated for the subset of surface meteorological stations that capture rainfall data. Then, facilities can be linked to the closest surface meteorological station with available data. | **High** |

| Parameter | Mechanism of Potential Influence in TRIM | Assessment of Parameter Significance and Ease in Implementation | Uncertainty in Site-Specific Data for Facilities | Priority for Inclusion |
|---|---|---|---|---|
| **Mixing height** | Greater mixing heights increase the dispersion of pollutants in the atmosphere and consequently reduce deposition to the ground in the areas around the stack. This is likely to be a highly sensitive parameter if there is a sizeable variation in mixing heights between facilities. | **Highly Significant**: Previous sensitivity analyses have shown risk to be very sensitive to mixing height.<br>**Low Effort to Implement:** This variable is relatively straightforward to vary in the Tier 1 screening scenario. | **Moderate to High:** Mixing height estimates are available for upper air meteorological stations, and this set of stations is more limited than the set of surface meteorological stations. Each surface station can be linked to the closest upper air station to estimate the average mixing height. Then, facilities can be linked to the closest surface meteorological station. The relative uncertainty in mixing height for a given facility is high, given diurnal variations in mixing height and the smaller number of upper air stations. | **High** |
| **Configurational Parameters** | | | | |
| **Distance of lake from stack** | Deposition is known to decrease with distance from stack, although this relationship also depends on meteorological parameters such as wind speed and wind direction. | **Significance Difficult to Determine:** Limited results from previous TRIM model runs show an inconclusive relationship between risk and distance from stack, possibly as a result of limited statistical power. Some studies in the literature show a definite decreasing risk gradient with distance but others report too many confounding factors to isolate the precise relationship.<br>**Moderate Effort to Implement:** This variable requires updates to the layout coordinates and requires more effort to vary in the Tier 1 screening scenario than the meteorological parameters. | **Low:** The lakes within a given radius of each facility can be found using ArcGIS (see section 4). | **High** |

| Parameter | Mechanism of Potential Influence in TRIM | Assessment of Parameter Significance and Ease in Implementation | Uncertainty in Site-Specific Data for Facilities | Priority for Inclusion |
|---|---|---|---|---|
| **Distance of farm from stack** | Deposition is known to decrease with distance from stack, although this relationship also depends on meteorological parameters such as wind speed and wind direction. | **Significance Difficult to Determine:** Limited results from previous TRIM model runs show an inconclusive relationship between risk and distance from stack, possibly as a result of limited statistical power. Some studies in the literature show a definite decreasing risk gradient with distance but others report too many confounding factors to isolate the precise relationship.<br>**Moderate Effort to Implement:** This variable requires updates to the layout coordinates and requires more effort to vary in the Tier 1 screening scenario than the meteorological parameters. | **High:** Although the distance to the farm will likely affect risk, it is difficult to determine the precise land parcels near each facility that are actually used for farming now or in the future. | **Medium** |
| **Watershed: lake area ratio** | A higher watershed:lake area ratio potentially increases the chemical input of water-soluble or particle-attached chemicals into the lake. But the associated higher flush rate will likely reduce this effect. | **Significance Difficult to Determine**: Changes in the watershed to lake ratio affect risk, but the interaction depends on other variables involved in the water balance.<br>**Moderate Effort to Implement:** In implementing changes in the watershed:lake ratios in TRIM, care must be taken to also preserve the overall water balance in the model. | **High:** The portion of land serving as a watershed to a particular lake is difficult to determine. | **Medium** |
| **Area and depth of lake** | A higher lake area would capture more deposition but this effect might be counterbalanced by the ensuing larger volume of water, which reduces chemical concentration. Similarly, a deeper lake would also reduce concentrations, but this effect might be counterbalanced by the ensuing lower flush rates at a constant level of precipitation/runoff. | **Significance Difficult to Determine**: The impact of these parameters is inconclusive based on current studies using the TRIM model.<br>**Moderate Effort to Implement:** The lake area variable requires updates to the layout coordinates and requires more effort to vary in the Tier 1 screening scenario than the meteorological parameters. In implementing changes in these variables in TRIM, care must be taken to also preserve the overall water balance in the model. | **High:** While the area of lakes near a facility can be determined using GIS, the depth cannot. | **Medium** |

| Parameter | Mechanism of Potential Influence in TRIM | Assessment of Parameter Significance and Ease in Implementation | Uncertainty in Site-Specific Data for Facilities | Priority for Inclusion |
|---|---|---|---|---|
| **Physical Parameters** | | | | |
| **Flush rate** | A higher flush rate out of the lake would result in a higher rate of chemical output from the lake, assuming constant inflow and volume. | **Significance Difficult to Determine**: The impact of this parameter is inconclusive based on current studies using the TRIM model.<br>**Moderate Effort to Implement:** In implementing changes in the flush rate in TRIM, care must be taken to also preserve the overall water balance in the model. | **High:** The flush rate of a lake cannot be determined easily for any lake found near a facility. In addition, erosion rates, watershed information, and lake depth needed to estimate the flushing rate are not readily available. | **Medium** |
| **Runoff rate and fraction** | A higher runoff rate (or fraction) would likely result in greater chemical input into the lake for some chemicals but also potentially a higher flush rate out of the lake. | **Significance Difficult to Determine**: The impact of this parameter is inconclusive based on current studies using the TRIM model.<br>**Moderate Effort to Implement:** In implementing changes in the runoff rate and fraction in TRIM, care must be taken to also preserve the overall water balance in the model. | **High:** As with the flush rate, the runoff rate and fraction for any lake near a facility cannot be readily determined. | **Medium** |
| **Erosion rate and fraction** | A higher erosion rate would likely result in greater chemical input into the lake for particle-bound chemicals. It would also result in greater chemical transport onto farmlands, but this might be counterbalanced by equally greater erosion off farmland. | **Highly Significant**: Previous analyses have shown risk to be sensitive to this parameter for some chemicals.<br>**Moderate Effort to Implement:** In implementing changes in the erosion rate and fraction in TRIM, care must be taken to also preserve the overall water balance in the model. | **High:** As with the flush rate, the erosion rate and fraction for any lake near a facility cannot be readily determined. | **Medium** |
| **Chemical Parameters** | | | | |
| **Methylation/ demethylation rates (Hg)** | For Hg, methylation and demethylation rates in lake sediment and surface water are potentially sensitive parameters affecting risk. A literature survey has indicated a relatively high range for rate constants describing these processes. | **Highly Significant**: Previous analyses run in TRIM have confirmed the high sensitivity of these parameters for Hg.<br>**Low Effort to Implement:** This variable is relatively straightforward to vary in the Tier 1 screening scenario | **High:** The specific methylation / demethylation rates for mercury in the vicinity of a specific facility cannot be readily determined. | **Low** |

| Parameter | Mechanism of Potential Influence in TRIM | Assessment of Parameter Significance and Ease in Implementation | Uncertainty in Site-Specific Data for Facilities | Priority for Inclusion |
|---|---|---|---|---|
| **Total phosphorus levels in the lake** | The total phosphorus content of a lake is used as part of the TRIM.FaTE parameterization process to estimate the biomass content of different trophic levels. These biomass levels affect the biomagnification of chemicals up the food chain and potentially risk to human consumers of fish. | **Not Significant**: Previous analyses have shown limited sensitivity to total phosphorus levels. This is likely because the empirical equations predicting biomass in each trophic level depend in similar ways on the level of total phosphorus. So changes in total phosphorus do not significantly affect the ratio of biomass between the different trophic levels.<br>**Low Effort to Implement:** This variable is relatively straightforward to vary in the Tier 1 screening scenario. | **High:** The total phosphorus levels in lakes near a specific facility cannot be readily determined. | **Low** |

# Supplement B. Analysis of Lake Size and Sustainable Fish Population

Identifying the smallest size of a lake that might maintain self-sustaining populations of fish from trophic levels (TL) 3 and 4 and is sufficient to support at least one angler at a specified fish ingestion rate requires consideration of many factors. Some factors depend on assumptions about the behavior of anglers who consume fish from a lake (Section B.1). Other factors depend upon the general biology of fish populations in North American ecoregions (see Section B.2). Based on evaluation of these factors, a set of assumptions was developed to support the estimation of minimum lake sizes that are needed to sustain a particular total human ingestion rate in grams/day (see Section B.3). Then, equations were developed (see Section B.4) that were used to create Exhibit 2, which was used to determine the threshold lake size of 25 acres.

## B.1. Angler Behavior

Several assumptions regarding angler behavior are important for estimating a minimum lake size that is fishable. The first assumption is that anglers (and their family members) consume about 50:50 TL3 and TL4 fish by biomass. TL3 fish are benthic carnivores (BC) such as catfish and chub that consume benthic invertebrates and small benthic fish. TL4 fish are pelagic piscivores—water column carnivores (WCC) such as largemouth bass and walleye. This assumption of 50:50 TL3 and TL4 consumption appears reasonable without being overly conservative. Although anglers might prefer to catch and consume the pelagic (TL4) game fish species, their generally lower abundance compared with lower trophic-level fish dictates that anglers will more often capture the benthic (TL3) carnivores. Some T2 (herbivorous) fish such as carp attain “catchable” size, but they generally are not popular fish for consumption and are not considered here.

A second assumption is that anglers and their family members consume only the fillet portion of a fish. According to Ebert et al. (1993), the edible fraction of fish as a proportion of total fresh body weight is 0.4 for salmon, 0.78 for smelt, and 0.3 for all other species. EPA recommends use of 0.30 for the consumable fraction of fish (USEPA, 1989). For this analysis, a 0.33 edible fraction for T4 fish was assumed. This factor is used in the lake size analysis to estimate total fish biomass associated with human consumption.

A third assumption relates to ingestion rates of the angler or angler family. Fish ingestion rates used for the purpose of the Tier 2 analysis are the same as those in Tier 1 and are consistent with subsistence angler ingestion rates.

Another important consideration related to angler behavior is how much fish removal in a lake is possible without resulting in local fish populations declining to extirpation. The productivity of any particular fishery (local population of a species of fish) and the proportion of adult fish that can be harvested for human consumption are difficult values to estimate, and various models to predict sustainable harvests of different fisheries are numerous and complex. Species-specific parameters of importance include fecundity with age and size; survivorship of eggs, fry, and juveniles to sexual maturity (recruitment); natural predation pressures; and temporal variation in food availability. For the purpose of this analysis, simplifying assumptions are required. In the analysis by Håkanson and Boulion (2004), which included a survey of 122 lakes, the authors noted that a typical loss from fishing by birds, mammals, and humans would be approximately 10 percent of the fish biomass in the prey fish compartment (T3) and 10 percent of the biomass in the predator fish compartment (T4). The authors also found that as overall lake productivity increased, the biomass of prey (T3) fish increased more rapidly than the biomass of predator

(T4) fish. For this lake size analysis, angler harvesting of fish is assumed to be 10 percent of the biomass of pelagic T4 fish.

## B.2. Fish Biology

Estimation of the minimum surface area of a pond or lake that is fishable also must be based on assumptions concerning fish biology, and assumptions have been drawn from several published studies across the United States. The productivity and trophic structure of fish communities in ponds and lakes across the United States are varied. Thus, any set of assumptions is unlikely to all hold true at any given location. Nonetheless, three factors are important to any estimate of a minimum lake surface area for Tier 2: the general productivity of a lake (expressed as grams of fish wet weight per meter squared, g ww/$m^2$); the maximum likely proportion of the total fish biomass in a lake that is comprised of the top trophic level fish (i.e., T3 and T4 fish); and the minimum viable population (MVP) size required for the fish species to be self-sustaining in the short term (for at least a few decades).

### *B.2.1. Lake Productivity*

The general productivity of a lake depends on many factors, including latitude, seasonal temperatures, and nutrients supporting the base of the food web. For lakes at approximately the same latitude in the same climate, nutrients play a key role in the total fish biomass that a lake might support. In a regression analysis of data on total phosphorus (TP) and fish biomass for 31 lakes across North America, Europe, and Russia, Nürnberg (1996) summarized the “limits” among three TP-defined lake trophic status categories with respect to total fish wet weight biomass per unit area for three categories of lakes:

Oligo-meso (TP = 10 µg/L) = 1.9 g ww/$m^2$
Meso-eutro (TP = 30 µg/L) = 3.7 g ww/$m^2$
Eutro-hypereutro (TP = 100 µg/L) = 8.5 g ww/$m^2$

Nürnberg (1996) also summarized total fish biomass limits from Bachmann et al. (1996) for the lake trophic status categories based on a sample of 60 lakes in Florida:

Oligo-meso (TP = 10 µg/L) = 7.4 g ww/$m^2$
Meso-eutro (TP = 30 µg/L) = 10.6 g ww/$m^2$
Eutro-hypereutro (TP = 100 µg/L) = 15.6 g ww/$m^2$

As might be expected, for the same TP concentrations, standing fish biomass per unit area in the Florida lakes is two to three times higher than standing fish biomass for more northerly lakes with shorter growing seasons.

Hanson and Legget (1982) estimated the relationship between TP and standing stock of fish using a regression model based on samples from 21 lakes ranging in surface area from 0.1–25,000 hectares (~0.25–62,000 acres) and located between 0° and 56° N latitude and 121° E to 122° W longitude. Their linear regression relating TP to total fish standing biomass (B) used the following equation and had a correlation coefficient ($r^2$) of 0.84:

$$B = 0.792 + 0.072\ (TP)$$

where:

$B$ = total fish biomass (kg/hectare)

$TP$ = total phosphorous (µg/L)

The regression model of Hanson and Legget (1982) predicted total fish biomass densities in lakes of 3.0–9.5 g ww/$m^2$ for TP concentrations ranging from 10–50 µg/L for oligo-mesotrophic to mid-range eutrophic lakes. Another regression model from Hoyer and Canfield (1991) predicted fish biomass densities in streams of 2.6–6.6 g ww/$m^2$ over the same range of TP concentrations.

In general, for very small lakes, relatively low fish productivity is likely. For example, Demers et al. (2001) found fish standing biomass values of 2.73 and 3.81 g ww/$m^2$ in two lakes of 27 and 22 acres (11 and 9 hectares), respectively, in south-central Ontario. Brönmark and Weisner (1996) reported on aquatic communities from a sample of 44 small ponds in southern Sweden (most were less than 5 hectares ≈ 12 acres). They found no fish in 5 of the smaller ponds (mean surface area of 0.20 ± 0.097 acres)—which also exhibited lower TP concentrations than the larger ponds—and no piscivorous fish in another 11 of the 44 ponds (mean surface area of 0.46 ± 0.27 acres). For the 28 ponds with piscivorous (TL4) fish present, the mean pond surface area was 1.4 (±1.3 SD) acres.

Ideally, one would have data indicating TP levels in lakes in the vicinity of facilities for a Tier 2 analysis. Such data, however, are rarely readily available. The general ranges of fish productivity across lakes of various surface areas, therefore, are considered to be independent of lake size over a wide range of lake sizes. Thus, lake size alone cannot be used to estimate fish productivity or maximal fish harvesting rates.

Scientists have also examined the relationship between TP and total fish biomass in reservoirs. Yurk and Ney (1989) examined the relationship between TP and standing stock of fish in 22 reservoirs in southern Appalachia sampled in 1973. Their logarithmic regression that related TP to total fish standing biomass (B) used the following equation and had an $r^2$ of 0.75:

$$\mathrm{Log}_{10}(\mathrm{B}) = 1.07 + 1.14 \times \mathrm{Log}_{10}(\mathrm{TP})$$

Use of the equations from Hanson and Legget (1982) and Yurk and Ney (1989) yielded similar predications of total fish biomass at intermediate TP concentrations. At low TP (e.g., 10 µg/L), predictions of total fish biomass were 3.0 g ww/$m^2$ (Yurk and Ney, 1989) and 1.6 g ww/$m^2$ (Hanson and Legget, 1982); at high TP (e.g., 100 µg/L), fish biomass predicted by the two models were 15.5 and 22.4 g ww/$m^2$, respectively.

Leidy and Jenkins (1977) reported analyses of several large data sets to support modeling of fish productivity and carrying capacity in reservoirs across the United States for the National Reservoir Research Program. The analyses included studies of fish standing biomass by species in 61 reservoirs across the midwestern and eastern United States sampled at different times between 1952 and 1975. Only reservoirs of at least 500 acres (202 hectares) in size were included, with some exceeding 65,000 acres (in the Missouri drainage basin). Considering all 61 reservoirs, the mean biomass density of fish was 41.3 (± 30.4 SD) g ww/$m^2$. The minimum and maximum total fish biomass densities were 3.2 and 133.2 g ww/$m^2$, respectively, and the median value was 30.9 g ww/$m^2$. Reservoirs typically have large drainage basins, which in some areas can receive excess TP from large expanses of agricultural areas.

In summary, the fish productivity in lakes and reservoirs can vary by more than three orders of magnitude. The reservoirs surveyed by Leidy and Jenkins (1977) in general were much larger (and were often more shallow and nutrient rich) than the natural lakes surveyed by others discussed above. The mean standing fish biomass of approximately 41.3 g ww/m² from the reservoir survey is likely to be higher than a mean value for any representative sample of natural lakes in the United States. For the purpose of the Tier 2 analysis, 40 g ww/$m^2$ was identified as the upper limit for total fish biomass in a lake.

### *B.2.2. Proportion of Fish Biomass by Trophic Level*

As indicated in Section B.1, for the Tier 2 analysis, the proportion of fish in an angler's diet that consists of TL3 and TL4 fish is assumed to be 50:50 by biomass (not numbers) for lakes that support the four trophic levels. In smaller lakes, TL4 fish are likely to be missing or rare, with TL3 fish (e.g., sunfish) being the highest trophic level supported by the primary productivity (algal/plant production) in some lakes. As a "rule of thumb" in ecology, 10 percent or less of the energy produced at one trophic level usually can be converted to biomass in the next trophic level (i.e., approximately 90 percent loss of energy) per trophic step. However, with different species having different energy assimilation efficiencies and with smaller species generally having higher turnover rates than larger species, the 10 percent energy rule does not necessarily translate into a standing biomass pyramid of similar proportions. In this section, the proportion of fish (based on biomass) that might be expected in TL3 and TL4 relative to total standing fish biomass are examined assuming TL4 fish are present.

Examination of several studies of fish biomass by trophic habits indicated that top trophic level fish might comprise approximately 20 percent of the standing fish biomass in many locations. Ploskey and Jenkins (1982) estimated that piscivorous fish, both those that are generally free-swimming or pelagic (e.g., pike, gar, walleye) and those that rest and forage primarily in the benthos (e.g., various species of catfish, suckers) comprise 22 percent of the total fish biomass in DeGray Lake, Arkansas (averaged across several years). Leidy and Jenkins (1977) estimated that 18 percent of the fish biomass across the 61 reservoirs they examined was piscivorous (minimum of 14 percent and maximum 24 percent). Demers et al. (2001) categorized 2 percent and 15 percent of the total fish biomass in two small lakes of 27 and 22 acres in size, respectively, as piscivorous/benthivorous fish (e.g., largemouth bass, creek chub); primary benthivores (e.g., catfish, suckers) dominated at >70 percent in both lakes.

One of the more recent food web models for freshwater lakes is that of Håkanson and Boulion (2004). Their model was designed to predict the productivity and standing crop of prey and predatory fishes in lakes of northern Europe. The authors acknowledged that fish feeding patterns are complicated by the fact that fish change their feeding preferences as they age—especially during early development, but also as adults, when they may switch between zooplankton and zoobenthos and from small fish to larger fish as they grow. A "distribution coefficient" was used to indicate what proportion of the total fish biomass in a lake is prey versus predatory fish. Based on data from 122 lakes in Europe and North America, Håkanson and Boulion (2004) concluded that 27 percent by biomass is a "normal" portion of predatory fish in a balanced system. They noted further, however, that for eutrophic lakes with TP levels >100 µg/L, the proportion of fish represented by piscivores declines to less than 20 percent.

Based on the information above, the top trophic level (T3 and T4) fish are assumed to comprise 21 percent of the total fish biomass. With the bulk of productivity in lakes originating from detritus in the benthos, the total biomass of strictly pelagic game fish is expected to be less than that of benthic fish. Therefore, for purpose of this lake size analysis, the piscivorous/benthivorous fish were separated into two compartments, with 17.5 percent of the total fish biomass in a benthic carnivore (T3) compartment and 3.5 percent of the total in a pelagic piscivore (T4) compartment. Thus, the T4 fish, when present, represent the limiting compartment for angler fish harvesting and consumption.

### *B.2.3. Minimum Viable Population Size*

The final step in estimating the minimum lake size that can support sustainable fishing of its T4 fish species is to invoke the concept of minimum viable population (MVP) size. MVP is a concept used frequently in conservation biology for animals and is defined as the smallest population that will persist for a specified duration (e.g., 100 years) with a given probability (e.g., 95 percent). MVP for any given species and general location depends on many attributes of the species biology (e.g., body size, reproductive rate, home range size, corridors between populations, variability in environmental characteristics that impact fecundity and survival). At lower numbers, the likelihood of population extinction increases due to environmental and demographic stochasticity (Menzie et al., 2008). As for fisheries biology, entire text books have been dedicated to applied population ecology with population simulations incorporating demographic and life-history characteristics, spatial separation of habitat patches and metapopulations, the probability of local catastrophes, genetic variation (e.g., drift), and other factors with predictions of time-to-extinction or probability of extinction within specified time periods (e.g., Soulé, 1987; Akçakaya et al., 1999). Consideration of such models in population-level ecological risk assessment has begun, but faces many challenges (Barnthouse et al., 2008).

Much of the initial work on MVP investigated the genetic minima required for short-term survival, continuing adaptation to environmental change, and ultimately evolution. Inbreeding has been considered the primary threat to short-term survival and genetic drift as the principal threat to losing the genetic variation required for adaptation (Shaffer, 1987). Several analyses (Senner, 1980; Franklin, 1980; Soulé, 1980; Frankel and Soulé, 1981; Lande and Barrowclough, 1987) have led to the conclusion that minimum effective population sizes on the order of 50 are required for short-term survival (e.g., several generations, decades), while effective population sizes on the order of 500 are necessary to provide adequate genetic variation for continuing adaptation over the long term (e.g., tens of generations, centuries for some animals) (Shaffer, 1981; 1987). Effective population size, $N_e$, is a measure of the rate of genetic drift (loss of genetic diversity or inbreeding), and its definition generally depends on the population in question (Rieman and Allendorft, 2001). $N_e$ can be estimated mathematically based on stochastic behavior of gene frequencies in a diploid population. Simple models assume a fixed population size, constant fecundity, specified sex ratio, and no overlap between generations (see studies cited in NRC, 1986). For animals with 50:50 sex ratios, the effective population size is essentially the same as the actual breeding adult population size (Ewens et al., 1987). One of the most extensive population viability analyses in the United States has been conducted on the spotted owl (Boyce, 1993). Given the number and complexity of factors that influence MVP, however, including the definitions of time horizon (e.g., 100 years) and probability of survival (e.g., 95 percent), population biologists caution against using a “rule” for MVP across circumstances (Ewens et al., 1987).

Note that the MVP is appropriate for a single species of fish, not for generic categories of fish such as TL3 or TL4. For this Tier 2 analysis, the MVP of 50 associated with short-term population survival was assumed for a T4 fish species isolated in a lake. In reality, short-term extirpations from a lake can be countered by purposeful introductions from other lakes or during flooding events. Thus, an MVP of 500 was not considered necessary for game fish in lakes.

## B.3. Summary of Assumptions for the Lake Size Analysis

The following assumptions were used in processing lake data for the Tier 2 analysis and in estimating the relationship between sustainable fish ingestion and harvest rates and lake size (see Section 4.1 of the main report).

1. Piscivorous fish (T3 plus T4), when present, comprise approximately 21 percent of the standing biomass of fish (ignoring seasonal changes). The T3 fish represent 17.5 percent of the standing fish biomass; T4 fish account for 3.5 percent of this total fish biomass. Thus, T4 fish, when present, represent the limiting compartment for angler fish harvesting and consumption.

2. Humans can harvest 10 percent of the T4 biomass without threatening the population due to overharvesting.

3. The MVP size for a single T4 species is at least 50 adult fish for a local population to survive over the short term (more than a decade).

4. Only 33 percent of a T4 fish is edible fillet muscle.

## B.4. Equations Used to Determine Lake Fish Populations

The standing biomass of T4 fish supported in Lake X (T4 SB) can be calculated as the total standing biomass of fish (Total SB) multiplied by 0.035, based on the assumption that T4 fish represent approximately 3.5 percent of the standing biomass in Lake X.

$$T4\ SB = Total\ SB \times \text{Fraction T4} \qquad (\textit{Equation 1})$$

where:

*T4 SB* = Standing biomass of T4 fish (g wet weight [ww]/m$^2$) in Lake X

*Total SB* = Total standing biomass of fish (g ww/m$^2$) in Lake X

*Fraction T4* = Fraction of T4 fish in Lake X (0.035)

Using T4 SB and the size of Lake X (Lake Size), the total number of T4 fish supported in Lake X can be calculated using the equation below.

$$No.\,T4 = \frac{LakeSize \times T4SB \times CF}{BW_a} \qquad (\textit{Equation 2})$$

where:

*No. T4* = Total number of T4 fish in Lake X

*Lake Size* = Size of Lake X (acres)

$T4\ SB$ = Standing biomass of T4 fish (g ww/m$^2$; from *Equation 1*)

$CF$ = 4047 m$^2$/acre

$BW_a$ = Body weight of adult T4 fish (2000 g; assumed based on professional judgment)

The likely annual productivity of T4 fish (kg/year) in Lake X can be estimated using Equation 3.

$$Productivity\ T4 = \frac{LakeSize \times T4\,SB \times CF1}{CF2} \quad \text{(Equation 3)}$$

where:

$Productivity\ T4$ = Likely annual productivity of T4 fish in Lake X (kg/year)

$Lake\ Size$ = Size of the Lake X (acres)

$T4\ SB$ = Standing biomass of T4 fish (g ww/m$^2$; from *Equation 1*)

$CF1$ = 4047 m$^2$/acre

$CF2$ = 1000 g/kg

The maximum fish ingestion rate (g/day) for T3 plus T4 fish associated with sustainable fishing can be predicted using Equation 4. It assumes 50:50 consumption behaviors of T3 and T4 fish, represented by the factor of 2 in Equation 4.

$$MaxSustainIR\,(T3 + T4) = \frac{2 \times Productivity\,T4 \times FF \times HF \times CF1}{CF2} \quad \text{(Equation 4)}$$

where:

$Max\ Sustain\ IR\ T3 + T4$ = Predicted maximum sustainable ingestion rate for T3 plus T4 fish (g/day)

$Productivity\ T4$ = Likely annual productivity of T4 fish in Lake X (kg/year; from *Equation 3*)

$FF$ = Fillet fraction; represents the assumed edible portion of fish (0.33; unitless)

$HF$ = Annual harvest fraction (0.10; unitless)

$CF1$ = 1000 g/kg

$CF2$ = 365 days/year

## B.5. References

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## Technical Support Document for the TRIM-Based Multipathway Tiered Screening Methodology for RTR

# Attachment C. Tier 3 Methodology

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# Appendix 5 Detailed Risk Modeling Results

## Table 1 - Facility Identification Information

| Source Category | Facility NEI ID | Facility Name | Address | City | State |
|---|---|---|---|---|---|
| Pulp and Papermaking | 01001NEI8560 | International Paper Company | 100 Jensen Rd | Prattville | AL |
| Pulp and Papermaking | 01023NEI18334 | Fort James-Pennington | 7530 Hwy 114 | Pennington | AL |
| Pulp and Papermaking | 01025NEI8601 | Boise White Paper Llc | 4585 Industrial Road | Jackson | AL |
| Pulp and Papermaking | 01047NEI18335 | International Paper - Riverdale Mill | 601 County Rd 78 | Selma | AL |
| Pulp and Papermaking | 01053NEI18338 | Georgia-Pacific Brewton Llc | 32224 Hwy 31 S | Brewton | AL |
| Pulp and Papermaking | 01071NEI18347 | Rocktenn Cp, Llc - Stevenson Mill | 1611 County Road 85 | Stevenson | AL |
| Pulp and Papermaking | 01079NEI18357 | International Paper Courtland Mill | Lawrence County Hwy 150 | Courtland | AL |
| Pulp and Papermaking | 01091NEI45474 | Rock-Tenn Mill Co Llc | 28270 Us Hwy 80 W | Demopolis | AL |
| Pulp and Papermaking | 01099NEI18373 | Alabama River Cellulose, Llc | 2373 Lena Landegger Hwy | Perdue Hill | AL |
| Pulp and Papermaking | 01113NEI46931 | Meadwestvaco Coated Board, Llc | Hwy 165 S | Cottonton | AL |
| Pulp and Papermaking | 01121NEI18390 | Abibow U. S., Inc. - Coosa Pines Operations | 17589 Plant Rd | Coosa Pines | AL |
| Pulp and Papermaking | 01131NEI8619 | International Paper Pine Hill | Hwy 10 E | Pine Hill | AL |
| Pulp and Papermaking | 04017NEI13216 | Catalyst Paper (Snowflake) Inc. | 15 M.W.Of Snwflk On Spur 277 | Snowflake | AZ |
| Pulp and Papermaking | 05003NEI54342 | Georgia-Pacific Llc Crossett Paper Mill | 100 Mill Supply Rd. | Crossett | AR |
| Pulp and Papermaking | 05029NEI46852 | Green Bay Packaging - Ark Kraft Division | 338 Highway 113 | Morrilton | AR |
| Pulp and Papermaking | 05041NEI18652 | Clearwater Paper Corporation-Cypress Bend Mill | 5082 Hwy. 4 N. | Arkansas City | AR |
| Pulp and Papermaking | 05069NEI18657 | Delta Natural Kraft & Mid-American Packg | 1701 Jefferson Pkwy | Pine Bluff | AR |
| Pulp and Papermaking | 05069NEI18658 | Evergreen Packaging Inc. | 5201 Fairfield Road | Pine Bluff | AR |
| Pulp and Papermaking | 05081NEI18660 | Domtar A.W. Llc | 285 Hwy 71 South | Ashdown | AR |
| Pulp and Papermaking | 09011NEICT3102 | Cascades Boxboard Group-Connecticut Llc Versailles Mill | 130 Inland Rd | Versailles | CT |
| Pulp and Papermaking | 12005NEI8278 | Rocktenn Cp, Llc - Panama City Mill | One Everitt Ave | Panama City | FL |
| Pulp and Papermaking | 12031NEI26304 | Rocktenn Cp, Llc - Seminole Mill | 9469 Eastport Rd | Jacksonville | FL |
| Pulp and Papermaking | 12033NEI26309 | International Paper Company | 375 Muscogee Road | Cantonment | FL |
| Pulp and Papermaking | 12089NEI26382 | Rayonier Performance Fibers Llc | 10 Gum Street | Fernandina Beach | FL |
| Pulp and Papermaking | 12089NEI8261 | Rocktenn Cp, Llc - Fernandina Beach Mill | N 8Th St | Fernandina Beach | FL |
| Pulp and Papermaking | 12107NEI8265 | Georgia-Pacific Consumer Operations Llc | 215 County Road 216 | Palatka | FL |
| Pulp and Papermaking | 12123NEI47091 | Buckeye Florida, Limited Partnership | One Buckeye Drive | Perry | FL |
| Pulp and Papermaking | 13021NEI26471 | Graphic Packaging Macon Mill | 100 Graphic Packaging International Way | Macon | GA |
| Pulp and Papermaking | 13051NEI26476 | Weyerhaeuser Nr Port Wentworth | 1 Bonnybridge Road | Port Wentworth | GA |
| Pulp and Papermaking | 13051NEI8186 | International Paper Co - Savannah Complex | 1201 W Lathrop Ave | Savannah | GA |

## Table 1 - Facility Identification Information

| Source Category | Facility NEI ID | Facility Name | Address | City | State |
|---|---|---|---|---|---|
| Pulp and Papermaking | 13095NEI26487 | Procter & Gamble Paper Products Co | 512 Liberty Expressway Se | Albany | GA |
| Pulp and Papermaking | 13099NEI26491 | Georgia-Pacific Cedar Springs, Llc | 12551 Hwy 273 West | Cedar Springs | GA |
| Pulp and Papermaking | 13103NEI8178 | Georgia-Pacific Consumer Products Lp Savannah River Mill | 393 Fort Howard Rd | Rincon | GA |
| Pulp and Papermaking | 13115NEI26495 | Tin Inc. Dba Temple-Inland | 238 Mays Bridge Road | Rome | GA |
| Pulp and Papermaking | 13127NEI8196 | Georgia-Pacific Corp.Brunswick Operations | West 9Th Street | Brunswick | GA |
| Pulp and Papermaking | 13175NEIGAT$3911 | Sp Newsprint Co. | 709 Papermill Road | East Dublin | GA |
| Pulp and Papermaking | 13179NEI8177 | Interstate Paper Llc | 2366 Interstate Paper Road | Riceboro | GA |
| Pulp and Papermaking | 13185NEI26504 | Packaging Corporation Of America - Valdosta Mill | 5495 Lake Park-Clyattville Rd | Clyattville | GA |
| Pulp and Papermaking | 13193NEI26506 | Weyerhaeuser Nr Company | 2449 Stagecoach Rd | Oglethorpe | GA |
| Pulp and Papermaking | 13235NEIGAT$3909 | Hollingsworth And Vose Company | 106 Industrial Boulevard | Hawkinsville | GA |
| Pulp and Papermaking | 13245NEI26514 | International Paper - Augusta Mill | 4278 Mike Padgett Highway | Augusta | GA |
| Pulp and Papermaking | 13245NEI8122 | Augusta Newsprint Company Llc | 2434 Doug Barnard Pkwy | Augusta | GA |
| Pulp and Papermaking | 13305NEI26526 | Rayonier Performance Fibers, Llc | 4470 Savannah Highway | Jesup | GA |
| Pulp and Papermaking | 16069NEI26581 | Clearwater Paper Corp - Ppd & Cpd, Idaho | 803 Mill Road | Lewiston | ID |
| Pulp and Papermaking | 17021NEIIL0215971 | Ahlstrom Filtration Llc | 1200 E Elm St | Taylorville | IL |
| Pulp and Papermaking | 18165NEI2INT16350 | Tin Inc. Dba Temple-Inland | 2585 East 200 North | Cayuga | IN |
| Pulp and Papermaking | 21007NEI11338 | Wickliffe Paper Company | 1724 Westvaco Rd | Wickliffe | KY |
| Pulp and Papermaking | 21091NEI32869A | Domtar Paper Company, Llc - Hawesville Operations | 58 Wescor Rd | Hawesville | KY |
| Pulp and Papermaking | 21107NEI11367 | Ahlstrom Filtration Llc | 215 Nebo Rd | Madisonville | KY |
| Pulp and Papermaking | 22011NEI7559 | Boise Packaging And Newsprint, Llc | 4200 Hwy 190 W | Deridder | LA |
| Pulp and Papermaking | 22031NEI33013 | International Paper Co Mansfield Mill | 1202 Louisiana Hwy 509 Ne | Mansfield | LA |
| Pulp and Papermaking | 22033NEI46817 | Georgia-Pacific Port Hudson Operations | 1000 W Mount Pleasant Rd | Zachary | LA |
| Pulp and Papermaking | 22049NEI33023 | Rocktenn Cp, Llc - Hodge Mill | 100 Mill Street | Hodge | LA |
| Pulp and Papermaking | 22069NEI33025 | International Paper - Red River Mill | 4537 Hwy 480 | Campti | LA |
| Pulp and Papermaking | 22073NEI6057 | Graphic Packaging International, Inc. - Plant 31 | 1000 Jonesboro Rd | West Monroe | LA |
| Pulp and Papermaking | 22117NEI46814 | Temple-Inland/Bogalusa Mill/Gaylord Container Corp | 4Th St & Ave. U | Bogalusa | LA |
| Pulp and Papermaking | 23005NEI33072 | S D Warren Co - Westbrook | 89 Cumberland St | Westbrook | ME |
| Pulp and Papermaking | 23007NEI6261 | Verso Paper - Androscoggin Mill | Po Box 20 Riley Rd | Jay | ME |

## Table 1 - Facility Identification Information

| Source Category | Facility NEI ID | Facility Name | Address | City | State |
|---|---|---|---|---|---|
| Pulp and Papermaking | 23009NEI6284 | Verso Bucksport, Llc | Main St | Bucksport | ME |
| Pulp and Papermaking | 23017NEI6273 | Rumford Paper Company | 35 Hartford St | Rumford | ME |
| Pulp and Papermaking | 23019NEI33103 | Old Town Fuel And Fiber | 24 Portland St | Old Town | ME |
| Pulp and Papermaking | 23019NEI33104 | Lincoln Paper And Tissue Llc | 50 Katahdin Avenue | Lincoln | ME |
| Pulp and Papermaking | 23025NEI33118 | Sappi - Somerset | 1329 Waterville Rd | Skowhegan | ME |
| Pulp and Papermaking | 23025NEIME0250002 | Madison Paper Industries | 3 Main Street | Madison | ME |
| Pulp and Papermaking | 23029NEI46835 | Woodland Pulp Llc | 144 Main St | Baileyville | ME |
| Pulp and Papermaking | 24001NEI33135 | Westvaco Fine Papers | 300 Pratt Street | Luke | MD |
| Pulp and Papermaking | 25003NEIMA10626 | Onyx Specialty Papers, Inc. | 40 Willow Street | South Lee | MA |
| Pulp and Papermaking | 25017NEI6175 | Hollingsworth & Vose | 219 Townsend Rd | Groton | MA |
| Pulp and Papermaking | 25021NEIMA131179 | Hollingsworth & Vose | 112 Washington Street | Walpole | MA |
| Pulp and Papermaking | 26003NEI33866 | Neenah Paper Michigan | 501 E Munising Ave | Munising | MI |
| Pulp and Papermaking | 26041NEI33883 | Newpage - Escanaba Paper Company | 7100 County Road 426 Po Box 757 | Escanaba | MI |
| Pulp and Papermaking | 26043NEI33887 | Verso Quinnesec Llc | W-6791 Us Highway 2 Quinnesec Mill | Quinnesec | MI |
| Pulp and Papermaking | 26101NEI33945 | Packaging Corporation Of America - Filer City Mill | 2246 Udell St. | Filer City | MI |
| Pulp and Papermaking | 26109NEI33950 | Menominee Paper Company | 144 First Street | Menominee | MI |
| Pulp and Papermaking | 26147NEI33981 | E.B. Eddy Paper Inc. | 1700 Washington Ave | Port Huron | MI |
| Pulp and Papermaking | 26153NEI33986 | Manistique Papers Inc | 453 South Mackinac Ave | Manistique | MI |
| Pulp and Papermaking | 27017NEI12368 | Sappi Cloquet Llc | 2201Avenue B | Cloquet | MN |
| Pulp and Papermaking | 27035NEI34020 | Wausau Paper Mills, Llc | 1801 Mill Ave Ne | Brainerd | MN |
| Pulp and Papermaking | 27061NEI34030 | Upm Blandin Paper Co | 115 Sw First St | Grand Rapids | MN |
| Pulp and Papermaking | 27071NEI12411 | Boise White Paper Llc - Intl Falls | 400 2Nd St | International Falls | MN |
| Pulp and Papermaking | 27137NEIMN14904 | Newpage - Duluth Paper & Recycle Pulp Mill | 100 N Central Ave | Duluth | MN |
| Pulp and Papermaking | 27145NEI12407 | Verso Paper Co - Sartell Mill/International Paper Co | 100 E Sartell St | Sartell | MN |
| Pulp and Papermaking | 28043NEI11108 | Abibow Us Inc. Grenada Operations | 1000 Papermill Road | Grenada | MS |
| Pulp and Papermaking | 28077NEI11172 | Georgia Pacific Monticello Llc | 604 N.A. Sandifer Hwy | Monticello | MS |
| Pulp and Papermaking | 28087NEI34064 | Weyerhaeuser Nr Company, Columbus Cellulose Fibers | 4335 Carson Road | Columbus | MS |
| Pulp and Papermaking | 28111NEI34066 | Leaf River Cellulose, Llc | 157 Buck Creek Road | New Augusta | MS |
| Pulp and Papermaking | 28149NEI34070 | International Paper Co. - Vicksburg Mill | 3737 Highway 3 North | Redwood | MS |
| Pulp and Papermaking | 36031NEI35908 | International Paper Ticonderoga Mill | 568 Shore Airport Rd | Ticonderoga | NY |
| Pulp and Papermaking | 36045NEI36019 | Knowlton Technologies, Llc | 213 Factory St | Watertown | NY |
| Pulp and Papermaking | 36113NEI39968 | Finch Paper Llc | 1 Glen St | Glens Falls | NY |
| Pulp and Papermaking | 36115NEINY5532600 | Hollingsworth & Vose-Easton Mill | Co Rt 113 | Easton | NY |
| Pulp and Papermaking | 36115NEINY5533400 | Hollingsworth & Vose Greenwich Mill | St Rte 29 - E Side | Greenwich | NY |
| Pulp and Papermaking | 37047NEI40247 | International Paper - Riegelwood Mill | 865 John L Riegel Road | Riegelwood | NC |

## Table 1 - Facility Identification Information

| Source Category | Facility NEI ID | Facility Name | Address | City | State |
|---|---|---|---|---|---|
| Pulp and Papermaking | 37049NEI45206 | Weyerhaeuser Company - Vanceboro Saw Mill | 1785 Weyerhaeuser Road | Vanceboro | NC |
| Pulp and Papermaking | 37083NEI47104 | Kapstone - Roanoke Rapids Mill | 100 Gaston Road | Roanoke Rapids | NC |
| Pulp and Papermaking | 37087NEI40282 | Blue Ridge Paper Products - Canton Mill | 175 Main Street | Canton | NC |
| Pulp and Papermaking | 37117NEI9201 | Domtar Paper Company, Llc | Nc Highway 149 North | Plymouth | NC |
| Pulp and Papermaking | 39017NEI11600 | Smart Papers Holdings Llc | 601 North 'B' Street | Hamilton | OH |
| Pulp and Papermaking | 39017NEI11602 | Graphic Packaging International Corp. | 407 Charles Street | Middletown | OH |
| Pulp and Papermaking | 39031NEI11461 | Rocktenn Cp, Llc - Coshocton Mill | 500 North Fourth Street | Coshocton | OH |
| Pulp and Papermaking | 39061NEI11610 | Rock-Tenn Company, Mill Division, Inc. | 3347 Madison Road | Cincinnati | OH |
| Pulp and Papermaking | 39113NEI11645 | Appleton Papers Inc. | 1030 West Alex-Bell Rd. | West Carrollton | OH |
| Pulp and Papermaking | 39141NEI40488 | P.H. Glatfelter Company - Chillicothe Facility | 232 East 8Th Street | Chillicothe | OH |
| Pulp and Papermaking | 40031NEW73505 | Republic Paperboard Company, Llc | 8801 Sw Lee Blvd | Lawton | OK |
| Pulp and Papermaking | 40089NEI11251 | International Paper - Valliant | 1.5 Miles On Us 70 Sw Of Valliant | Valliant | OK |
| Pulp and Papermaking | 40101NEI12980 | Georgia Pacific Consumer Prod Lp | 4901 Chandler Rd | Muskogee | OK |
| Pulp and Papermaking | 41007NEI40554 | Georgia-Pacific Consumer Products Lp - Wauna Mill | 92326 Taylorville Road | Clatskanie | OR |
| Pulp and Papermaking | 41009NEI40553 | Boise White Paper Llc | 1300 Kaster Rd | Saint Helens | OR |
| Pulp and Papermaking | 41039NEI45182 | International Paper Company | 801 42Nd Street | Springfield | OR |
| Pulp and Papermaking | 41041NEI40600 | Georgia-Pacific Toledo, Llc | 1400 Se Butler Bridge Rd | Toledo | OR |
| Pulp and Papermaking | 41043NEI13340 | Cascade Pacific Pulp | 30480 American Dr | Halsey | OR |
| Pulp and Papermaking | 41071NEI40648 | Sp Newsprint Co. - Newberg M Ill | 1301 Wynooski St | Newberg | OR |
| Pulp and Papermaking | 42013NEI7104 | Appleton Papers Inc Spring Mill | 100 Paper Mill Rd | Roaring Spring | PA |
| Pulp and Papermaking | 42013NEI7106 | Team Ten/Tyrone Paper Mill | 1600 Pennsylvania Ave | Tyrone | PA |
| Pulp and Papermaking | 42047NEI40686 | Domtar Paper Company Llc - Johnsonburg Mill | 100 W Center St | Johnsonburg | PA |
| Pulp and Papermaking | 42101NEI40720 | Paperworks Industries Inc. | 5000 Flat Rock Rd. | Philadelphia | PA |
| Pulp and Papermaking | 42101NEIPA1013489 | Newman & Company | 6101 Tacony St | Philadelphia | PA |
| Pulp and Papermaking | 42131NEI40738 | Procter & Gamble Paper Prod Mehoopany Plt | Rte 87 S & Rte 6 | Mehoopany | PA |
| Pulp and Papermaking | 42133NEI7181 | P. H. Glatfelter Co - Spring Grove Mill | 228 S Main St | Spring Grove | PA |
| Pulp and Papermaking | 45019NEI41252 | Kapstone Charleston Kraft Llc | 5600 Virginia Avenue | North Charleston | SC |
| Pulp and Papermaking | 45031NEI43472 | Sonoco:Hartsville | 1 N Second St | Hartsville | SC |
| Pulp and Papermaking | 45041NEI7933 | Rocktenn Cp, Llc - Florence Mill | 7320 Paper Mill Rd | Florence | SC |
| Pulp and Papermaking | 45043NEI41314 | International Paper:Georgetown Mill | 700 S Kaminski St | Georgetown | SC |
| Pulp and Papermaking | 45069NEI47074 | Domtar Company:Marlboro Paper Mill | 585 Willamette Rd | Bennettsville | SC |
| Pulp and Papermaking | 45079NEI46760 | International Paper:Eastover | 4001 Mccords Ferry Road | Eastover | SC |
| Pulp and Papermaking | 45091NEI47077 | Abibow Us Inc. Catawba Operations | 5300 Cureton Ferry Rd | Catawba | SC |

## Table 1 - Facility Identification Information

| Source Category | Facility NEI ID | Facility Name | Address | City | State |
|---|---|---|---|---|---|
| Pulp and Papermaking | 47071NEI41552 | Packaging Corporation Of America | Highway 57 | Counce | TN |
| Pulp and Papermaking | 47085NEI46866 | Temple Inland | 2877 Scepter Road | Waverly | TN |
| Pulp and Papermaking | 47105NEITN1050093 | Kimberly Clark Corporation | 5600 Kimberly Way | Loudon | TN |
| Pulp and Papermaking | 47107NEI41565 | Bowater Newsprint & Directory - Calhoun Operations | 5020 Highway 11, South | Calhoun | TN |
| Pulp and Papermaking | 47163NEI41599 | Domtar Paper Co Llc Kingsport Mill | 100 Clinchfield Street | Kingsport | TN |
| Pulp and Papermaking | 48067NEI41628 | International Paper Texarkana Mill | 9978 Fm 3129 | Queen City | TX |
| Pulp and Papermaking | 48241NEI6450 | Westvaco Texas Lp | 1913 Fm 105 | Evadale | TX |
| Pulp and Papermaking | 48361NEI12492 | Orange Mill | 1750 Inland Road | Orange | TX |
| Pulp and Papermaking | 51009NEIVA00022 | Greif Packaging Llc | 861 Fibre Plant Rd | Amherst | VA |
| Pulp and Papermaking | 51019NEI42211 | Gp Big Island Llc | 9363 Lee Jackson Hwy - Rte 501 | Big Island | VA |
| Pulp and Papermaking | 51085NEI208 | White Birch Paper Company Bear Island Llc Division | Na | Ashland | VA |
| Pulp and Papermaking | 51101NEI42254 | Rocktenn Cp, Llc - West Point Mill | 1901 Main Street | West Point | VA |
| Pulp and Papermaking | 51580NEI759 | Meadwestvaco Packaging Resource Group | 104 E Riverside St | Covington | VA |
| Pulp and Papermaking | 51670NEI42317 | Rocktenn Cp, Llc - Hopewell Mill | 910 Industrial St | Hopewell | VA |
| Pulp and Papermaking | 53009NEI42329 | Nippon Paper Industries Usa Co. Ltd. | 1902 Marine Dr | Port Angeles | WA |
| Pulp and Papermaking | 53011NEI46599 | Georgia Pacific Consumer Products (Camas), Llc | 401 Ne Adams St | Camas | WA |
| Pulp and Papermaking | 53015NEI42338 | Longview Fibre Paper & Packaging Inc | 300 Fibre Way | Longview | WA |
| Pulp and Papermaking | 53015NEI42341A | Weyerhaeuser Co | 3401 Industrial Way | Longview | WA |
| Pulp and Papermaking | 53015NEI42341B | North Pacific Paper Corporation (Norpac) (Longview Mill) | 3001 Industrial Way | Longview | WA |
| Pulp and Papermaking | 53031NEI42357 | Port Townsend Paper Corp | 100 Mill Rd | Port Townsend | WA |
| Pulp and Papermaking | 53051NEI2WAT18798 | Ponderay Newsprint Co | 422767 Sr20 | Usk | WA |
| Pulp and Papermaking | 53053NEI13363 | Simpson Tacoma Kraft Co Llc | 801 Portland Ave | Tacoma | WA |
| Pulp and Papermaking | 53061NEI42385 | Kimberly-Clark Corporation | 2600 Federal Ave | Everett | WA |
| Pulp and Papermaking | 53071NEI42410 | Boise White Paper Llc | 31831 W Hwy 12 | Wallula | WA |
| Pulp and Papermaking | 54037NEI23 | Ox Paperboard Llc | 164 Eyster Road | Halltown | WV |
| Pulp and Papermaking | 54057NEI706 | Meadwestvaco Corporation | 300 Pratt Street | Luke | WV |
| Pulp and Papermaking | 55009NEI42482 | Georgia Pacific Consumer Products Lp - Green Bay Broadway Mill | 1919 S Broadway | Green Bay | WI |
| Pulp and Papermaking | 55009NEI42486 | Green Bay Packaging Inc.- Green Bay Mill | 1601 N. Quincy St. | Green Bay | WI |
| Pulp and Papermaking | 55009NEI42495 | Thilmany Papers Nicolet Mill | 200 Main Ave | De Pere | WI |
| Pulp and Papermaking | 55009NEIWI4050324 | Georgia Pacific Consumer Products Lp - Green Bay Day Street Mill | 500 Day St | Green Bay | WI |
| Pulp and Papermaking | 55069NEI46750 | Packaging Corporation Of America-Tomahawk | N9090 County Road E | Tomahawk | WI |

## Table 1 - Facility Identification Information

| Source Category | Facility NEI ID | Facility Name | Address | City | State |
|---|---|---|---|---|---|
| Pulp and Papermaking | 55073NEI42689 | Wausau Paper Mills, Llc | 100 Main St | Mosinee | WI |
| Pulp and Papermaking | 55073NEI42690 | Wausau Paper Mills, Llc | 202 Second St. | Brokaw | WI |
| Pulp and Papermaking | 55073NEI54400 | Domtar Paper Company Llc - Rothschild | 200 N Grand Ave | Rothschild | WI |
| Pulp and Papermaking | 55079NEIWI0793640 | Wisconsin Paperboard Corp | 1514 E Thomas Ave | Milwaukee | WI |
| Pulp and Papermaking | 55085NEI43202 | Wausau Paper Mills, Llc | 515 W Davenport St | Rhinelander | WI |
| Pulp and Papermaking | 55087NEI42710 | Thilmany, Llc-Kaukauna Mill | 600 Thilmany Rd | Kaukauna | WI |
| Pulp and Papermaking | 55087NEI43207 | Appleton Coated L.L.C. Locks Mill | 540 Prospect St | Combined Locks | WI |
| Pulp and Papermaking | 55097NEIWI7500086 | Newpage Stevens Point Mill | 707 Arlington Pl | Stevens Point | WI |
| Pulp and Papermaking | 55097NEIWIT$8597 | Newpage Corp - Water Renewal Center | 2690 W. River Drive | Stevens Point | WI |
| Pulp and Papermaking | 55099NEI42730 | Flambeau River Papers | 200 1St Ave N | Park Falls | WI |
| Pulp and Papermaking | 55115NEI42800 | Little Rapids Corp - Shawano Specialty Papers | W7575 Poplar Road | Shawano | WI |
| Pulp and Papermaking | 55139NEIWI4710355 | Sca Tissue North America Llc Menasha Paper Mill | 190 Third St | Menasha | WI |
| Pulp and Papermaking | 55141NEI42695 | Domtar A.W. Llc | 301 Point Basse Ave. | Nekoosa | WI |
| Pulp and Papermaking | 55141NEI42961 | Newpage Corp - Biron Mill | 621 North Biron Drive | Wisconsin Rapids | WI |
| Pulp and Papermaking | 55141NEI42963 | Newpage, Wisconsin Systems Inc. | 310 3Rd Avenue North | Wisconsin Rapids | WI |
| Pulp and Papermaking | 55141NEI46739 | Newpage, Wisconsin Systems Inc. | 950 4Th Ave N | Wisconsin Rapids | WI |
| Pulp and Papermaking | 55141NEIWI7720116 | Newpage, Wisconsin Systems Inc. | 2811 5Th Ave N | Wisconsin Rapid | WI |

## Table 2 – Maximum Predicted HEM-3 Chronic Risks

| | Source Category Chronic Risk [1] | | | | Facility-Wide Chronic Risk [1, 2] | | | |
|---|---|---|---|---|---|---|---|---|
| **Facility NEI ID** | **Cancer MIR** | **Cancer Incidence** | **Noncancer Max HI** | **Target Organ** | **Cancer MIR** | **Noncancer Max HI** | **Target Organ** | **SC % of Facility-wide Cancer Risk** |
| 21091NEI32869A | **1.21E-05** | 1.12E-04 | 0.17 | Respiratory | **1.23E-05** | 0.23 | Respiratory | 98% |
| 01023NEI18334 | **1.04E-05** | 8.04E-05 | 0.20 | Respiratory | **1.64E-05** | **1.67** | Respiratory | 64% |
| 41071NEI40648 | **9.01E-06** | 1.22E-04 | 0.44 | Respiratory | **9.07E-06** | 0.44 | Respiratory | 99% |
| 37087NEI40282 | **8.98E-06** | 1.07E-04 | 0.29 | Respiratory | **3.36E-05** | **1.60** | Respiratory | 27% |
| 55141NEIWI7720116 | **8.51E-06** | 1.19E-04 | 0.41 | Respiratory | **8.65E-06** | 0.42 | Respiratory | 98% |
| 23025NEIME0250002 | **7.58E-06** | 5.45E-05 | 0.31 | Respiratory | **8.78E-06** | 0.34 | Respiratory | 86% |
| 55141NEI42695 | **7.42E-06** | 7.54E-05 | 0.29 | Respiratory | **7.44E-06** | 0.29 | Respiratory | 100% |
| 47071NEI41552 | **7.14E-06** | 4.83E-05 | 0.36 | Respiratory | **7.94E-06** | 0.64 | Respiratory | 90% |
| 22073NEI6057 | **5.27E-06** | 4.13E-04 | 0.22 | Respiratory | **8.40E-06** | 0.35 | Respiratory | 63% |
| 12123NEI47091 | **5.22E-06** | 7.15E-05 | 0.16 | Respiratory | **2.88E-05** | 0.52 | Developmental | 18% |
| 41041NEI40600 | **4.94E-06** | 7.08E-05 | 0.15 | Respiratory | **6.74E-06** | 0.29 | Respiratory | 73% |
| 23029NEI46835 | **4.86E-06** | 1.81E-05 | 0.20 | Respiratory | **5.35E-06** | 0.32 | Respiratory | 91% |
| 55087NEI43207 | **4.32E-06** | 6.42E-04 | 0.22 | Respiratory | **1.02E-05** | 0.32 | Respiratory | 42% |
| 53053NEI13363 | **4.30E-06** | 2.29E-03 | 0.07 | Respiratory | **4.85E-06** | 0.15 | Respiratory | 89% |
| 51019NEI42211 | **4.25E-06** | 1.91E-04 | 0.20 | Respiratory | **4.27E-06** | 0.24 | Respiratory | 100% |
| 45043NEI41314 | **4.25E-06** | 1.20E-04 | 0.16 | Respiratory | **5.62E-06** | 0.30 | Respiratory | 76% |
| 42013NEI7104 | **4.09E-06** | 2.83E-05 | 0.07 | Neurological | **7.91E-06** | 0.50 | Respiratory | 52% |
| 42047NEI40686 | **3.85E-06** | 4.21E-05 | 0.07 | Respiratory | **4.43E-06** | 0.38 | Respiratory | 87% |
| 24001NEI33135 | **3.77E-06** | 2.49E-05 | 0.14 | Respiratory | **8.69E-06** | 0.36 | Respiratory | 43% |
| 47163NEI41599 | **3.62E-06** | 2.28E-04 | 0.14 | Respiratory | **5.13E-06** | 0.95 | Respiratory | 71% |
| 13103NEI8178 | **3.34E-06** | 1.81E-04 | 0.06 | Respiratory | **3.91E-06** | 0.08 | Respiratory | 86% |
| 13127NEI8196 | **3.27E-06** | 4.42E-04 | 0.14 | Respiratory | **3.57E-06** | 0.16 | Respiratory | 91% |
| 48241NEI6450 | **3.25E-06** | 9.37E-05 | 0.09 | Respiratory | **4.03E-06** | 0.14 | Respiratory | 81% |
| 13115NEI26495 | **3.18E-06** | 8.91E-05 | 0.09 | Respiratory | **5.02E-06** | 0.25 | Respiratory | 63% |
| 53031NEI42357 | **3.10E-06** | 4.85E-05 | 0.18 | Respiratory | **3.18E-06** | 0.18 | Respiratory | 98% |
| 05081NEI18660 | **3.04E-06** | 9.56E-05 | 0.08 | Respiratory | **3.42E-06** | 0.18 | Respiratory | 89% |
| 17021NEIIL0215971 | **3.00E-06** | 5.73E-05 | 0.15 | Respiratory | **3.18E-06** | 0.16 | Respiratory | 94% |
| 41039NEI45182 | **2.80E-06** | 2.10E-04 | 0.05 | Respiratory | **3.59E-06** | 0.11 | Respiratory | 78% |
| 37083NEI47104 | **2.73E-06** | 1.18E-04 | 0.12 | Respiratory | **7.08E-06** | 0.17 | Respiratory | 39% |
| 27145NEI12407 | **2.72E-06** | 7.50E-05 | 0.09 | Kidney | **2.75E-06** | 0.09 | Kidney | 99% |
| 37047NEI40247 | **2.69E-06** | 1.38E-04 | 0.09 | Respiratory | **4.56E-06** | 0.17 | Respiratory | 59% |
| 51580NEI759 | **2.62E-06** | 3.80E-05 | 0.08 | Respiratory | **5.80E-06** | 0.19 | Respiratory | 45% |
| 01001NEI8560 | **2.58E-06** | 4.36E-04 | 0.10 | Respiratory | **3.67E-06** | 0.15 | Respiratory | 70% |
| 55009NEI42482 | **2.46E-06** | 9.36E-04 | 0.03 | Respiratory | **2.70E-06** | 0.04 | Respiratory | 91% |
| 51009NEIVA00022 | **2.32E-06** | 2.16E-05 | 0.10 | Respiratory | **2.58E-06** | 0.10 | Respiratory | 90% |
| 27061NEI34030 | **2.30E-06** | 7.37E-05 | 0.04 | Respiratory | **2.39E-06** | 0.38 | Respiratory | 96% |
| 12005NEI8278 | **2.28E-06** | 1.17E-04 | 0.07 | Respiratory | **3.54E-06** | 0.11 | Respiratory | 64% |
| 39061NEI11610 | **2.27E-06** | 8.13E-05 | 0.05 | Respiratory | **6.84E-06** | 0.11 | Respiratory | 33% |
| 23007NEI6261 | **2.22E-06** | 3.36E-05 | 0.12 | Respiratory | **2.72E-06** | 0.22 | Respiratory | 81% |
| 45031NEI43472 | **2.19E-06** | 3.54E-05 | 0.11 | Respiratory | **2.36E-06** | 0.12 | Respiratory | 93% |
| 26041NEI33883 | **2.04E-06** | 2.66E-05 | 0.12 | Respiratory | **2.31E-06** | 0.20 | Respiratory | 88% |
| 13051NEI8186 | **2.00E-06** | 2.91E-04 | 0.03 | Respiratory | **2.41E-06** | 0.05 | Respiratory | 83% |
| 13051NEI26476 | **1.91E-06** | 5.88E-05 | 0.10 | Respiratory | **1.95E-06** | 0.11 | Respiratory | 98% |
| 47107NEI41565 | **1.89E-06** | 3.49E-05 | 0.13 | Respiratory | **3.44E-06** | **1.56** | Neurological | 55% |
| 42131NEI40738 | **1.86E-06** | 3.32E-05 | 0.06 | Respiratory | **2.15E-06** | 0.06 | Respiratory | 86% |
| 40089NEI11251 | **1.84E-06** | 1.72E-05 | 0.06 | Respiratory | **2.32E-06** | 0.14 | Respiratory | 79% |
| 28077NEI11172 | **1.71E-06** | 2.70E-05 | 0.06 | Respiratory | **5.74E-06** | 0.22 | Respiratory | 30% |
| 05003NEI54342 | **1.68E-06** | 7.00E-05 | 0.06 | Respiratory | **2.58E-06** | 0.14 | Respiratory | 65% |
| 16069NEI26581 | 1.49E-06 | 5.48E-05 | 0.03 | Respiratory | **5.65E-06** | 0.08 | Respiratory | 26% |
| 28111NEI34066 | 1.44E-06 | 2.21E-05 | 0.04 | Respiratory | **1.90E-06** | 0.07 | Respiratory | 76% |
| 21107NEI11367 | 1.42E-06 | 1.91E-05 | 0.16 | Respiratory | **6.94E-06** | 0.20 | Respiratory | 20% |
| 05069NEI18658 | 1.39E-06 | 1.36E-04 | 0.22 | Respiratory | **1.88E-06** | 0.28 | Respiratory | 74% |
| 42133NEI7181 | 1.35E-06 | 9.60E-05 | 0.05 | Respiratory | **2.07E-06** | 0.22 | Respiratory | 65% |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 28149NEI34070 | 1.32E-06 | 3.30E-05 | 0.04 | Respiratory | **2.05E-06** | 0.08 | Respiratory | 64% |
| 41043NEI13340 | 1.29E-06 | 3.31E-05 | 0.14 | Respiratory | **1.59E-06** | 0.27 | Respiratory | 81% |
| 13305NEI26526 | 1.28E-06 | 4.55E-05 | 0.13 | Respiratory | **2.51E-06** | 0.32 | Respiratory | 51% |
| 55073NEI54400 | 1.18E-06 | 5.23E-05 | 0.04 | Respiratory | 1.39E-06 | 0.07 | Respiratory | 85% |
| 12107NEI8265 | 1.16E-06 | 1.25E-04 | 0.03 | Respiratory | 1.45E-06 | 0.11 | Respiratory | 80% |
| 53015NEI42341B | 1.15E-06 | 2.18E-04 | 0.03 | Respiratory | 1.15E-06 | 0.03 | Respiratory | 100% |
| 22117NEI46814 | 1.10E-06 | 6.14E-05 | 0.03 | Respiratory | **3.40E-06** | 0.13 | Respiratory | 32% |
| 22049NEI33023 | 1.10E-06 | 2.37E-05 | 0.03 | Respiratory | **1.59E-06** | 0.07 | Respiratory | 69% |
| 22069NEI33025 | 1.10E-06 | 1.03E-05 | 0.04 | Respiratory | 1.30E-06 | 0.08 | Respiratory | 84% |
| 23017NEI6273 | 1.09E-06 | 2.46E-05 | 0.04 | Respiratory | 1.37E-06 | 0.04 | Respiratory | 80% |
| 53011NEI46599 | 1.05E-06 | 2.96E-04 | 0.03 | Respiratory | **2.73E-06** | 0.36 | Respiratory | 38% |
| 01131NEI8619 | 1.04E-06 | 9.89E-06 | 0.04 | Respiratory | **1.79E-06** | 0.11 | Respiratory | 58% |
| 51101NEI42254 | 1.02E-06 | 2.46E-05 | 0.05 | Respiratory | **2.45E-06** | 0.13 | Respiratory | 42% |
| 45069NEI47074 | 1.02E-06 | 3.56E-05 | 0.03 | Respiratory | 1.40E-06 | 0.07 | Respiratory | 73% |
| 13099NEI26491 | 9.95E-07 | 4.09E-05 | 0.04 | Respiratory | **2.21E-06** | 0.26 | Neurological | 45% |
| 12089NEI8261 | 9.31E-07 | 6.27E-05 | 0.03 | Respiratory | 1.24E-06 | 0.10 | Respiratory | 75% |
| 12033NEI26309 | 9.23E-07 | 9.22E-05 | 0.04 | Respiratory | **2.76E-06** | 0.15 | Respiratory | 33% |
| 45019NEI41252 | 8.85E-07 | 1.59E-04 | 0.02 | Respiratory | 1.29E-06 | 0.05 | Respiratory | 69% |
| 37049NEI45206 | 8.85E-07 | 5.83E-05 | 0.01 | Respiratory | 9.54E-07 | 0.04 | Respiratory | 93% |
| 22011NEI7559 | 8.80E-07 | 1.15E-05 | 0.04 | Respiratory | **1.51E-05** | 0.14 | Respiratory | 6% |
| 22031NEI33013 | 8.44E-07 | 1.29E-04 | 0.03 | Respiratory | 1.30E-06 | 0.05 | Respiratory | 65% |
| 39031NEI11461 | 8.18E-07 | 3.23E-05 | 0.04 | Respiratory | **3.13E-06** | 0.89 | Respiratory | 26% |
| 26101NEI33945 | 8.16E-07 | 8.57E-06 | 0.04 | Respiratory | 8.98E-07 | 0.04 | Respiratory | 91% |
| 41007NEI40554 | 8.00E-07 | 6.74E-06 | 0.01 | Respiratory | **1.78E-06** | 0.07 | Respiratory | 45% |
| 13185NEI26504 | 7.94E-07 | 2.22E-05 | 0.03 | Respiratory | **5.49E-06** | **1.61** | Respiratory | 14% |
| 01047NEI18335 | 7.69E-07 | 4.21E-05 | 0.05 | Respiratory | 1.08E-06 | 0.09 | Respiratory | 71% |
| 21007NEI11338 | 7.44E-07 | 2.19E-05 | 0.03 | Respiratory | **1.80E-05** | 0.48 | Respiratory | 4% |
| 05029NEI46852 | 7.35E-07 | 2.29E-05 | 0.04 | Respiratory | 7.96E-07 | 0.04 | Respiratory | 92% |
| 01121NEI18390 | 6.85E-07 | 1.34E-05 | 0.02 | Respiratory | **6.34E-06** | 0.13 | Neurological | 11% |
| 54037NEI23 | 6.53E-07 | 3.04E-06 | 0.03 | Respiratory | 7.11E-07 | 0.04 | Respiratory | 92% |
| 53015NEI42341A | 6.47E-07 | 8.58E-05 | 0.07 | Respiratory | 7.19E-07 | 0.08 | Respiratory | 90% |
| 22033NEI46817 | 6.43E-07 | 1.05E-04 | 0.02 | Respiratory | **1.98E-06** | 0.06 | Respiratory | 32% |
| 45091NEI47077 | 6.42E-07 | 1.03E-04 | 0.04 | Respiratory | **1.55E-06** | 0.08 | Respiratory | 41% |
| 13021NEI26471 | 6.28E-07 | 1.33E-04 | 0.01 | Respiratory | **1.56E-06** | 0.33 | Respiratory | 40% |
| 23019NEI33103 | 5.54E-07 | 8.74E-06 | 0.03 | Respiratory | 1.23E-06 | 0.49 | Respiratory | 45% |
| 55073NEI42689 | 5.50E-07 | 2.98E-05 | 0.10 | Respiratory | 6.66E-07 | 0.12 | Respiratory | 83% |
| 47085NEI46866 | 5.40E-07 | 6.64E-06 | 0.03 | Respiratory | 1.23E-06 | 0.05 | Respiratory | 44% |
| 55009NEI42486 | 5.12E-07 | 6.92E-05 | 0.01 | Respiratory | 9.07E-07 | 0.02 | Respiratory | 56% |
| 25017NEI6175 | 5.08E-07 | 1.17E-05 | 0.00 | Respiratory | 5.08E-07 | 0.00 | Respiratory | 100% |
| 12089NEI26382 | 5.05E-07 | 5.91E-05 | 0.02 | Respiratory | 8.00E-07 | 0.05 | Respiratory | 63% |
| 53009NEI42329 | 5.05E-07 | 1.17E-05 | 0.01 | Respiratory | 1.04E-06 | 0.44 | Respiratory | 48% |
| 53015NEI42338 | 5.02E-07 | 7.31E-05 | 0.03 | Respiratory | 7.80E-07 | 0.06 | Respiratory | 64% |
| 01113NEI46931 | 4.77E-07 | 8.03E-05 | 0.02 | Respiratory | 1.47E-06 | 0.10 | Respiratory | 32% |
| 37117NEI9201 | 4.73E-07 | 8.06E-06 | 0.02 | Respiratory | 9.90E-07 | 0.03 | Respiratory | 48% |
| 54057NEI706 | 4.65E-07 | 1.77E-06 | 0.01 | Respiratory | 5.36E-07 | 0.02 | Respiratory | 87% |
| 48067NEI41628 | 4.52E-07 | 5.97E-05 | 0.03 | Respiratory | 1.02E-06 | 0.09 | Respiratory | 44% |
| 27071NEI12411 | 4.44E-07 | 6.85E-06 | 0.02 | Respiratory | 9.42E-07 | 0.04 | Respiratory | 47% |
| 01053NEI18338 | 4.31E-07 | 1.23E-05 | 0.01 | Respiratory | 1.24E-06 | 0.28 | Respiratory | 35% |
| 01079NEI18357 | 4.29E-07 | 6.81E-05 | 0.01 | Respiratory | 1.26E-06 | 0.06 | Respiratory | 34% |
| 13245NEI26514 | 4.17E-07 | 1.11E-04 | 0.02 | Respiratory | 8.98E-07 | 0.06 | Respiratory | 46% |
| 55141NEI46739 | 4.00E-07 | 2.35E-05 | 0.05 | Respiratory | 1.11E-06 | 0.11 | Respiratory | 36% |
| 28087NEI34064 | 3.90E-07 | 5.65E-05 | 0.04 | Respiratory | 4.89E-07 | 0.05 | Respiratory | 80% |
| 48361NEI12492 | 3.83E-07 | 5.20E-05 | 0.01 | Respiratory | **1.95E-06** | 0.11 | Respiratory | 20% |
| 23025NEI33118 | 3.83E-07 | 1.88E-05 | 0.01 | Respiratory | 5.14E-07 | 0.04 | Respiratory | 74% |
| 05069NEI18657 | 3.70E-07 | 4.80E-05 | 0.01 | Respiratory | 8.80E-07 | 0.16 | Neurological | 42% |
| 25003NEIMA10626 | 3.62E-07 | 1.13E-05 | 0.00 | Respiratory | 1.26E-06 | 0.02 | Respiratory | 29% |
| 01071NEI18347 | 3.57E-07 | 1.06E-05 | 0.02 | Respiratory | 9.64E-07 | 0.04 | Respiratory | 37% |
| 51085NEI208 | 3.54E-07 | 4.53E-05 | 0.02 | Respiratory | 6.04E-07 | 0.21 | Respiratory | 59% |
| 45079NEI46760 | 3.49E-07 | 8.61E-05 | 0.07 | Respiratory | 8.71E-07 | 0.13 | Respiratory | 40% |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 55085NEI43202 | 3.35E-07 | 1.04E-05 | 0.01 | Respiratory | 1.02E-06 | 0.03 | Respiratory | 33% |
| 01025NEI8601 | 2.93E-07 | 6.77E-06 | 0.01 | Respiratory | 8.23E-07 | 0.10 | Neurological | 36% |
| 01099NEI18373 | 2.92E-07 | 8.00E-06 | 0.01 | Respiratory | 3.54E-07 | 0.02 | Respiratory | 82% |
| 26043NEI33887 | 2.88E-07 | 7.74E-06 | 0.01 | Respiratory | 4.35E-07 | 0.02 | Respiratory | 66% |
| 51670NEI42317 | 2.83E-07 | 7.95E-05 | 0.01 | Respiratory | 4.51E-07 | 0.13 | Respiratory | 63% |
| 13095NEI26487 | 2.79E-07 | 2.98E-05 | 0.01 | Respiratory | 2.90E-07 | 0.01 | Respiratory | 96% |
| 01091NEI45474 | 2.77E-07 | 1.26E-05 | 0.11 | Respiratory | 6.04E-07 | 0.12 | Respiratory | 46% |
| 55087NEI42710 | 2.73E-07 | 2.70E-05 | 0.01 | Respiratory | 3.23E-07 | 0.07 | Respiratory | 85% |
| 13245NEI8122 | 2.62E-07 | 3.37E-05 | 0.01 | Respiratory | 5.38E-07 | 0.02 | Respiratory | 49% |
| 55099NEI42730 | 2.40E-07 | 1.49E-06 | 0.01 | Developmental | 1.44E-06 | 0.13 | Respiratory | 17% |
| 55009NEIWI4050324 | 2.18E-07 | 4.94E-05 | 0.14 | Respiratory | 2.22E-07 | 0.14 | Respiratory | 98% |
| 26147NEI33981 | 2.13E-07 | 1.26E-05 | 0.01 | Respiratory | **3.16E-05** | 0.57 | Developmental | 1% |
| 53071NEI42410 | 1.93E-07 | 1.41E-05 | 0.01 | Respiratory | 5.56E-07 | 0.07 | Respiratory | 35% |
| 27137NEIMN14904 | 1.89E-07 | 8.25E-06 | 0.01 | Respiratory | 1.89E-07 | 0.01 | Respiratory | 100% |
| 36113NEI39968 | 1.86E-07 | 7.01E-06 | 0.14 | Respiratory | 8.38E-07 | 0.16 | Respiratory | 22% |
| 04017NEI13216 | 1.76E-07 | 9.41E-07 | 0.00 | Respiratory | 4.14E-07 | 0.01 | Respiratory | 43% |
| 27017NEI12368 | 1.73E-07 | 1.55E-05 | 0.00 | Respiratory | 7.29E-07 | 0.03 | Respiratory | 24% |
| 13193NEI26506 | 1.59E-07 | 1.47E-06 | 0.01 | Respiratory | **2.22E-06** | 0.02 | Respiratory | 7% |
| 28043NEI11108 | 1.57E-07 | 3.63E-06 | 0.01 | Respiratory | 4.84E-07 | 0.49 | Respiratory | 32% |
| 55141NEI42963 | 1.56E-07 | 1.20E-05 | 0.00 | Respiratory | 1.57E-07 | 0.00 | Respiratory | 99% |
| 55009NEI42495 | 1.51E-07 | 2.10E-05 | 0.01 | Respiratory | 4.97E-07 | 0.01 | Respiratory | 30% |
| 40101NEI12980 | 1.49E-07 | 1.01E-05 | 0.01 | Respiratory | 6.35E-07 | 0.01 | Respiratory | 23% |
| 23019NEI33104 | 1.48E-07 | 2.47E-06 | 0.00 | Respiratory | 3.16E-07 | 0.04 | Respiratory | 47% |
| 55115NEI42800 | 1.47E-07 | 3.87E-06 | 0.01 | Respiratory | **1.91E-06** | 0.05 | Respiratory | 8% |
| 55073NEI42690 | 1.45E-07 | 4.53E-07 | 0.01 | Respiratory | 6.81E-07 | 0.02 | Respiratory | 21% |
| 05041NEI18652 | 1.29E-07 | 4.16E-06 | 0.05 | Respiratory | 3.59E-07 | 0.06 | Respiratory | 36% |
| 36031NEI35908 | 1.17E-07 | 3.29E-06 | 0.01 | Respiratory | 5.54E-07 | 0.03 | Respiratory | 21% |
| 55097NEIWI7500086 | 1.13E-07 | 1.02E-05 | 0.01 | Respiratory | 1.16E-07 | 0.01 | Respiratory | 97% |
| 55079NEIWI0793640 | 1.12E-07 | 4.36E-05 | 0.00 | Respiratory | 1.22E-07 | 0.00 | Respiratory | 92% |
| 45041NEI7933 | 1.08E-07 | 2.28E-05 | 0.00 | Respiratory | 2.17E-07 | 0.02 | Respiratory | 50% |
| 13179NEI8177 | 1.07E-07 | 9.03E-06 | 0.00 | Respiratory | 3.97E-07 | 0.03 | Respiratory | 27% |
| 23009NEI6284 | 1.05E-07 | 5.42E-06 | 0.00 | Respiratory | 1.97E-07 | 0.01 | Respiratory | 53% |
| 55069NEI46750 | 9.83E-08 | 1.99E-06 | 0.00 | Respiratory | 5.27E-07 | 0.01 | Respiratory | 19% |
| 27035NEI34020 | 9.79E-08 | 1.66E-06 | 0.00 | Respiratory | 2.87E-07 | 0.02 | Respiratory | 34% |
| 39017NEI11602 | 7.40E-08 | 7.95E-06 | 0.00 | Respiratory | 1.19E-07 | 0.01 | Respiratory | 62% |
| 42101NEIPA1013489 | 7.36E-08 | 2.78E-05 | 0.00 | Respiratory | 1.30E-07 | 0.00 | Respiratory | 57% |
| 18165NEI2INT16350 | 6.75E-08 | 5.25E-06 | 0.00 | Respiratory | 6.75E-08 | 0.00 | Respiratory | 100% |
| 47105NEITN1050093 | 6.34E-08 | 7.25E-07 | 0.01 | Liver | 7.54E-08 | 0.01 | Liver | 84% |
| 39113NEI11645 | 6.13E-08 | 1.18E-05 | 0.07 | Respiratory | 1.75E-07 | 0.07 | Respiratory | 35% |
| 39017NEI11600 | 5.51E-08 | 4.53E-06 | 0.00 | Respiratory | **6.55E-06** | 0.12 | Developmental | 1% |
| 36045NEI36019 | 5.18E-08 | 1.02E-06 | 0.00 | Respiratory | 1.82E-07 | 0.00 | Respiratory | 28% |
| 09011NEICT3102 | 5.01E-08 | 4.86E-06 | 0.00 | Respiratory | 6.09E-08 | 0.00 | Respiratory | 82% |
| 55139NEIWI4710355 | 4.43E-08 | 1.29E-05 | 0.00 | Respiratory | 5.56E-08 | 0.00 | Respiratory | 80% |
| 55141NEI42961 | 4.32E-08 | 2.04E-06 | 0.00 | Respiratory | 6.39E-08 | 0.00 | Respiratory | 68% |
| 40031NEW73505 | 4.22E-08 | 2.03E-06 | 0.00 | Respiratory | 4.22E-08 | 0.00 | Respiratory | 100% |
| 39141NEI40488 | 3.76E-08 | 1.82E-06 | 0.00 | Respiratory | **5.25E-06** | 1.21 | Respiratory | 1% |
| 13175NEIGAT$3911 | 3.39E-08 | 1.07E-06 | 0.02 | Respiratory | **6.97E-06** | 0.59 | Neurological | 0% |
| 26003NEI33866 | 2.45E-08 | 2.80E-07 | 0.00 | Respiratory | 1.08E-07 | 0.01 | Respiratory | 23% |
| 42013NEI7106 | 1.40E-08 | 4.48E-07 | 0.00 | Reproductive | 1.40E-08 | 0.01 | Respiratory | 100% |
| 26109NEI33950 | 8.45E-09 | 1.99E-07 | 0.00 | Respiratory | 8.45E-09 | 0.10 | Respiratory | 100% |
| 42101NEI40720 | 7.58E-09 | 3.04E-06 | 0.00 | Respiratory | 1.76E-07 | 0.00 | Respiratory | 4% |
| 12031NEI26304 | 4.13E-09 | 5.58E-06 | 0.00 | Respiratory | 4.13E-09 | 0.00 | Respiratory | 100% |
| 36115NEINY5532600 | 1.44E-09 | 3.53E-08 | 0.00 | Respiratory | 9.08E-07 | 0.01 | Respiratory | 0% |
| 41009NEI40553 | 4.20E-10 | 8.09E-07 | 0.00 | Kidney | 6.70E-10 | 0.00 | Kidney | 63% |
| 36115NEINY5533400 | 3.12E-10 | 1.18E-08 | 0.00 | Respiratory | 1.02E-07 | 0.00 | Respiratory | 0% |
| 53051NEI2WAT18798 | 0.00E+00 | 0.00E+00 | 0.00 | Developmental | 0.00E+00 | 0.00 | Developmental | |
| 55097NEIWIT$8597 | 0.00E+00 | 0.00E+00 | 0.00 | Developmental | 0.00E+00 | 0.00 | Developmental | |
| 13235NEIGAT$3909 | 0.00E+00 | 0.00E+00 | 0.00 | Liver | 0.00E+00 | 0.00 | Liver | |
| 53061NEI42385 | 0.00E+00 | 0.00E+00 | 0.00 | Developmental | 4.78E-07 | 0.03 | Respiratory | 0% |

1  BOLD indicates a cancer risk greater than 1 in a million or a noncancer risk greater than 1

2  Facility cancer and non-cancer risks represent MIR at census block locations using Draft 2005 NATA.

## Table 3 – Maximum Predicted Acute Risks (HEM-3)
## Refined with Emissions Multiplier 2(x)

| Facility NEI ID | Pollutant | Maximum Hazard Quotient[1] | | | | |
|---|---|---|---|---|---|---|
| | | REL | AEGL1 | AEGL2 | ERPG1 | ERPG2 |
| 53015NEI42338 | Chloroform | **3.90E+01** | 0.00E+00 | 1.89E-02 | 0.00E+00 | 2.44E-02 |
| 23029NEI46835 | Acetaldehyde | **1.52E+01** | 8.82E-02 | 1.46E-02 | 3.97E-01 | 1.98E-02 |
| 37083NEI47104 | Acetaldehyde | **9.32E+00** | 5.41E-02 | 8.94E-03 | 2.43E-01 | 1.22E-02 |
| 05069NEI18657 | 1,2-Dimethoxyethane | **8.54E+00** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01023NEI18334 | Formaldehyde | **5.67E+00** | 2.84E-01 | 1.84E-02 | 2.60E-01 | 2.60E-02 |
| 47105NEITN1050093 | Chloroform | **5.24E+00** | 0.00E+00 | 2.54E-03 | 0.00E+00 | 3.28E-03 |
| 01023NEI18334 | Methanol | **4.91E+00** | 1.99E-01 | 5.09E-02 | 5.28E-01 | 1.06E-01 |
| 41043NEI13340 | Formaldehyde | **4.67E+00** | 2.34E-01 | 1.51E-02 | 2.14E-01 | 2.14E-02 |
| 01023NEI18334 | Acetaldehyde | **4.66E+00** | 2.71E-02 | 4.47E-03 | 1.22E-01 | 6.09E-03 |
| 53053NEI13363 | Formaldehyde | **4.62E+00** | 2.31E-01 | 1.50E-02 | 2.12E-01 | 2.12E-02 |
| 55141NEIWI7720116 | Acetaldehyde | **4.29E+00** | 2.49E-02 | 4.11E-03 | 1.12E-01 | 5.60E-03 |
| 51085NEI208 | Chloroform | **4.16E+00** | 0.00E+00 | 2.01E-03 | 0.00E+00 | 2.60E-03 |
| 53015NEI42341A | Chloroform | **4.03E+00** | 0.00E+00 | 1.95E-03 | 0.00E+00 | 2.52E-03 |
| 55141NEIWI7720116 | Methanol | **3.43E+00** | 1.39E-01 | 3.56E-02 | 3.69E-01 | 7.39E-02 |
| 41071NEI40648 | Chloroform | **3.17E+00** | 0.00E+00 | 1.53E-03 | 0.00E+00 | 1.98E-03 |
| 55141NEIWI7720116 | Chloroform | **3.12E+00** | 0.00E+00 | 1.51E-03 | 0.00E+00 | 1.95E-03 |
| 01023NEI18334 | Chloroform | **2.91E+00** | 0.00E+00 | 1.41E-03 | 0.00E+00 | 1.82E-03 |
| 05069NEI18658 | Chloroform | **2.90E+00** | 0.00E+00 | 1.40E-03 | 0.00E+00 | 1.81E-03 |
| 05069NEI18657 | Formaldehyde | **2.75E+00** | 1.38E-01 | 8.90E-03 | 1.26E-01 | 1.26E-02 |
| 41043NEI13340 | Acetaldehyde | **2.57E+00** | 1.49E-02 | 2.46E-03 | 6.70E-02 | 3.35E-03 |
| 47071NEI41552 | Acetaldehyde | **2.12E+00** | 1.23E-02 | 2.04E-03 | 5.55E-02 | 2.77E-03 |
| 21107NEI11367 | Formaldehyde | **2.07E+00** | 1.04E-01 | 6.71E-03 | 9.51E-02 | 9.51E-03 |
| 13127NEI8196 | Acetaldehyde | **1.98E+00** | 1.15E-02 | 1.90E-03 | 5.18E-02 | 2.59E-03 |
| 01091NEI45474 | Chlorine | **1.93E+00** | 2.70E-01 | 6.98E-02 | 1.40E-01 | 4.65E-02 |
| 39113NEI11645 | Chloroform | **1.90E+00** | 0.00E+00 | 9.20E-04 | 0.00E+00 | 1.19E-03 |
| 12123NEI47091 | Chloroform | **1.68E+00** | 0.00E+00 | 8.14E-04 | 0.00E+00 | 1.05E-03 |
| 41043NEI13340 | Methanol | **1.58E+00** | 6.41E-02 | 1.64E-02 | 1.70E-01 | 3.40E-02 |
| 23025NEIME0250002 | Acetaldehyde | **1.57E+00** | 9.10E-03 | 1.50E-03 | 4.10E-02 | 2.05E-03 |
| 13051NEI8186 | Formaldehyde | **1.57E+00** | 7.84E-02 | 5.07E-03 | 7.18E-02 | 7.18E-03 |
| 01099NEI18373 | Acetaldehyde | **1.53E+00** | 8.90E-03 | 1.47E-03 | 4.00E-02 | 2.00E-03 |
| 37083NEI47104 | Formaldehyde | 1.48E+00 | 7.42E-02 | 4.80E-03 | 6.80E-02 | 6.80E-03 |
| 53015NEI42338 | Formaldehyde | 1.46E+00 | 7.28E-02 | 4.71E-03 | 6.67E-02 | 6.67E-03 |
| 51580NEI759 | Chloroform | 1.44E+00 | 0.00E+00 | 6.98E-04 | 0.00E+00 | 9.02E-04 |
| 23029NEI46835 | Chloroform | 1.40E+00 | 0.00E+00 | 6.75E-04 | 0.00E+00 | 8.72E-04 |
| 55141NEIWI7720116 | Formaldehyde | 1.38E+00 | 6.89E-02 | 4.46E-03 | 6.31E-02 | 6.31E-03 |
| 23025NEIME0250002 | Formaldehyde | 1.32E+00 | 6.62E-02 | 4.29E-03 | 6.07E-02 | 6.07E-03 |
| 45031NEI43472 | Acetaldehyde | 1.32E+00 | 7.64E-03 | 1.26E-03 | 3.44E-02 | 1.72E-03 |
| 51019NEI42211 | Acetaldehyde | 1.29E+00 | 7.49E-03 | 1.24E-03 | 3.37E-02 | 1.69E-03 |
| 47107NEI41565 | Chloroform | 1.27E+00 | 0.00E+00 | 6.14E-04 | 0.00E+00 | 7.93E-04 |
| 48241NEI6450 | Acetaldehyde | 1.20E+00 | 6.95E-03 | 1.15E-03 | 3.13E-02 | 1.56E-03 |
| 21107NEI11367 | Methanol | 1.18E+00 | 4.80E-02 | 1.23E-02 | 1.27E-01 | 2.55E-02 |
| 12089NEI26382 | Chloroform | 1.10E+00 | 0.00E+00 | 5.31E-04 | 0.00E+00 | 6.86E-04 |
| 13051NEI26476 | Acetaldehyde | 1.09E+00 | 6.32E-03 | 1.04E-03 | 2.84E-02 | 1.42E-03 |
| 47163NEI41599 | Acetaldehyde | 1.09E+00 | 6.30E-03 | 1.04E-03 | 2.84E-02 | 1.42E-03 |
| 48241NEI6450 | Chloroform | 1.03E+00 | 0.00E+00 | 5.00E-04 | 0.00E+00 | 6.46E-04 |
| 22033NEI46817 | Acetaldehyde | 1.03E+00 | 5.98E-03 | 9.88E-04 | 2.69E-02 | 1.34E-03 |
| 01071NEI18347 | Acetaldehyde | 1.00E+00 | 5.83E-03 | 9.64E-04 | 2.62E-02 | 1.31E-03 |
| 13103NEI8178 | Chloroform | 9.14E-01 | 0.00E+00 | 4.42E-04 | 0.00E+00 | 5.71E-04 |
| 12123NEI47091 | Acetaldehyde | 8.88E-01 | 5.15E-03 | 8.51E-04 | 2.32E-02 | 1.16E-03 |
| 53053NEI13363 | Acetaldehyde | 8.75E-01 | 5.08E-03 | 8.39E-04 | 2.29E-02 | 1.14E-03 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 55073NEI54400 | Chloroform | 8.28E-01 | 0.00E+00 | 4.01E-04 | 0.00E+00 | 5.17E-04 |
| 05081NEI18660 | Formaldehyde | 8.21E-01 | 4.11E-02 | 2.66E-03 | 3.76E-02 | 3.76E-03 |
| 05069NEI18657 | Acetaldehyde | 7.95E-01 | 4.61E-03 | 7.63E-04 | 2.08E-02 | 1.04E-03 |
| 28087NEI34064 | Acetaldehyde | 7.50E-01 | 4.35E-03 | 7.20E-04 | 1.96E-02 | 9.79E-04 |
| 05029NEI46852 | Acetaldehyde | 7.46E-01 | 4.33E-03 | 7.15E-04 | 1.95E-02 | 9.74E-04 |
| 41043NEI13340 | Chloroform | 7.42E-01 | 0.00E+00 | 3.59E-04 | 0.00E+00 | 4.64E-04 |
| 53015NEI42341A | Acetaldehyde | 7.36E-01 | 4.27E-03 | 7.06E-04 | 1.92E-02 | 9.61E-04 |
| 48067NEI41628 | Methanol | 7.15E-01 | 2.90E-02 | 7.41E-03 | 7.69E-02 | 1.54E-02 |
| 55009NEI42482 | Formaldehyde | 7.09E-01 | 3.55E-02 | 2.29E-03 | 3.25E-02 | 3.25E-03 |
| 45091NEI47077 | Acetaldehyde | 6.94E-01 | 4.03E-03 | 6.66E-04 | 1.81E-02 | 9.07E-04 |
| 41071NEI40648 | Acetaldehyde | 6.85E-01 | 3.98E-03 | 6.57E-04 | 1.79E-02 | 8.94E-04 |
| 22033NEI46817 | Chloroform | 6.75E-01 | 0.00E+00 | 3.27E-04 | 0.00E+00 | 4.22E-04 |
| 12107NEI8265 | Methanol | 6.69E-01 | 2.71E-02 | 6.94E-03 | 7.20E-02 | 1.44E-02 |
| 55087NEI43207 | Acetaldehyde | 6.62E-01 | 3.84E-03 | 6.35E-04 | 1.73E-02 | 8.64E-04 |
| 05069NEI18658 | Methanol | 6.53E-01 | 2.65E-02 | 6.77E-03 | 7.03E-02 | 1.41E-02 |
| 01099NEI18373 | Methanol | 6.39E-01 | 2.59E-02 | 6.62E-03 | 6.88E-02 | 1.38E-02 |
| 26041NEI33883 | Formaldehyde | 6.35E-01 | 3.17E-02 | 2.05E-03 | 2.91E-02 | 2.91E-03 |
| 01023NEI18334 | Carbon tetrachloride | 6.08E-01 | 4.13E-03 | 9.63E-04 | 8.89E-03 | 1.83E-03 |
| 26041NEI33883 | Acetaldehyde | 5.96E-01 | 3.46E-03 | 5.72E-04 | 1.56E-02 | 7.78E-04 |
| 27145NEI12407 | Chloroform | 5.73E-01 | 0.00E+00 | 2.77E-04 | 0.00E+00 | 3.58E-04 |
| 23025NEI33118 | Chloroform | 5.71E-01 | 0.00E+00 | 2.76E-04 | 0.00E+00 | 3.57E-04 |
| 13245NEI26514 | Acetaldehyde | 5.70E-01 | 3.30E-03 | 5.46E-04 | 1.49E-02 | 7.44E-04 |
| 13305NEI26526 | Chloroform | 5.41E-01 | 0.00E+00 | 2.62E-04 | 0.00E+00 | 3.38E-04 |
| 24001NEI33135 | Acetaldehyde | 5.30E-01 | 3.08E-03 | 5.09E-04 | 1.38E-02 | 6.92E-04 |
| 05069NEI18657 | Methanol | 5.18E-01 | 2.10E-02 | 5.37E-03 | 5.57E-02 | 1.11E-02 |
| 39031NEI11461 | Acetaldehyde | 5.14E-01 | 2.99E-03 | 4.93E-04 | 1.34E-02 | 6.72E-04 |
| 13115NEI26495 | Chloroform | 5.12E-01 | 0.00E+00 | 2.48E-04 | 0.00E+00 | 3.20E-04 |
| 05003NEI54342 | Acetaldehyde | 5.10E-01 | 2.96E-03 | 4.89E-04 | 1.33E-02 | 6.65E-04 |
| 12107NEI8265 | Chloroform | 5.05E-01 | 0.00E+00 | 2.45E-04 | 0.00E+00 | 3.16E-04 |
| 01053NEI18338 | Acetaldehyde | 5.05E-01 | 2.93E-03 | 4.84E-04 | 1.32E-02 | 6.59E-04 |
| 05081NEI18660 | Acetaldehyde | 4.96E-01 | 2.88E-03 | 4.76E-04 | 1.30E-02 | 6.48E-04 |
| 23007NEI6261 | Acetaldehyde | 4.86E-01 | 2.82E-03 | 4.66E-04 | 1.27E-02 | 6.35E-04 |
| 40089NEI11251 | Methanol | 4.75E-01 | 1.93E-02 | 4.93E-03 | 5.12E-02 | 1.02E-02 |
| 13103NEI8178 | Acetaldehyde | 4.75E-01 | 2.76E-03 | 4.55E-04 | 1.24E-02 | 6.20E-04 |
| 13115NEI26495 | Formaldehyde | 4.74E-01 | 2.37E-02 | 1.53E-03 | 2.17E-02 | 2.17E-03 |
| 45019NEI41252 | Methanol | 4.65E-01 | 1.88E-02 | 4.82E-03 | 5.00E-02 | 1.00E-02 |
| 53015NEI42341B | Formaldehyde | 4.59E-01 | 2.30E-02 | 1.49E-03 | 2.10E-02 | 2.10E-03 |
| 12107NEI8265 | Acetaldehyde | 4.45E-01 | 2.58E-03 | 4.26E-04 | 1.16E-02 | 5.80E-04 |
| 55073NEI42689 | Hydrochloric acid | 4.21E-01 | 3.27E-01 | 2.68E-02 | 1.96E-01 | 2.95E-02 |
| 51085NEI208 | Acetaldehyde | 4.14E-01 | 2.40E-03 | 3.97E-04 | 1.08E-02 | 5.40E-04 |
| 13193NEI26506 | Methanol | 4.05E-01 | 1.64E-02 | 4.20E-03 | 4.36E-02 | 8.71E-03 |
| 01071NEI18347 | Methanol | 4.00E-01 | 1.62E-02 | 4.14E-03 | 4.30E-02 | 8.61E-03 |
| 23029NEI46835 | Methanol | 3.93E-01 | 1.60E-02 | 4.08E-03 | 4.23E-02 | 8.47E-03 |
| 13115NEI26495 | Acetaldehyde | 3.86E-01 | 2.24E-03 | 3.70E-04 | 1.01E-02 | 5.04E-04 |
| 54057NEI706 | Formaldehyde | 3.73E-01 | 1.86E-02 | 1.21E-03 | 1.71E-02 | 1.71E-03 |
| 51009NEIVA00022 | Acetaldehyde | 3.70E-01 | 2.15E-03 | 3.55E-04 | 9.67E-03 | 4.83E-04 |
| 13021NEI26471 | Acetaldehyde | 3.63E-01 | 2.11E-03 | 3.48E-04 | 9.48E-03 | 4.74E-04 |
| 51670NEI42317 | Acetaldehyde | 3.60E-01 | 2.09E-03 | 3.46E-04 | 9.41E-03 | 4.70E-04 |
| 21107NEI11367 | Triethylamine | 3.47E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37087NEI40282 | Acetaldehyde | 3.44E-01 | 2.00E-03 | 3.30E-04 | 8.99E-03 | 4.50E-04 |
| 45091NEI47077 | Methanol | 3.43E-01 | 1.39E-02 | 3.55E-03 | 3.69E-02 | 7.38E-03 |
| 01053NEI18338 | Chloroform | 3.42E-01 | 0.00E+00 | 1.65E-04 | 0.00E+00 | 2.13E-04 |
| 53071NEI42410 | Chloroform | 3.39E-01 | 0.00E+00 | 1.64E-04 | 0.00E+00 | 2.12E-04 |
| 45069NEI47074 | Formaldehyde | 3.32E-01 | 1.66E-02 | 1.07E-03 | 1.52E-02 | 1.52E-03 |
| 28111NEI34066 | Acetaldehyde | 3.17E-01 | 1.84E-03 | 3.04E-04 | 8.27E-03 | 4.13E-04 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 05069NEI18658 | Acetaldehyde | 3.11E-01 | 1.81E-03 | 2.98E-04 | 8.12E-03 | 4.06E-04 |
| 53051NEI2WAT18798 | Methanol | 3.10E-01 | 1.26E-02 | 3.22E-03 | 3.34E-02 | 6.68E-03 |
| 05069NEI18658 | Formaldehyde | 3.09E-01 | 1.54E-02 | 9.99E-04 | 1.42E-02 | 1.42E-03 |
| 22073NEI6057 | Acetaldehyde | 3.05E-01 | 1.77E-03 | 2.93E-04 | 7.98E-03 | 3.99E-04 |
| 48361NEI12492 | Methanol | 2.96E-01 | 1.20E-02 | 3.07E-03 | 3.19E-02 | 6.38E-03 |
| 22073NEI6057 | Formaldehyde | 2.93E-01 | 1.47E-02 | 9.49E-04 | 1.34E-02 | 1.34E-03 |
| 17021NEIIL0215971 | Acetaldehyde | 2.93E-01 | 1.70E-03 | 2.81E-04 | 7.65E-03 | 3.83E-04 |
| 23007NEI6261 | Methanol | 2.91E-01 | 1.18E-02 | 3.02E-03 | 3.13E-02 | 6.26E-03 |
| 40089NEI11251 | Acetaldehyde | 2.81E-01 | 1.63E-03 | 2.70E-04 | 7.34E-03 | 3.67E-04 |
| 01001NEI8560 | Acetaldehyde | 2.81E-01 | 1.63E-03 | 2.70E-04 | 7.34E-03 | 3.67E-04 |
| 24001NEI33135 | Formaldehyde | 2.79E-01 | 1.40E-02 | 9.03E-04 | 1.28E-02 | 1.28E-03 |
| 37087NEI40282 | Formaldehyde | 2.69E-01 | 1.35E-02 | 8.71E-04 | 1.23E-02 | 1.23E-03 |
| 01001NEI8560 | Formaldehyde | 2.67E-01 | 1.33E-02 | 8.63E-04 | 1.22E-02 | 1.22E-03 |
| 48241NEI6450 | Formaldehyde | 2.61E-01 | 1.31E-02 | 8.45E-04 | 1.20E-02 | 1.20E-03 |
| 13051NEI26476 | Methanol | 2.61E-01 | 1.06E-02 | 2.70E-03 | 2.81E-02 | 5.61E-03 |
| 48361NEI12492 | Formaldehyde | 2.61E-01 | 1.30E-02 | 8.43E-04 | 1.19E-02 | 1.19E-03 |
| 37083NEI47104 | Methanol | 2.61E-01 | 1.06E-02 | 2.70E-03 | 2.81E-02 | 5.61E-03 |
| 01091NEI45474 | Formaldehyde | 2.61E-01 | 1.30E-02 | 8.43E-04 | 1.19E-02 | 1.19E-03 |
| 26101NEI33945 | Acetaldehyde | 2.58E-01 | 1.50E-03 | 2.47E-04 | 6.73E-03 | 3.37E-04 |
| 45069NEI47074 | Acetaldehyde | 2.57E-01 | 1.49E-03 | 2.46E-04 | 6.71E-03 | 3.35E-04 |
| 47085NEI46866 | Acetaldehyde | 2.53E-01 | 1.47E-03 | 2.43E-04 | 6.62E-03 | 3.31E-04 |
| 22011NEI7559 | Acetaldehyde | 2.51E-01 | 1.46E-03 | 2.41E-04 | 6.56E-03 | 3.28E-04 |
| 28077NEI11172 | Acetaldehyde | 2.50E-01 | 1.45E-03 | 2.40E-04 | 6.53E-03 | 3.27E-04 |
| 55009NEI42482 | Chloroform | 2.48E-01 | 0.00E+00 | 1.20E-04 | 0.00E+00 | 1.55E-04 |
| 23025NEI33118 | Acetaldehyde | 2.47E-01 | 1.44E-03 | 2.37E-04 | 6.46E-03 | 3.23E-04 |
| 23017NEI6273 | Chloroform | 2.46E-01 | 0.00E+00 | 1.19E-04 | 0.00E+00 | 1.54E-04 |
| 24001NEI33135 | Chloroform | 2.45E-01 | 0.00E+00 | 1.19E-04 | 0.00E+00 | 1.53E-04 |
| 05081NEI18660 | Methanol | 2.45E-01 | 9.95E-03 | 2.54E-03 | 2.64E-02 | 5.28E-03 |
| 01079NEI18357 | Methanol | 2.44E-01 | 9.89E-03 | 2.53E-03 | 2.62E-02 | 5.25E-03 |
| 28149NEI34070 | Acetaldehyde | 2.43E-01 | 1.41E-03 | 2.33E-04 | 6.35E-03 | 3.17E-04 |
| 13099NEI26491 | Acetaldehyde | 2.40E-01 | 1.39E-03 | 2.30E-04 | 6.27E-03 | 3.14E-04 |
| 45019NEI41252 | Acetaldehyde | 2.40E-01 | 1.39E-03 | 2.30E-04 | 6.26E-03 | 3.13E-04 |
| 25003NEIMA10626 | Formaldehyde | 2.35E-01 | 1.18E-02 | 7.61E-04 | 1.08E-02 | 1.08E-03 |
| 13127NEI8196 | Formaldehyde | 2.35E-01 | 1.18E-02 | 7.61E-04 | 1.08E-02 | 1.08E-03 |
| 22033NEI46817 | Methanol | 2.31E-01 | 9.39E-03 | 2.40E-03 | 2.49E-02 | 4.99E-03 |
| 01131NEI8619 | Acetaldehyde | 2.31E-01 | 1.34E-03 | 2.21E-04 | 6.03E-03 | 3.01E-04 |
| 42131NEI40738 | Acetaldehyde | 2.29E-01 | 1.33E-03 | 2.20E-04 | 5.98E-03 | 2.99E-04 |
| 24001NEI33135 | Methanol | 2.28E-01 | 9.26E-03 | 2.37E-03 | 2.46E-02 | 4.92E-03 |
| 13245NEI26514 | Methanol | 2.27E-01 | 9.22E-03 | 2.36E-03 | 2.45E-02 | 4.89E-03 |
| 53031NEI42357 | Acetaldehyde | 2.20E-01 | 1.28E-03 | 2.11E-04 | 5.75E-03 | 2.87E-04 |
| 55087NEI42710 | Acetaldehyde | 2.13E-01 | 1.24E-03 | 2.04E-04 | 5.56E-03 | 2.78E-04 |
| 13021NEI26471 | Formaldehyde | 2.13E-01 | 1.06E-02 | 6.88E-04 | 9.74E-03 | 9.74E-04 |
| 05003NEI54342 | Chloroform | 2.12E-01 | 0.00E+00 | 1.02E-04 | 0.00E+00 | 1.32E-04 |
| 28149NEI34070 | Methanol | 2.11E-01 | 8.58E-03 | 2.19E-03 | 2.28E-02 | 4.55E-03 |
| 23017NEI6273 | Methanol | 2.11E-01 | 8.57E-03 | 2.19E-03 | 2.28E-02 | 4.55E-03 |
| 39061NEI11610 | Formaldehyde | 2.04E-01 | 1.02E-02 | 6.59E-04 | 9.33E-03 | 9.33E-04 |
| 22073NEI6057 | Methanol | 2.03E-01 | 8.25E-03 | 2.11E-03 | 2.19E-02 | 4.38E-03 |
| 23019NEI33103 | Chloroform | 2.03E-01 | 0.00E+00 | 9.81E-05 | 0.00E+00 | 1.27E-04 |
| 23025NEIME0250002 | Phenol | 2.02E-01 | 2.02E-02 | 1.32E-02 | 3.09E-02 | 6.18E-03 |
| 37047NEI40247 | Formaldehyde | 2.02E-01 | 1.01E-02 | 6.55E-04 | 9.27E-03 | 9.27E-04 |
| 48067NEI41628 | Acetaldehyde | 2.01E-01 | 1.17E-03 | 1.93E-04 | 5.25E-03 | 2.63E-04 |
| 01079NEI18357 | Acetaldehyde | 2.00E-01 | 1.16E-03 | 1.91E-04 | 5.21E-03 | 2.61E-04 |
| 42133NEI7181 | Chloroform | 1.96E-01 | 0.00E+00 | 9.46E-05 | 0.00E+00 | 1.22E-04 |
| 13051NEI8186 | Acetaldehyde | 1.94E-01 | 1.13E-03 | 1.86E-04 | 5.07E-03 | 2.53E-04 |
| 13127NEI8196 | Chloroform | 1.89E-01 | 0.00E+00 | 9.15E-05 | 0.00E+00 | 1.18E-04 |

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|---|---|---|---|---|---|---|
| 13175NEIGAT$3911 | Hydrochloric acid | 1.88E-01 | 1.46E-01 | 1.19E-02 | 8.75E-02 | 1.31E-02 |
| 51580NEI759 | Acetaldehyde | 1.87E-01 | 1.09E-03 | 1.80E-04 | 4.89E-03 | 2.44E-04 |
| 37047NEI40247 | Acetaldehyde | 1.87E-01 | 1.09E-03 | 1.80E-04 | 4.89E-03 | 2.44E-04 |
| 23019NEI33103 | Acetaldehyde | 1.86E-01 | 1.08E-03 | 1.78E-04 | 4.85E-03 | 2.42E-04 |
| 45019NEI41252 | Formaldehyde | 1.85E-01 | 9.26E-03 | 5.99E-04 | 8.49E-03 | 8.49E-04 |
| 53011NEI46599 | Formaldehyde | 1.82E-01 | 9.11E-03 | 5.90E-04 | 8.35E-03 | 8.35E-04 |
| 13051NEI26476 | Formaldehyde | 1.81E-01 | 9.07E-03 | 5.87E-04 | 8.31E-03 | 8.31E-04 |
| 01023NEI18334 | Phenol | 1.80E-01 | 1.80E-02 | 1.17E-02 | 2.74E-02 | 5.48E-03 |
| 55073NEI54400 | Formaldehyde | 1.77E-01 | 8.85E-03 | 5.72E-04 | 8.11E-03 | 8.11E-04 |
| 05041NEI18652 | Methanol | 1.77E-01 | 7.18E-03 | 1.83E-03 | 1.91E-02 | 3.81E-03 |
| 21107NEI11367 | Phenol | 1.76E-01 | 1.76E-02 | 1.15E-02 | 2.69E-02 | 5.38E-03 |
| 05003NEI54342 | Formaldehyde | 1.74E-01 | 8.71E-03 | 5.64E-04 | 7.99E-03 | 7.99E-04 |
| 12033NEI26309 | Acetaldehyde | 1.73E-01 | 1.01E-03 | 1.66E-04 | 4.53E-03 | 2.26E-04 |
| 13099NEI26491 | Formaldehyde | 1.68E-01 | 8.42E-03 | 5.45E-04 | 7.71E-03 | 7.71E-04 |
| 01047NEI18335 | Acetaldehyde | 1.67E-01 | 9.69E-04 | 1.60E-04 | 4.36E-03 | 2.18E-04 |
| 01113NEI46931 | Acetaldehyde | 1.67E-01 | 9.69E-04 | 1.60E-04 | 4.36E-03 | 2.18E-04 |
| 12123NEI47091 | Methanol | 1.66E-01 | 6.72E-03 | 1.72E-03 | 1.78E-02 | 3.57E-03 |
| 13245NEI26514 | Formaldehyde | 1.65E-01 | 8.25E-03 | 5.34E-04 | 7.57E-03 | 7.57E-04 |
| 01091NEI45474 | Methanol | 1.63E-01 | 6.63E-03 | 1.69E-03 | 1.76E-02 | 3.52E-03 |
| 55073NEI54400 | Acetaldehyde | 1.63E-01 | 9.48E-04 | 1.57E-04 | 4.27E-03 | 2.13E-04 |
| 22033NEI46817 | Formaldehyde | 1.63E-01 | 8.14E-03 | 5.27E-04 | 7.46E-03 | 7.46E-04 |
| 48067NEI41628 | Chloroform | 1.59E-01 | 0.00E+00 | 7.69E-05 | 0.00E+00 | 9.93E-05 |
| 28149NEI34070 | Formaldehyde | 1.54E-01 | 7.68E-03 | 4.97E-04 | 7.04E-03 | 7.04E-04 |
| 41039NEI45182 | Acetaldehyde | 1.54E-01 | 8.91E-04 | 1.47E-04 | 4.01E-03 | 2.01E-04 |
| 13305NEI26526 | Acetaldehyde | 1.53E-01 | 8.87E-04 | 1.47E-04 | 3.99E-03 | 2.00E-04 |
| 55073NEI42690 | Chloroform | 1.53E-01 | 0.00E+00 | 7.39E-05 | 0.00E+00 | 9.55E-05 |
| 36031NEI35908 | Acetaldehyde | 1.53E-01 | 8.86E-04 | 1.46E-04 | 3.98E-03 | 1.99E-04 |
| 45043NEI41314 | Acetaldehyde | 1.51E-01 | 8.74E-04 | 1.44E-04 | 3.93E-03 | 1.97E-04 |
| 41039NEI45182 | Formaldehyde | 1.45E-01 | 7.25E-03 | 4.69E-04 | 6.64E-03 | 6.64E-04 |
| 13305NEI26526 | Methanol | 1.45E-01 | 5.87E-03 | 1.50E-03 | 1.56E-02 | 3.12E-03 |
| 05081NEI18660 | Chloroform | 1.44E-01 | 0.00E+00 | 6.99E-05 | 0.00E+00 | 9.03E-05 |
| 22031NEI33013 | Methanol | 1.44E-01 | 5.85E-03 | 1.50E-03 | 1.55E-02 | 3.11E-03 |
| 13193NEI26506 | Acetaldehyde | 1.43E-01 | 8.31E-04 | 1.37E-04 | 3.74E-03 | 1.87E-04 |
| 39061NEI11610 | Acetaldehyde | 1.43E-01 | 8.28E-04 | 1.37E-04 | 3.73E-03 | 1.86E-04 |
| 51101NEI42254 | Methanol | 1.42E-01 | 5.75E-03 | 1.47E-03 | 1.53E-02 | 3.05E-03 |
| 21091NEI32869A | Chloroform | 1.40E-01 | 0.00E+00 | 6.79E-05 | 0.00E+00 | 8.77E-05 |
| 22073NEI6057 | Chloroform | 1.35E-01 | 0.00E+00 | 6.53E-05 | 0.00E+00 | 8.43E-05 |
| 53031NEI42357 | Formaldehyde | 1.35E-01 | 6.73E-03 | 4.36E-04 | 6.17E-03 | 6.17E-04 |
| 22031NEI33013 | Formaldehyde | 1.35E-01 | 6.73E-03 | 4.36E-04 | 6.17E-03 | 6.17E-04 |
| 21007NEI11338 | Acetaldehyde | 1.33E-01 | 7.69E-04 | 1.27E-04 | 3.46E-03 | 1.73E-04 |
| 01047NEI18335 | Methanol | 1.32E-01 | 5.37E-03 | 1.37E-03 | 1.42E-02 | 2.85E-03 |
| 01091NEI45474 | Acetaldehyde | 1.29E-01 | 7.47E-04 | 1.23E-04 | 3.36E-03 | 1.68E-04 |
| 22069NEI33025 | Acetaldehyde | 1.28E-01 | 7.43E-04 | 1.23E-04 | 3.35E-03 | 1.67E-04 |
| 28087NEI34064 | Methanol | 1.27E-01 | 5.14E-03 | 1.31E-03 | 1.37E-02 | 2.73E-03 |
| 47163NEI41599 | Methanol | 1.26E-01 | 5.13E-03 | 1.31E-03 | 1.36E-02 | 2.72E-03 |
| 05003NEI54342 | Methanol | 1.26E-01 | 5.13E-03 | 1.31E-03 | 1.36E-02 | 2.72E-03 |
| 23017NEI6273 | Acetaldehyde | 1.26E-01 | 7.30E-04 | 1.21E-04 | 3.29E-03 | 1.64E-04 |
| 13127NEI8196 | Methanol | 1.25E-01 | 5.07E-03 | 1.29E-03 | 1.34E-02 | 2.69E-03 |
| 53011NEI46599 | Chloroform | 1.23E-01 | 0.00E+00 | 5.97E-05 | 0.00E+00 | 7.71E-05 |
| 13115NEI26495 | Methanol | 1.23E-01 | 5.00E-03 | 1.28E-03 | 1.33E-02 | 2.65E-03 |
| 51580NEI759 | Formaldehyde | 1.23E-01 | 6.15E-03 | 3.98E-04 | 5.64E-03 | 5.64E-04 |
| 13305NEI26526 | Formaldehyde | 1.21E-01 | 6.05E-03 | 3.92E-04 | 5.55E-03 | 5.55E-04 |
| 01099NEI18373 | Formaldehyde | 1.20E-01 | 5.99E-03 | 3.88E-04 | 5.49E-03 | 5.49E-04 |
| 53071NEI42410 | Methanol | 1.19E-01 | 4.84E-03 | 1.24E-03 | 1.28E-02 | 2.57E-03 |
| 23029NEI46835 | Formaldehyde | 1.18E-01 | 5.92E-03 | 3.83E-04 | 5.42E-03 | 5.42E-04 |

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| 26043NEI33887 | Chloroform | 1.14E-01 | 0.00E+00 | 5.52E-05 | 0.00E+00 | 7.13E-05 |
| 22117NEI46814 | Acetaldehyde | 1.14E-01 | 6.61E-04 | 1.09E-04 | 2.98E-03 | 1.49E-04 |
| 51580NEI759 | Methanol | 1.12E-01 | 4.54E-03 | 1.16E-03 | 1.21E-02 | 2.41E-03 |
| 53015NEI42341B | Acetaldehyde | 1.12E-01 | 6.48E-04 | 1.07E-04 | 2.92E-03 | 1.46E-04 |
| 55087NEI43207 | Chloroform | 1.10E-01 | 0.00E+00 | 5.33E-05 | 0.00E+00 | 6.88E-05 |
| 21091NEI32869A | Formaldehyde | 1.10E-01 | 5.48E-03 | 3.55E-04 | 5.03E-03 | 5.03E-04 |
| 12033NEI26309 | Methanol | 1.10E-01 | 4.45E-03 | 1.14E-03 | 1.18E-02 | 2.36E-03 |
| 55141NEI46739 | Formaldehyde | 1.09E-01 | 5.43E-03 | 3.51E-04 | 4.97E-03 | 4.97E-04 |
| 12107NEI8265 | Formaldehyde | 1.07E-01 | 5.35E-03 | 3.46E-04 | 4.90E-03 | 4.90E-04 |
| 12005NEI8278 | Acetaldehyde | 1.07E-01 | 6.19E-04 | 1.02E-04 | 2.79E-03 | 1.39E-04 |
| 45069NEI47074 | Chloroform | 1.07E-01 | 0.00E+00 | 5.16E-05 | 0.00E+00 | 6.66E-05 |
| 22069NEI33025 | Chloroform | 1.05E-01 | 0.00E+00 | 5.09E-05 | 0.00E+00 | 6.58E-05 |
| 01091NEI45474 | Chloroform | 1.04E-01 | 0.00E+00 | 5.04E-05 | 0.00E+00 | 6.50E-05 |
| 42047NEI40686 | Formaldehyde | 1.04E-01 | 5.20E-03 | 3.37E-04 | 4.77E-03 | 4.77E-04 |
| 37049NEI45206 | Acetaldehyde | 1.04E-01 | 6.01E-04 | 9.93E-05 | 2.70E-03 | 1.35E-04 |
| 41041NEI40600 | Acetaldehyde | 1.03E-01 | 5.98E-04 | 9.89E-05 | 2.69E-03 | 1.35E-04 |
| 55009NEI42486 | Formaldehyde | 9.99E-02 | 5.00E-03 | 3.23E-04 | 4.58E-03 | 4.58E-04 |
| 05029NEI46852 | Methanol | 9.64E-02 | 3.91E-03 | 9.99E-04 | 1.04E-02 | 2.08E-03 |
| 22031NEI33013 | Acetaldehyde | 9.61E-02 | 5.57E-04 | 9.21E-05 | 2.51E-03 | 1.25E-04 |
| 48361NEI12492 | Acetaldehyde | 9.56E-02 | 5.55E-04 | 9.17E-05 | 2.50E-03 | 1.25E-04 |
| 22049NEI33023 | Acetaldehyde | 9.37E-02 | 5.44E-04 | 8.99E-05 | 2.45E-03 | 1.22E-04 |
| 37087NEI40282 | Methanol | 9.37E-02 | 3.80E-03 | 9.72E-04 | 1.01E-02 | 2.02E-03 |
| 05041NEI18652 | Chloroform | 9.32E-02 | 0.00E+00 | 4.51E-05 | 0.00E+00 | 5.82E-05 |
| 53009NEI42329 | Formaldehyde | 9.29E-02 | 4.65E-03 | 3.01E-04 | 4.26E-03 | 4.26E-04 |
| 12089NEI8261 | Acetaldehyde | 9.26E-02 | 5.37E-04 | 8.88E-05 | 2.42E-03 | 1.21E-04 |
| 51101NEI42254 | Acetaldehyde | 9.18E-02 | 5.33E-04 | 8.80E-05 | 2.40E-03 | 1.20E-04 |
| 23019NEI33103 | Methanol | 9.15E-02 | 3.71E-03 | 9.49E-04 | 9.86E-03 | 1.97E-03 |
| 27071NEI12411 | Chloroform | 9.08E-02 | 0.00E+00 | 4.39E-05 | 0.00E+00 | 5.67E-05 |
| 28077NEI11172 | Formaldehyde | 9.07E-02 | 4.54E-03 | 2.93E-04 | 4.16E-03 | 4.16E-04 |
| 51009NEIVA00022 | Methanol | 9.02E-02 | 3.66E-03 | 9.35E-04 | 9.71E-03 | 1.94E-03 |
| 53015NEI42338 | Carbon tetrachloride | 8.88E-02 | 6.02E-04 | 1.41E-04 | 1.30E-03 | 2.68E-04 |
| 23017NEI6273 | Formaldehyde | 8.84E-02 | 4.42E-03 | 2.86E-04 | 4.05E-03 | 4.05E-04 |
| 01079NEI18357 | Formaldehyde | 8.69E-02 | 4.34E-03 | 2.81E-04 | 3.98E-03 | 3.98E-04 |
| 45031NEI43472 | Methanol | 8.57E-02 | 3.48E-03 | 8.88E-04 | 9.22E-03 | 1.84E-03 |
| 13021NEI26471 | Chloroform | 8.55E-02 | 0.00E+00 | 4.14E-05 | 0.00E+00 | 5.34E-05 |
| 01053NEI18338 | Methanol | 8.49E-02 | 3.45E-03 | 8.81E-04 | 9.15E-03 | 1.83E-03 |
| 42133NEI7181 | Acetaldehyde | 8.48E-02 | 4.92E-04 | 8.14E-05 | 2.22E-03 | 1.11E-04 |
| 37047NEI40247 | Methanol | 8.22E-02 | 3.34E-03 | 8.52E-04 | 8.85E-03 | 1.77E-03 |
| 01001NEI8560 | Methanol | 8.21E-02 | 3.33E-03 | 8.51E-04 | 8.84E-03 | 1.77E-03 |
| 18165NEI2INT16350 | Formaldehyde | 8.11E-02 | 4.05E-03 | 2.62E-04 | 3.72E-03 | 3.72E-04 |
| 24001NEI33135 | Phenol | 8.09E-02 | 8.09E-03 | 5.27E-03 | 1.23E-02 | 2.47E-03 |
| 05069NEI18658 | Xylenes (mixed) | 7.95E-02 | 3.12E-03 | 4.37E-04 | 0.00E+00 | 0.00E+00 |
| 22069NEI33025 | Formaldehyde | 7.80E-02 | 3.90E-03 | 2.52E-04 | 3.58E-03 | 3.58E-04 |
| 01025NEI8601 | Acetaldehyde | 7.80E-02 | 4.52E-04 | 7.48E-05 | 2.04E-03 | 1.02E-04 |
| 01053NEI18338 | Formaldehyde | 7.79E-02 | 3.90E-03 | 2.52E-04 | 3.57E-03 | 3.57E-04 |
| 21091NEI32869A | Methanol | 7.75E-02 | 3.15E-03 | 8.04E-04 | 8.35E-03 | 1.67E-03 |
| 01113NEI46931 | Chloroform | 7.73E-02 | 0.00E+00 | 3.74E-05 | 0.00E+00 | 4.83E-05 |
| 42133NEI7181 | Methanol | 7.65E-02 | 3.11E-03 | 7.94E-04 | 8.24E-03 | 1.65E-03 |
| 12005NEI8278 | Methanol | 7.63E-02 | 3.09E-03 | 7.91E-04 | 8.21E-03 | 1.64E-03 |
| 47071NEI41552 | Formaldehyde | 7.62E-02 | 3.81E-03 | 2.46E-04 | 3.49E-03 | 3.49E-04 |
| 21091NEI32869A | Acetaldehyde | 7.58E-02 | 4.40E-04 | 7.27E-05 | 1.98E-03 | 9.90E-05 |
| 16069NEI26581 | Acetaldehyde | 7.49E-02 | 4.35E-04 | 7.19E-05 | 1.96E-03 | 9.78E-05 |
| 55087NEI42710 | Methanol | 7.44E-02 | 3.02E-03 | 7.71E-04 | 8.01E-03 | 1.60E-03 |
| 22069NEI33025 | Methanol | 7.39E-02 | 3.00E-03 | 7.67E-04 | 7.96E-03 | 1.59E-03 |
| 40101NEI12980 | Chloroform | 7.34E-02 | 0.00E+00 | 3.55E-05 | 0.00E+00 | 4.59E-05 |

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| 51019NEI42211 | Formaldehyde | 7.34E-02 | 3.67E-03 | 2.37E-04 | 3.36E-03 | 3.36E-04 |
| 53071NEI42410 | Acetaldehyde | 7.28E-02 | 4.22E-04 | 6.98E-05 | 1.90E-03 | 9.50E-05 |
| 45041NEI7933 | Acetaldehyde | 7.21E-02 | 4.18E-04 | 6.91E-05 | 1.88E-03 | 9.41E-05 |
| 48241NEI6450 | Methanol | 7.17E-02 | 2.91E-03 | 7.43E-04 | 7.72E-03 | 1.54E-03 |
| 42047NEI40686 | Acetaldehyde | 7.14E-02 | 4.14E-04 | 6.85E-05 | 1.86E-03 | 9.32E-05 |
| 42131NEI40738 | Nickel compounds | 7.13E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 47107NEI41565 | Acetaldehyde | 7.13E-02 | 4.14E-04 | 6.84E-05 | 1.86E-03 | 9.31E-05 |
| 55141NEI42695 | Acetaldehyde | 7.01E-02 | 4.07E-04 | 6.72E-05 | 1.83E-03 | 9.15E-05 |
| 51670NEI42317 | Methanol | 7.00E-02 | 2.84E-03 | 7.26E-04 | 7.54E-03 | 1.51E-03 |
| 01113NEI46931 | Methanol | 6.96E-02 | 2.83E-03 | 7.22E-04 | 7.50E-03 | 1.50E-03 |
| 55099NEI42730 | Chloroform | 6.94E-02 | 0.00E+00 | 3.36E-05 | 0.00E+00 | 4.34E-05 |
| 12123NEI47091 | Formaldehyde | 6.93E-02 | 3.47E-03 | 2.24E-04 | 3.18E-03 | 3.18E-04 |
| 26041NEI33883 | Chloroform | 6.93E-02 | 0.00E+00 | 3.35E-05 | 0.00E+00 | 4.33E-05 |
| 40089NEI11251 | Formaldehyde | 6.86E-02 | 3.43E-03 | 2.22E-04 | 3.14E-03 | 3.14E-04 |
| 28087NEI34064 | Formaldehyde | 6.83E-02 | 3.42E-03 | 2.21E-04 | 3.13E-03 | 3.13E-04 |
| 01131NEI8619 | Methanol | 6.82E-02 | 2.77E-03 | 7.07E-04 | 7.34E-03 | 1.47E-03 |
| 51019NEI42211 | Methanol | 6.78E-02 | 2.75E-03 | 7.03E-04 | 7.30E-03 | 1.46E-03 |
| 45043NEI41314 | Chloroform | 6.71E-02 | 0.00E+00 | 3.25E-05 | 0.00E+00 | 4.20E-05 |
| 23019NEI33103 | Formaldehyde | 6.71E-02 | 3.36E-03 | 2.17E-04 | 3.08E-03 | 3.08E-04 |
| 01121NEI18390 | Acetaldehyde | 6.62E-02 | 3.84E-04 | 6.35E-05 | 1.73E-03 | 8.65E-05 |
| 39031NEI11461 | Methanol | 6.62E-02 | 2.69E-03 | 6.87E-04 | 7.13E-03 | 1.43E-03 |
| 53015NEI42338 | Acetaldehyde | 6.57E-02 | 3.81E-04 | 6.30E-05 | 1.72E-03 | 8.58E-05 |
| 01023NEI18334 | Methylene chloride | 6.42E-02 | 1.30E-03 | 4.73E-04 | 8.98E-04 | 3.46E-04 |
| 13103NEI8178 | Formaldehyde | 6.12E-02 | 3.06E-03 | 1.98E-04 | 2.80E-03 | 2.80E-04 |
| 45043NEI41314 | Methanol | 6.01E-02 | 2.44E-03 | 6.23E-04 | 6.47E-03 | 1.29E-03 |
| 42047NEI40686 | Chloroform | 5.99E-02 | 0.00E+00 | 2.90E-05 | 0.00E+00 | 3.75E-05 |
| 01025NEI8601 | Chloroform | 5.96E-02 | 0.00E+00 | 2.88E-05 | 0.00E+00 | 3.72E-05 |
| 16069NEI26581 | Formaldehyde | 5.85E-02 | 2.93E-03 | 1.89E-04 | 2.68E-03 | 2.68E-04 |
| 28087NEI34064 | Chloroform | 5.82E-02 | 0.00E+00 | 2.82E-05 | 0.00E+00 | 3.64E-05 |
| 55141NEI46739 | Chloroform | 5.81E-02 | 0.00E+00 | 2.81E-05 | 0.00E+00 | 3.63E-05 |
| 55009NEIWI4050324 | Chloroform | 5.81E-02 | 0.00E+00 | 2.81E-05 | 0.00E+00 | 3.63E-05 |
| 21007NEI11338 | Methanol | 5.68E-02 | 2.31E-03 | 5.89E-04 | 6.12E-03 | 1.22E-03 |
| 23025NEIME0250002 | Methanol | 5.68E-02 | 2.30E-03 | 5.89E-04 | 6.11E-03 | 1.22E-03 |
| 26043NEI33887 | Methanol | 5.67E-02 | 2.30E-03 | 5.88E-04 | 6.11E-03 | 1.22E-03 |
| 47071NEI41552 | Methanol | 5.65E-02 | 2.29E-03 | 5.85E-04 | 6.08E-03 | 1.22E-03 |
| 12089NEI26382 | Methanol | 5.62E-02 | 2.28E-03 | 5.83E-04 | 6.06E-03 | 1.21E-03 |
| 13095NEI26487 | Acetaldehyde | 5.62E-02 | 3.26E-04 | 5.39E-05 | 1.47E-03 | 7.34E-05 |
| 16069NEI26581 | Chloroform | 5.55E-02 | 0.00E+00 | 2.69E-05 | 0.00E+00 | 3.47E-05 |
| 51101NEI42254 | Formaldehyde | 5.50E-02 | 2.75E-03 | 1.78E-04 | 2.52E-03 | 2.52E-04 |
| 41071NEI40648 | Formaldehyde | 5.50E-02 | 2.75E-03 | 1.78E-04 | 2.52E-03 | 2.52E-04 |
| 41039NEI45182 | Methanol | 5.40E-02 | 2.19E-03 | 5.59E-04 | 5.81E-03 | 1.16E-03 |
| 36113NEI39968 | Chloroform | 5.33E-02 | 0.00E+00 | 2.58E-05 | 0.00E+00 | 3.33E-05 |
| 22011NEI7559 | Formaldehyde | 5.23E-02 | 2.62E-03 | 1.69E-04 | 2.40E-03 | 2.40E-04 |
| 47107NEI41565 | Formaldehyde | 5.14E-02 | 2.57E-03 | 1.66E-04 | 2.36E-03 | 2.36E-04 |
| 45041NEI7933 | Methanol | 5.12E-02 | 2.08E-03 | 5.31E-04 | 5.51E-03 | 1.10E-03 |
| 13051NEI8186 | Methanol | 4.99E-02 | 2.03E-03 | 5.18E-04 | 5.38E-03 | 1.08E-03 |
| 13021NEI26471 | Methanol | 4.97E-02 | 2.02E-03 | 5.16E-04 | 5.36E-03 | 1.07E-03 |
| 22049NEI33023 | Methanol | 4.94E-02 | 2.01E-03 | 5.13E-04 | 5.32E-03 | 1.06E-03 |
| 22011NEI7559 | Methanol | 4.89E-02 | 1.98E-03 | 5.07E-04 | 5.27E-03 | 1.05E-03 |
| 27061NEI34030 | Formaldehyde | 4.76E-02 | 2.38E-03 | 1.54E-04 | 2.18E-03 | 2.18E-04 |
| 45091NEI47077 | Formaldehyde | 4.74E-02 | 2.37E-03 | 1.53E-04 | 2.17E-03 | 2.17E-04 |
| 13185NEI26504 | Acetaldehyde | 4.69E-02 | 2.72E-04 | 4.50E-05 | 1.22E-03 | 6.12E-05 |
| 51101NEI42254 | Chloroform | 4.61E-02 | 0.00E+00 | 2.23E-05 | 0.00E+00 | 2.88E-05 |
| 45079NEI46760 | Chloroform | 4.59E-02 | 0.00E+00 | 2.22E-05 | 0.00E+00 | 2.87E-05 |
| 22049NEI33023 | Formaldehyde | 4.55E-02 | 2.28E-03 | 1.47E-04 | 2.09E-03 | 2.09E-04 |

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| 28111NEI34066 | Formaldehyde | 4.54E-02 | 2.27E-03 | 1.47E-04 | 2.08E-03 | 2.08E-04 |
| 55141NEI42695 | Methanol | 4.53E-02 | 1.84E-03 | 4.69E-04 | 4.87E-03 | 9.75E-04 |
| 05041NEI18652 | Acetaldehyde | 4.47E-02 | 2.60E-04 | 4.29E-05 | 1.17E-03 | 5.84E-05 |
| 41041NEI40600 | Formaldehyde | 4.42E-02 | 2.21E-03 | 1.43E-04 | 2.03E-03 | 2.03E-04 |
| 55009NEI42482 | Acetaldehyde | 4.32E-02 | 2.51E-04 | 4.15E-05 | 1.13E-03 | 5.64E-05 |
| 01121NEI18390 | Formaldehyde | 4.28E-02 | 2.14E-03 | 1.39E-04 | 1.96E-03 | 1.96E-04 |
| 28077NEI11172 | Methanol | 4.28E-02 | 1.74E-03 | 4.44E-04 | 4.61E-03 | 9.22E-04 |
| 45079NEI46760 | Acetaldehyde | 4.26E-02 | 2.47E-04 | 4.08E-05 | 1.11E-03 | 5.56E-05 |
| 12089NEI8261 | Chloroform | 4.23E-02 | 0.00E+00 | 2.05E-05 | 0.00E+00 | 2.65E-05 |
| 45043NEI41314 | Formaldehyde | 4.23E-02 | 2.11E-03 | 1.37E-04 | 1.94E-03 | 1.94E-04 |
| 37087NEI40282 | Chloroform | 4.17E-02 | 0.00E+00 | 2.02E-05 | 0.00E+00 | 2.61E-05 |
| 53011NEI46599 | Acetaldehyde | 4.16E-02 | 2.41E-04 | 3.99E-05 | 1.09E-03 | 5.43E-05 |
| 25017NEI6175 | Formaldehyde | 4.14E-02 | 2.07E-03 | 1.34E-04 | 1.90E-03 | 1.90E-04 |
| 13099NEI26491 | Methanol | 4.13E-02 | 1.67E-03 | 4.28E-04 | 4.44E-03 | 8.89E-04 |
| 45069NEI47074 | Methanol | 4.09E-02 | 1.66E-03 | 4.24E-04 | 4.41E-03 | 8.81E-04 |
| 37117NEI9201 | Acetaldehyde | 4.06E-02 | 2.36E-04 | 3.90E-05 | 1.06E-03 | 5.30E-05 |
| 21007NEI11338 | Formaldehyde | 3.99E-02 | 1.99E-03 | 1.29E-04 | 1.83E-03 | 1.83E-04 |
| 22117NEI46814 | Methanol | 3.96E-02 | 1.61E-03 | 4.10E-04 | 4.26E-03 | 8.52E-04 |
| 26101NEI33945 | Formaldehyde | 3.89E-02 | 1.95E-03 | 1.26E-04 | 1.78E-03 | 1.78E-04 |
| 37117NEI9201 | Formaldehyde | 3.73E-02 | 1.87E-03 | 1.21E-04 | 1.71E-03 | 1.71E-04 |
| 37049NEI45206 | Formaldehyde | 3.71E-02 | 1.86E-03 | 1.20E-04 | 1.70E-03 | 1.70E-04 |
| 01047NEI18335 | Formaldehyde | 3.61E-02 | 1.81E-03 | 1.17E-04 | 1.66E-03 | 1.66E-04 |
| 23007NEI6261 | Formaldehyde | 3.61E-02 | 1.81E-03 | 1.17E-04 | 1.66E-03 | 1.66E-04 |
| 37083NEI47104 | Benzene | 3.54E-02 | 2.71E-04 | 1.77E-05 | 2.88E-04 | 9.60E-05 |
| 48067NEI41628 | Formaldehyde | 3.53E-02 | 1.76E-03 | 1.14E-04 | 1.62E-03 | 1.62E-04 |
| 01023NEI18334 | Styrene | 3.48E-02 | 8.60E-03 | 1.33E-03 | 3.48E-03 | 6.65E-04 |
| 12033NEI26309 | Formaldehyde | 3.46E-02 | 1.73E-03 | 1.12E-04 | 1.59E-03 | 1.59E-04 |
| 27071NEI12411 | Methanol | 3.44E-02 | 1.40E-03 | 3.57E-04 | 3.71E-03 | 7.42E-04 |
| 24001NEI33135 | Carbon tetrachloride | 3.44E-02 | 2.34E-04 | 5.45E-05 | 5.03E-04 | 1.04E-04 |
| 55141NEI42695 | Formaldehyde | 3.37E-02 | 1.69E-03 | 1.09E-04 | 1.54E-03 | 1.54E-04 |
| 01023NEI18334 | Hydrochloric acid | 3.36E-02 | 2.61E-02 | 2.14E-03 | 1.57E-02 | 2.35E-03 |
| 51670NEI42317 | Formaldehyde | 3.35E-02 | 1.68E-03 | 1.09E-04 | 1.54E-03 | 1.54E-04 |
| 01023NEI18334 | Carbon disulfide | 3.34E-02 | 5.18E-03 | 4.15E-04 | 6.69E-02 | 1.30E-03 |
| 55087NEI42710 | Formaldehyde | 3.31E-02 | 1.66E-03 | 1.07E-04 | 1.52E-03 | 1.52E-04 |
| 53009NEI42329 | Acetaldehyde | 3.29E-02 | 1.91E-04 | 3.15E-05 | 8.58E-04 | 4.29E-05 |
| 27145NEI12407 | Formaldehyde | 3.28E-02 | 1.64E-03 | 1.06E-04 | 1.50E-03 | 1.50E-04 |
| 21007NEI11338 | Chloroform | 3.27E-02 | 0.00E+00 | 1.58E-05 | 0.00E+00 | 2.04E-05 |
| 12005NEI8278 | Formaldehyde | 3.25E-02 | 1.63E-03 | 1.05E-04 | 1.49E-03 | 1.49E-04 |
| 54037NEI23 | Acetaldehyde | 3.23E-02 | 1.87E-04 | 3.09E-05 | 8.42E-04 | 4.21E-05 |
| 39031NEI11461 | Chloroform | 3.22E-02 | 0.00E+00 | 1.56E-05 | 0.00E+00 | 2.01E-05 |
| 27145NEI12407 | Acetaldehyde | 3.21E-02 | 1.86E-04 | 3.08E-05 | 8.39E-04 | 4.19E-05 |
| 55073NEI42690 | Acetaldehyde | 3.19E-02 | 1.85E-04 | 3.06E-05 | 8.32E-04 | 4.16E-05 |
| 26101NEI33945 | Methanol | 3.18E-02 | 1.29E-03 | 3.30E-04 | 3.43E-03 | 6.86E-04 |
| 13185NEI26504 | Formaldehyde | 3.12E-02 | 1.56E-03 | 1.01E-04 | 1.43E-03 | 1.43E-04 |
| 12089NEI8261 | Methanol | 3.10E-02 | 1.26E-03 | 3.21E-04 | 3.34E-03 | 6.67E-04 |
| 53071NEI42410 | Formaldehyde | 3.07E-02 | 1.53E-03 | 9.92E-05 | 1.40E-03 | 1.40E-04 |
| 04017NEI13216 | Formaldehyde | 3.05E-02 | 1.52E-03 | 9.87E-05 | 1.40E-03 | 1.40E-04 |
| 55069NEI46750 | Acetaldehyde | 3.02E-02 | 1.75E-04 | 2.90E-05 | 7.90E-04 | 3.95E-05 |
| 13185NEI26504 | Methanol | 2.97E-02 | 1.20E-03 | 3.08E-04 | 3.19E-03 | 6.39E-04 |
| 53031NEI42357 | Methanol | 2.94E-02 | 1.19E-03 | 3.05E-04 | 3.17E-03 | 6.33E-04 |
| 36113NEI39968 | Acetaldehyde | 2.93E-02 | 1.70E-04 | 2.81E-05 | 7.66E-04 | 3.83E-05 |
| 41071NEI40648 | Methanol | 2.93E-02 | 1.19E-03 | 3.04E-04 | 3.16E-03 | 6.31E-04 |
| 36113NEI39968 | Methanol | 2.93E-02 | 1.19E-03 | 3.03E-04 | 3.15E-03 | 6.30E-04 |
| 09011NEICT3102 | Acetaldehyde | 2.88E-02 | 1.67E-04 | 2.76E-05 | 7.52E-04 | 3.76E-05 |
| 41039NEI45182 | Chloroform | 2.88E-02 | 0.00E+00 | 1.39E-05 | 0.00E+00 | 1.80E-05 |

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| 01025NEI8601 | Formaldehyde | 2.83E-02 | 1.41E-03 | 9.15E-05 | 1.30E-03 | 1.30E-04 |
| 05069NEI18658 | Chlorine | 2.80E-02 | 3.92E-03 | 1.02E-03 | 2.03E-03 | 6.77E-04 |
| 26043NEI33887 | Acetaldehyde | 2.80E-02 | 1.62E-04 | 2.68E-05 | 7.30E-04 | 3.65E-05 |
| 26043NEI33887 | Formaldehyde | 2.78E-02 | 1.39E-03 | 8.99E-05 | 1.27E-03 | 1.27E-04 |
| 05041NEI18652 | Formaldehyde | 2.78E-02 | 1.39E-03 | 8.99E-05 | 1.27E-03 | 1.27E-04 |
| 01113NEI46931 | Formaldehyde | 2.77E-02 | 1.38E-03 | 8.96E-05 | 1.27E-03 | 1.27E-04 |
| 16069NEI26581 | Methanol | 2.67E-02 | 1.08E-03 | 2.77E-04 | 2.88E-03 | 5.75E-04 |
| 27017NEI12368 | Acetaldehyde | 2.67E-02 | 1.55E-04 | 2.56E-05 | 6.96E-04 | 3.48E-05 |
| 55099NEI42730 | Methanol | 2.66E-02 | 1.08E-03 | 2.76E-04 | 2.86E-03 | 5.73E-04 |
| 41007NEI40554 | Acetaldehyde | 2.66E-02 | 1.54E-04 | 2.55E-05 | 6.94E-04 | 3.47E-05 |
| 41041NEI40600 | Chloroform | 2.66E-02 | 0.00E+00 | 1.29E-05 | 0.00E+00 | 1.66E-05 |
| 01113NEI46931 | Phenol | 2.62E-02 | 2.62E-03 | 1.71E-03 | 4.00E-03 | 7.99E-04 |
| 47085NEI46866 | Methanol | 2.61E-02 | 1.06E-03 | 2.71E-04 | 2.82E-03 | 5.63E-04 |
| 27017NEI12368 | Formaldehyde | 2.59E-02 | 1.29E-03 | 8.37E-05 | 1.19E-03 | 1.19E-04 |
| 53009NEI42329 | Chloroform | 2.54E-02 | 0.00E+00 | 1.23E-05 | 0.00E+00 | 1.59E-05 |
| 28149NEI34070 | Chloroform | 2.48E-02 | 0.00E+00 | 1.20E-05 | 0.00E+00 | 1.55E-05 |
| 55141NEI42695 | Chloroform | 2.47E-02 | 0.00E+00 | 1.20E-05 | 0.00E+00 | 1.55E-05 |
| 13115NEI26495 | Phenol | 2.47E-02 | 2.47E-03 | 1.61E-03 | 3.77E-03 | 7.53E-04 |
| 22117NEI46814 | Formaldehyde | 2.44E-02 | 1.22E-03 | 7.90E-05 | 1.12E-03 | 1.12E-04 |
| 01047NEI18335 | Chloroform | 2.42E-02 | 0.00E+00 | 1.17E-05 | 0.00E+00 | 1.51E-05 |
| 12005NEI8278 | Chloroform | 2.42E-02 | 0.00E+00 | 1.17E-05 | 0.00E+00 | 1.51E-05 |
| 37049NEI45206 | Methanol | 2.42E-02 | 9.82E-04 | 2.51E-04 | 2.61E-03 | 5.21E-04 |
| 27145NEI12407 | Arsenic compounds | 2.39E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 42133NEI7181 | Formaldehyde | 2.32E-02 | 1.16E-03 | 7.51E-05 | 1.06E-03 | 1.06E-04 |
| 41071NEI40648 | Hydrogen cyanide | 2.29E-02 | 3.54E-03 | 9.98E-04 | 0.00E+00 | 7.07E-04 |
| 54057NEI706 | Acetaldehyde | 2.28E-02 | 1.33E-04 | 2.19E-05 | 5.96E-04 | 2.98E-05 |
| 13193NEI26506 | Phenol | 2.28E-02 | 2.28E-03 | 1.49E-03 | 3.48E-03 | 6.96E-04 |
| 22031NEI33013 | Chloroform | 2.28E-02 | 0.00E+00 | 1.10E-05 | 0.00E+00 | 1.42E-05 |
| 01131NEI8619 | Formaldehyde | 2.27E-02 | 1.13E-03 | 7.34E-05 | 1.04E-03 | 1.04E-04 |
| 55073NEI42689 | Formaldehyde | 2.25E-02 | 1.13E-03 | 7.28E-05 | 1.03E-03 | 1.03E-04 |
| 01121NEI18390 | Chloroform | 2.23E-02 | 0.00E+00 | 1.08E-05 | 0.00E+00 | 1.39E-05 |
| 12089NEI26382 | Formaldehyde | 2.21E-02 | 1.11E-03 | 7.16E-05 | 1.01E-03 | 1.01E-04 |
| 42013NEI7106 | 1,2-Dimethoxyethane | 2.20E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55009NEIWI4050324 | Formaldehyde | 2.19E-02 | 1.09E-03 | 7.08E-05 | 1.00E-03 | 1.00E-04 |
| 39017NEI11600 | Acetaldehyde | 2.15E-02 | 1.25E-04 | 2.06E-05 | 5.62E-04 | 2.81E-05 |
| 55099NEI42730 | Formaldehyde | 2.12E-02 | 1.06E-03 | 6.86E-05 | 9.72E-04 | 9.72E-05 |
| 45091NEI47077 | Chloroform | 2.12E-02 | 0.00E+00 | 1.03E-05 | 0.00E+00 | 1.33E-05 |
| 37047NEI40247 | Chloroform | 2.12E-02 | 0.00E+00 | 1.03E-05 | 0.00E+00 | 1.33E-05 |
| 41041NEI40600 | Methanol | 2.10E-02 | 8.54E-04 | 2.18E-04 | 2.27E-03 | 4.53E-04 |
| 05041NEI18652 | Chlorine | 2.10E-02 | 2.94E-03 | 7.61E-04 | 1.52E-03 | 5.07E-04 |
| 12089NEI8261 | Formaldehyde | 2.09E-02 | 1.05E-03 | 6.77E-05 | 9.60E-04 | 9.60E-05 |
| 05069NEI18658 | Carbon tetrachloride | 2.08E-02 | 1.41E-04 | 3.30E-05 | 3.04E-04 | 6.28E-05 |
| 55141NEI46739 | Methanol | 2.07E-02 | 8.39E-04 | 2.14E-04 | 2.23E-03 | 4.45E-04 |
| 55139NEIWI4710355 | Chloroform | 2.07E-02 | 0.00E+00 | 1.00E-05 | 0.00E+00 | 1.29E-05 |
| 05003NEI54342 | Phenol | 2.06E-02 | 2.06E-03 | 1.34E-03 | 3.14E-03 | 6.28E-04 |
| 13245NEI8122 | Acetaldehyde | 2.06E-02 | 1.19E-04 | 1.97E-05 | 5.37E-04 | 2.69E-05 |
| 01121NEI18390 | Methanol | 2.06E-02 | 8.34E-04 | 2.13E-04 | 2.21E-03 | 4.43E-04 |
| 40101NEI12980 | Acetaldehyde | 2.05E-02 | 1.19E-04 | 1.97E-05 | 5.35E-04 | 2.68E-05 |
| 27137NEIMN14904 | Acetaldehyde | 2.03E-02 | 1.18E-04 | 1.95E-05 | 5.30E-04 | 2.65E-05 |
| 13115NEI26495 | Carbon disulfide | 1.99E-02 | 3.08E-03 | 2.47E-04 | 3.98E-02 | 7.71E-04 |
| 27061NEI34030 | Chloroform | 1.95E-02 | 0.00E+00 | 9.42E-06 | 0.00E+00 | 1.22E-05 |
| 53053NEI13363 | Methanol | 1.93E-02 | 7.82E-04 | 2.00E-04 | 2.07E-03 | 4.15E-04 |
| 23007NEI6261 | Chloroform | 1.88E-02 | 0.00E+00 | 9.10E-06 | 0.00E+00 | 1.18E-05 |
| 04017NEI13216 | Methanol | 1.87E-02 | 7.59E-04 | 1.94E-04 | 2.02E-03 | 4.03E-04 |
| 42047NEI40686 | Methanol | 1.85E-02 | 7.52E-04 | 1.92E-04 | 2.00E-03 | 3.99E-04 |

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|---|---|---|---|---|---|---|
| 01025NEI8601 | Methanol | 1.84E-02 | 7.46E-04 | 1.91E-04 | 1.98E-03 | 3.96E-04 |
| 23025NEI33118 | Formaldehyde | 1.79E-02 | 8.96E-04 | 5.80E-05 | 8.21E-04 | 8.21E-05 |
| 53015NEI42338 | Methanol | 1.78E-02 | 7.23E-04 | 1.85E-04 | 1.92E-03 | 3.84E-04 |
| 12107NEI8265 | Phenol | 1.77E-02 | 1.77E-03 | 1.15E-03 | 2.70E-03 | 5.41E-04 |
| 55069NEI46750 | Methanol | 1.77E-02 | 7.18E-04 | 1.83E-04 | 1.90E-03 | 3.81E-04 |
| 45079NEI46760 | Methanol | 1.75E-02 | 7.10E-04 | 1.81E-04 | 1.88E-03 | 3.77E-04 |
| 53015NEI42341A | 1,2-Dimethoxyethane | 1.74E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45041NEI7933 | Formaldehyde | 1.74E-02 | 8.70E-04 | 5.63E-05 | 7.98E-04 | 7.98E-05 |
| 53015NEI42338 | 1,2-Dimethoxyethane | 1.73E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41007NEI40554 | Methanol | 1.71E-02 | 6.94E-04 | 1.77E-04 | 1.84E-03 | 3.68E-04 |
| 27061NEI34030 | 1,2-Dimethoxyethane | 1.70E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45079NEI46760 | Formaldehyde | 1.69E-02 | 8.46E-04 | 5.48E-05 | 7.76E-04 | 7.76E-05 |
| 47163NEI41599 | Formaldehyde | 1.69E-02 | 8.45E-04 | 5.47E-05 | 7.74E-04 | 7.74E-05 |
| 53015NEI42338 | Phenol | 1.68E-02 | 1.68E-03 | 1.10E-03 | 2.57E-03 | 5.14E-04 |
| 51085NEI208 | Methanol | 1.68E-02 | 6.81E-04 | 1.74E-04 | 1.81E-03 | 3.62E-04 |
| 26101NEI33945 | Chloroform | 1.66E-02 | 0.00E+00 | 8.05E-06 | 0.00E+00 | 1.04E-05 |
| 54057NEI706 | Methanol | 1.66E-02 | 6.73E-04 | 1.72E-04 | 1.79E-03 | 3.57E-04 |
| 01023NEI18334 | Chlorine | 1.65E-02 | 2.30E-03 | 5.96E-04 | 1.19E-03 | 3.97E-04 |
| 53011NEI46599 | Methanol | 1.63E-02 | 6.63E-04 | 1.69E-04 | 1.76E-03 | 3.52E-04 |
| 13179NEI8177 | Formaldehyde | 1.63E-02 | 8.15E-04 | 5.28E-05 | 7.47E-04 | 7.47E-05 |
| 05069NEI18658 | Styrene | 1.62E-02 | 4.00E-03 | 6.18E-04 | 1.62E-03 | 3.09E-04 |
| 51101NEI42254 | Phenol | 1.58E-02 | 1.58E-03 | 1.03E-03 | 2.41E-03 | 4.82E-04 |
| 36031NEI35908 | Methanol | 1.51E-02 | 6.12E-04 | 1.56E-04 | 1.63E-03 | 3.25E-04 |
| 27071NEI12411 | Formaldehyde | 1.50E-02 | 7.49E-04 | 4.84E-05 | 6.86E-04 | 6.86E-05 |
| 12123NEI47091 | Phenol | 1.49E-02 | 1.49E-03 | 9.70E-04 | 2.27E-03 | 4.54E-04 |
| 45079NEI46760 | Chlorine | 1.48E-02 | 2.07E-03 | 5.34E-04 | 1.07E-03 | 3.56E-04 |
| 55009NEI42486 | Acetaldehyde | 1.46E-02 | 8.49E-05 | 1.40E-05 | 3.82E-04 | 1.91E-05 |
| 13179NEI8177 | Acetaldehyde | 1.46E-02 | 8.47E-05 | 1.40E-05 | 3.81E-04 | 1.91E-05 |
| 23009NEI6284 | Formaldehyde | 1.45E-02 | 7.27E-04 | 4.70E-05 | 6.66E-04 | 6.66E-05 |
| 24001NEI33135 | Carbon disulfide | 1.44E-02 | 2.24E-03 | 1.79E-04 | 2.88E-02 | 5.59E-04 |
| 05069NEI18658 | Carbon disulfide | 1.37E-02 | 2.13E-03 | 1.70E-04 | 2.74E-02 | 5.31E-04 |
| 13175NEIGAT$3911 | Methanol | 1.37E-02 | 5.55E-04 | 1.42E-04 | 1.47E-03 | 2.95E-04 |
| 55141NEI42963 | Formaldehyde | 1.36E-02 | 6.80E-04 | 4.40E-05 | 6.23E-04 | 6.23E-05 |
| 53053NEI13363 | Chloroform | 1.34E-02 | 0.00E+00 | 6.50E-06 | 0.00E+00 | 8.40E-06 |
| 12089NEI26382 | Acetaldehyde | 1.33E-02 | 7.73E-05 | 1.28E-05 | 3.48E-04 | 1.74E-05 |
| 04017NEI13216 | Chloroform | 1.30E-02 | 0.00E+00 | 6.31E-06 | 0.00E+00 | 8.15E-06 |
| 37083NEI47104 | Styrene | 1.28E-02 | 3.17E-03 | 4.90E-04 | 1.28E-03 | 2.45E-04 |
| 41071NEI40648 | Toluene | 1.27E-02 | 6.26E-04 | 1.04E-04 | 2.47E-03 | 4.27E-04 |
| 05069NEI18658 | Phenol | 1.27E-02 | 1.27E-03 | 8.26E-04 | 1.93E-03 | 3.87E-04 |
| 22011NEI7559 | Chloroform | 1.26E-02 | 0.00E+00 | 6.09E-06 | 0.00E+00 | 7.87E-06 |
| 37049NEI45206 | Chloroform | 1.26E-02 | 0.00E+00 | 6.08E-06 | 0.00E+00 | 7.86E-06 |
| 23009NEI6284 | Acetaldehyde | 1.25E-02 | 7.25E-05 | 1.20E-05 | 3.26E-04 | 1.63E-05 |
| 51580NEI759 | Carbon tetrachloride | 1.24E-02 | 8.41E-05 | 1.96E-05 | 1.81E-04 | 3.74E-05 |
| 41007NEI40554 | Formaldehyde | 1.23E-02 | 6.16E-04 | 3.98E-05 | 5.64E-04 | 5.64E-05 |
| 47085NEI46866 | Formaldehyde | 1.23E-02 | 6.14E-04 | 3.98E-05 | 5.63E-04 | 5.63E-05 |
| 55087NEI43207 | Methanol | 1.22E-02 | 4.96E-04 | 1.27E-04 | 1.32E-03 | 2.63E-04 |
| 55009NEIWI4050324 | Chlorine | 1.22E-02 | 1.71E-03 | 4.42E-04 | 8.83E-04 | 2.94E-04 |
| 23019NEI33103 | Phenol | 1.21E-02 | 1.21E-03 | 7.89E-04 | 1.85E-03 | 3.69E-04 |
| 53015NEI42341A | Formaldehyde | 1.17E-02 | 5.85E-04 | 3.79E-05 | 5.36E-04 | 5.36E-05 |
| 53011NEI46599 | Hydrochloric acid | 1.15E-02 | 8.97E-03 | 7.34E-04 | 5.38E-03 | 8.08E-04 |
| 01047NEI18335 | Arsenic compounds | 1.14E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45069NEI47074 | Carbon tetrachloride | 1.13E-02 | 7.69E-05 | 1.79E-05 | 1.66E-04 | 3.42E-05 |
| 28111NEI34066 | Methanol | 1.13E-02 | 4.60E-04 | 1.17E-04 | 1.22E-03 | 2.44E-04 |
| 55115NEI42800 | Acetaldehyde | 1.13E-02 | 6.55E-05 | 1.08E-05 | 2.95E-04 | 1.47E-05 |
| 01023NEI18334 | Benzene | 1.13E-02 | 8.62E-05 | 5.64E-06 | 9.16E-05 | 3.05E-05 |

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|---|---|---|---|---|---|---|
| 55009NEIWI4050324 | Acetaldehyde | 1.12E-02 | 6.47E-05 | 1.07E-05 | 2.91E-04 | 1.46E-05 |
| 22069NEI33025 | 1,2-Dimethoxyethane | 1.11E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01071NEI18347 | Phenol | 1.09E-02 | 1.09E-03 | 7.13E-04 | 1.67E-03 | 3.34E-04 |
| 55087NEI42710 | Chloroform | 1.09E-02 | 0.00E+00 | 5.25E-06 | 0.00E+00 | 6.78E-06 |
| 55009NEI42495 | Acetaldehyde | 1.08E-02 | 6.27E-05 | 1.04E-05 | 2.82E-04 | 1.41E-05 |
| 27017NEI12368 | Chloroform | 1.08E-02 | 0.00E+00 | 5.22E-06 | 0.00E+00 | 6.74E-06 |
| 41043NEI13340 | Phenol | 1.08E-02 | 1.08E-03 | 7.02E-04 | 1.64E-03 | 3.29E-04 |
| 55141NEI46739 | Chlorine | 1.07E-02 | 1.50E-03 | 3.89E-04 | 7.78E-04 | 2.59E-04 |
| 55085NEI43202 | Acetaldehyde | 1.07E-02 | 6.20E-05 | 1.02E-05 | 2.79E-04 | 1.40E-05 |
| 39031NEI11461 | Phenol | 1.06E-02 | 1.06E-03 | 6.93E-04 | 1.62E-03 | 3.25E-04 |
| 55069NEI46750 | Formaldehyde | 1.06E-02 | 5.31E-04 | 3.44E-05 | 4.87E-04 | 4.87E-05 |
| 47107NEI41565 | Phenol | 1.05E-02 | 1.05E-03 | 6.84E-04 | 1.60E-03 | 3.20E-04 |
| 13245NEI8122 | Formaldehyde | 1.04E-02 | 5.20E-04 | 3.37E-05 | 4.77E-04 | 4.77E-05 |
| 22033NEI46817 | Phenol | 1.04E-02 | 1.04E-03 | 6.77E-04 | 1.59E-03 | 3.17E-04 |
| 39141NEI40488 | Acetaldehyde | 1.03E-02 | 6.00E-05 | 9.92E-06 | 2.70E-04 | 1.35E-05 |
| 27071NEI12411 | Acetaldehyde | 1.02E-02 | 5.92E-05 | 9.79E-06 | 2.66E-04 | 1.33E-05 |
| 12089NEI8261 | Phenol | 1.01E-02 | 1.01E-03 | 6.56E-04 | 1.54E-03 | 3.07E-04 |
| 51009NEIVA00022 | Benzene | 9.80E-03 | 7.49E-05 | 4.90E-06 | 7.96E-05 | 2.65E-05 |
| 27061NEI34030 | Acetaldehyde | 9.66E-03 | 5.60E-05 | 9.26E-06 | 2.52E-04 | 1.26E-05 |
| 13175NEIGAT$3911 | Acetaldehyde | 9.64E-03 | 5.59E-05 | 9.25E-06 | 2.52E-04 | 1.26E-05 |
| 55079NEIWI0793640 | Formaldehyde | 9.64E-03 | 4.82E-04 | 3.12E-05 | 4.42E-04 | 4.42E-05 |
| 13193NEI26506 | Formaldehyde | 9.63E-03 | 4.82E-04 | 3.12E-05 | 4.41E-04 | 4.41E-05 |
| 55073NEI54400 | Methanol | 9.60E-03 | 3.90E-04 | 9.96E-05 | 1.03E-03 | 2.07E-04 |
| 51101NEI42254 | Carbon disulfide | 9.29E-03 | 1.44E-03 | 1.15E-04 | 1.86E-02 | 3.60E-04 |
| 12005NEI8278 | Phenol | 9.28E-03 | 9.28E-04 | 6.05E-04 | 1.42E-03 | 2.83E-04 |
| 18165NEI2INT16350 | Acetaldehyde | 9.27E-03 | 5.38E-05 | 8.89E-06 | 2.42E-04 | 1.21E-05 |
| 37083NEI47104 | Methylene chloride | 9.25E-03 | 1.88E-04 | 6.82E-05 | 1.30E-04 | 4.98E-05 |
| 01071NEI18347 | Formaldehyde | 8.96E-03 | 4.48E-04 | 2.90E-05 | 4.11E-04 | 4.11E-05 |
| 41043NEI13340 | Carbon tetrachloride | 8.95E-03 | 6.07E-05 | 1.42E-05 | 1.31E-04 | 2.70E-05 |
| 26101NEI33945 | 1,2-Dimethoxyethane | 8.93E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37117NEI9201 | Methanol | 8.92E-03 | 3.62E-04 | 9.25E-05 | 9.61E-04 | 1.92E-04 |
| 28077NEI11172 | Chloroform | 8.89E-03 | 0.00E+00 | 4.30E-06 | 0.00E+00 | 5.55E-06 |
| 41007NEI40554 | Chloroform | 8.84E-03 | 0.00E+00 | 4.28E-06 | 0.00E+00 | 5.53E-06 |
| 55073NEI42689 | Chloroform | 8.80E-03 | 0.00E+00 | 4.26E-06 | 0.00E+00 | 5.50E-06 |
| 48361NEI12492 | Xylenes (mixed) | 8.66E-03 | 3.40E-04 | 4.76E-05 | 0.00E+00 | 0.00E+00 |
| 05069NEI18658 | Hydrochloric acid | 8.56E-03 | 6.65E-03 | 5.44E-04 | 3.99E-03 | 5.99E-04 |
| 12089NEI26382 | Nickel compounds | 8.55E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 28087NEI34064 | Chlorine | 8.46E-03 | 1.18E-03 | 3.06E-04 | 6.13E-04 | 2.04E-04 |
| 41041NEI40600 | Carbon disulfide | 8.46E-03 | 1.31E-03 | 1.05E-04 | 1.69E-02 | 3.28E-04 |
| 42047NEI40686 | Hydrochloric acid | 8.42E-03 | 6.55E-03 | 5.36E-04 | 3.93E-03 | 5.89E-04 |
| 53015NEI42338 | Styrene | 8.36E-03 | 2.07E-03 | 3.19E-04 | 8.36E-04 | 1.60E-04 |
| 55073NEI42689 | Methanol | 8.30E-03 | 3.37E-04 | 8.60E-05 | 8.93E-04 | 1.79E-04 |
| 53015NEI42341B | Methanol | 8.28E-03 | 3.36E-04 | 8.58E-05 | 8.91E-04 | 1.78E-04 |
| 36113NEI39968 | Formaldehyde | 8.23E-03 | 4.11E-04 | 2.66E-05 | 3.77E-04 | 3.77E-05 |
| 01099NEI18373 | Chloroform | 8.16E-03 | 0.00E+00 | 3.95E-06 | 0.00E+00 | 5.10E-06 |
| 04017NEI13216 | Acetaldehyde | 8.14E-03 | 4.72E-05 | 7.80E-06 | 2.12E-04 | 1.06E-05 |
| 01079NEI18357 | Phenol | 8.01E-03 | 8.01E-04 | 5.22E-04 | 1.22E-03 | 2.44E-04 |
| 37083NEI47104 | Xylenes (mixed) | 8.00E-03 | 3.14E-04 | 4.40E-05 | 0.00E+00 | 0.00E+00 |
| 53015NEI42341A | Chlorine | 7.74E-03 | 1.08E-03 | 2.80E-04 | 5.61E-04 | 1.87E-04 |
| 36031NEI35908 | Chloroform | 7.72E-03 | 0.00E+00 | 3.74E-06 | 0.00E+00 | 4.83E-06 |
| 13305NEI26526 | Carbon disulfide | 7.71E-03 | 1.20E-03 | 9.56E-05 | 1.54E-02 | 2.99E-04 |
| 47163NEI41599 | Hydrochloric acid | 7.70E-03 | 5.99E-03 | 4.90E-04 | 3.59E-03 | 5.39E-04 |
| 27145NEI12407 | Nickel compounds | 7.62E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39113NEI11645 | Formaldehyde | 7.45E-03 | 3.73E-04 | 2.41E-05 | 3.42E-04 | 3.42E-05 |
| 53015NEI42341A | Methanol | 7.37E-03 | 2.99E-04 | 7.64E-05 | 7.93E-04 | 1.59E-04 |

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|---|---|---|---|---|---|---|
| 13305NEI26526 | Chlorine | 7.30E-03 | 1.02E-03 | 2.64E-04 | 5.28E-04 | 1.76E-04 |
| 28043NEI11108 | Acetaldehyde | 7.06E-03 | 4.10E-05 | 6.77E-06 | 1.84E-04 | 9.21E-06 |
| 55085NEI43202 | Formaldehyde | 6.98E-03 | 3.49E-04 | 2.26E-05 | 3.20E-04 | 3.20E-05 |
| 41071NEI40648 | Phenol | 6.94E-03 | 6.94E-04 | 4.53E-04 | 1.06E-03 | 2.12E-04 |
| 55009NEI42482 | Methanol | 6.94E-03 | 2.82E-04 | 7.20E-05 | 7.48E-04 | 1.50E-04 |
| 36031NEI35908 | Formaldehyde | 6.89E-03 | 3.45E-04 | 2.23E-05 | 3.16E-04 | 3.16E-05 |
| 45041NEI7933 | Chloroform | 6.83E-03 | 0.00E+00 | 3.30E-06 | 0.00E+00 | 4.27E-06 |
| 55141NEI46739 | Acetaldehyde | 6.81E-03 | 3.95E-05 | 6.53E-06 | 1.78E-04 | 8.89E-06 |
| 26147NEI33981 | Acetaldehyde | 6.73E-03 | 3.91E-05 | 6.46E-06 | 1.76E-04 | 8.79E-06 |
| 51085NEI208 | Phenol | 6.72E-03 | 6.72E-04 | 4.38E-04 | 1.03E-03 | 2.05E-04 |
| 47107NEI41565 | 1,2-Dimethoxyethane | 6.71E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01071NEI18347 | Chloroform | 6.70E-03 | 0.00E+00 | 3.24E-06 | 0.00E+00 | 4.19E-06 |
| 41043NEI13340 | Chlorine | 6.68E-03 | 9.35E-04 | 2.42E-04 | 4.84E-04 | 1.61E-04 |
| 40031NEW73505 | Acetaldehyde | 6.56E-03 | 3.81E-05 | 6.29E-06 | 1.71E-04 | 8.57E-06 |
| 13179NEI8177 | Methanol | 6.56E-03 | 2.66E-04 | 6.80E-05 | 7.07E-04 | 1.41E-04 |
| 01053NEI18338 | Xylenes (mixed) | 6.46E-03 | 2.54E-04 | 3.55E-05 | 0.00E+00 | 0.00E+00 |
| 13235NEIGAT$3909 | Methanol | 6.44E-03 | 2.61E-04 | 6.67E-05 | 6.93E-04 | 1.39E-04 |
| 23017NEI6273 | Carbon disulfide | 6.33E-03 | 9.82E-04 | 7.85E-05 | 1.27E-02 | 2.45E-04 |
| 55073NEI42689 | Acetaldehyde | 6.29E-03 | 3.65E-05 | 6.03E-06 | 1.64E-04 | 8.21E-06 |
| 42047NEI40686 | Phenol | 6.22E-03 | 6.22E-04 | 4.05E-04 | 9.49E-04 | 1.90E-04 |
| 22117NEI46814 | Chloroform | 6.21E-03 | 0.00E+00 | 3.01E-06 | 0.00E+00 | 3.88E-06 |
| 39061NEI11610 | Methanol | 6.16E-03 | 2.50E-04 | 6.39E-05 | 6.64E-04 | 1.33E-04 |
| 55097NEIWI7500086 | Acetaldehyde | 6.10E-03 | 3.54E-05 | 5.85E-06 | 1.59E-04 | 7.96E-06 |
| 22069NEI33025 | Carbon disulfide | 6.06E-03 | 9.39E-04 | 7.51E-05 | 1.21E-02 | 2.35E-04 |
| 01053NEI18338 | Carbon disulfide | 6.04E-03 | 9.36E-04 | 7.49E-05 | 1.21E-02 | 2.34E-04 |
| 23019NEI33104 | Formaldehyde | 6.01E-03 | 3.01E-04 | 1.95E-05 | 2.76E-04 | 2.76E-05 |
| 01023NEI18334 | Xylenes (mixed) | 5.82E-03 | 2.29E-04 | 3.20E-05 | 0.00E+00 | 0.00E+00 |
| 22033NEI46817 | Carbon tetrachloride | 5.76E-03 | 3.91E-05 | 9.12E-06 | 8.42E-05 | 1.74E-05 |
| 01079NEI18357 | Chloroform | 5.74E-03 | 0.00E+00 | 2.78E-06 | 0.00E+00 | 3.59E-06 |
| 45091NEI47077 | Chlorine | 5.72E-03 | 8.01E-04 | 2.07E-04 | 4.14E-04 | 1.38E-04 |
| 23025NEI33118 | Methanol | 5.49E-03 | 2.23E-04 | 5.70E-05 | 5.92E-04 | 1.18E-04 |
| 47107NEI41565 | Methanol | 5.46E-03 | 2.22E-04 | 5.66E-05 | 5.88E-04 | 1.18E-04 |
| 41041NEI40600 | 1,2-Dimethoxyethane | 5.45E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 17021NEIIL0215971 | Methanol | 5.41E-03 | 2.19E-04 | 5.61E-05 | 5.82E-04 | 1.16E-04 |
| 26147NEI33981 | Formaldehyde | 5.37E-03 | 2.69E-04 | 1.74E-05 | 2.46E-04 | 2.46E-05 |
| 21091NEI32869A | Phenol | 5.36E-03 | 5.36E-04 | 3.49E-04 | 8.18E-04 | 1.64E-04 |
| 22073NEI6057 | Phenol | 5.33E-03 | 5.33E-04 | 3.47E-04 | 8.14E-04 | 1.63E-04 |
| 13127NEI8196 | Carbon tetrachloride | 5.32E-03 | 3.61E-05 | 8.43E-06 | 7.78E-05 | 1.61E-05 |
| 27035NEI34020 | Acetaldehyde | 5.28E-03 | 3.06E-05 | 5.06E-06 | 1.38E-04 | 6.89E-06 |
| 48361NEI12492 | Benzene | 5.23E-03 | 4.00E-05 | 2.62E-06 | 4.25E-05 | 1.42E-05 |
| 45019NEI41252 | Chloroform | 5.22E-03 | 0.00E+00 | 2.53E-06 | 0.00E+00 | 3.26E-06 |
| 22069NEI33025 | Phenol | 5.19E-03 | 5.19E-04 | 3.38E-04 | 7.93E-04 | 1.59E-04 |
| 53015NEI42338 | Benzene | 5.06E-03 | 3.87E-05 | 2.53E-06 | 4.11E-05 | 1.37E-05 |
| 39017NEI11602 | Acetaldehyde | 4.99E-03 | 2.90E-05 | 4.79E-06 | 1.30E-04 | 6.52E-06 |
| 28111NEI34066 | Chloroform | 4.95E-03 | 0.00E+00 | 2.40E-06 | 0.00E+00 | 3.10E-06 |
| 01053NEI18338 | Benzene | 4.95E-03 | 3.78E-05 | 2.47E-06 | 4.02E-05 | 1.34E-05 |
| 42013NEI7104 | Methanol | 4.94E-03 | 2.01E-04 | 5.13E-05 | 5.32E-04 | 1.06E-04 |
| 51670NEI42317 | Methylene chloride | 4.91E-03 | 9.96E-05 | 3.62E-05 | 6.87E-05 | 2.64E-05 |
| 13245NEI8122 | 1,2-Dimethoxyethane | 4.86E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 40101NEI12980 | Phenol | 4.85E-03 | 4.85E-04 | 3.16E-04 | 7.41E-04 | 1.48E-04 |
| 26041NEI33883 | Methanol | 4.85E-03 | 1.97E-04 | 5.03E-05 | 5.22E-04 | 1.04E-04 |
| 42101NEIPA1013489 | Acetaldehyde | 4.84E-03 | 2.81E-05 | 4.64E-06 | 1.26E-04 | 6.32E-06 |
| 39113NEI11645 | Chlorine | 4.83E-03 | 6.77E-04 | 1.75E-04 | 3.50E-04 | 1.17E-04 |
| 22073NEI6057 | Carbon disulfide | 4.82E-03 | 7.47E-04 | 5.97E-05 | 9.64E-03 | 1.87E-04 |
| 37087NEI40282 | Phenol | 4.78E-03 | 4.78E-04 | 3.11E-04 | 7.29E-04 | 1.46E-04 |

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|---|---|---|---|---|---|---|
| 36113NEI39968 | Chlorine | 4.76E-03 | 6.66E-04 | 1.72E-04 | 3.45E-04 | 1.15E-04 |
| 47085NEI46866 | Carbon disulfide | 4.75E-03 | 7.36E-04 | 5.89E-05 | 9.50E-03 | 1.84E-04 |
| 27145NEI12407 | Mercury (elemental) | 4.72E-03 | 0.00E+00 | 1.66E-06 | 0.00E+00 | 1.42E-06 |
| 12123NEI47091 | Carbon tetrachloride | 4.71E-03 | 3.19E-05 | 7.45E-06 | 6.88E-05 | 1.42E-05 |
| 45091NEI47077 | Benzene | 4.65E-03 | 3.55E-05 | 2.32E-06 | 3.78E-05 | 1.26E-05 |
| 22033NEI46817 | Methylene chloride | 4.64E-03 | 9.42E-05 | 3.42E-05 | 6.50E-05 | 2.50E-05 |
| 22049NEI33023 | Chloroform | 4.63E-03 | 0.00E+00 | 2.24E-06 | 0.00E+00 | 2.90E-06 |
| 23025NEIME0250002 | Toluene | 4.60E-03 | 2.27E-04 | 3.78E-05 | 8.96E-04 | 1.55E-04 |
| 13099NEI26491 | Phenol | 4.56E-03 | 4.56E-04 | 2.97E-04 | 6.97E-04 | 1.39E-04 |
| 05029NEI46852 | Formaldehyde | 4.55E-03 | 2.27E-04 | 1.47E-05 | 2.08E-04 | 2.08E-05 |
| 55079NEIWI0793640 | Acetaldehyde | 4.53E-03 | 2.63E-05 | 4.34E-06 | 1.18E-04 | 5.91E-06 |
| 53015NEI42338 | Methylene chloride | 4.51E-03 | 9.16E-05 | 3.33E-05 | 6.32E-05 | 2.43E-05 |
| 01091NEI45474 | Phenol | 4.44E-03 | 4.44E-04 | 2.89E-04 | 6.77E-04 | 1.35E-04 |
| 05003NEI54342 | Carbon tetrachloride | 4.43E-03 | 3.00E-05 | 7.01E-06 | 6.47E-05 | 1.34E-05 |
| 13245NEI8122 | Chloroform | 4.41E-03 | 0.00E+00 | 2.13E-06 | 0.00E+00 | 2.75E-06 |
| 16069NEI26581 | Phenol | 4.30E-03 | 4.30E-04 | 2.81E-04 | 6.57E-04 | 1.31E-04 |
| 23019NEI33104 | Arsenic compounds | 4.24E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12123NEI47091 | Benzene | 4.24E-03 | 3.24E-05 | 2.12E-06 | 3.44E-05 | 1.15E-05 |
| 42131NEI40738 | Methanol | 4.23E-03 | 1.71E-04 | 4.38E-05 | 4.55E-04 | 9.10E-05 |
| 27035NEI34020 | Formaldehyde | 4.22E-03 | 2.11E-04 | 1.37E-05 | 1.93E-04 | 1.93E-05 |
| 23017NEI6273 | Styrene | 4.19E-03 | 1.04E-03 | 1.60E-04 | 4.19E-04 | 8.00E-05 |
| 01001NEI8560 | Chloroform | 4.05E-03 | 0.00E+00 | 1.96E-06 | 0.00E+00 | 2.53E-06 |
| 13103NEI8178 | Carbon disulfide | 4.04E-03 | 6.27E-04 | 5.01E-05 | 8.09E-03 | 1.57E-04 |
| 22033NEI46817 | Carbon disulfide | 4.03E-03 | 6.24E-04 | 4.99E-05 | 8.05E-03 | 1.56E-04 |
| 37083NEI47104 | Toluene | 4.02E-03 | 1.98E-04 | 3.31E-05 | 7.83E-04 | 1.35E-04 |
| 13245NEI8122 | Methanol | 4.01E-03 | 1.63E-04 | 4.16E-05 | 4.32E-04 | 8.64E-05 |
| 40101NEI12980 | Methanol | 3.99E-03 | 1.62E-04 | 4.14E-05 | 4.29E-04 | 8.59E-05 |
| 01113NEI46931 | Styrene | 3.94E-03 | 9.74E-04 | 1.51E-04 | 3.94E-04 | 7.53E-05 |
| 55073NEI42690 | Formaldehyde | 3.90E-03 | 1.95E-04 | 1.26E-05 | 1.79E-04 | 1.79E-05 |
| 13175NEIGAT$3911 | Formaldehyde | 3.90E-03 | 1.95E-04 | 1.26E-05 | 1.79E-04 | 1.79E-05 |
| 48361NEI12492 | Chloroform | 3.89E-03 | 0.00E+00 | 1.88E-06 | 0.00E+00 | 2.43E-06 |
| 13127NEI8196 | Chlorine | 3.87E-03 | 5.42E-04 | 1.40E-04 | 2.80E-04 | 9.34E-05 |
| 54057NEI706 | Phenol | 3.84E-03 | 3.84E-04 | 2.50E-04 | 5.87E-04 | 1.17E-04 |
| 16069NEI26581 | Carbon disulfide | 3.82E-03 | 5.92E-04 | 4.73E-05 | 7.63E-03 | 1.48E-04 |
| 36031NEI35908 | Chlorine | 3.80E-03 | 5.32E-04 | 1.37E-04 | 2.75E-04 | 9.16E-05 |
| 45043NEI41314 | Carbon tetrachloride | 3.76E-03 | 2.55E-05 | 5.95E-06 | 5.49E-05 | 1.13E-05 |
| 13021NEI26471 | Phenol | 3.67E-03 | 3.67E-04 | 2.39E-04 | 5.61E-04 | 1.12E-04 |
| 05069NEI18657 | Benzene | 3.65E-03 | 2.79E-05 | 1.83E-06 | 2.97E-05 | 9.89E-06 |
| 12123NEI47091 | Carbon disulfide | 3.63E-03 | 5.63E-04 | 4.50E-05 | 7.26E-03 | 1.41E-04 |
| 53009NEI42329 | Methanol | 3.63E-03 | 1.47E-04 | 3.76E-05 | 3.90E-04 | 7.81E-05 |
| 53009NEI42329 | 1,2-Dimethoxyethane | 3.56E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55079NEIWI0793640 | Chloroform | 3.53E-03 | 0.00E+00 | 1.71E-06 | 0.00E+00 | 2.21E-06 |
| 55141NEI42961 | Acetaldehyde | 3.53E-03 | 2.05E-05 | 3.39E-06 | 9.23E-05 | 4.61E-06 |
| 28043NEI11108 | Formaldehyde | 3.52E-03 | 1.76E-04 | 1.14E-05 | 1.61E-04 | 1.61E-05 |
| 51019NEI42211 | Benzene | 3.47E-03 | 2.65E-05 | 1.74E-06 | 2.82E-05 | 9.40E-06 |
| 21091NEI32869A | Hydrochloric acid | 3.41E-03 | 2.66E-03 | 2.17E-04 | 1.59E-03 | 2.39E-04 |
| 47163NEI41599 | Chlorine | 3.41E-03 | 4.78E-04 | 1.24E-04 | 2.47E-04 | 8.24E-05 |
| 36045NEI36019 | Methanol | 3.39E-03 | 1.38E-04 | 3.52E-05 | 3.66E-04 | 7.31E-05 |
| 28111NEI34066 | Hydrochloric acid | 3.38E-03 | 2.63E-03 | 2.15E-04 | 1.58E-03 | 2.37E-04 |
| 13115NEI26495 | Carbon tetrachloride | 3.37E-03 | 2.29E-05 | 5.33E-06 | 4.92E-05 | 1.02E-05 |
| 22117NEI46814 | Carbon disulfide | 3.36E-03 | 5.21E-04 | 4.17E-05 | 6.73E-03 | 1.30E-04 |
| 26003NEI33866 | Acetaldehyde | 3.35E-03 | 1.94E-05 | 3.21E-06 | 8.75E-05 | 4.38E-06 |
| 01071NEI18347 | 1,2-Dimethoxyethane | 3.33E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 40089NEI11251 | Chloroform | 3.33E-03 | 0.00E+00 | 1.61E-06 | 0.00E+00 | 2.08E-06 |
| 21007NEI11338 | Carbon disulfide | 3.28E-03 | 5.08E-04 | 4.07E-05 | 6.56E-03 | 1.27E-04 |

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| 13305NEI26526 | Phenol | 3.27E-03 | 3.27E-04 | 2.13E-04 | 5.00E-04 | 9.99E-05 |
| 23007NEI6261 | Arsenic compounds | 3.25E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23025NEI33118 | Carbon disulfide | 3.24E-03 | 5.02E-04 | 4.02E-05 | 6.48E-03 | 1.26E-04 |
| 53053NEI13363 | Carbon disulfide | 3.20E-03 | 4.96E-04 | 3.97E-05 | 6.41E-03 | 1.24E-04 |
| 13127NEI8196 | Benzene | 3.20E-03 | 2.45E-05 | 1.60E-06 | 2.60E-05 | 8.66E-06 |
| 12031NEI26304 | Chloroform | 3.19E-03 | 0.00E+00 | 1.54E-06 | 0.00E+00 | 1.99E-06 |
| 05081NEI18660 | Hydrochloric acid | 3.15E-03 | 2.45E-03 | 2.01E-04 | 1.47E-03 | 2.21E-04 |
| 45091NEI47077 | Carbon disulfide | 3.15E-03 | 4.88E-04 | 3.90E-05 | 6.30E-03 | 1.22E-04 |
| 26101NEI33945 | Phenol | 3.14E-03 | 3.14E-04 | 2.05E-04 | 4.79E-04 | 9.59E-05 |
| 23019NEI33104 | Acetaldehyde | 3.13E-03 | 1.82E-05 | 3.01E-06 | 8.18E-05 | 4.09E-06 |
| 51580NEI759 | Carbon disulfide | 3.06E-03 | 4.74E-04 | 3.79E-05 | 6.11E-03 | 1.18E-04 |
| 42013NEI7104 | Carbon tetrachloride | 3.05E-03 | 2.07E-05 | 4.83E-06 | 4.45E-05 | 9.19E-06 |
| 13127NEI8196 | Phenol | 3.04E-03 | 3.04E-04 | 1.98E-04 | 4.65E-04 | 9.29E-05 |
| 42133NEI7181 | Hydrochloric acid | 3.02E-03 | 2.35E-03 | 1.92E-04 | 1.41E-03 | 2.12E-04 |
| 27137NEIMN14904 | Formaldehyde | 3.01E-03 | 1.51E-04 | 9.75E-06 | 1.38E-04 | 1.38E-05 |
| 37047NEI40247 | Chlorine | 2.99E-03 | 4.19E-04 | 1.08E-04 | 2.17E-04 | 7.23E-05 |
| 51670NEI42317 | Chloroform | 2.98E-03 | 0.00E+00 | 1.44E-06 | 0.00E+00 | 1.86E-06 |
| 47085NEI46866 | Chloroform | 2.98E-03 | 0.00E+00 | 1.44E-06 | 0.00E+00 | 1.86E-06 |
| 23025NEIME0250002 | Methylene chloride | 2.97E-03 | 6.02E-05 | 2.19E-05 | 4.15E-05 | 1.60E-05 |
| 51670NEI42317 | Phenol | 2.96E-03 | 2.96E-04 | 1.93E-04 | 4.51E-04 | 9.02E-05 |
| 13051NEI26476 | Phenol | 2.96E-03 | 2.96E-04 | 1.93E-04 | 4.51E-04 | 9.02E-05 |
| 23017NEI6273 | Carbon tetrachloride | 2.93E-03 | 1.99E-05 | 4.64E-06 | 4.28E-05 | 8.84E-06 |
| 22033NEI46817 | Hydrochloric acid | 2.93E-03 | 2.28E-03 | 1.86E-04 | 1.37E-03 | 2.05E-04 |
| 37117NEI9201 | Chloroform | 2.89E-03 | 0.00E+00 | 1.40E-06 | 0.00E+00 | 1.81E-06 |
| 42133NEI7181 | Phenol | 2.87E-03 | 2.87E-04 | 1.87E-04 | 4.38E-04 | 8.76E-05 |
| 21007NEI11338 | Hydrochloric acid | 2.85E-03 | 2.22E-03 | 1.81E-04 | 1.33E-03 | 2.00E-04 |
| 55139NEIWI4710355 | Acetaldehyde | 2.81E-03 | 1.63E-05 | 2.69E-06 | 7.33E-05 | 3.67E-06 |
| 12089NEI8261 | Carbon disulfide | 2.80E-03 | 4.33E-04 | 3.47E-05 | 5.59E-03 | 1.08E-04 |
| 55141NEI42695 | Phenol | 2.79E-03 | 2.79E-04 | 1.82E-04 | 4.26E-04 | 8.52E-05 |
| 55141NEI42963 | Acetaldehyde | 2.79E-03 | 1.62E-05 | 2.68E-06 | 7.28E-05 | 3.64E-06 |
| 26003NEI33866 | Formaldehyde | 2.78E-03 | 1.39E-04 | 9.00E-06 | 1.27E-04 | 1.27E-05 |
| 13245NEI26514 | Chloroform | 2.69E-03 | 0.00E+00 | 1.30E-06 | 0.00E+00 | 1.68E-06 |
| 13103NEI8178 | Phenol | 2.68E-03 | 2.68E-04 | 1.75E-04 | 4.09E-04 | 8.18E-05 |
| 54057NEI706 | Chloroform | 2.66E-03 | 0.00E+00 | 1.29E-06 | 0.00E+00 | 1.66E-06 |
| 26109NEI33950 | Acetaldehyde | 2.61E-03 | 1.52E-05 | 2.51E-06 | 6.83E-05 | 3.41E-06 |
| 41043NEI13340 | Tetrachloroethene | 2.59E-03 | 2.16E-04 | 3.24E-05 | 7.62E-05 | 3.70E-05 |
| 42131NEI40738 | Formaldehyde | 2.54E-03 | 1.27E-04 | 8.22E-06 | 1.16E-04 | 1.16E-05 |
| 24001NEI33135 | Hydrochloric acid | 2.51E-03 | 1.95E-03 | 1.60E-04 | 1.17E-03 | 1.76E-04 |
| 51101NEI42254 | Carbon tetrachloride | 2.48E-03 | 1.68E-05 | 3.93E-06 | 3.63E-05 | 7.49E-06 |
| 48361NEI12492 | Carbon disulfide | 2.48E-03 | 3.84E-04 | 3.07E-05 | 4.95E-03 | 9.59E-05 |
| 13099NEI26491 | Chloroform | 2.45E-03 | 0.00E+00 | 1.19E-06 | 0.00E+00 | 1.53E-06 |
| 54037NEI23 | Methanol | 2.45E-03 | 9.93E-05 | 2.54E-05 | 2.64E-04 | 5.27E-05 |
| 55141NEI42695 | Carbon tetrachloride | 2.43E-03 | 1.65E-05 | 3.85E-06 | 3.56E-05 | 7.34E-06 |
| 05003NEI54342 | Methylene chloride | 2.43E-03 | 4.93E-05 | 1.79E-05 | 3.40E-05 | 1.31E-05 |
| 48067NEI41628 | Xylenes (mixed) | 2.41E-03 | 9.48E-05 | 1.33E-05 | 0.00E+00 | 0.00E+00 |
| 12123NEI47091 | Hydrochloric acid | 2.40E-03 | 1.87E-03 | 1.53E-04 | 1.12E-03 | 1.68E-04 |
| 47107NEI41565 | Chlorine | 2.38E-03 | 3.33E-04 | 8.60E-05 | 1.72E-04 | 5.73E-05 |
| 01131NEI8619 | Chloroform | 2.37E-03 | 0.00E+00 | 1.15E-06 | 0.00E+00 | 1.48E-06 |
| 45041NEI7933 | Phenol | 2.36E-03 | 2.36E-04 | 1.54E-04 | 3.61E-04 | 7.21E-05 |
| 40089NEI11251 | Carbon disulfide | 2.36E-03 | 3.66E-04 | 2.93E-05 | 4.72E-03 | 9.15E-05 |
| 42013NEI7104 | Benzene | 2.30E-03 | 1.76E-05 | 1.15E-06 | 1.87E-05 | 6.23E-06 |
| 16069NEI26581 | Hydrochloric acid | 2.29E-03 | 1.78E-03 | 1.46E-04 | 1.07E-03 | 1.60E-04 |
| 01047NEI18335 | Chlorine | 2.28E-03 | 3.19E-04 | 8.25E-05 | 1.65E-04 | 5.50E-05 |
| 53015NEI42338 | Tetrachloroethene | 2.24E-03 | 1.87E-04 | 2.81E-05 | 6.60E-05 | 3.21E-05 |
| 13305NEI26526 | Hydrochloric acid | 2.24E-03 | 1.74E-03 | 1.43E-04 | 1.05E-03 | 1.57E-04 |

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| 48067NEI41628 | Phenol | 2.24E-03 | 2.24E-04 | 1.46E-04 | 3.42E-04 | 6.85E-05 |
| 13115NEI26495 | 1,2-Dimethoxyethane | 2.22E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 21091NEI32869A | Xylenes (mixed) | 2.22E-03 | 8.72E-05 | 1.22E-05 | 0.00E+00 | 0.00E+00 |
| 36031NEI35908 | Hydrochloric acid | 2.22E-03 | 1.73E-03 | 1.41E-04 | 1.04E-03 | 1.55E-04 |
| 26041NEI33883 | Chlorine | 2.21E-03 | 3.10E-04 | 8.02E-05 | 1.60E-04 | 5.35E-05 |
| 09011NEICT3102 | Methanol | 2.19E-03 | 8.87E-05 | 2.27E-05 | 2.35E-04 | 4.71E-05 |
| 13127NEI8196 | Carbon disulfide | 2.19E-03 | 3.39E-04 | 2.71E-05 | 4.37E-03 | 8.47E-05 |
| 28043NEI11108 | Methanol | 2.17E-03 | 8.79E-05 | 2.25E-05 | 2.33E-04 | 4.67E-05 |
| 55139NEIWI4710355 | Methanol | 2.12E-03 | 8.59E-05 | 2.20E-05 | 2.28E-04 | 4.56E-05 |
| 13235NEIGAT$3909 | Phenol | 2.11E-03 | 2.11E-04 | 1.37E-04 | 3.21E-04 | 6.43E-05 |
| 41007NEI40554 | Hydrochloric acid | 2.10E-03 | 1.64E-03 | 1.34E-04 | 9.82E-04 | 1.47E-04 |
| 45069NEI47074 | Methylene chloride | 2.10E-03 | 4.27E-05 | 1.55E-05 | 2.94E-05 | 1.13E-05 |
| 41043NEI13340 | Styrene | 2.10E-03 | 5.18E-04 | 8.01E-05 | 2.10E-04 | 4.01E-05 |
| 37047NEI40247 | Hydrochloric acid | 2.09E-03 | 1.63E-03 | 1.33E-04 | 9.76E-04 | 1.46E-04 |
| 13051NEI8186 | Chloroform | 2.08E-03 | 0.00E+00 | 1.00E-06 | 0.00E+00 | 1.30E-06 |
| 01099NEI18373 | Phenol | 2.08E-03 | 2.08E-04 | 1.35E-04 | 3.17E-04 | 6.33E-05 |
| 37087NEI40282 | Chlorine | 2.05E-03 | 2.87E-04 | 7.42E-05 | 1.48E-04 | 4.94E-05 |
| 12123NEI47091 | Chlorine | 2.04E-03 | 2.86E-04 | 7.40E-05 | 1.48E-04 | 4.93E-05 |
| 23007NEI6261 | Hydrochloric acid | 2.04E-03 | 1.58E-03 | 1.30E-04 | 9.50E-04 | 1.43E-04 |
| 41007NEI40554 | Phenol | 2.03E-03 | 2.03E-04 | 1.32E-04 | 3.10E-04 | 6.21E-05 |
| 13021NEI26471 | Carbon tetrachloride | 2.03E-03 | 1.38E-05 | 3.21E-06 | 2.96E-05 | 6.12E-06 |
| 48067NEI41628 | Carbon disulfide | 2.02E-03 | 3.14E-04 | 2.51E-05 | 4.05E-03 | 7.84E-05 |
| 01023NEI18334 | 1,1,1-Trichloroethane | 1.98E-03 | 1.04E-04 | 4.08E-05 | 7.08E-05 | 3.54E-05 |
| 55141NEI42695 | Carbon disulfide | 1.98E-03 | 3.06E-04 | 2.45E-05 | 3.95E-03 | 7.65E-05 |
| 22033NEI46817 | Benzene | 1.96E-03 | 1.50E-05 | 9.81E-07 | 1.59E-05 | 5.32E-06 |
| 01053NEI18338 | Phenol | 1.96E-03 | 1.96E-04 | 1.28E-04 | 2.99E-04 | 5.99E-05 |
| 39031NEI11461 | Formaldehyde | 1.95E-03 | 9.75E-05 | 6.31E-06 | 8.94E-05 | 8.94E-06 |
| 13051NEI26476 | Chlorine | 1.95E-03 | 2.73E-04 | 7.06E-05 | 1.41E-04 | 4.70E-05 |
| 23007NEI6261 | Phenol | 1.94E-03 | 1.94E-04 | 1.26E-04 | 2.96E-04 | 5.92E-05 |
| 22069NEI33025 | Xylenes (mixed) | 1.94E-03 | 7.62E-05 | 1.07E-05 | 0.00E+00 | 0.00E+00 |
| 55141NEI42963 | Methanol | 1.94E-03 | 7.86E-05 | 2.01E-05 | 2.09E-04 | 4.17E-05 |
| 13245NEI26514 | Tetrachloroethene | 1.93E-03 | 1.61E-04 | 2.42E-05 | 5.68E-05 | 2.76E-05 |
| 13245NEI26514 | Hydrochloric acid | 1.91E-03 | 1.49E-03 | 1.22E-04 | 8.92E-04 | 1.34E-04 |
| 45043NEI41314 | Phenol | 1.87E-03 | 1.87E-04 | 1.22E-04 | 2.86E-04 | 5.72E-05 |
| 53015NEI42338 | Toluene | 1.87E-03 | 9.21E-05 | 1.53E-05 | 3.63E-04 | 6.28E-05 |
| 48067NEI41628 | Benzene | 1.84E-03 | 1.41E-05 | 9.20E-07 | 1.50E-05 | 4.99E-06 |
| 40101NEI12980 | 1,2-Dimethoxyethane | 1.83E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13305NEI26526 | Carbon tetrachloride | 1.82E-03 | 1.24E-05 | 2.88E-06 | 2.66E-05 | 5.49E-06 |
| 27145NEI12407 | Phenol | 1.81E-03 | 1.81E-04 | 1.18E-04 | 2.77E-04 | 5.53E-05 |
| 28043NEI11108 | 1,2-Dimethoxyethane | 1.81E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 25017NEI6175 | Methanol | 1.79E-03 | 7.27E-05 | 1.86E-05 | 1.93E-04 | 3.86E-05 |
| 12033NEI26309 | Carbon disulfide | 1.79E-03 | 2.77E-04 | 2.22E-05 | 3.58E-03 | 6.94E-05 |
| 42013NEI7106 | Acetaldehyde | 1.78E-03 | 1.03E-05 | 1.71E-06 | 4.66E-05 | 2.33E-06 |
| 45069NEI47074 | Chlorine | 1.78E-03 | 2.49E-04 | 6.44E-05 | 1.29E-04 | 4.29E-05 |
| 23007NEI6261 | Carbon disulfide | 1.75E-03 | 2.72E-04 | 2.17E-05 | 3.50E-03 | 6.79E-05 |
| 37047NEI40247 | Phenol | 1.74E-03 | 1.74E-04 | 1.14E-04 | 2.66E-04 | 5.32E-05 |
| 53031NEI42357 | Phenol | 1.73E-03 | 1.73E-04 | 1.13E-04 | 2.64E-04 | 5.27E-05 |
| 24001NEI33135 | Tetrachloroethene | 1.71E-03 | 1.43E-04 | 2.14E-05 | 5.04E-05 | 2.45E-05 |
| 45069NEI47074 | Benzene | 1.71E-03 | 1.30E-05 | 8.53E-07 | 1.39E-05 | 4.62E-06 |
| 47071NEI41552 | Benzene | 1.70E-03 | 1.30E-05 | 8.49E-07 | 1.38E-05 | 4.60E-06 |
| 47105NEITN1050093 | Formaldehyde | 1.68E-03 | 8.41E-05 | 5.44E-06 | 7.71E-05 | 7.71E-06 |
| 48067NEI41628 | Chlorine | 1.68E-03 | 2.35E-04 | 6.09E-05 | 1.22E-04 | 4.06E-05 |
| 12005NEI8278 | Hydrochloric acid | 1.67E-03 | 1.30E-03 | 1.06E-04 | 7.80E-04 | 1.17E-04 |
| 47163NEI41599 | Phenol | 1.66E-03 | 1.66E-04 | 1.08E-04 | 2.53E-04 | 5.07E-05 |
| 45019NEI41252 | Phenol | 1.65E-03 | 1.65E-04 | 1.08E-04 | 2.52E-04 | 5.04E-05 |

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| 45031NEI43472 | Benzene | 1.65E-03 | 1.26E-05 | 8.25E-07 | 1.34E-05 | 4.47E-06 |
| 23017NEI6273 | Phenol | 1.64E-03 | 1.64E-04 | 1.07E-04 | 2.51E-04 | 5.02E-05 |
| 01079NEI18357 | Hydrochloric acid | 1.64E-03 | 1.28E-03 | 1.04E-04 | 7.65E-04 | 1.15E-04 |
| 39017NEI11600 | Methanol | 1.63E-03 | 6.63E-05 | 1.69E-05 | 1.76E-04 | 3.52E-05 |
| 21091NEI32869A | Benzene | 1.61E-03 | 1.23E-05 | 8.06E-07 | 1.31E-05 | 4.37E-06 |
| 48067NEI41628 | Hydrochloric acid | 1.61E-03 | 1.25E-03 | 1.02E-04 | 7.50E-04 | 1.13E-04 |
| 53071NEI42410 | Phenol | 1.60E-03 | 1.60E-04 | 1.04E-04 | 2.44E-04 | 4.89E-05 |
| 22073NEI6057 | Carbon tetrachloride | 1.60E-03 | 1.08E-05 | 2.53E-06 | 2.33E-05 | 4.81E-06 |
| 23017NEI6273 | Chlorine | 1.59E-03 | 2.23E-04 | 5.77E-05 | 1.15E-04 | 3.84E-05 |
| 28043NEI11108 | Chloroform | 1.59E-03 | 0.00E+00 | 7.69E-07 | 0.00E+00 | 9.94E-07 |
| 51085NEI208 | Formaldehyde | 1.58E-03 | 7.91E-05 | 5.12E-06 | 7.25E-05 | 7.25E-06 |
| 26041NEI33883 | Carbon disulfide | 1.58E-03 | 2.44E-04 | 1.95E-05 | 3.15E-03 | 6.11E-05 |
| 01023NEI18334 | Tetrachloroethene | 1.57E-03 | 1.31E-04 | 1.97E-05 | 4.63E-05 | 2.25E-05 |
| 41043NEI13340 | Xylenes (mixed) | 1.57E-03 | 6.17E-05 | 8.63E-06 | 0.00E+00 | 0.00E+00 |
| 45043NEI41314 | Hydrochloric acid | 1.56E-03 | 1.21E-03 | 9.94E-05 | 7.29E-04 | 1.09E-04 |
| 53011NEI46599 | Phenol | 1.56E-03 | 1.56E-04 | 1.02E-04 | 2.38E-04 | 4.76E-05 |
| 45043NEI41314 | Carbon disulfide | 1.55E-03 | 2.40E-04 | 1.92E-05 | 3.10E-03 | 6.01E-05 |
| 01025NEI8601 | Phenol | 1.53E-03 | 1.53E-04 | 9.95E-05 | 2.33E-04 | 4.66E-05 |
| 24001NEI33135 | Benzene | 1.53E-03 | 1.17E-05 | 7.63E-07 | 1.24E-05 | 4.13E-06 |
| 27137NEIMN14904 | Methanol | 1.52E-03 | 6.17E-05 | 1.58E-05 | 1.64E-04 | 3.27E-05 |
| 39141NEI40488 | Chloroform | 1.50E-03 | 0.00E+00 | 7.26E-07 | 0.00E+00 | 9.38E-07 |
| 42013NEI7104 | Phenol | 1.49E-03 | 1.49E-04 | 9.70E-05 | 2.27E-04 | 4.54E-05 |
| 37087NEI40282 | o-Xylene | 1.49E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 24001NEI33135 | Methylene chloride | 1.49E-03 | 3.01E-05 | 1.09E-05 | 2.08E-05 | 8.00E-06 |
| 47105NEITN1050093 | Arsenic compounds | 1.48E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 26043NEI33887 | Hydrochloric acid | 1.48E-03 | 1.15E-03 | 9.40E-05 | 6.89E-04 | 1.03E-04 |
| 27061NEI34030 | Phenol | 1.48E-03 | 1.48E-04 | 9.61E-05 | 2.25E-04 | 4.50E-05 |
| 36045NEI36019 | Acetaldehyde | 1.47E-03 | 8.55E-06 | 1.41E-06 | 3.85E-05 | 1.92E-06 |
| 37087NEI40282 | Xylenes (mixed) | 1.47E-03 | 5.77E-05 | 8.08E-06 | 0.00E+00 | 0.00E+00 |
| 53015NEI42338 | Xylenes (mixed) | 1.46E-03 | 5.72E-05 | 8.01E-06 | 0.00E+00 | 0.00E+00 |
| 45079NEI46760 | Hydrochloric acid | 1.45E-03 | 1.13E-03 | 9.21E-05 | 6.76E-04 | 1.01E-04 |
| 01047NEI18335 | Phenol | 1.43E-03 | 1.43E-04 | 9.34E-05 | 2.19E-04 | 4.37E-05 |
| 53011NEI46599 | Benzene | 1.43E-03 | 1.09E-05 | 7.13E-07 | 1.16E-05 | 3.86E-06 |
| 01047NEI18335 | Mercury (elemental) | 1.42E-03 | 0.00E+00 | 5.02E-07 | 0.00E+00 | 4.27E-07 |
| 13185NEI26504 | Carbon disulfide | 1.40E-03 | 2.17E-04 | 1.74E-05 | 2.80E-03 | 5.43E-05 |
| 22031NEI33013 | 1,2-Dimethoxyethane | 1.40E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27145NEI12407 | Methanol | 1.39E-03 | 5.63E-05 | 1.44E-05 | 1.49E-04 | 2.99E-05 |
| 22069NEI33025 | Benzene | 1.39E-03 | 1.06E-05 | 6.94E-07 | 1.13E-05 | 3.76E-06 |
| 01023NEI18334 | Toluene | 1.39E-03 | 6.84E-05 | 1.14E-05 | 2.70E-04 | 4.66E-05 |
| 12033NEI26309 | Chloroform | 1.37E-03 | 0.00E+00 | 6.65E-07 | 0.00E+00 | 8.59E-07 |
| 45043NEI41314 | Xylenes (mixed) | 1.36E-03 | 5.34E-05 | 7.48E-06 | 0.00E+00 | 0.00E+00 |
| 13245NEI26514 | Chlorine | 1.36E-03 | 1.90E-04 | 4.91E-05 | 9.82E-05 | 3.27E-05 |
| 28087NEI34064 | Carbon disulfide | 1.35E-03 | 2.09E-04 | 1.67E-05 | 2.69E-03 | 5.21E-05 |
| 13051NEI26476 | Hydrochloric acid | 1.33E-03 | 1.04E-03 | 8.49E-05 | 6.23E-04 | 9.34E-05 |
| 23029NEI46835 | Methylene chloride | 1.33E-03 | 2.71E-05 | 9.83E-06 | 1.87E-05 | 7.18E-06 |
| 23009NEI6284 | Phenol | 1.32E-03 | 1.32E-04 | 8.60E-05 | 2.01E-04 | 4.03E-05 |
| 21091NEI32869A | Carbon tetrachloride | 1.31E-03 | 8.91E-06 | 2.08E-06 | 1.92E-05 | 3.96E-06 |
| 01131NEI8619 | Carbon disulfide | 1.29E-03 | 2.00E-04 | 1.60E-05 | 2.58E-03 | 5.01E-05 |
| 28087NEI34064 | Benzene | 1.28E-03 | 9.81E-06 | 6.41E-07 | 1.04E-05 | 3.47E-06 |
| 04017NEI13216 | Phenol | 1.28E-03 | 1.28E-04 | 8.33E-05 | 1.95E-04 | 3.90E-05 |
| 45091NEI47077 | Hydrochloric acid | 1.27E-03 | 9.90E-04 | 8.10E-05 | 5.94E-04 | 8.91E-05 |
| 22073NEI6057 | Toluene | 1.27E-03 | 6.28E-05 | 1.05E-05 | 2.48E-04 | 4.28E-05 |
| 28111NEI34066 | Phenol | 1.26E-03 | 1.26E-04 | 8.20E-05 | 1.92E-04 | 3.84E-05 |
| 55141NEI46739 | Carbon tetrachloride | 1.24E-03 | 8.42E-06 | 1.96E-06 | 1.81E-05 | 3.74E-06 |
| 01091NEI45474 | Hydrochloric acid | 1.22E-03 | 9.50E-04 | 7.77E-05 | 5.70E-04 | 8.55E-05 |

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| 23019NEI33104 | Hydrochloric acid | 1.22E-03 | 9.46E-04 | 7.74E-05 | 5.67E-04 | 8.51E-05 |
| 27145NEI12407 | Benzene | 1.21E-03 | 9.24E-06 | 6.04E-07 | 9.82E-06 | 3.27E-06 |
| 55141NEI42695 | Hydrochloric acid | 1.21E-03 | 9.40E-04 | 7.69E-05 | 5.64E-04 | 8.46E-05 |
| 53071NEI42410 | Carbon tetrachloride | 1.20E-03 | 8.18E-06 | 1.91E-06 | 1.76E-05 | 3.63E-06 |
| 53053NEI13363 | Hydrochloric acid | 1.20E-03 | 9.33E-04 | 7.64E-05 | 5.60E-04 | 8.40E-05 |
| 13103NEI8178 | Methanol | 1.20E-03 | 4.87E-05 | 1.24E-05 | 1.29E-04 | 2.58E-05 |
| 48361NEI12492 | 1,2-Dimethoxyethane | 1.20E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12107NEI8265 | Carbon disulfide | 1.19E-03 | 1.84E-04 | 1.47E-05 | 2.38E-03 | 4.60E-05 |
| 36045NEI36019 | Formaldehyde | 1.18E-03 | 5.92E-05 | 3.83E-06 | 5.43E-05 | 5.43E-06 |
| 22049NEI33023 | Phenol | 1.18E-03 | 1.18E-04 | 7.69E-05 | 1.80E-04 | 3.60E-05 |
| 45043NEI41314 | Benzene | 1.17E-03 | 8.98E-06 | 5.87E-07 | 9.54E-06 | 3.18E-06 |
| 05081NEI18660 | Phenol | 1.16E-03 | 1.16E-04 | 7.54E-05 | 1.77E-04 | 3.53E-05 |
| 37049NEI45206 | Hydrochloric acid | 1.15E-03 | 8.93E-04 | 7.31E-05 | 5.36E-04 | 8.04E-05 |
| 05069NEI18658 | Benzene | 1.15E-03 | 8.76E-06 | 5.73E-07 | 9.30E-06 | 3.10E-06 |
| 21007NEI11338 | Phenol | 1.14E-03 | 1.14E-04 | 7.40E-05 | 1.73E-04 | 3.47E-05 |
| 53053NEI13363 | Phenol | 1.13E-03 | 1.13E-04 | 7.39E-05 | 1.73E-04 | 3.46E-05 |
| 13175NEIGAT$3911 | Toluene | 1.12E-03 | 5.51E-05 | 9.18E-06 | 2.17E-04 | 3.75E-05 |
| 51580NEI759 | Phenol | 1.12E-03 | 1.12E-04 | 7.27E-05 | 1.70E-04 | 3.40E-05 |
| 53015NEI42341A | Styrene | 1.10E-03 | 2.72E-04 | 4.21E-05 | 1.10E-04 | 2.10E-05 |
| 41041NEI40600 | Phenol | 1.10E-03 | 1.10E-04 | 7.17E-05 | 1.68E-04 | 3.36E-05 |
| 47107NEI41565 | Hydrochloric acid | 1.09E-03 | 8.49E-04 | 6.95E-05 | 5.09E-04 | 7.64E-05 |
| 01079NEI18357 | Benzene | 1.09E-03 | 8.31E-06 | 5.44E-07 | 8.83E-06 | 2.94E-06 |
| 01047NEI18335 | Hydrochloric acid | 1.09E-03 | 8.45E-04 | 6.92E-05 | 5.07E-04 | 7.61E-05 |
| 42133NEI7181 | Chlorine | 1.08E-03 | 1.51E-04 | 3.91E-05 | 7.82E-05 | 2.61E-05 |
| 12031NEI26304 | Formaldehyde | 1.07E-03 | 5.35E-05 | 3.46E-06 | 4.91E-05 | 4.91E-06 |
| 28077NEI11172 | Phenol | 1.06E-03 | 1.06E-04 | 6.93E-05 | 1.62E-04 | 3.25E-05 |
| 40089NEI11251 | Carbon tetrachloride | 1.06E-03 | 7.22E-06 | 1.68E-06 | 1.55E-05 | 3.21E-06 |
| 12031NEI26304 | Acetaldehyde | 1.05E-03 | 6.12E-06 | 1.01E-06 | 2.75E-05 | 1.38E-06 |
| 24001NEI33135 | Xylenes (mixed) | 1.05E-03 | 4.14E-05 | 5.80E-06 | 0.00E+00 | 0.00E+00 |
| 13095NEI26487 | Methanol | 1.04E-03 | 4.21E-05 | 1.08E-05 | 1.12E-04 | 2.23E-05 |
| 13245NEI26514 | Styrene | 1.04E-03 | 2.56E-04 | 3.96E-05 | 1.04E-04 | 1.98E-05 |
| 22031NEI33013 | Carbon disulfide | 1.03E-03 | 1.59E-04 | 1.27E-05 | 2.06E-03 | 3.98E-05 |
| 27017NEI12368 | Methanol | 1.03E-03 | 4.17E-05 | 1.06E-05 | 1.11E-04 | 2.21E-05 |
| 37087NEI40282 | Styrene | 1.01E-03 | 2.51E-04 | 3.87E-05 | 1.01E-04 | 1.94E-05 |
| 01121NEI18390 | Hydrochloric acid | 1.01E-03 | 7.88E-04 | 6.45E-05 | 4.73E-04 | 7.10E-05 |
| 01099NEI18373 | Hydrochloric acid | 9.97E-04 | 7.76E-04 | 6.35E-05 | 4.65E-04 | 6.98E-05 |
| 01053NEI18338 | Methyl Cellosolve Acrylate | 9.79E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01047NEI18335 | Benzene | 9.75E-04 | 7.45E-06 | 4.87E-07 | 7.92E-06 | 2.64E-06 |
| 47085NEI46866 | Phenol | 9.72E-04 | 9.72E-05 | 6.33E-05 | 1.48E-04 | 2.97E-05 |
| 47163NEI41599 | Chloroform | 9.71E-04 | 0.00E+00 | 4.70E-07 | 0.00E+00 | 6.07E-07 |
| 47071NEI41552 | 1,2-Dimethoxyethane | 9.66E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23009NEI6284 | Chloroform | 9.61E-04 | 0.00E+00 | 4.65E-07 | 0.00E+00 | 6.01E-07 |
| 01071NEI18347 | Benzene | 9.40E-04 | 7.19E-06 | 4.70E-07 | 7.63E-06 | 2.54E-06 |
| 55069NEI46750 | Benzene | 9.40E-04 | 7.19E-06 | 4.70E-07 | 7.63E-06 | 2.54E-06 |
| 28077NEI11172 | Carbon disulfide | 9.36E-04 | 1.45E-04 | 1.16E-05 | 1.87E-03 | 3.63E-05 |
| 42047NEI40686 | Benzene | 9.19E-04 | 7.02E-06 | 4.59E-07 | 7.46E-06 | 2.49E-06 |
| 12005NEI8278 | Carbon disulfide | 9.17E-04 | 1.42E-04 | 1.14E-05 | 1.83E-03 | 3.55E-05 |
| 27145NEI12407 | 1,2-Dimethoxyethane | 9.08E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 40089NEI11251 | Phenol | 9.07E-04 | 9.07E-05 | 5.91E-05 | 1.38E-04 | 2.77E-05 |
| 13051NEI26476 | Carbon tetrachloride | 9.05E-04 | 6.14E-06 | 1.43E-06 | 1.32E-05 | 2.73E-06 |
| 39061NEI11610 | Toluene | 9.03E-04 | 4.45E-05 | 7.42E-06 | 1.76E-04 | 3.04E-05 |
| 13245NEI8122 | Phenol | 8.96E-04 | 8.96E-05 | 5.84E-05 | 1.37E-04 | 2.74E-05 |
| 55073NEI42690 | Methanol | 8.91E-04 | 3.62E-05 | 9.24E-06 | 9.60E-05 | 1.92E-05 |
| 51101NEI42254 | Hydrochloric acid | 8.91E-04 | 6.93E-04 | 5.67E-05 | 4.16E-04 | 6.24E-05 |
| 12089NEI8261 | Methylene chloride | 8.87E-04 | 1.80E-05 | 6.54E-06 | 1.24E-05 | 4.78E-06 |

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| 51019NEI42211 | Phenol | 8.86E-04 | 8.86E-05 | 5.78E-05 | 1.35E-04 | 2.71E-05 |
| 42013NEI7104 | Acetaldehyde | 8.80E-04 | 5.10E-06 | 8.44E-07 | 2.30E-05 | 1.15E-06 |
| 21091NEI32869A | Carbon disulfide | 8.74E-04 | 1.35E-04 | 1.08E-05 | 1.75E-03 | 3.39E-05 |
| 13179NEI8177 | Chloroform | 8.73E-04 | 0.00E+00 | 4.22E-07 | 0.00E+00 | 5.45E-07 |
| 39031NEI11461 | 1,2-Dimethoxyethane | 8.65E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01091NEI45474 | Carbon disulfide | 8.63E-04 | 1.34E-04 | 1.07E-05 | 1.73E-03 | 3.34E-05 |
| 23019NEI33103 | Hydrochloric acid | 8.62E-04 | 6.70E-04 | 5.48E-05 | 4.02E-04 | 6.03E-05 |
| 37047NEI40247 | Carbon disulfide | 8.60E-04 | 1.33E-04 | 1.07E-05 | 1.72E-03 | 3.33E-05 |
| 05003NEI54342 | Hydrochloric acid | 8.58E-04 | 6.68E-04 | 5.46E-05 | 4.01E-04 | 6.01E-05 |
| 55009NEI42482 | Toluene | 8.53E-04 | 4.21E-05 | 7.01E-06 | 1.66E-04 | 2.87E-05 |
| 12031NEI26304 | Phenol | 8.52E-04 | 8.52E-05 | 5.55E-05 | 1.30E-04 | 2.60E-05 |
| 01025NEI8601 | Hydrochloric acid | 8.49E-04 | 6.60E-04 | 5.40E-05 | 3.96E-04 | 5.94E-05 |
| 23007NEI6261 | Chlorine | 8.39E-04 | 1.17E-04 | 3.04E-05 | 6.08E-05 | 2.03E-05 |
| 01121NEI18390 | Phenol | 8.29E-04 | 8.29E-05 | 5.40E-05 | 1.27E-04 | 2.53E-05 |
| 48241NEI6450 | Benzene | 8.22E-04 | 6.28E-06 | 4.11E-07 | 6.68E-06 | 2.23E-06 |
| 28087NEI34064 | Hydrochloric acid | 8.19E-04 | 6.37E-04 | 5.21E-05 | 3.82E-04 | 5.74E-05 |
| 37117NEI9201 | Phenol | 8.15E-04 | 8.15E-05 | 5.31E-05 | 1.24E-04 | 2.49E-05 |
| 05081NEI18660 | Chlorine | 8.10E-04 | 1.13E-04 | 2.93E-05 | 5.86E-05 | 1.95E-05 |
| 01047NEI18335 | Carbon tetrachloride | 8.02E-04 | 5.44E-06 | 1.27E-06 | 1.17E-05 | 2.42E-06 |
| 13099NEI26491 | Carbon disulfide | 7.95E-04 | 1.23E-04 | 9.85E-06 | 1.59E-03 | 3.08E-05 |
| 01071NEI18347 | Carbon disulfide | 7.90E-04 | 1.22E-04 | 9.79E-06 | 1.58E-03 | 3.06E-05 |
| 45091NEI47077 | 1,2-Dimethoxyethane | 7.87E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 28111NEI34066 | Carbon disulfide | 7.82E-04 | 1.21E-04 | 9.70E-06 | 1.56E-03 | 3.03E-05 |
| 41007NEI40554 | Arsenic compounds | 7.79E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13115NEI26495 | Benzene | 7.64E-04 | 5.84E-06 | 3.82E-07 | 6.21E-06 | 2.07E-06 |
| 47071NEI41552 | Chloroform | 7.59E-04 | 0.00E+00 | 3.67E-07 | 0.00E+00 | 4.74E-07 |
| 01091NEI45474 | Benzene | 7.54E-04 | 5.76E-06 | 3.77E-07 | 6.12E-06 | 2.04E-06 |
| 45079NEI46760 | Phenol | 7.47E-04 | 7.47E-05 | 4.87E-05 | 1.14E-04 | 2.28E-05 |
| 45069NEI47074 | Xylenes (mixed) | 7.42E-04 | 2.92E-05 | 4.08E-06 | 0.00E+00 | 0.00E+00 |
| 23007NEI6261 | Carbon tetrachloride | 7.36E-04 | 4.99E-06 | 1.17E-06 | 1.08E-05 | 2.22E-06 |
| 13175NEIGAT$3911 | Chloroform | 7.15E-04 | 0.00E+00 | 3.46E-07 | 0.00E+00 | 4.47E-07 |
| 42101NEI40720 | Methanol | 7.13E-04 | 2.89E-05 | 7.39E-06 | 7.68E-05 | 1.54E-05 |
| 01091NEI45474 | Methylene chloride | 7.12E-04 | 1.44E-05 | 5.25E-06 | 9.97E-06 | 3.83E-06 |
| 12031NEI26304 | Methanol | 7.05E-04 | 2.86E-05 | 7.32E-06 | 7.60E-05 | 1.52E-05 |
| 22069NEI33025 | Toluene | 7.04E-04 | 3.47E-05 | 5.79E-06 | 1.37E-04 | 2.37E-05 |
| 13245NEI8122 | Carbon disulfide | 7.03E-04 | 1.09E-04 | 8.72E-06 | 1.41E-03 | 2.73E-05 |
| 13179NEI8177 | Phenol | 6.99E-04 | 6.99E-05 | 4.56E-05 | 1.07E-04 | 2.13E-05 |
| 42047NEI40686 | Methylene chloride | 6.89E-04 | 1.40E-05 | 5.07E-06 | 9.64E-06 | 3.71E-06 |
| 21091NEI32869A | Chlorine | 6.86E-04 | 9.61E-05 | 2.48E-05 | 4.97E-05 | 1.66E-05 |
| 27071NEI12411 | Chlorine | 6.74E-04 | 9.43E-05 | 2.44E-05 | 4.88E-05 | 1.63E-05 |
| 01113NEI46931 | Benzene | 6.72E-04 | 5.14E-06 | 3.36E-07 | 5.46E-06 | 1.82E-06 |
| 05029NEI46852 | Benzene | 6.70E-04 | 5.12E-06 | 3.35E-07 | 5.44E-06 | 1.81E-06 |
| 12107NEI8265 | Hydrochloric acid | 6.69E-04 | 5.20E-04 | 4.26E-05 | 3.12E-04 | 4.68E-05 |
| 01001NEI8560 | Carbon disulfide | 6.66E-04 | 1.03E-04 | 8.26E-06 | 1.33E-03 | 2.58E-05 |
| 41041NEI40600 | Benzene | 6.64E-04 | 5.08E-06 | 3.32E-07 | 5.39E-06 | 1.80E-06 |
| 47107NEI41565 | Carbon disulfide | 6.59E-04 | 1.02E-04 | 8.17E-06 | 1.32E-03 | 2.55E-05 |
| 37087NEI40282 | Benzene | 6.52E-04 | 4.99E-06 | 3.26E-07 | 5.30E-06 | 1.77E-06 |
| 41041NEI40600 | Methylene chloride | 6.52E-04 | 1.32E-05 | 4.80E-06 | 9.12E-06 | 3.51E-06 |
| 24001NEI33135 | Styrene | 6.49E-04 | 1.60E-04 | 2.48E-05 | 6.49E-05 | 1.24E-05 |
| 23009NEI6284 | Methanol | 6.49E-04 | 2.63E-05 | 6.73E-06 | 6.99E-05 | 1.40E-05 |
| 42101NEI40720 | Acetaldehyde | 6.33E-04 | 3.67E-06 | 6.07E-07 | 1.65E-05 | 8.26E-07 |
| 01113NEI46931 | o-Xylene | 6.28E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53053NEI13363 | Benzene | 6.27E-04 | 4.80E-06 | 3.14E-07 | 5.10E-06 | 1.70E-06 |
| 48361NEI12492 | Phenol | 6.23E-04 | 6.23E-05 | 4.06E-05 | 9.51E-05 | 1.90E-05 |
| 22049NEI33023 | Carbon disulfide | 6.22E-04 | 9.65E-05 | 7.72E-06 | 1.24E-03 | 2.41E-05 |

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| 22117NEI46814 | Phenol | 6.20E-04 | 6.20E-05 | 4.04E-05 | 9.47E-05 | 1.89E-05 |
| 28077NEI11172 | Carbon tetrachloride | 6.15E-04 | 4.17E-06 | 9.73E-07 | 8.98E-06 | 1.85E-06 |
| 22033NEI46817 | Xylenes (mixed) | 6.14E-04 | 2.41E-05 | 3.38E-06 | 0.00E+00 | 0.00E+00 |
| 37049NEI45206 | Phenol | 6.11E-04 | 6.11E-05 | 3.98E-05 | 9.33E-05 | 1.87E-05 |
| 05081NEI18660 | Methylene chloride | 6.08E-04 | 1.23E-05 | 4.48E-06 | 8.52E-06 | 3.28E-06 |
| 13305NEI26526 | Methylene chloride | 6.07E-04 | 1.23E-05 | 4.48E-06 | 8.50E-06 | 3.27E-06 |
| 41043NEI13340 | Methylene chloride | 6.02E-04 | 1.22E-05 | 4.44E-06 | 8.43E-06 | 3.24E-06 |
| 13245NEI26514 | Phenol | 6.01E-04 | 6.01E-05 | 3.92E-05 | 9.17E-05 | 1.83E-05 |
| 12107NEI8265 | Arsenic compounds | 5.96E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13103NEI8178 | Benzene | 5.94E-04 | 4.54E-06 | 2.97E-07 | 4.83E-06 | 1.61E-06 |
| 13127NEI8196 | Styrene | 5.86E-04 | 1.45E-04 | 2.24E-05 | 5.86E-05 | 1.12E-05 |
| 51101NEI42254 | Benzene | 5.85E-04 | 4.48E-06 | 2.93E-07 | 4.76E-06 | 1.59E-06 |
| 47071NEI41552 | Carbon disulfide | 5.83E-04 | 9.04E-05 | 7.23E-06 | 1.17E-03 | 2.26E-05 |
| 45019NEI41252 | Benzene | 5.73E-04 | 4.38E-06 | 2.86E-07 | 4.66E-06 | 1.55E-06 |
| 37087NEI40282 | Toluene | 5.71E-04 | 2.82E-05 | 4.69E-06 | 1.11E-04 | 1.92E-05 |
| 45031NEI43472 | Formaldehyde | 5.70E-04 | 2.85E-05 | 1.84E-06 | 2.61E-05 | 2.61E-06 |
| 01113NEI46931 | Methylene chloride | 5.68E-04 | 1.15E-05 | 4.19E-06 | 7.96E-06 | 3.06E-06 |
| 12033NEI26309 | Chlorine | 5.65E-04 | 7.91E-05 | 2.05E-05 | 4.09E-05 | 1.36E-05 |
| 47107NEI41565 | Benzene | 5.55E-04 | 4.25E-06 | 2.78E-07 | 4.51E-06 | 1.50E-06 |
| 47071NEI41552 | Phenol | 5.55E-04 | 5.55E-05 | 3.61E-05 | 8.46E-05 | 1.69E-05 |
| 13021NEI26471 | Styrene | 5.53E-04 | 1.37E-04 | 2.11E-05 | 5.53E-05 | 1.06E-05 |
| 25017NEI6175 | Phenol | 5.50E-04 | 5.50E-05 | 3.59E-05 | 8.40E-05 | 1.68E-05 |
| 01113NEI46931 | 1,2-Dimethoxyethane | 5.48E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13305NEI26526 | Benzene | 5.46E-04 | 4.17E-06 | 2.73E-07 | 4.43E-06 | 1.48E-06 |
| 23029NEI46835 | Phenol | 5.39E-04 | 5.39E-05 | 3.51E-05 | 8.23E-05 | 1.65E-05 |
| 53011NEI46599 | Carbon tetrachloride | 5.37E-04 | 3.65E-06 | 8.51E-07 | 7.85E-06 | 1.62E-06 |
| 24001NEI33135 | Chlorine | 5.35E-04 | 7.49E-05 | 1.94E-05 | 3.87E-05 | 1.29E-05 |
| 36031NEI35908 | Carbon disulfide | 5.35E-04 | 8.29E-05 | 6.63E-06 | 1.07E-03 | 2.07E-05 |
| 13245NEI26514 | Benzene | 5.32E-04 | 4.07E-06 | 2.66E-07 | 4.32E-06 | 1.44E-06 |
| 23019NEI33104 | Mercury (elemental) | 5.28E-04 | 0.00E+00 | 1.86E-07 | 0.00E+00 | 1.59E-07 |
| 45069NEI47074 | Styrene | 5.28E-04 | 1.30E-04 | 2.02E-05 | 5.28E-05 | 1.01E-05 |
| 13193NEI26506 | Chlorine | 5.27E-04 | 7.38E-05 | 1.91E-05 | 3.82E-05 | 1.27E-05 |
| 40101NEI12980 | Formaldehyde | 5.26E-04 | 2.63E-05 | 1.70E-06 | 2.41E-05 | 2.41E-06 |
| 55073NEI42689 | Chlorine | 5.23E-04 | 7.32E-05 | 1.89E-05 | 3.79E-05 | 1.26E-05 |
| 23029NEI46835 | Hydrochloric acid | 5.18E-04 | 4.03E-04 | 3.29E-05 | 2.42E-04 | 3.62E-05 |
| 55099NEI42730 | Benzene | 5.13E-04 | 3.92E-06 | 2.57E-07 | 4.17E-06 | 1.39E-06 |
| 27137NEIMN14904 | Phenol | 5.13E-04 | 5.13E-05 | 3.34E-05 | 7.83E-05 | 1.57E-05 |
| 45069NEI47074 | Tetrachloroethene | 5.06E-04 | 4.21E-05 | 6.32E-06 | 1.49E-05 | 7.22E-06 |
| 53015NEI42338 | 1,1,1-Trichloroethane | 5.05E-04 | 2.64E-05 | 1.04E-05 | 1.81E-05 | 9.04E-06 |
| 55009NEI42486 | Methanol | 5.05E-04 | 2.05E-05 | 5.23E-06 | 5.43E-05 | 1.09E-05 |
| 05069NEI18658 | Toluene | 5.02E-04 | 2.48E-05 | 4.13E-06 | 9.78E-05 | 1.69E-05 |
| 05069NEI18658 | Tetrachloroethene | 5.01E-04 | 4.18E-05 | 6.26E-06 | 1.47E-05 | 7.16E-06 |
| 48361NEI12492 | Toluene | 5.00E-04 | 2.46E-05 | 4.11E-06 | 9.73E-05 | 1.68E-05 |
| 01001NEI8560 | Phenol | 4.98E-04 | 4.98E-05 | 3.25E-05 | 7.60E-05 | 1.52E-05 |
| 40031NEW73505 | Methanol | 4.98E-04 | 2.02E-05 | 5.16E-06 | 5.36E-05 | 1.07E-05 |
| 13245NEI26514 | Carbon disulfide | 4.94E-04 | 7.66E-05 | 6.13E-06 | 9.88E-04 | 1.91E-05 |
| 41071NEI40648 | o-Xylene | 4.92E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05003NEI54342 | Benzene | 4.92E-04 | 3.76E-06 | 2.46E-07 | 3.99E-06 | 1.33E-06 |
| 22073NEI6057 | Benzene | 4.86E-04 | 3.72E-06 | 2.43E-07 | 3.95E-06 | 1.32E-06 |
| 22117NEI46814 | Methylene chloride | 4.84E-04 | 9.81E-06 | 3.56E-06 | 6.77E-06 | 2.60E-06 |
| 42133NEI7181 | Methylene chloride | 4.83E-04 | 9.80E-06 | 3.56E-06 | 6.76E-06 | 2.60E-06 |
| 28077NEI11172 | Benzene | 4.82E-04 | 3.69E-06 | 2.41E-07 | 3.92E-06 | 1.31E-06 |
| 53071NEI42410 | Benzene | 4.68E-04 | 3.58E-06 | 2.34E-07 | 3.81E-06 | 1.27E-06 |
| 22117NEI46814 | Carbon tetrachloride | 4.67E-04 | 3.17E-06 | 7.39E-07 | 6.82E-06 | 1.41E-06 |
| 51670NEI42317 | Benzene | 4.66E-04 | 3.56E-06 | 2.33E-07 | 3.79E-06 | 1.26E-06 |

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| 39141NEI40488 | Methanol | 4.65E-04 | 1.89E-05 | 4.83E-06 | 5.01E-05 | 1.00E-05 |
| 01113NEI46931 | Toluene | 4.63E-04 | 2.29E-05 | 3.81E-06 | 9.02E-05 | 1.56E-05 |
| 12033NEI26309 | Phenol | 4.62E-04 | 4.62E-05 | 3.01E-05 | 7.05E-05 | 1.41E-05 |
| 36031NEI35908 | Phenol | 4.60E-04 | 4.60E-05 | 3.00E-05 | 7.02E-05 | 1.40E-05 |
| 05069NEI18658 | Methylene chloride | 4.57E-04 | 9.28E-06 | 3.37E-06 | 6.40E-06 | 2.46E-06 |
| 28087NEI34064 | Styrene | 4.54E-04 | 1.12E-04 | 1.73E-05 | 4.54E-05 | 8.67E-06 |
| 12005NEI8278 | Carbon tetrachloride | 4.53E-04 | 3.07E-06 | 7.17E-07 | 6.62E-06 | 1.37E-06 |
| 01053NEI18338 | Styrene | 4.51E-04 | 1.11E-04 | 1.72E-05 | 4.51E-05 | 8.61E-06 |
| 01047NEI18335 | Carbon disulfide | 4.51E-04 | 6.99E-05 | 5.59E-06 | 9.02E-04 | 1.75E-05 |
| 45043NEI41314 | Chlorine | 4.47E-04 | 6.26E-05 | 1.62E-05 | 3.24E-05 | 1.08E-05 |
| 22031NEI33013 | Phenol | 4.44E-04 | 4.44E-05 | 2.90E-05 | 6.78E-05 | 1.36E-05 |
| 26043NEI33887 | Phenol | 4.43E-04 | 4.43E-05 | 2.89E-05 | 6.76E-05 | 1.35E-05 |
| 24001NEI33135 | Toluene | 4.40E-04 | 2.17E-05 | 3.62E-06 | 8.58E-05 | 1.48E-05 |
| 47163NEI41599 | Carbon disulfide | 4.40E-04 | 6.82E-05 | 5.45E-06 | 8.79E-04 | 1.70E-05 |
| 01001NEI8560 | Benzene | 4.38E-04 | 3.35E-06 | 2.19E-07 | 3.56E-06 | 1.19E-06 |
| 01113NEI46931 | Carbon disulfide | 4.36E-04 | 6.76E-05 | 5.41E-06 | 8.72E-04 | 1.69E-05 |
| 37087NEI40282 | Methylene chloride | 4.34E-04 | 8.80E-06 | 3.20E-06 | 6.07E-06 | 2.34E-06 |
| 47105NEITN1050093 | Nickel compounds | 4.32E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 40089NEI11251 | Benzene | 4.31E-04 | 3.30E-06 | 2.16E-07 | 3.51E-06 | 1.17E-06 |
| 55097NEIWIT$8597 | Methanol | 4.27E-04 | 1.73E-05 | 4.43E-06 | 4.60E-05 | 9.21E-06 |
| 13021NEI26471 | Tetrachloroethene | 4.26E-04 | 3.55E-05 | 5.33E-06 | 1.25E-05 | 6.09E-06 |
| 13115NEI26495 | Methylene chloride | 4.23E-04 | 8.57E-06 | 3.11E-06 | 5.92E-06 | 2.28E-06 |
| 12107NEI8265 | Benzene | 4.17E-04 | 3.19E-06 | 2.09E-07 | 3.39E-06 | 1.13E-06 |
| 13127NEI8196 | Toluene | 4.16E-04 | 2.05E-05 | 3.42E-06 | 8.10E-05 | 1.40E-05 |
| 51101NEI42254 | Methylene chloride | 4.16E-04 | 8.43E-06 | 3.06E-06 | 5.82E-06 | 2.24E-06 |
| 55079NEIWI0793640 | Methanol | 4.16E-04 | 1.69E-05 | 4.31E-06 | 4.48E-05 | 8.95E-06 |
| 41071NEI40648 | Tetrachloroethene | 4.15E-04 | 3.46E-05 | 5.19E-06 | 1.22E-05 | 5.93E-06 |
| 12107NEI8265 | Carbon tetrachloride | 4.15E-04 | 2.81E-06 | 6.57E-07 | 6.06E-06 | 1.25E-06 |
| 51019NEI42211 | Methylene chloride | 4.13E-04 | 8.38E-06 | 3.04E-06 | 5.78E-06 | 2.22E-06 |
| 39141NEI40488 | Phenol | 4.11E-04 | 4.11E-05 | 2.68E-05 | 6.28E-05 | 1.26E-05 |
| 42047NEI40686 | Carbon tetrachloride | 4.08E-04 | 2.77E-06 | 6.46E-07 | 5.96E-06 | 1.23E-06 |
| 37049NEI45206 | Carbon disulfide | 4.07E-04 | 6.31E-05 | 5.04E-06 | 8.14E-04 | 1.58E-05 |
| 41041NEI40600 | Carbon tetrachloride | 4.07E-04 | 2.76E-06 | 6.44E-07 | 5.94E-06 | 1.23E-06 |
| 23007NEI6261 | Mercury (elemental) | 4.06E-04 | 0.00E+00 | 1.43E-07 | 0.00E+00 | 1.22E-07 |
| 01079NEI18357 | Chlorine | 4.02E-04 | 5.63E-05 | 1.46E-05 | 2.91E-05 | 9.71E-06 |
| 55141NEI42695 | Methylene chloride | 3.88E-04 | 7.88E-06 | 2.86E-06 | 5.44E-06 | 2.09E-06 |
| 22033NEI46817 | Styrene | 3.85E-04 | 9.52E-05 | 1.47E-05 | 3.85E-05 | 7.35E-06 |
| 55085NEI43202 | Arsenic compounds | 3.82E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 26041NEI33883 | Phenol | 3.82E-04 | 3.82E-05 | 2.49E-05 | 5.83E-05 | 1.17E-05 |
| 23019NEI33103 | Chlorine | 3.80E-04 | 5.32E-05 | 1.37E-05 | 2.75E-05 | 9.17E-06 |
| 51580NEI759 | Benzene | 3.75E-04 | 2.87E-06 | 1.88E-07 | 3.05E-06 | 1.02E-06 |
| 01053NEI18338 | Toluene | 3.75E-04 | 1.85E-05 | 3.08E-06 | 7.30E-05 | 1.26E-05 |
| 45041NEI7933 | Carbon disulfide | 3.74E-04 | 5.80E-05 | 4.64E-06 | 7.48E-04 | 1.45E-05 |
| 01023NEI18334 | Ethylene glycol ethyl ether | 3.71E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41039NEI45182 | Carbon disulfide | 3.71E-04 | 5.75E-05 | 4.60E-06 | 7.42E-04 | 1.44E-05 |
| 01053NEI18338 | Hydrochloric acid | 3.71E-04 | 2.88E-04 | 2.36E-05 | 1.73E-04 | 2.60E-05 |
| 47071NEI41552 | Xylenes (mixed) | 3.69E-04 | 1.45E-05 | 2.03E-06 | 0.00E+00 | 0.00E+00 |
| 37087NEI40282 | Hydrochloric acid | 3.68E-04 | 2.86E-04 | 2.34E-05 | 1.72E-04 | 2.58E-05 |
| 42101NEIPA1013489 | Methanol | 3.67E-04 | 1.49E-05 | 3.81E-06 | 3.95E-05 | 7.91E-06 |
| 27145NEI12407 | Carbon disulfide | 3.66E-04 | 5.67E-05 | 4.54E-06 | 7.32E-04 | 1.42E-05 |
| 01079NEI18357 | Styrene | 3.65E-04 | 9.01E-05 | 1.39E-05 | 3.65E-05 | 6.96E-06 |
| 01023NEI18334 | Vinyl chloride | 3.65E-04 | 1.03E-04 | 2.12E-05 | 5.05E-05 | 5.05E-06 |
| 01053NEI18338 | Carbon tetrachloride | 3.63E-04 | 2.46E-06 | 5.74E-07 | 5.30E-06 | 1.09E-06 |
| 48361NEI12492 | Styrene | 3.63E-04 | 8.96E-05 | 1.38E-05 | 3.63E-05 | 6.92E-06 |
| 22073NEI6057 | Chlorine | 3.62E-04 | 5.07E-05 | 1.31E-05 | 2.62E-05 | 8.75E-06 |

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| 01113NEI46931 | Carbon tetrachloride | 3.60E-04 | 2.45E-06 | 5.71E-07 | 5.27E-06 | 1.09E-06 |
| 45041NEI7933 | Benzene | 3.57E-04 | 2.73E-06 | 1.78E-07 | 2.90E-06 | 9.67E-07 |
| 13115NEI26495 | Tetrachloroethene | 3.54E-04 | 2.95E-05 | 4.43E-06 | 1.04E-05 | 5.06E-06 |
| 13175NEIGAT$3911 | Phenol | 3.51E-04 | 3.51E-05 | 2.29E-05 | 5.36E-05 | 1.07E-05 |
| 28149NEI34070 | Benzene | 3.48E-04 | 2.66E-06 | 1.74E-07 | 2.83E-06 | 9.43E-07 |
| 55009NEIWI4050324 | Arsenic compounds | 3.47E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 26147NEI33981 | Chloroform | 3.44E-04 | 0.00E+00 | 1.66E-07 | 0.00E+00 | 2.15E-07 |
| 22069NEI33025 | Methylene chloride | 3.44E-04 | 6.97E-06 | 2.53E-06 | 4.81E-06 | 1.85E-06 |
| 53053NEI13363 | Methylene chloride | 3.43E-04 | 6.97E-06 | 2.53E-06 | 4.81E-06 | 1.85E-06 |
| 51580NEI759 | Xylenes (mixed) | 3.40E-04 | 1.34E-05 | 1.87E-06 | 0.00E+00 | 0.00E+00 |
| 27145NEI12407 | Toluene | 3.39E-04 | 1.67E-05 | 2.79E-06 | 6.60E-05 | 1.14E-05 |
| 28149NEI34070 | Phenol | 3.37E-04 | 3.37E-05 | 2.20E-05 | 5.14E-05 | 1.03E-05 |
| 40089NEI11251 | Toluene | 3.34E-04 | 1.65E-05 | 2.74E-06 | 6.50E-05 | 1.12E-05 |
| 13185NEI26504 | Phenol | 3.33E-04 | 3.33E-05 | 2.17E-05 | 5.09E-05 | 1.02E-05 |
| 21007NEI11338 | Carbon tetrachloride | 3.32E-04 | 2.25E-06 | 5.25E-07 | 4.85E-06 | 1.00E-06 |
| 13099NEI26491 | Benzene | 3.30E-04 | 2.53E-06 | 1.65E-07 | 2.68E-06 | 8.95E-07 |
| 45069NEI47074 | Carbon disulfide | 3.30E-04 | 5.12E-05 | 4.10E-06 | 6.61E-04 | 1.28E-05 |
| 26041NEI33883 | Benzene | 3.26E-04 | 2.50E-06 | 1.63E-07 | 2.65E-06 | 8.84E-07 |
| 53015NEI42338 | Chlorine | 3.22E-04 | 4.51E-05 | 1.17E-05 | 2.33E-05 | 7.78E-06 |
| 22049NEI33023 | Benzene | 3.22E-04 | 2.46E-06 | 1.61E-07 | 2.62E-06 | 8.72E-07 |
| 53061NEI42385 | Methanol | 3.21E-04 | 1.30E-05 | 3.33E-06 | 3.46E-05 | 6.92E-06 |
| 39061NEI11610 | Arsenic compounds | 3.21E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53071NEI42410 | Methylene chloride | 3.19E-04 | 6.47E-06 | 2.35E-06 | 4.46E-06 | 1.72E-06 |
| 53015NEI42341A | Phenol | 3.19E-04 | 3.19E-05 | 2.08E-05 | 4.86E-05 | 9.72E-06 |
| 51580NEI759 | Styrene | 3.18E-04 | 7.87E-05 | 1.22E-05 | 3.18E-05 | 6.08E-06 |
| 51580NEI759 | Chlorine | 3.18E-04 | 4.45E-05 | 1.15E-05 | 2.30E-05 | 7.68E-06 |
| 22117NEI46814 | Xylenes (mixed) | 3.18E-04 | 1.25E-05 | 1.75E-06 | 0.00E+00 | 0.00E+00 |
| 05069NEI18657 | Styrene | 3.10E-04 | 7.65E-05 | 1.18E-05 | 3.10E-05 | 5.91E-06 |
| 41071NEI40648 | Methylene chloride | 3.09E-04 | 6.26E-06 | 2.28E-06 | 4.32E-06 | 1.66E-06 |
| 39141NEI40488 | Formaldehyde | 3.08E-04 | 1.54E-05 | 9.96E-07 | 1.41E-05 | 1.41E-06 |
| 53009NEI42329 | Phenol | 3.06E-04 | 3.06E-05 | 2.00E-05 | 4.67E-05 | 9.35E-06 |
| 54057NEI706 | Benzene | 3.04E-04 | 2.33E-06 | 1.52E-07 | 2.47E-06 | 8.24E-07 |
| 23007NEI6261 | Methylene chloride | 3.04E-04 | 6.16E-06 | 2.24E-06 | 4.25E-06 | 1.64E-06 |
| 22011NEI7559 | Benzene | 3.03E-04 | 2.32E-06 | 1.52E-07 | 2.46E-06 | 8.22E-07 |
| 22117NEI46814 | Benzene | 2.99E-04 | 2.29E-06 | 1.49E-07 | 2.43E-06 | 8.10E-07 |
| 53011NEI46599 | Methylene chloride | 2.99E-04 | 6.06E-06 | 2.20E-06 | 4.18E-06 | 1.61E-06 |
| 04017NEI13216 | Toluene | 2.95E-04 | 1.46E-05 | 2.43E-06 | 5.75E-05 | 9.94E-06 |
| 01053NEI18338 | Ethylene glycol ethyl ether | 2.95E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55097NEIWI7500086 | Formaldehyde | 2.93E-04 | 1.46E-05 | 9.47E-07 | 1.34E-05 | 1.34E-06 |
| 45079NEI46760 | Carbon disulfide | 2.91E-04 | 4.51E-05 | 3.60E-06 | 5.81E-04 | 1.13E-05 |
| 01079NEI18357 | Carbon disulfide | 2.89E-04 | 4.48E-05 | 3.58E-06 | 5.78E-04 | 1.12E-05 |
| 39031NEI11461 | Benzene | 2.89E-04 | 2.21E-06 | 1.44E-07 | 2.35E-06 | 7.82E-07 |
| 12089NEI8261 | Benzene | 2.86E-04 | 2.19E-06 | 1.43E-07 | 2.32E-06 | 7.75E-07 |
| 01047NEI18335 | Nickel compounds | 2.84E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55009NEI42482 | Phenol | 2.84E-04 | 2.84E-05 | 1.85E-05 | 4.33E-05 | 8.67E-06 |
| 42013NEI7104 | Methylene chloride | 2.84E-04 | 5.76E-06 | 2.09E-06 | 3.98E-06 | 1.53E-06 |
| 45019NEI41252 | Methylene chloride | 2.83E-04 | 5.75E-06 | 2.09E-06 | 3.97E-06 | 1.53E-06 |
| 40089NEI11251 | Methylene chloride | 2.83E-04 | 5.75E-06 | 2.09E-06 | 3.97E-06 | 1.53E-06 |
| 22031NEI33013 | Benzene | 2.77E-04 | 2.12E-06 | 1.39E-07 | 2.25E-06 | 7.51E-07 |
| 05069NEI18658 | o-Xylene | 2.76E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27035NEI34020 | Chloroform | 2.73E-04 | 0.00E+00 | 1.32E-07 | 0.00E+00 | 1.71E-07 |
| 05029NEI46852 | Chloroform | 2.72E-04 | 0.00E+00 | 1.32E-07 | 0.00E+00 | 1.70E-07 |
| 13115NEI26495 | Methyl bromide | 2.71E-04 | 0.00E+00 | 1.29E-06 | 0.00E+00 | 5.57E-06 |
| 13103NEI8178 | Toluene | 2.70E-04 | 1.33E-05 | 2.22E-06 | 5.26E-05 | 9.09E-06 |
| 18165NEI2INT16350 | Methanol | 2.69E-04 | 1.09E-05 | 2.79E-06 | 2.89E-05 | 5.79E-06 |

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| 45091NEI47077 | Tetrachloroethene | 2.68E-04 | 2.23E-05 | 3.35E-06 | 7.88E-06 | 3.83E-06 |
| 13021NEI26471 | Benzene | 2.68E-04 | 2.05E-06 | 1.34E-07 | 2.18E-06 | 7.25E-07 |
| 47105NEITN1050093 | Mercury (elemental) | 2.67E-04 | 0.00E+00 | 9.43E-08 | 0.00E+00 | 8.02E-08 |
| 48241NEI6450 | Hydrochloric acid | 2.66E-04 | 2.07E-04 | 1.69E-05 | 1.24E-04 | 1.86E-05 |
| 28043NEI11108 | Phenol | 2.65E-04 | 2.65E-05 | 1.73E-05 | 4.05E-05 | 8.09E-06 |
| 40101NEI12980 | Toluene | 2.64E-04 | 1.30E-05 | 2.17E-06 | 5.14E-05 | 8.88E-06 |
| 01091NEI45474 | Xylenes (mixed) | 2.63E-04 | 1.03E-05 | 1.45E-06 | 0.00E+00 | 0.00E+00 |
| 55141NEI42695 | Chlorine | 2.62E-04 | 3.67E-05 | 9.50E-06 | 1.90E-05 | 6.33E-06 |
| 13305NEI26526 | Xylenes (mixed) | 2.60E-04 | 1.02E-05 | 1.43E-06 | 0.00E+00 | 0.00E+00 |
| 28043NEI11108 | Carbon disulfide | 2.59E-04 | 4.02E-05 | 3.22E-06 | 5.19E-04 | 1.00E-05 |
| 13051NEI8186 | Carbon disulfide | 2.58E-04 | 4.00E-05 | 3.20E-06 | 5.17E-04 | 1.00E-05 |
| 23019NEI33103 | Styrene | 2.58E-04 | 6.38E-05 | 9.86E-06 | 2.58E-05 | 4.93E-06 |
| 13127NEI8196 | Methylene chloride | 2.58E-04 | 5.23E-06 | 1.90E-06 | 3.61E-06 | 1.39E-06 |
| 55079NEIWI0793640 | Phenol | 2.57E-04 | 2.57E-05 | 1.67E-05 | 3.92E-05 | 7.83E-06 |
| 01079NEI18357 | Methylene chloride | 2.55E-04 | 5.17E-06 | 1.88E-06 | 3.57E-06 | 1.37E-06 |
| 01099NEI18373 | Benzene | 2.52E-04 | 1.92E-06 | 1.26E-07 | 2.04E-06 | 6.81E-07 |
| 47071NEI41552 | Styrene | 2.51E-04 | 6.21E-05 | 9.59E-06 | 2.51E-05 | 4.80E-06 |
| 45019NEI41252 | Tetrachloroethene | 2.50E-04 | 2.08E-05 | 3.12E-06 | 7.35E-06 | 3.57E-06 |
| 27137NEIMN14904 | Toluene | 2.50E-04 | 1.23E-05 | 2.05E-06 | 4.86E-05 | 8.39E-06 |
| 55009NEI42482 | Arsenic compounds | 2.49E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55141NEI42961 | Methanol | 2.49E-04 | 1.01E-05 | 2.58E-06 | 2.68E-05 | 5.36E-06 |
| 22049NEI33023 | Methylene chloride | 2.46E-04 | 5.00E-06 | 1.81E-06 | 3.45E-06 | 1.33E-06 |
| 45041NEI7933 | Methylene chloride | 2.46E-04 | 4.99E-06 | 1.81E-06 | 3.44E-06 | 1.32E-06 |
| 23019NEI33103 | Benzene | 2.45E-04 | 1.87E-06 | 1.22E-07 | 1.99E-06 | 6.63E-07 |
| 53053NEI13363 | Tetrachloroethene | 2.44E-04 | 2.04E-05 | 3.05E-06 | 7.18E-06 | 3.49E-06 |
| 22011NEI7559 | Phenol | 2.44E-04 | 2.44E-05 | 1.59E-05 | 3.73E-05 | 7.45E-06 |
| 13245NEI8122 | Methylene chloride | 2.41E-04 | 4.88E-06 | 1.77E-06 | 3.37E-06 | 1.30E-06 |
| 01131NEI8619 | Phenol | 2.40E-04 | 2.40E-05 | 1.57E-05 | 3.67E-05 | 7.34E-06 |
| 22033NEI46817 | Toluene | 2.40E-04 | 1.18E-05 | 1.97E-06 | 4.66E-05 | 8.06E-06 |
| 13051NEI8186 | Benzene | 2.39E-04 | 1.82E-06 | 1.19E-07 | 1.94E-06 | 6.46E-07 |
| 37049NEI45206 | Chlorine | 2.35E-04 | 3.29E-05 | 8.51E-06 | 1.70E-05 | 5.67E-06 |
| 53031NEI42357 | Benzene | 2.32E-04 | 1.77E-06 | 1.16E-07 | 1.88E-06 | 6.28E-07 |
| 12005NEI8278 | Benzene | 2.30E-04 | 1.76E-06 | 1.15E-07 | 1.87E-06 | 6.23E-07 |
| 37087NEI40282 | Carbon disulfide | 2.30E-04 | 3.56E-05 | 2.85E-06 | 4.59E-04 | 8.90E-06 |
| 21007NEI11338 | Chlorine | 2.29E-04 | 3.21E-05 | 8.30E-06 | 1.66E-05 | 5.53E-06 |
| 48067NEI41628 | Styrene | 2.29E-04 | 5.66E-05 | 8.75E-06 | 2.29E-05 | 4.37E-06 |
| 13021NEI26471 | Carbon disulfide | 2.28E-04 | 3.53E-05 | 2.83E-06 | 4.56E-04 | 8.84E-06 |
| 22031NEI33013 | Xylenes (mixed) | 2.27E-04 | 8.92E-06 | 1.25E-06 | 0.00E+00 | 0.00E+00 |
| 13127NEI8196 | Xylenes (mixed) | 2.27E-04 | 8.91E-06 | 1.25E-06 | 0.00E+00 | 0.00E+00 |
| 47107NEI41565 | Methylene chloride | 2.27E-04 | 4.60E-06 | 1.67E-06 | 3.17E-06 | 1.22E-06 |
| 05003NEI54342 | Xylenes (mixed) | 2.27E-04 | 8.90E-06 | 1.25E-06 | 0.00E+00 | 0.00E+00 |
| 45069NEI47074 | Hydrochloric acid | 2.26E-04 | 1.76E-04 | 1.44E-05 | 1.06E-04 | 1.58E-05 |
| 13115NEI26495 | Xylenes (mixed) | 2.25E-04 | 8.84E-06 | 1.24E-06 | 0.00E+00 | 0.00E+00 |
| 01001NEI8560 | Methylene chloride | 2.25E-04 | 4.56E-06 | 1.65E-06 | 3.14E-06 | 1.21E-06 |
| 53071NEI42410 | Carbon disulfide | 2.24E-04 | 3.47E-05 | 2.77E-06 | 4.47E-04 | 8.67E-06 |
| 18165NEI2INT16350 | Phenol | 2.21E-04 | 2.21E-05 | 1.44E-05 | 3.37E-05 | 6.73E-06 |
| 05003NEI54342 | o-Xylene | 2.20E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13245NEI8122 | Toluene | 2.19E-04 | 1.08E-05 | 1.80E-06 | 4.26E-05 | 7.36E-06 |
| 41043NEI13340 | Benzene | 2.18E-04 | 1.66E-06 | 1.09E-07 | 1.77E-06 | 5.89E-07 |
| 45091NEI47077 | Arsenic compounds | 2.17E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 51580NEI759 | Methylene chloride | 2.15E-04 | 4.36E-06 | 1.58E-06 | 3.01E-06 | 1.16E-06 |
| 22069NEI33025 | Styrene | 2.14E-04 | 5.29E-05 | 8.18E-06 | 2.14E-05 | 4.09E-06 |
| 41007NEI40554 | Mercury (elemental) | 2.13E-04 | 0.00E+00 | 7.51E-08 | 0.00E+00 | 6.38E-08 |
| 37047NEI40247 | Carbon tetrachloride | 2.12E-04 | 1.44E-06 | 3.35E-07 | 3.10E-06 | 6.39E-07 |
| 47107NEI41565 | Styrene | 2.11E-04 | 5.22E-05 | 8.06E-06 | 2.11E-05 | 4.03E-06 |

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| 23017NEI6273 | Benzene | 2.10E-04 | 1.61E-06 | 1.05E-07 | 1.71E-06 | 5.70E-07 |
| 22073NEI6057 | Xylenes (mixed) | 2.09E-04 | 8.21E-06 | 1.15E-06 | 0.00E+00 | 0.00E+00 |
| 55115NEI42800 | Methanol | 2.08E-04 | 8.46E-06 | 2.16E-06 | 2.24E-05 | 4.49E-06 |
| 21007NEI11338 | Methylene chloride | 2.08E-04 | 4.22E-06 | 1.53E-06 | 2.91E-06 | 1.12E-06 |
| 48241NEI6450 | o-Xylene | 2.08E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27061NEI34030 | Methanol | 2.06E-04 | 8.34E-06 | 2.13E-06 | 2.21E-05 | 4.43E-06 |
| 13115NEI26495 | Toluene | 2.06E-04 | 1.01E-05 | 1.69E-06 | 4.00E-05 | 6.91E-06 |
| 22073NEI6057 | Tetrachloroethene | 2.05E-04 | 1.71E-05 | 2.56E-06 | 6.03E-06 | 2.93E-06 |
| 53011NEI46599 | Carbon disulfide | 2.04E-04 | 3.16E-05 | 2.53E-06 | 4.07E-04 | 7.89E-06 |
| 05003NEI54342 | Arsenic compounds | 2.03E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01001NEI8560 | Tetrachloroethene | 2.02E-04 | 1.68E-05 | 2.52E-06 | 5.94E-06 | 2.88E-06 |
| 45043NEI41314 | Styrene | 2.00E-04 | 4.95E-05 | 7.65E-06 | 2.00E-05 | 3.83E-06 |
| 23029NEI46835 | Benzene | 2.00E-04 | 1.53E-06 | 1.00E-07 | 1.63E-06 | 5.43E-07 |
| 48067NEI41628 | Methylene chloride | 2.00E-04 | 4.06E-06 | 1.48E-06 | 2.80E-06 | 1.08E-06 |
| 53015NEI42341A | Hydrochloric acid | 2.00E-04 | 1.56E-04 | 1.27E-05 | 9.35E-05 | 1.40E-05 |
| 01121NEI18390 | Chlorine | 2.00E-04 | 2.80E-05 | 7.25E-06 | 1.45E-05 | 4.83E-06 |
| 41041NEI40600 | Tetrachloroethene | 2.00E-04 | 1.66E-05 | 2.50E-06 | 5.87E-06 | 2.85E-06 |
| 55009NEI42495 | Methanol | 1.99E-04 | 8.09E-06 | 2.07E-06 | 2.15E-05 | 4.29E-06 |
| 37047NEI40247 | Benzene | 1.97E-04 | 1.50E-06 | 9.83E-08 | 1.60E-06 | 5.33E-07 |
| 26147NEI33981 | Phenol | 1.96E-04 | 1.96E-05 | 1.28E-05 | 3.00E-05 | 6.00E-06 |
| 01053NEI18338 | Butyl carbitol acetate | 1.96E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05041NEI18652 | Carbon tetrachloride | 1.94E-04 | 1.32E-06 | 3.08E-07 | 2.84E-06 | 5.86E-07 |
| 42047NEI40686 | Tetrachloroethene | 1.94E-04 | 1.62E-05 | 2.42E-06 | 5.70E-06 | 2.77E-06 |
| 13115NEI26495 | Styrene | 1.92E-04 | 4.74E-05 | 7.33E-06 | 1.92E-05 | 3.66E-06 |
| 23019NEI33103 | Xylenes (mixed) | 1.91E-04 | 7.52E-06 | 1.05E-06 | 0.00E+00 | 0.00E+00 |
| 13179NEI8177 | Carbon disulfide | 1.91E-04 | 2.96E-05 | 2.37E-06 | 3.83E-04 | 7.41E-06 |
| 22069NEI33025 | Tetrachloroethene | 1.91E-04 | 1.59E-05 | 2.38E-06 | 5.61E-06 | 2.73E-06 |
| 12107NEI8265 | Nickel compounds | 1.90E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 40101NEI12980 | Arsenic compounds | 1.90E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37083NEI47104 | Phenol | 1.88E-04 | 1.88E-05 | 1.22E-05 | 2.87E-05 | 5.73E-06 |
| 37117NEI9201 | Carbon tetrachloride | 1.86E-04 | 1.27E-06 | 2.95E-07 | 2.73E-06 | 5.62E-07 |
| 40089NEI11251 | Tetrachloroethene | 1.85E-04 | 1.54E-05 | 2.32E-06 | 5.45E-06 | 2.65E-06 |
| 22011NEI7559 | Carbon disulfide | 1.84E-04 | 2.85E-05 | 2.28E-06 | 3.68E-04 | 7.13E-06 |
| 48241NEI6450 | Phenol | 1.84E-04 | 1.84E-05 | 1.20E-05 | 2.81E-05 | 5.62E-06 |
| 13099NEI26491 | Methylene chloride | 1.84E-04 | 3.73E-06 | 1.35E-06 | 2.57E-06 | 9.89E-07 |
| 42013NEI7104 | m-Xylene | 1.83E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 42013NEI7104 | o-Xylene | 1.83E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 42013NEI7104 | p-Xylene | 1.83E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 21007NEI11338 | Benzene | 1.83E-04 | 1.40E-06 | 9.15E-08 | 1.49E-06 | 4.96E-07 |
| 16069NEI26581 | Carbon tetrachloride | 1.82E-04 | 1.23E-06 | 2.88E-07 | 2.65E-06 | 5.48E-07 |
| 13021NEI26471 | Methyl bromide | 1.81E-04 | 0.00E+00 | 8.59E-07 | 0.00E+00 | 3.71E-06 |
| 55073NEI42689 | Benzene | 1.80E-04 | 1.38E-06 | 9.00E-08 | 1.46E-06 | 4.87E-07 |
| 22073NEI6057 | Styrene | 1.80E-04 | 4.44E-05 | 6.87E-06 | 1.80E-05 | 3.43E-06 |
| 42133NEI7181 | Benzene | 1.78E-04 | 1.36E-06 | 8.92E-08 | 1.45E-06 | 4.83E-07 |
| 37087NEI40282 | Tetrachloroethene | 1.77E-04 | 1.48E-05 | 2.22E-06 | 5.22E-06 | 2.53E-06 |
| 13099NEI26491 | Carbon tetrachloride | 1.77E-04 | 1.20E-06 | 2.80E-07 | 2.59E-06 | 5.34E-07 |
| 13021NEI26471 | Methylene chloride | 1.76E-04 | 3.58E-06 | 1.30E-06 | 2.47E-06 | 9.50E-07 |
| 16069NEI26581 | Benzene | 1.74E-04 | 1.33E-06 | 8.69E-08 | 1.41E-06 | 4.71E-07 |
| 26003NEI33866 | Chloroform | 1.74E-04 | 0.00E+00 | 8.40E-08 | 0.00E+00 | 1.08E-07 |
| 21091NEI32869A | Methylene chloride | 1.72E-04 | 3.50E-06 | 1.27E-06 | 2.41E-06 | 9.28E-07 |
| 13051NEI8186 | Carbon tetrachloride | 1.72E-04 | 1.17E-06 | 2.73E-07 | 2.52E-06 | 5.19E-07 |
| 26147NEI33981 | 1,2-Dimethoxyethane | 1.71E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13185NEI26504 | Benzene | 1.70E-04 | 1.30E-06 | 8.52E-08 | 1.38E-06 | 4.62E-07 |
| 22117NEI46814 | Toluene | 1.70E-04 | 8.37E-06 | 1.40E-06 | 3.30E-05 | 5.71E-06 |
| 21091NEI32869A | Styrene | 1.68E-04 | 4.15E-05 | 6.41E-06 | 1.68E-05 | 3.21E-06 |

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| 51580NEI759 | Toluene | 1.68E-04 | 8.27E-06 | 1.38E-06 | 3.27E-05 | 5.64E-06 |
| 22011NEI7559 | Hydrochloric acid | 1.68E-04 | 1.30E-04 | 1.07E-05 | 7.82E-05 | 1.17E-05 |
| 47107NEI41565 | Tetrachloroethene | 1.67E-04 | 1.39E-05 | 2.09E-06 | 4.92E-06 | 2.39E-06 |
| 45043NEI41314 | Tetrachloroethene | 1.66E-04 | 1.38E-05 | 2.07E-06 | 4.88E-06 | 2.37E-06 |
| 41039NEI45182 | Phenol | 1.65E-04 | 1.65E-05 | 1.07E-05 | 2.51E-05 | 5.03E-06 |
| 27017NEI12368 | Styrene | 1.64E-04 | 4.05E-05 | 6.26E-06 | 1.64E-05 | 3.13E-06 |
| 55141NEI42963 | Benzene | 1.59E-04 | 1.22E-06 | 7.97E-08 | 1.30E-06 | 4.32E-07 |
| 55141NEI46739 | Benzene | 1.59E-04 | 1.22E-06 | 7.97E-08 | 1.29E-06 | 4.31E-07 |
| 05029NEI46852 | Carbon disulfide | 1.59E-04 | 2.46E-05 | 1.97E-06 | 3.17E-04 | 6.14E-06 |
| 42047NEI40686 | Carbon disulfide | 1.58E-04 | 2.45E-05 | 1.96E-06 | 3.15E-04 | 6.11E-06 |
| 28077NEI11172 | Methylene chloride | 1.57E-04 | 3.18E-06 | 1.16E-06 | 2.20E-06 | 8.45E-07 |
| 27035NEI34020 | Phenol | 1.57E-04 | 1.57E-05 | 1.02E-05 | 2.39E-05 | 4.79E-06 |
| 01113NEI46931 | Xylenes (mixed) | 1.57E-04 | 6.16E-06 | 8.62E-07 | 0.00E+00 | 0.00E+00 |
| 04017NEI13216 | Methylene chloride | 1.57E-04 | 3.18E-06 | 1.15E-06 | 2.19E-06 | 8.44E-07 |
| 12005NEI8278 | Methylene chloride | 1.55E-04 | 3.14E-06 | 1.14E-06 | 2.17E-06 | 8.34E-07 |
| 27145NEI12407 | Methylene chloride | 1.54E-04 | 3.11E-06 | 1.13E-06 | 2.15E-06 | 8.27E-07 |
| 41007NEI40554 | Carbon tetrachloride | 1.53E-04 | 1.04E-06 | 2.43E-07 | 2.24E-06 | 4.62E-07 |
| 37117NEI9201 | Methylene chloride | 1.53E-04 | 3.11E-06 | 1.13E-06 | 2.15E-06 | 8.25E-07 |
| 26101NEI33945 | Methylene chloride | 1.53E-04 | 3.11E-06 | 1.13E-06 | 2.14E-06 | 8.24E-07 |
| 37049NEI45206 | Methylene chloride | 1.53E-04 | 3.10E-06 | 1.12E-06 | 2.14E-06 | 8.22E-07 |
| 13127NEI8196 | o-Xylene | 1.52E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23019NEI33104 | Benzene | 1.52E-04 | 1.16E-06 | 7.60E-08 | 1.23E-06 | 4.11E-07 |
| 37117NEI9201 | Carbon disulfide | 1.51E-04 | 2.34E-05 | 1.87E-06 | 3.02E-04 | 5.85E-06 |
| 47085NEI46866 | Toluene | 1.51E-04 | 7.44E-06 | 1.24E-06 | 2.94E-05 | 5.07E-06 |
| 47071NEI41552 | Toluene | 1.50E-04 | 7.41E-06 | 1.23E-06 | 2.92E-05 | 5.05E-06 |
| 55141NEI42695 | Benzene | 1.50E-04 | 1.14E-06 | 7.48E-08 | 1.22E-06 | 4.05E-07 |
| 27145NEI12407 | 1,1,1-Trichloroethane | 1.49E-04 | 7.78E-06 | 3.06E-06 | 5.32E-06 | 2.66E-06 |
| 51101NEI42254 | Toluene | 1.48E-04 | 7.32E-06 | 1.22E-06 | 2.89E-05 | 4.99E-06 |
| 48067NEI41628 | Toluene | 1.47E-04 | 7.25E-06 | 1.21E-06 | 2.86E-05 | 4.94E-06 |
| 42133NEI7181 | Carbon tetrachloride | 1.47E-04 | 9.95E-07 | 2.32E-07 | 2.14E-06 | 4.42E-07 |
| 01071NEI18347 | Toluene | 1.46E-04 | 7.21E-06 | 1.20E-06 | 2.85E-05 | 4.92E-06 |
| 54057NEI706 | Xylenes (mixed) | 1.46E-04 | 5.72E-06 | 8.01E-07 | 0.00E+00 | 0.00E+00 |
| 37087NEI40282 | Carbon tetrachloride | 1.46E-04 | 9.88E-07 | 2.31E-07 | 2.13E-06 | 4.39E-07 |
| 05081NEI18660 | Benzene | 1.45E-04 | 1.11E-06 | 7.26E-08 | 1.18E-06 | 3.93E-07 |
| 51101NEI42254 | o-Xylene | 1.42E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55087NEI43207 | Benzene | 1.41E-04 | 1.08E-06 | 7.07E-08 | 1.15E-06 | 3.83E-07 |
| 05003NEI54342 | Styrene | 1.41E-04 | 3.49E-05 | 5.40E-06 | 1.41E-05 | 2.70E-06 |
| 55139NEIWI4710355 | Formaldehyde | 1.41E-04 | 7.04E-06 | 4.55E-07 | 6.45E-06 | 6.45E-07 |
| 13127NEI8196 | Tetrachloroethene | 1.40E-04 | 1.17E-05 | 1.75E-06 | 4.13E-06 | 2.00E-06 |
| 27061NEI34030 | Methylene chloride | 1.39E-04 | 2.83E-06 | 1.03E-06 | 1.95E-06 | 7.51E-07 |
| 23017NEI6273 | Methylene chloride | 1.39E-04 | 2.83E-06 | 1.03E-06 | 1.95E-06 | 7.50E-07 |
| 45091NEI47077 | Toluene | 1.38E-04 | 6.82E-06 | 1.14E-06 | 2.69E-05 | 4.65E-06 |
| 41043NEI13340 | Vinyl chloride | 1.37E-04 | 3.86E-05 | 7.97E-06 | 1.90E-05 | 1.90E-06 |
| 53009NEI42329 | Methylene chloride | 1.37E-04 | 2.77E-06 | 1.01E-06 | 1.91E-06 | 7.36E-07 |
| 55097NEIWI7500086 | Methanol | 1.36E-04 | 5.54E-06 | 1.42E-06 | 1.47E-05 | 2.94E-06 |
| 27017NEI12368 | Tetrachloroethene | 1.36E-04 | 1.13E-05 | 1.70E-06 | 3.99E-06 | 1.94E-06 |
| 36045NEI36019 | Chloroform | 1.36E-04 | 0.00E+00 | 6.56E-08 | 0.00E+00 | 8.47E-08 |
| 42013NEI7106 | Methanol | 1.35E-04 | 5.49E-06 | 1.40E-06 | 1.46E-05 | 2.91E-06 |
| 47163NEI41599 | Methylene chloride | 1.35E-04 | 2.74E-06 | 9.95E-07 | 1.89E-06 | 7.27E-07 |
| 51670NEI42317 | Styrene | 1.33E-04 | 3.27E-05 | 5.06E-06 | 1.33E-05 | 2.53E-06 |
| 12089NEI26382 | Carbon tetrachloride | 1.31E-04 | 8.89E-07 | 2.07E-07 | 1.92E-06 | 3.95E-07 |
| 55085NEI43202 | Nickel compounds | 1.31E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01099NEI18373 | Xylenes (mixed) | 1.30E-04 | 5.10E-06 | 7.14E-07 | 0.00E+00 | 0.00E+00 |
| 12123NEI47091 | Styrene | 1.29E-04 | 3.19E-05 | 4.93E-06 | 1.29E-05 | 2.46E-06 |
| 22117NEI46814 | Tetrachloroethene | 1.29E-04 | 1.07E-05 | 1.61E-06 | 3.79E-06 | 1.84E-06 |

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|---|---|---|---|---|---|---|
| 37049NEI45206 | Benzene | 1.28E-04 | 9.80E-07 | 6.41E-08 | 1.04E-06 | 3.47E-07 |
| 28149NEI34070 | Methylene chloride | 1.28E-04 | 2.60E-06 | 9.43E-07 | 1.79E-06 | 6.89E-07 |
| 21091NEI32869A | Toluene | 1.28E-04 | 6.32E-06 | 1.05E-06 | 2.49E-05 | 4.31E-06 |
| 01079NEI18357 | o-Xylene | 1.28E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23007NEI6261 | Benzene | 1.27E-04 | 9.70E-07 | 6.34E-08 | 1.03E-06 | 3.44E-07 |
| 53011NEI46599 | Xylenes (mixed) | 1.27E-04 | 4.98E-06 | 6.97E-07 | 0.00E+00 | 0.00E+00 |
| 40089NEI11251 | 1,2-Dimethoxyethane | 1.27E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23009NEI6284 | Carbon disulfide | 1.27E-04 | 1.96E-05 | 1.57E-06 | 2.53E-04 | 4.91E-06 |
| 51580NEI759 | o-Xylene | 1.26E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 51019NEI42211 | Toluene | 1.26E-04 | 6.19E-06 | 1.03E-06 | 2.44E-05 | 4.22E-06 |
| 12033NEI26309 | Benzene | 1.25E-04 | 9.56E-07 | 6.25E-08 | 1.02E-06 | 3.38E-07 |
| 01131NEI8619 | Benzene | 1.25E-04 | 9.54E-07 | 6.24E-08 | 1.01E-06 | 3.38E-07 |
| 26101NEI33945 | Toluene | 1.24E-04 | 6.13E-06 | 1.02E-06 | 2.42E-05 | 4.18E-06 |
| 01113NEI46931 | Tetrachloroethene | 1.24E-04 | 1.03E-05 | 1.55E-06 | 3.65E-06 | 1.77E-06 |
| 26147NEI33981 | Methanol | 1.24E-04 | 5.03E-06 | 1.29E-06 | 1.34E-05 | 2.67E-06 |
| 55141NEI42695 | Tetrachloroethene | 1.23E-04 | 1.03E-05 | 1.54E-06 | 3.62E-06 | 1.76E-06 |
| 22049NEI33023 | Carbon tetrachloride | 1.23E-04 | 8.35E-07 | 1.95E-07 | 1.80E-06 | 3.71E-07 |
| 51580NEI759 | Tetrachloroethene | 1.23E-04 | 1.02E-05 | 1.53E-06 | 3.61E-06 | 1.75E-06 |
| 45079NEI46760 | Benzene | 1.22E-04 | 9.36E-07 | 6.12E-08 | 9.95E-07 | 3.32E-07 |
| 45019NEI41252 | Styrene | 1.22E-04 | 3.02E-05 | 4.67E-06 | 1.22E-05 | 2.33E-06 |
| 12123NEI47091 | Tetrachloroethene | 1.22E-04 | 1.02E-05 | 1.53E-06 | 3.59E-06 | 1.74E-06 |
| 27137NEIMN14904 | Chloroform | 1.22E-04 | 0.00E+00 | 5.89E-08 | 0.00E+00 | 7.61E-08 |
| 55009NEIWI4050324 | Nickel compounds | 1.20E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22033NEI46817 | Tetrachloroethene | 1.20E-04 | 9.96E-06 | 1.49E-06 | 3.52E-06 | 1.71E-06 |
| 13305NEI26526 | Toluene | 1.19E-04 | 5.88E-06 | 9.81E-07 | 2.32E-05 | 4.01E-06 |
| 28077NEI11172 | Tetrachloroethene | 1.19E-04 | 9.92E-06 | 1.49E-06 | 3.50E-06 | 1.70E-06 |
| 53071NEI42410 | o-Xylene | 1.18E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 26041NEI33883 | Xylenes (mixed) | 1.18E-04 | 4.63E-06 | 6.48E-07 | 0.00E+00 | 0.00E+00 |
| 41007NEI40554 | Methylene chloride | 1.18E-04 | 2.39E-06 | 8.68E-07 | 1.65E-06 | 6.34E-07 |
| 12107NEI8265 | Mercury (elemental) | 1.17E-04 | 0.00E+00 | 4.15E-08 | 0.00E+00 | 3.52E-08 |
| 13305NEI26526 | Tetrachloroethene | 1.17E-04 | 9.78E-06 | 1.47E-06 | 3.45E-06 | 1.68E-06 |
| 45041NEI7933 | Tetrachloroethene | 1.17E-04 | 9.74E-06 | 1.46E-06 | 3.44E-06 | 1.67E-06 |
| 22117NEI46814 | Styrene | 1.17E-04 | 2.88E-05 | 4.46E-06 | 1.17E-05 | 2.23E-06 |
| 01091NEI45474 | Carbon tetrachloride | 1.16E-04 | 7.86E-07 | 1.84E-07 | 1.69E-06 | 3.50E-07 |
| 05003NEI54342 | Carbon disulfide | 1.16E-04 | 1.79E-05 | 1.43E-06 | 2.31E-04 | 4.48E-06 |
| 12107NEI8265 | Tetrachloroethene | 1.15E-04 | 9.61E-06 | 1.44E-06 | 3.39E-06 | 1.65E-06 |
| 28149NEI34070 | Tetrachloroethene | 1.15E-04 | 9.60E-06 | 1.44E-06 | 3.39E-06 | 1.65E-06 |
| 22031NEI33013 | Styrene | 1.15E-04 | 2.84E-05 | 4.39E-06 | 1.15E-05 | 2.20E-06 |
| 41039NEI45182 | 1,2-Dimethoxyethane | 1.15E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41071NEI40648 | Benzene | 1.14E-04 | 8.73E-07 | 5.71E-08 | 9.27E-07 | 3.09E-07 |
| 01053NEI18338 | Methylene chloride | 1.14E-04 | 2.31E-06 | 8.40E-07 | 1.60E-06 | 6.14E-07 |
| 27017NEI12368 | Benzene | 1.13E-04 | 8.62E-07 | 5.63E-08 | 9.16E-07 | 3.05E-07 |
| 45091NEI47077 | Phenol | 1.13E-04 | 1.13E-05 | 7.34E-06 | 1.72E-05 | 3.44E-06 |
| 55139NEIWI4710355 | Arsenic compounds | 1.13E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39061NEI11610 | Nickel compounds | 1.12E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39031NEI11461 | Carbon disulfide | 1.12E-04 | 1.74E-05 | 1.39E-06 | 2.24E-04 | 4.34E-06 |
| 47107NEI41565 | Toluene | 1.12E-04 | 5.51E-06 | 9.18E-07 | 2.17E-05 | 3.75E-06 |
| 13051NEI8186 | Methylene chloride | 1.11E-04 | 2.25E-06 | 8.18E-07 | 1.55E-06 | 5.98E-07 |
| 54057NEI706 | Carbon tetrachloride | 1.09E-04 | 7.40E-07 | 1.73E-07 | 1.59E-06 | 3.29E-07 |
| 13179NEI8177 | Benzene | 1.08E-04 | 8.28E-07 | 5.41E-08 | 8.80E-07 | 2.93E-07 |
| 05029NEI46852 | Toluene | 1.08E-04 | 5.34E-06 | 8.89E-07 | 2.11E-05 | 3.64E-06 |
| 16069NEI26581 | Tetrachloroethene | 1.08E-04 | 8.98E-06 | 1.35E-06 | 3.17E-06 | 1.54E-06 |
| 41039NEI45182 | Benzene | 1.07E-04 | 8.17E-07 | 5.34E-08 | 8.68E-07 | 2.89E-07 |
| 23019NEI33104 | Nickel compounds | 1.06E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53071NEI42410 | Xylenes (mixed) | 1.06E-04 | 4.15E-06 | 5.81E-07 | 0.00E+00 | 0.00E+00 |

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| 51670NEI42317 | p-Xylene | 1.05E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22011NEI7559 | Chlorine | 1.04E-04 | 1.45E-05 | 3.76E-06 | 7.52E-06 | 2.51E-06 |
| 55141NEIWI7720116 | Phenol | 1.02E-04 | 1.02E-05 | 6.65E-06 | 1.56E-05 | 3.12E-06 |
| 48241NEI6450 | Tetrachloroethene | 1.01E-04 | 8.43E-06 | 1.26E-06 | 2.97E-06 | 1.44E-06 |
| 12123NEI47091 | Methylene chloride | 1.01E-04 | 2.04E-06 | 7.42E-07 | 1.41E-06 | 5.42E-07 |
| 39141NEI40488 | Arsenic compounds | 1.01E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 28087NEI34064 | Methylene chloride | 1.01E-04 | 2.04E-06 | 7.41E-07 | 1.41E-06 | 5.42E-07 |
| 45043NEI41314 | Toluene | 9.98E-05 | 4.92E-06 | 8.21E-07 | 1.94E-05 | 3.36E-06 |
| 13175NEIGAT$3911 | Methylene chloride | 9.96E-05 | 2.02E-06 | 7.34E-07 | 1.39E-06 | 5.36E-07 |
| 41043NEI13340 | Toluene | 9.95E-05 | 4.91E-06 | 8.18E-07 | 1.94E-05 | 3.35E-06 |
| 47163NEI41599 | Benzene | 9.93E-05 | 7.60E-07 | 4.97E-08 | 8.07E-07 | 2.69E-07 |
| 13051NEI8186 | Tetrachloroethene | 9.92E-05 | 8.27E-06 | 1.24E-06 | 2.92E-06 | 1.42E-06 |
| 18165NEI2INT16350 | Carbon disulfide | 9.91E-05 | 1.54E-05 | 1.23E-06 | 1.98E-04 | 3.84E-06 |
| 05003NEI54342 | Toluene | 9.86E-05 | 4.87E-06 | 8.11E-07 | 1.92E-05 | 3.32E-06 |
| 26003NEI33866 | Phenol | 9.86E-05 | 9.86E-06 | 6.42E-06 | 1.50E-05 | 3.01E-06 |
| 01121NEI18390 | Benzene | 9.82E-05 | 7.51E-07 | 4.91E-08 | 7.98E-07 | 2.66E-07 |
| 27035NEI34020 | Methanol | 9.74E-05 | 3.95E-06 | 1.01E-06 | 1.05E-05 | 2.10E-06 |
| 01079NEI18357 | Toluene | 9.68E-05 | 4.77E-06 | 7.96E-07 | 1.88E-05 | 3.25E-06 |
| 23019NEI33104 | Phenol | 9.66E-05 | 9.66E-06 | 6.30E-06 | 1.47E-05 | 2.95E-06 |
| 13051NEI26476 | Xylenes (mixed) | 9.56E-05 | 3.75E-06 | 5.26E-07 | 0.00E+00 | 0.00E+00 |
| 48241NEI6450 | Xylenes (mixed) | 9.39E-05 | 3.69E-06 | 5.16E-07 | 0.00E+00 | 0.00E+00 |
| 42013NEI7104 | Toluene | 9.32E-05 | 4.60E-06 | 7.67E-07 | 1.82E-05 | 3.14E-06 |
| 28111NEI34066 | Benzene | 9.32E-05 | 7.13E-07 | 4.66E-08 | 7.57E-07 | 2.52E-07 |
| 22049NEI33023 | Tetrachloroethene | 9.28E-05 | 7.73E-06 | 1.16E-06 | 2.73E-06 | 1.33E-06 |
| 05041NEI18652 | Phenol | 9.22E-05 | 9.22E-06 | 6.01E-06 | 1.41E-05 | 2.81E-06 |
| 39017NEI11602 | Methanol | 9.22E-05 | 3.74E-06 | 9.56E-07 | 9.92E-06 | 1.98E-06 |
| 12107NEI8265 | Styrene | 9.13E-05 | 2.25E-05 | 3.48E-06 | 9.13E-06 | 1.74E-06 |
| 27017NEI12368 | Arsenic compounds | 9.06E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13103NEI8178 | Arsenic compounds | 9.02E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 16069NEI26581 | Methylene chloride | 8.88E-05 | 1.80E-06 | 6.54E-07 | 1.24E-06 | 4.78E-07 |
| 41041NEI40600 | Styrene | 8.87E-05 | 2.19E-05 | 3.39E-06 | 8.87E-06 | 1.69E-06 |
| 01099NEI18373 | Carbon disulfide | 8.84E-05 | 1.37E-05 | 1.10E-06 | 1.77E-04 | 3.43E-06 |
| 55009NEI42482 | Nickel compounds | 8.80E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55085NEI43202 | Chloroform | 8.75E-05 | 0.00E+00 | 4.23E-08 | 0.00E+00 | 5.47E-08 |
| 51670NEI42317 | Toluene | 8.74E-05 | 4.31E-06 | 7.19E-07 | 1.70E-05 | 2.94E-06 |
| 41071NEI40648 | Carbon disulfide | 8.73E-05 | 1.35E-05 | 1.08E-06 | 1.75E-04 | 3.38E-06 |
| 12123NEI47091 | Xylenes (mixed) | 8.65E-05 | 3.40E-06 | 4.76E-07 | 0.00E+00 | 0.00E+00 |
| 27071NEI12411 | Benzene | 8.56E-05 | 6.55E-07 | 4.28E-08 | 6.96E-07 | 2.32E-07 |
| 39113NEI11645 | Hydrochloric acid | 8.55E-05 | 6.65E-05 | 5.44E-06 | 3.99E-05 | 5.99E-06 |
| 22011NEI7559 | Xylenes (mixed) | 8.54E-05 | 3.35E-06 | 4.70E-07 | 0.00E+00 | 0.00E+00 |
| 13021NEI26471 | o-Xylene | 8.54E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27061NEI34030 | Benzene | 8.52E-05 | 6.51E-07 | 4.26E-08 | 6.92E-07 | 2.31E-07 |
| 01079NEI18357 | Xylenes (mixed) | 8.49E-05 | 3.34E-06 | 4.67E-07 | 0.00E+00 | 0.00E+00 |
| 53053NEI13363 | Styrene | 8.48E-05 | 2.10E-05 | 3.24E-06 | 8.48E-06 | 1.62E-06 |
| 37083NEI47104 | Chloroform | 8.46E-05 | 0.00E+00 | 4.10E-08 | 0.00E+00 | 5.29E-08 |
| 22031NEI33013 | Toluene | 8.43E-05 | 4.16E-06 | 6.93E-07 | 1.64E-05 | 2.84E-06 |
| 41071NEI40648 | Styrene | 8.36E-05 | 2.07E-05 | 3.19E-06 | 8.36E-06 | 1.60E-06 |
| 12005NEI8278 | Tetrachloroethene | 8.35E-05 | 6.95E-06 | 1.04E-06 | 2.45E-06 | 1.19E-06 |
| 53071NEI42410 | Toluene | 8.33E-05 | 4.11E-06 | 6.85E-07 | 1.62E-05 | 2.80E-06 |
| 55141NEI42695 | Xylenes (mixed) | 8.31E-05 | 3.27E-06 | 4.57E-07 | 0.00E+00 | 0.00E+00 |
| 55073NEI42689 | Tetrachloroethene | 8.29E-05 | 6.91E-06 | 1.04E-06 | 2.44E-06 | 1.18E-06 |
| 05029NEI46852 | m-Xylene | 8.23E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55141NEI46739 | Methylene chloride | 8.21E-05 | 1.66E-06 | 6.05E-07 | 1.15E-06 | 4.42E-07 |
| 36115NEINY5533400 | Acetaldehyde | 8.15E-05 | 4.73E-07 | 7.82E-08 | 2.13E-06 | 1.06E-07 |
| 51670NEI42317 | Carbon disulfide | 8.12E-05 | 1.26E-05 | 1.01E-06 | 1.62E-04 | 3.15E-06 |

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| 23007NEI6261 | Nickel compounds | 8.12E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55085NEI43202 | Mercury (elemental) | 8.10E-05 | 0.00E+00 | 2.86E-08 | 0.00E+00 | 2.43E-08 |
| 01099NEI18373 | Methylene chloride | 8.09E-05 | 1.64E-06 | 5.96E-07 | 1.13E-06 | 4.36E-07 |
| 13099NEI26491 | Tetrachloroethene | 8.05E-05 | 6.71E-06 | 1.01E-06 | 2.37E-06 | 1.15E-06 |
| 55141NEI46739 | Xylenes (mixed) | 8.01E-05 | 3.15E-06 | 4.41E-07 | 0.00E+00 | 0.00E+00 |
| 27071NEI12411 | Methylene chloride | 8.01E-05 | 1.63E-06 | 5.90E-07 | 1.12E-06 | 4.31E-07 |
| 12089NEI8261 | Tetrachloroethene | 7.95E-05 | 6.63E-06 | 9.94E-07 | 2.34E-06 | 1.14E-06 |
| 28077NEI11172 | Styrene | 7.93E-05 | 1.96E-05 | 3.03E-06 | 7.93E-06 | 1.51E-06 |
| 39141NEI40488 | Styrene | 7.90E-05 | 1.95E-05 | 3.02E-06 | 7.90E-06 | 1.51E-06 |
| 05029NEI46852 | p-Xylene | 7.84E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45019NEI41252 | Xylenes (mixed) | 7.79E-05 | 3.06E-06 | 4.28E-07 | 0.00E+00 | 0.00E+00 |
| 01001NEI8560 | Styrene | 7.66E-05 | 1.89E-05 | 2.93E-06 | 7.66E-06 | 1.46E-06 |
| 18165NEI2INT16350 | Methylene chloride | 7.62E-05 | 1.55E-06 | 5.62E-07 | 1.07E-06 | 4.11E-07 |
| 12123NEI47091 | Toluene | 7.61E-05 | 3.75E-06 | 6.25E-07 | 1.48E-05 | 2.56E-06 |
| 22011NEI7559 | Styrene | 7.59E-05 | 1.88E-05 | 2.90E-06 | 7.59E-06 | 1.45E-06 |
| 55009NEIWI4050324 | Mercury (elemental) | 7.55E-05 | 0.00E+00 | 2.66E-08 | 0.00E+00 | 2.26E-08 |
| 51670NEI42317 | Tetrachloroethene | 7.50E-05 | 6.25E-06 | 9.38E-07 | 2.21E-06 | 1.07E-06 |
| 23025NEI33118 | Benzene | 7.49E-05 | 5.73E-07 | 3.75E-08 | 6.09E-07 | 2.03E-07 |
| 05029NEI46852 | o-Xylene | 7.42E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27071NEI12411 | Carbon tetrachloride | 7.34E-05 | 4.98E-07 | 1.16E-07 | 1.07E-06 | 2.21E-07 |
| 45041NEI7933 | Xylenes (mixed) | 7.34E-05 | 2.88E-06 | 4.04E-07 | 0.00E+00 | 0.00E+00 |
| 13099NEI26491 | Methyl bromide | 7.33E-05 | 0.00E+00 | 3.49E-07 | 0.00E+00 | 1.50E-06 |
| 55009NEIWI4050324 | Methanol | 7.33E-05 | 2.97E-06 | 7.60E-07 | 7.89E-06 | 1.58E-06 |
| 05029NEI46852 | Styrene | 7.33E-05 | 1.81E-05 | 2.80E-06 | 7.33E-06 | 1.40E-06 |
| 28149NEI34070 | Styrene | 7.28E-05 | 1.80E-05 | 2.78E-06 | 7.28E-06 | 1.39E-06 |
| 42013NEI7104 | 1,1,1-Trichloroethane | 7.19E-05 | 3.76E-06 | 1.48E-06 | 2.57E-06 | 1.29E-06 |
| 13051NEI8186 | Phenol | 7.17E-05 | 7.17E-06 | 4.67E-06 | 1.09E-05 | 2.19E-06 |
| 26041NEI33883 | Methylene chloride | 7.16E-05 | 1.45E-06 | 5.28E-07 | 1.00E-06 | 3.86E-07 |
| 22049NEI33023 | Toluene | 7.13E-05 | 3.52E-06 | 5.87E-07 | 1.39E-05 | 2.40E-06 |
| 28043NEI11108 | Methylene chloride | 7.13E-05 | 1.45E-06 | 5.25E-07 | 9.98E-07 | 3.84E-07 |
| 05003NEI54342 | Nickel compounds | 7.10E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12089NEI8261 | o-Xylene | 7.08E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45069NEI47074 | Toluene | 7.03E-05 | 3.47E-06 | 5.78E-07 | 1.37E-05 | 2.37E-06 |
| 45091NEI47077 | Nickel compounds | 7.03E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23009NEI6284 | Benzene | 7.01E-05 | 5.36E-07 | 3.51E-08 | 5.70E-07 | 1.90E-07 |
| 48241NEI6450 | Chlorine | 6.97E-05 | 9.76E-06 | 2.52E-06 | 5.05E-06 | 1.68E-06 |
| 40089NEI11251 | o-Xylene | 6.96E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01099NEI18373 | Toluene | 6.89E-05 | 3.40E-06 | 5.66E-07 | 1.34E-05 | 2.32E-06 |
| 40089NEI11251 | Styrene | 6.86E-05 | 1.70E-05 | 2.62E-06 | 6.86E-06 | 1.31E-06 |
| 51101NEI42254 | Styrene | 6.85E-05 | 1.69E-05 | 2.62E-06 | 6.85E-06 | 1.31E-06 |
| 53053NEI13363 | Xylenes (mixed) | 6.81E-05 | 2.68E-06 | 3.75E-07 | 0.00E+00 | 0.00E+00 |
| 51085NEI208 | Benzene | 6.69E-05 | 5.12E-07 | 3.35E-08 | 5.44E-07 | 1.81E-07 |
| 42047NEI40686 | Styrene | 6.66E-05 | 1.64E-05 | 2.54E-06 | 6.66E-06 | 1.27E-06 |
| 36115NEINY5532600 | Acetaldehyde | 6.59E-05 | 3.82E-07 | 6.32E-08 | 1.72E-06 | 8.60E-08 |
| 41041NEI40600 | Toluene | 6.56E-05 | 3.24E-06 | 5.39E-07 | 1.28E-05 | 2.21E-06 |
| 51670NEI42317 | Xylenes (mixed) | 6.51E-05 | 2.56E-06 | 3.58E-07 | 0.00E+00 | 0.00E+00 |
| 45043NEI41314 | Methylene chloride | 6.50E-05 | 1.32E-06 | 4.79E-07 | 9.10E-07 | 3.50E-07 |
| 51019NEI42211 | Styrene | 6.46E-05 | 1.60E-05 | 2.47E-06 | 6.46E-06 | 1.23E-06 |
| 22049NEI33023 | Styrene | 6.46E-05 | 1.60E-05 | 2.47E-06 | 6.46E-06 | 1.23E-06 |
| 55141NEI42695 | Styrene | 6.41E-05 | 1.58E-05 | 2.45E-06 | 6.41E-06 | 1.22E-06 |
| 55009NEI42482 | Xylenes (mixed) | 6.39E-05 | 2.51E-06 | 3.51E-07 | 0.00E+00 | 0.00E+00 |
| 53071NEI42410 | Tetrachloroethene | 6.34E-05 | 5.29E-06 | 7.93E-07 | 1.87E-06 | 9.06E-07 |
| 55141NEI42961 | Benzene | 6.34E-05 | 4.85E-07 | 3.17E-08 | 5.15E-07 | 1.72E-07 |
| 37047NEI40247 | Methylene chloride | 6.33E-05 | 1.29E-06 | 4.67E-07 | 8.87E-07 | 3.41E-07 |
| 45069NEI47074 | 1,1,1-Trichloroethane | 6.31E-05 | 3.30E-06 | 1.30E-06 | 2.26E-06 | 1.13E-06 |

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| 27061NEI34030 | Toluene | 6.30E-05 | 3.11E-06 | 5.18E-07 | 1.23E-05 | 2.12E-06 |
| 40089NEI11251 | Xylenes (mixed) | 6.29E-05 | 2.47E-06 | 3.46E-07 | 0.00E+00 | 0.00E+00 |
| 21007NEI11338 | Tetrachloroethene | 6.28E-05 | 5.24E-06 | 7.85E-07 | 1.85E-06 | 8.98E-07 |
| 26003NEI33866 | Methanol | 6.28E-05 | 2.55E-06 | 6.51E-07 | 6.76E-06 | 1.35E-06 |
| 53053NEI13363 | Carbon tetrachloride | 6.27E-05 | 4.25E-07 | 9.93E-08 | 9.16E-07 | 1.89E-07 |
| 12107NEI8265 | Xylenes (mixed) | 6.05E-05 | 2.38E-06 | 3.33E-07 | 0.00E+00 | 0.00E+00 |
| 40101NEI12980 | Nickel compounds | 6.03E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55141NEI42961 | Formaldehyde | 5.99E-05 | 3.00E-06 | 1.94E-07 | 2.75E-06 | 2.75E-07 |
| 28111NEI34066 | Methyl bromide | 5.99E-05 | 0.00E+00 | 2.85E-07 | 0.00E+00 | 1.23E-06 |
| 48241NEI6450 | Styrene | 5.98E-05 | 1.48E-05 | 2.28E-06 | 5.98E-06 | 1.14E-06 |
| 13099NEI26491 | Styrene | 5.97E-05 | 1.48E-05 | 2.28E-06 | 5.97E-06 | 1.14E-06 |
| 53009NEI42329 | Toluene | 5.95E-05 | 2.93E-06 | 4.89E-07 | 1.16E-05 | 2.00E-06 |
| 01001NEI8560 | Toluene | 5.94E-05 | 2.93E-06 | 4.88E-07 | 1.16E-05 | 2.00E-06 |
| 01099NEI18373 | Chlorine | 5.94E-05 | 8.31E-06 | 2.15E-06 | 4.30E-06 | 1.43E-06 |
| 05029NEI46852 | Phenol | 5.93E-05 | 5.93E-06 | 3.87E-06 | 9.06E-06 | 1.81E-06 |
| 05003NEI54342 | Tetrachloroethene | 5.91E-05 | 4.93E-06 | 7.39E-07 | 1.74E-06 | 8.44E-07 |
| 01071NEI18347 | Methylene chloride | 5.88E-05 | 1.19E-06 | 4.33E-07 | 8.23E-07 | 3.17E-07 |
| 48067NEI41628 | Arsenic compounds | 5.87E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01025NEI8601 | Benzene | 5.85E-05 | 4.47E-07 | 2.92E-08 | 4.75E-07 | 1.58E-07 |
| 28077NEI11172 | Toluene | 5.83E-05 | 2.88E-06 | 4.79E-07 | 1.14E-05 | 1.96E-06 |
| 13103NEI8178 | Methylene chloride | 5.82E-05 | 1.18E-06 | 4.28E-07 | 8.14E-07 | 3.13E-07 |
| 12005NEI8278 | o-Xylene | 5.81E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 21091NEI32869A | Tetrachloroethene | 5.71E-05 | 4.76E-06 | 7.14E-07 | 1.68E-06 | 8.16E-07 |
| 12107NEI8265 | Methylene chloride | 5.71E-05 | 1.16E-06 | 4.21E-07 | 7.99E-07 | 3.07E-07 |
| 01001NEI8560 | 1,2-Dimethoxyethane | 5.68E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41007NEI40554 | Benzene | 5.65E-05 | 4.32E-07 | 2.83E-08 | 4.59E-07 | 1.53E-07 |
| 53071NEI42410 | 1,1,1-Trichloroethane | 5.61E-05 | 2.94E-06 | 1.16E-06 | 2.01E-06 | 1.00E-06 |
| 13305NEI26526 | Styrene | 5.61E-05 | 1.39E-05 | 2.14E-06 | 5.61E-06 | 1.07E-06 |
| 45041NEI7933 | Styrene | 5.56E-05 | 1.37E-05 | 2.12E-06 | 5.56E-06 | 1.06E-06 |
| 55009NEI42482 | Mercury (elemental) | 5.50E-05 | 0.00E+00 | 1.94E-08 | 0.00E+00 | 1.65E-08 |
| 53053NEI13363 | o-Xylene | 5.42E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 47107NEI41565 | o-Xylene | 5.31E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01091NEI45474 | Toluene | 5.26E-05 | 2.59E-06 | 4.32E-07 | 1.02E-05 | 1.77E-06 |
| 45019NEI41252 | Toluene | 5.23E-05 | 2.58E-06 | 4.30E-07 | 1.02E-05 | 1.76E-06 |
| 42047NEI40686 | Xylenes (mixed) | 5.22E-05 | 2.05E-06 | 2.87E-07 | 0.00E+00 | 0.00E+00 |
| 01079NEI18357 | Tetrachloroethene | 5.19E-05 | 4.33E-06 | 6.49E-07 | 1.53E-06 | 7.42E-07 |
| 01001NEI8560 | Xylenes (mixed) | 5.19E-05 | 2.04E-06 | 2.85E-07 | 0.00E+00 | 0.00E+00 |
| 37047NEI40247 | o-Xylene | 5.16E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12005NEI8278 | Xylenes (mixed) | 5.11E-05 | 2.01E-06 | 2.81E-07 | 0.00E+00 | 0.00E+00 |
| 28111NEI34066 | Methylene chloride | 5.03E-05 | 1.02E-06 | 3.71E-07 | 7.05E-07 | 2.71E-07 |
| 12089NEI8261 | Styrene | 5.00E-05 | 1.24E-05 | 1.91E-06 | 5.00E-06 | 9.55E-07 |
| 12089NEI8261 | Xylenes (mixed) | 5.00E-05 | 1.96E-06 | 2.75E-07 | 0.00E+00 | 0.00E+00 |
| 12031NEI26304 | Carbon disulfide | 4.99E-05 | 7.73E-06 | 6.19E-07 | 9.98E-05 | 1.93E-06 |
| 53053NEI13363 | Toluene | 4.99E-05 | 2.46E-06 | 4.10E-07 | 9.71E-06 | 1.68E-06 |
| 22069NEI33025 | Carbon tetrachloride | 4.97E-05 | 3.37E-07 | 7.86E-08 | 7.26E-07 | 1.50E-07 |
| 36031NEI35908 | Benzene | 4.94E-05 | 3.78E-07 | 2.47E-08 | 4.01E-07 | 1.34E-07 |
| 16069NEI26581 | Styrene | 4.91E-05 | 1.21E-05 | 1.87E-06 | 4.91E-06 | 9.37E-07 |
| 01131NEI8619 | 1,2-Dimethoxyethane | 4.88E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55141NEI46739 | Phenol | 4.83E-05 | 4.83E-06 | 3.15E-06 | 7.38E-06 | 1.48E-06 |
| 26109NEI33950 | Methanol | 4.82E-05 | 1.96E-06 | 5.00E-07 | 5.19E-06 | 1.04E-06 |
| 41039NEI45182 | Carbon tetrachloride | 4.81E-05 | 3.27E-07 | 7.62E-08 | 7.04E-07 | 1.45E-07 |
| 26147NEI33981 | Methylene chloride | 4.80E-05 | 9.74E-07 | 3.54E-07 | 6.72E-07 | 2.58E-07 |
| 28077NEI11172 | o-Xylene | 4.80E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41041NEI40600 | Xylenes (mixed) | 4.79E-05 | 1.88E-06 | 2.63E-07 | 0.00E+00 | 0.00E+00 |
| 01025NEI8601 | Carbon disulfide | 4.75E-05 | 7.37E-06 | 5.89E-07 | 9.51E-05 | 1.84E-06 |

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| 13021NEI26471 | Toluene | 4.72E-05 | 2.33E-06 | 3.88E-07 | 9.19E-06 | 1.59E-06 |
| 01053NEI18338 | o-Xylene | 4.72E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 28149NEI34070 | Xylenes (mixed) | 4.70E-05 | 1.85E-06 | 2.58E-07 | 0.00E+00 | 0.00E+00 |
| 21007NEI11338 | Toluene | 4.67E-05 | 2.30E-06 | 3.84E-07 | 9.09E-06 | 1.57E-06 |
| 28111NEI34066 | Carbon tetrachloride | 4.66E-05 | 3.16E-07 | 7.37E-08 | 6.80E-07 | 1.40E-07 |
| 23019NEI33103 | Toluene | 4.65E-05 | 2.30E-06 | 3.83E-07 | 9.06E-06 | 1.57E-06 |
| 53015NEI42341A | Benzene | 4.65E-05 | 3.56E-07 | 2.32E-08 | 3.78E-07 | 1.26E-07 |
| 01131NEI8619 | Methylene chloride | 4.63E-05 | 9.39E-07 | 3.41E-07 | 6.48E-07 | 2.49E-07 |
| 22011NEI7559 | Carbon tetrachloride | 4.62E-05 | 3.14E-07 | 7.32E-08 | 6.76E-07 | 1.39E-07 |
| 16069NEI26581 | Xylenes (mixed) | 4.62E-05 | 1.81E-06 | 2.54E-07 | 0.00E+00 | 0.00E+00 |
| 45041NEI7933 | Toluene | 4.61E-05 | 2.27E-06 | 3.79E-07 | 8.98E-06 | 1.55E-06 |
| 01091NEI45474 | Styrene | 4.60E-05 | 1.14E-05 | 1.76E-06 | 4.60E-06 | 8.79E-07 |
| 51101NEI42254 | Xylenes (mixed) | 4.59E-05 | 1.80E-06 | 2.52E-07 | 0.00E+00 | 0.00E+00 |
| 01047NEI18335 | Methylene chloride | 4.59E-05 | 9.31E-07 | 3.38E-07 | 6.42E-07 | 2.47E-07 |
| 47107NEI41565 | m-Xylene | 4.58E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 47107NEI41565 | p-Xylene | 4.58E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12107NEI8265 | Toluene | 4.57E-05 | 2.25E-06 | 3.75E-07 | 8.89E-06 | 1.54E-06 |
| 45091NEI47077 | Styrene | 4.52E-05 | 1.12E-05 | 1.73E-06 | 4.52E-06 | 8.63E-07 |
| 53071NEI42410 | Styrene | 4.52E-05 | 1.12E-05 | 1.72E-06 | 4.52E-06 | 8.62E-07 |
| 13185NEI26504 | Methylene chloride | 4.51E-05 | 9.16E-07 | 3.33E-07 | 6.32E-07 | 2.43E-07 |
| 01001NEI8560 | o-Xylene | 4.49E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01047NEI18335 | 1,2-Dimethoxyethane | 4.49E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55141NEI42963 | Styrene | 4.47E-05 | 1.10E-05 | 1.71E-06 | 4.47E-06 | 8.54E-07 |
| 42133NEI7181 | Carbon disulfide | 4.46E-05 | 6.91E-06 | 5.52E-07 | 8.91E-05 | 1.73E-06 |
| 13051NEI8186 | Styrene | 4.44E-05 | 1.10E-05 | 1.69E-06 | 4.44E-06 | 8.47E-07 |
| 27061NEI34030 | Styrene | 4.40E-05 | 1.09E-05 | 1.68E-06 | 4.40E-06 | 8.40E-07 |
| 05003NEI54342 | Mercury (elemental) | 4.40E-05 | 0.00E+00 | 1.55E-08 | 0.00E+00 | 1.32E-08 |
| 36045NEI36019 | Phenol | 4.39E-05 | 4.39E-06 | 2.86E-06 | 6.71E-06 | 1.34E-06 |
| 26043NEI33887 | Methylene chloride | 4.39E-05 | 8.91E-07 | 3.23E-07 | 6.14E-07 | 2.36E-07 |
| 01047NEI18335 | Toluene | 4.36E-05 | 2.15E-06 | 3.58E-07 | 8.49E-06 | 1.47E-06 |
| 55087NEI42710 | Carbon tetrachloride | 4.36E-05 | 2.96E-07 | 6.90E-08 | 6.37E-07 | 1.31E-07 |
| 45041NEI7933 | o-Xylene | 4.32E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 04017NEI13216 | Carbon disulfide | 4.28E-05 | 6.63E-06 | 5.30E-07 | 8.55E-05 | 1.66E-06 |
| 41043NEI13340 | 1,1,1-Trichloroethane | 4.27E-05 | 2.24E-06 | 8.81E-07 | 1.53E-06 | 7.65E-07 |
| 28087NEI34064 | Xylenes (mixed) | 4.27E-05 | 1.68E-06 | 2.35E-07 | 0.00E+00 | 0.00E+00 |
| 41041NEI40600 | o-Xylene | 4.26E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 26043NEI33887 | Carbon disulfide | 4.25E-05 | 6.58E-06 | 5.27E-07 | 8.50E-05 | 1.65E-06 |
| 12089NEI8261 | Toluene | 4.25E-05 | 2.10E-06 | 3.49E-07 | 8.27E-06 | 1.43E-06 |
| 12005NEI8278 | Styrene | 4.22E-05 | 1.04E-05 | 1.61E-06 | 4.22E-06 | 8.06E-07 |
| 28149NEI34070 | Toluene | 4.21E-05 | 2.08E-06 | 3.46E-07 | 8.19E-06 | 1.42E-06 |
| 55009NEI42482 | Benzene | 4.20E-05 | 3.21E-07 | 2.10E-08 | 3.41E-07 | 1.14E-07 |
| 28149NEI34070 | o-Xylene | 4.09E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01131NEI8619 | Tetrachloroethene | 3.95E-05 | 3.29E-06 | 4.93E-07 | 1.16E-06 | 5.64E-07 |
| 55139NEIWI4710355 | Nickel compounds | 3.94E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01053NEI18338 | Methyl bromide | 3.89E-05 | 0.00E+00 | 1.85E-07 | 0.00E+00 | 7.98E-07 |
| 51101NEI42254 | Methyl bromide | 3.88E-05 | 0.00E+00 | 1.84E-07 | 0.00E+00 | 7.96E-07 |
| 13099NEI26491 | Toluene | 3.88E-05 | 1.91E-06 | 3.19E-07 | 7.55E-06 | 1.30E-06 |
| 27017NEI12368 | Xylenes (mixed) | 3.85E-05 | 1.51E-06 | 2.12E-07 | 0.00E+00 | 0.00E+00 |
| 12033NEI26309 | Toluene | 3.82E-05 | 1.88E-06 | 3.14E-07 | 7.43E-06 | 1.28E-06 |
| 37087NEI40282 | m-Xylene | 3.80E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39141NEI40488 | Xylenes (mixed) | 3.78E-05 | 1.49E-06 | 2.08E-07 | 0.00E+00 | 0.00E+00 |
| 45091NEI47077 | Mercury (elemental) | 3.77E-05 | 0.00E+00 | 1.33E-08 | 0.00E+00 | 1.13E-08 |
| 51101NEI42254 | Tetrachloroethene | 3.71E-05 | 3.09E-06 | 4.63E-07 | 1.09E-06 | 5.29E-07 |
| 21007NEI11338 | Styrene | 3.70E-05 | 9.15E-06 | 1.41E-06 | 3.70E-06 | 7.07E-07 |
| 41039NEI45182 | Styrene | 3.67E-05 | 9.07E-06 | 1.40E-06 | 3.67E-06 | 7.01E-07 |

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|---|---|---|---|---|---|---|
| 55141NEI42695 | Toluene | 3.67E-05 | 1.81E-06 | 3.02E-07 | 7.15E-06 | 1.23E-06 |
| 48067NEI41628 | 1,1,1-Trichloroethane | 3.66E-05 | 1.92E-06 | 7.55E-07 | 1.31E-06 | 6.56E-07 |
| 21007NEI11338 | Xylenes (mixed) | 3.61E-05 | 1.42E-06 | 1.98E-07 | 0.00E+00 | 0.00E+00 |
| 28077NEI11172 | Xylenes (mixed) | 3.60E-05 | 1.42E-06 | 1.98E-07 | 0.00E+00 | 0.00E+00 |
| 36031NEI35908 | Methylene chloride | 3.59E-05 | 7.29E-07 | 2.65E-07 | 5.03E-07 | 1.93E-07 |
| 22049NEI33023 | Xylenes (mixed) | 3.56E-05 | 1.40E-06 | 1.96E-07 | 0.00E+00 | 0.00E+00 |
| 41039NEI45182 | Methylene chloride | 3.54E-05 | 7.19E-07 | 2.61E-07 | 4.96E-07 | 1.91E-07 |
| 47085NEI46866 | Xylenes (mixed) | 3.53E-05 | 1.39E-06 | 1.94E-07 | 0.00E+00 | 0.00E+00 |
| 39141NEI40488 | Nickel compounds | 3.52E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37047NEI40247 | Styrene | 3.42E-05 | 8.45E-06 | 1.31E-06 | 3.42E-06 | 6.53E-07 |
| 13127NEI8196 | 1,1,1-Trichloroethane | 3.41E-05 | 1.79E-06 | 7.03E-07 | 1.22E-06 | 6.11E-07 |
| 55141NEI42963 | Xylenes (mixed) | 3.38E-05 | 1.33E-06 | 1.86E-07 | 0.00E+00 | 0.00E+00 |
| 37047NEI40247 | Xylenes (mixed) | 3.37E-05 | 1.33E-06 | 1.86E-07 | 0.00E+00 | 0.00E+00 |
| 48241NEI6450 | Carbon tetrachloride | 3.33E-05 | 2.26E-07 | 5.28E-08 | 4.87E-07 | 1.01E-07 |
| 55141NEI46739 | Styrene | 3.31E-05 | 8.19E-06 | 1.27E-06 | 3.31E-06 | 6.33E-07 |
| 27071NEI12411 | Xylenes (mixed) | 3.31E-05 | 1.30E-06 | 1.82E-07 | 0.00E+00 | 0.00E+00 |
| 05081NEI18660 | o-Xylene | 3.30E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23009NEI6284 | Toluene | 3.29E-05 | 1.62E-06 | 2.71E-07 | 6.41E-06 | 1.11E-06 |
| 37049NEI45206 | Tetrachloroethene | 3.28E-05 | 2.73E-06 | 4.10E-07 | 9.65E-07 | 4.69E-07 |
| 22011NEI7559 | Methylene chloride | 3.28E-05 | 6.65E-07 | 2.42E-07 | 4.59E-07 | 1.77E-07 |
| 05081NEI18660 | Carbon disulfide | 3.26E-05 | 5.06E-06 | 4.05E-07 | 6.53E-05 | 1.26E-06 |
| 01113NEI46931 | Methyl bromide | 3.25E-05 | 0.00E+00 | 1.54E-07 | 0.00E+00 | 6.66E-07 |
| 41039NEI45182 | Tetrachloroethene | 3.21E-05 | 2.67E-06 | 4.01E-07 | 9.44E-07 | 4.58E-07 |
| 13051NEI8186 | Xylenes (mixed) | 3.20E-05 | 1.26E-06 | 1.76E-07 | 0.00E+00 | 0.00E+00 |
| 27017NEI12368 | Nickel compounds | 3.17E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13103NEI8178 | Nickel compounds | 3.16E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 48361NEI12492 | Carbon tetrachloride | 3.15E-05 | 2.13E-07 | 4.98E-08 | 4.60E-07 | 9.49E-08 |
| 13021NEI26471 | m-Xylene | 3.11E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23017NEI6273 | Arsenic compounds | 3.10E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55085NEI43202 | Toluene | 3.09E-05 | 1.52E-06 | 2.54E-07 | 6.01E-06 | 1.04E-06 |
| 53011NEI46599 | Styrene | 3.06E-05 | 7.57E-06 | 1.17E-06 | 3.06E-06 | 5.85E-07 |
| 13099NEI26491 | o-Xylene | 3.06E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45091NEI47077 | Carbon tetrachloride | 3.05E-05 | 2.07E-07 | 4.83E-08 | 4.46E-07 | 9.21E-08 |
| 01121NEI18390 | Methylene chloride | 3.05E-05 | 6.19E-07 | 2.25E-07 | 4.27E-07 | 1.64E-07 |
| 01121NEI18390 | Carbon disulfide | 3.05E-05 | 4.72E-06 | 3.78E-07 | 6.09E-05 | 1.18E-06 |
| 13115NEI26495 | 1,1,1-Trichloroethane | 3.04E-05 | 1.59E-06 | 6.26E-07 | 1.09E-06 | 5.44E-07 |
| 05069NEI18658 | 1,1,1-Trichloroethane | 3.01E-05 | 1.57E-06 | 6.20E-07 | 1.08E-06 | 5.39E-07 |
| 37049NEI45206 | Carbon tetrachloride | 2.96E-05 | 2.01E-07 | 4.68E-08 | 4.32E-07 | 8.92E-08 |
| 23025NEI33118 | Tetrachloroethene | 2.95E-05 | 2.46E-06 | 3.69E-07 | 8.69E-07 | 4.22E-07 |
| 42047NEI40686 | Toluene | 2.95E-05 | 1.45E-06 | 2.42E-07 | 5.74E-06 | 9.91E-07 |
| 26041NEI33883 | Toluene | 2.94E-05 | 1.45E-06 | 2.41E-07 | 5.72E-06 | 9.87E-07 |
| 23017NEI6273 | Tetrachloroethene | 2.94E-05 | 2.45E-06 | 3.67E-07 | 8.63E-07 | 4.19E-07 |
| 01131NEI8619 | Toluene | 2.91E-05 | 1.43E-06 | 2.39E-07 | 5.66E-06 | 9.78E-07 |
| 37087NEI40282 | Arsenic compounds | 2.90E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01047NEI18335 | Styrene | 2.89E-05 | 7.13E-06 | 1.10E-06 | 2.89E-06 | 5.51E-07 |
| 13185NEI26504 | Toluene | 2.88E-05 | 1.42E-06 | 2.37E-07 | 5.61E-06 | 9.68E-07 |
| 12033NEI26309 | Methyl bromide | 2.87E-05 | 0.00E+00 | 1.36E-07 | 0.00E+00 | 5.89E-07 |
| 05081NEI18660 | Styrene | 2.85E-05 | 7.04E-06 | 1.09E-06 | 2.85E-06 | 5.44E-07 |
| 45091NEI47077 | Methylene chloride | 2.84E-05 | 5.76E-07 | 2.09E-07 | 3.98E-07 | 1.53E-07 |
| 01047NEI18335 | o-Xylene | 2.84E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 51670NEI42317 | Carbon tetrachloride | 2.81E-05 | 1.91E-07 | 4.45E-08 | 4.11E-07 | 8.48E-08 |
| 27137NEIMN14904 | Methylene chloride | 2.79E-05 | 5.66E-07 | 2.06E-07 | 3.91E-07 | 1.50E-07 |
| 01113NEI46931 | 1,1,1-Trichloroethane | 2.78E-05 | 1.45E-06 | 5.72E-07 | 9.94E-07 | 4.97E-07 |
| 55141NEI46739 | o-Xylene | 2.75E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 47071NEI41552 | Methylene chloride | 2.74E-05 | 5.57E-07 | 2.02E-07 | 3.84E-07 | 1.48E-07 |

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| 55099NEI42730 | Carbon tetrachloride | 2.74E-05 | 1.86E-07 | 4.34E-08 | 4.00E-07 | 8.26E-08 |
| 41039NEI45182 | Toluene | 2.73E-05 | 1.35E-06 | 2.25E-07 | 5.32E-06 | 9.19E-07 |
| 13099NEI26491 | m-Xylene | 2.73E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55073NEI42689 | Styrene | 2.73E-05 | 6.74E-06 | 1.04E-06 | 2.73E-06 | 5.21E-07 |
| 22011NEI7559 | Toluene | 2.72E-05 | 1.34E-06 | 2.24E-07 | 5.30E-06 | 9.15E-07 |
| 23029NEI46835 | Tetrachloroethene | 2.71E-05 | 2.26E-06 | 3.39E-07 | 7.98E-07 | 3.87E-07 |
| 01131NEI8619 | o-Xylene | 2.71E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 16069NEI26581 | o-Xylene | 2.69E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01053NEI18338 | Tetrachloroethene | 2.69E-05 | 2.24E-06 | 3.36E-07 | 7.90E-07 | 3.84E-07 |
| 05041NEI18652 | Styrene | 2.62E-05 | 6.46E-06 | 9.99E-07 | 2.62E-06 | 4.99E-07 |
| 01121NEI18390 | Xylenes (mixed) | 2.61E-05 | 1.03E-06 | 1.44E-07 | 0.00E+00 | 0.00E+00 |
| 37083NEI47104 | Carbon tetrachloride | 2.58E-05 | 1.75E-07 | 4.09E-08 | 3.77E-07 | 7.79E-08 |
| 37049NEI45206 | Styrene | 2.57E-05 | 6.36E-06 | 9.82E-07 | 2.57E-06 | 4.91E-07 |
| 01025NEI8601 | Methylene chloride | 2.56E-05 | 5.20E-07 | 1.89E-07 | 3.59E-07 | 1.38E-07 |
| 51019NEI42211 | Tetrachloroethene | 2.55E-05 | 2.13E-06 | 3.19E-07 | 7.50E-07 | 3.64E-07 |
| 51019NEI42211 | m-Xylene | 2.55E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 51019NEI42211 | p-Xylene | 2.55E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13051NEI8186 | Toluene | 2.54E-05 | 1.25E-06 | 2.09E-07 | 4.95E-06 | 8.55E-07 |
| 22031NEI33013 | Methylene chloride | 2.49E-05 | 5.05E-07 | 1.84E-07 | 3.49E-07 | 1.34E-07 |
| 39031NEI11461 | Methylene chloride | 2.49E-05 | 5.04E-07 | 1.83E-07 | 3.48E-07 | 1.34E-07 |
| 48067NEI41628 | Carbon tetrachloride | 2.45E-05 | 1.66E-07 | 3.87E-08 | 3.58E-07 | 7.38E-08 |
| 28087NEI34064 | Tetrachloroethene | 2.44E-05 | 2.04E-06 | 3.06E-07 | 7.19E-07 | 3.49E-07 |
| 28111NEI34066 | Tetrachloroethene | 2.44E-05 | 2.03E-06 | 3.05E-07 | 7.17E-07 | 3.48E-07 |
| 41009NEI40553 | Formaldehyde | 2.43E-05 | 1.22E-06 | 7.87E-08 | 1.11E-06 | 1.11E-07 |
| 26003NEI33866 | Methylene chloride | 2.41E-05 | 4.90E-07 | 1.78E-07 | 3.38E-07 | 1.30E-07 |
| 23007NEI6261 | Tetrachloroethene | 2.39E-05 | 1.99E-06 | 2.99E-07 | 7.03E-07 | 3.41E-07 |
| 39031NEI11461 | Toluene | 2.39E-05 | 1.18E-06 | 1.96E-07 | 4.64E-06 | 8.02E-07 |
| 22031NEI33013 | Arsenic compounds | 2.38E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 42133NEI7181 | Xylenes (mixed) | 2.37E-05 | 9.31E-07 | 1.30E-07 | 0.00E+00 | 0.00E+00 |
| 40101NEI12980 | Carbon disulfide | 2.37E-05 | 3.67E-06 | 2.93E-07 | 4.73E-05 | 9.17E-07 |
| 45079NEI46760 | Methylene chloride | 2.36E-05 | 4.79E-07 | 1.74E-07 | 3.30E-07 | 1.27E-07 |
| 12005NEI8278 | Toluene | 2.33E-05 | 1.15E-06 | 1.92E-07 | 4.54E-06 | 7.85E-07 |
| 13051NEI8186 | o-Xylene | 2.29E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01131NEI8619 | Styrene | 2.28E-05 | 5.63E-06 | 8.69E-07 | 2.28E-06 | 4.35E-07 |
| 51019NEI42211 | 1,1,1-Trichloroethane | 2.23E-05 | 1.17E-06 | 4.59E-07 | 7.97E-07 | 3.99E-07 |
| 12089NEI8261 | Methyl bromide | 2.22E-05 | 0.00E+00 | 1.06E-07 | 0.00E+00 | 4.56E-07 |
| 48241NEI6450 | Toluene | 2.21E-05 | 1.09E-06 | 1.82E-07 | 4.31E-06 | 7.45E-07 |
| 41007NEI40554 | Carbon disulfide | 2.21E-05 | 3.43E-06 | 2.74E-07 | 4.42E-05 | 8.57E-07 |
| 54057NEI706 | Styrene | 2.21E-05 | 5.46E-06 | 8.43E-07 | 2.21E-06 | 4.22E-07 |
| 39141NEI40488 | Mercury (elemental) | 2.18E-05 | 0.00E+00 | 7.69E-09 | 0.00E+00 | 6.54E-09 |
| 23025NEI33118 | Styrene | 2.17E-05 | 5.36E-06 | 8.28E-07 | 2.17E-06 | 4.14E-07 |
| 45079NEI46760 | Styrene | 2.14E-05 | 5.29E-06 | 8.18E-07 | 2.14E-06 | 4.09E-07 |
| 05069NEI18657 | Toluene | 2.13E-05 | 1.05E-06 | 1.75E-07 | 4.16E-06 | 7.18E-07 |
| 45019NEI41252 | 1,1,1-Trichloroethane | 2.13E-05 | 1.12E-06 | 4.40E-07 | 7.64E-07 | 3.82E-07 |
| 12089NEI8261 | Carbon tetrachloride | 2.11E-05 | 1.43E-07 | 3.34E-08 | 3.08E-07 | 6.36E-08 |
| 47163NEI41599 | o-Xylene | 2.08E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22011NEI7559 | Tetrachloroethene | 2.07E-05 | 1.72E-06 | 2.58E-07 | 6.08E-07 | 2.95E-07 |
| 51019NEI42211 | o-Xylene | 2.06E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 47085NEI46866 | Benzene | 2.06E-05 | 1.57E-07 | 1.03E-08 | 1.67E-07 | 5.58E-08 |
| 13127NEI8196 | Arsenic compounds | 2.06E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12033NEI26309 | Xylenes (mixed) | 2.05E-05 | 8.07E-07 | 1.13E-07 | 0.00E+00 | 0.00E+00 |
| 28149NEI34070 | Methyl bromide | 2.04E-05 | 0.00E+00 | 9.73E-08 | 0.00E+00 | 4.20E-07 |
| 12033NEI26309 | Styrene | 2.04E-05 | 5.04E-06 | 7.79E-07 | 2.04E-06 | 3.90E-07 |
| 01121NEI18390 | Toluene | 2.04E-05 | 1.01E-06 | 1.68E-07 | 3.97E-06 | 6.86E-07 |
| 01131NEI8619 | Xylenes (mixed) | 2.03E-05 | 7.99E-07 | 1.12E-07 | 0.00E+00 | 0.00E+00 |

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| 53053NEI13363 | 1,1,1-Trichloroethane | 2.03E-05 | 1.06E-06 | 4.19E-07 | 7.27E-07 | 3.64E-07 |
| 42013NEI7104 | Styrene | 2.03E-05 | 5.01E-06 | 7.75E-07 | 2.03E-06 | 3.87E-07 |
| 41039NEI45182 | o-Xylene | 2.02E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37117NEI9201 | Benzene | 2.01E-05 | 1.54E-07 | 1.01E-08 | 1.63E-07 | 5.45E-08 |
| 55073NEI42689 | Phenol | 2.01E-05 | 2.01E-06 | 1.31E-06 | 3.06E-06 | 6.12E-07 |
| 01047NEI18335 | Xylenes (mixed) | 1.97E-05 | 7.73E-07 | 1.08E-07 | 0.00E+00 | 0.00E+00 |
| 27017NEI12368 | Mercury (elemental) | 1.96E-05 | 0.00E+00 | 6.92E-09 | 0.00E+00 | 5.89E-09 |
| 53011NEI46599 | Toluene | 1.96E-05 | 9.66E-07 | 1.61E-07 | 3.81E-06 | 6.59E-07 |
| 13103NEI8178 | Mercury (elemental) | 1.95E-05 | 0.00E+00 | 6.90E-09 | 0.00E+00 | 5.86E-09 |
| 23029NEI46835 | Styrene | 1.94E-05 | 4.79E-06 | 7.41E-07 | 1.94E-06 | 3.70E-07 |
| 23029NEI46835 | Toluene | 1.94E-05 | 9.57E-07 | 1.59E-07 | 3.78E-06 | 6.52E-07 |
| 37047NEI40247 | Tetrachloroethene | 1.92E-05 | 1.60E-06 | 2.40E-07 | 5.66E-07 | 2.75E-07 |
| 54057NEI706 | Tetrachloroethene | 1.91E-05 | 1.59E-06 | 2.39E-07 | 5.63E-07 | 2.73E-07 |
| 22031NEI33013 | Methyl bromide | 1.91E-05 | 0.00E+00 | 9.08E-08 | 0.00E+00 | 3.92E-07 |
| 12033NEI26309 | o-Xylene | 1.90E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27071NEI12411 | Styrene | 1.90E-05 | 4.70E-06 | 7.27E-07 | 1.90E-06 | 3.63E-07 |
| 28077NEI11172 | 1,2-Dimethoxyethane | 1.89E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53015NEI42341A | Methylene chloride | 1.89E-05 | 3.84E-07 | 1.39E-07 | 2.65E-07 | 1.02E-07 |
| 01079NEI18357 | Methyl bromide | 1.88E-05 | 0.00E+00 | 8.94E-08 | 0.00E+00 | 3.86E-07 |
| 48067NEI41628 | Nickel compounds | 1.87E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22049NEI33023 | 1,1,1-Trichloroethane | 1.86E-05 | 9.71E-07 | 3.83E-07 | 6.64E-07 | 3.32E-07 |
| 01131NEI8619 | Arsenic compounds | 1.85E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 54057NEI706 | Toluene | 1.85E-05 | 9.10E-07 | 1.52E-07 | 3.59E-06 | 6.21E-07 |
| 01053NEI18338 | 1,1,1-Trichloroethane | 1.84E-05 | 9.60E-07 | 3.78E-07 | 6.57E-07 | 3.28E-07 |
| 16069NEI26581 | Toluene | 1.83E-05 | 9.04E-07 | 1.51E-07 | 3.57E-06 | 6.17E-07 |
| 37047NEI40247 | Toluene | 1.79E-05 | 8.85E-07 | 1.48E-07 | 3.50E-06 | 6.04E-07 |
| 13245NEI26514 | Methylene chloride | 1.78E-05 | 3.62E-07 | 1.31E-07 | 2.50E-07 | 9.61E-08 |
| 41009NEI40553 | Arsenic compounds | 1.78E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01001NEI8560 | Methyl bromide | 1.78E-05 | 0.00E+00 | 8.47E-08 | 0.00E+00 | 3.65E-07 |
| 13021NEI26471 | 1,1,1-Trichloroethane | 1.78E-05 | 9.30E-07 | 3.66E-07 | 6.36E-07 | 3.18E-07 |
| 01047NEI18335 | Tetrachloroethene | 1.76E-05 | 1.46E-06 | 2.19E-07 | 5.16E-07 | 2.51E-07 |
| 01001NEI8560 | 1,1,1-Trichloroethane | 1.75E-05 | 9.15E-07 | 3.60E-07 | 6.26E-07 | 3.13E-07 |
| 05041NEI18652 | Tetrachloroethene | 1.74E-05 | 1.45E-06 | 2.18E-07 | 5.13E-07 | 2.49E-07 |
| 23009NEI6284 | Methylene chloride | 1.69E-05 | 3.43E-07 | 1.24E-07 | 2.37E-07 | 9.10E-08 |
| 01091NEI45474 | Tetrachloroethene | 1.68E-05 | 1.40E-06 | 2.10E-07 | 4.94E-07 | 2.40E-07 |
| 23025NEI33118 | Xylenes (mixed) | 1.67E-05 | 6.57E-07 | 9.19E-08 | 0.00E+00 | 0.00E+00 |
| 42133NEI7181 | Toluene | 1.67E-05 | 8.24E-07 | 1.37E-07 | 3.25E-06 | 5.62E-07 |
| 41039NEI45182 | Xylenes (mixed) | 1.66E-05 | 6.53E-07 | 9.15E-08 | 0.00E+00 | 0.00E+00 |
| 12033NEI26309 | Methylene chloride | 1.66E-05 | 3.36E-07 | 1.22E-07 | 2.32E-07 | 8.91E-08 |
| 28087NEI34064 | Phenol | 1.64E-05 | 1.64E-06 | 1.07E-06 | 2.50E-06 | 5.01E-07 |
| 45079NEI46760 | o-Xylene | 1.64E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01001NEI8560 | Carbon tetrachloride | 1.62E-05 | 1.10E-07 | 2.56E-08 | 2.37E-07 | 4.88E-08 |
| 13179NEI8177 | Methylene chloride | 1.61E-05 | 3.27E-07 | 1.19E-07 | 2.26E-07 | 8.69E-08 |
| 28111NEI34066 | Styrene | 1.60E-05 | 3.95E-06 | 6.11E-07 | 1.60E-06 | 3.06E-07 |
| 40089NEI11251 | 1,1,1-Trichloroethane | 1.59E-05 | 8.33E-07 | 3.28E-07 | 5.70E-07 | 2.85E-07 |
| 23007NEI6261 | Styrene | 1.59E-05 | 3.93E-06 | 6.07E-07 | 1.59E-06 | 3.04E-07 |
| 28111NEI34066 | Toluene | 1.59E-05 | 7.82E-07 | 1.30E-07 | 3.09E-06 | 5.33E-07 |
| 22073NEI6057 | Methyl bromide | 1.58E-05 | 0.00E+00 | 7.50E-08 | 0.00E+00 | 3.24E-07 |
| 41007NEI40554 | Xylenes (mixed) | 1.58E-05 | 6.19E-07 | 8.66E-08 | 0.00E+00 | 0.00E+00 |
| 22033NEI46817 | 1,1,1-Trichloroethane | 1.55E-05 | 8.09E-07 | 3.19E-07 | 5.54E-07 | 2.77E-07 |
| 13245NEI26514 | Toluene | 1.55E-05 | 7.62E-07 | 1.27E-07 | 3.01E-06 | 5.20E-07 |
| 48067NEI41628 | Tetrachloroethene | 1.54E-05 | 1.29E-06 | 1.93E-07 | 4.54E-07 | 2.20E-07 |
| 41007NEI40554 | Nickel compounds | 1.54E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05003NEI54342 | Vinyl chloride | 1.51E-05 | 4.24E-06 | 8.76E-07 | 2.09E-06 | 2.09E-07 |
| 12031NEI26304 | Methylene chloride | 1.49E-05 | 3.03E-07 | 1.10E-07 | 2.09E-07 | 8.03E-08 |

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| 05029NEI46852 | Carbon tetrachloride | 1.49E-05 | 1.01E-07 | 2.36E-08 | 2.18E-07 | 4.49E-08 |
| 55069NEI46750 | Styrene | 1.48E-05 | 3.65E-06 | 5.64E-07 | 1.48E-06 | 2.82E-07 |
| 45091NEI47077 | o-Xylene | 1.47E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27061NEI34030 | Xylenes (mixed) | 1.44E-05 | 5.65E-07 | 7.91E-08 | 0.00E+00 | 0.00E+00 |
| 37117NEI9201 | Tetrachloroethene | 1.43E-05 | 1.19E-06 | 1.79E-07 | 4.20E-07 | 2.04E-07 |
| 45043NEI41314 | Arsenic compounds | 1.43E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01025NEI8601 | Xylenes (mixed) | 1.41E-05 | 5.54E-07 | 7.76E-08 | 0.00E+00 | 0.00E+00 |
| 12089NEI26382 | Benzene | 1.40E-05 | 1.07E-07 | 7.01E-09 | 1.14E-07 | 3.80E-08 |
| 23007NEI6261 | Xylenes (mixed) | 1.40E-05 | 5.49E-07 | 7.68E-08 | 0.00E+00 | 0.00E+00 |
| 12033NEI26309 | Carbon tetrachloride | 1.39E-05 | 9.43E-08 | 2.20E-08 | 2.03E-07 | 4.19E-08 |
| 26101NEI33945 | Benzene | 1.37E-05 | 1.05E-07 | 6.85E-09 | 1.11E-07 | 3.71E-08 |
| 27071NEI12411 | Toluene | 1.34E-05 | 6.61E-07 | 1.10E-07 | 2.61E-06 | 4.51E-07 |
| 05081NEI18660 | Toluene | 1.33E-05 | 6.58E-07 | 1.10E-07 | 2.60E-06 | 4.49E-07 |
| 39031NEI11461 | Styrene | 1.33E-05 | 3.29E-06 | 5.08E-07 | 1.33E-06 | 2.54E-07 |
| 26041NEI33883 | Carbon tetrachloride | 1.33E-05 | 9.03E-08 | 2.11E-08 | 1.94E-07 | 4.01E-08 |
| 42133NEI7181 | Styrene | 1.30E-05 | 3.21E-06 | 4.96E-07 | 1.30E-06 | 2.48E-07 |
| 36031NEI35908 | o-Xylene | 1.26E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01071NEI18347 | Xylenes (mixed) | 1.26E-05 | 4.94E-07 | 6.92E-08 | 0.00E+00 | 0.00E+00 |
| 39031NEI11461 | Xylenes (mixed) | 1.26E-05 | 4.93E-07 | 6.90E-08 | 0.00E+00 | 0.00E+00 |
| 53011NEI46599 | Tetrachloroethene | 1.25E-05 | 1.04E-06 | 1.57E-07 | 3.68E-07 | 1.79E-07 |
| 01025NEI8601 | Toluene | 1.25E-05 | 6.17E-07 | 1.03E-07 | 2.44E-06 | 4.21E-07 |
| 41007NEI40554 | Toluene | 1.25E-05 | 6.16E-07 | 1.03E-07 | 2.43E-06 | 4.20E-07 |
| 47163NEI41599 | Carbon tetrachloride | 1.24E-05 | 8.44E-08 | 1.97E-08 | 1.82E-07 | 3.75E-08 |
| 47107NEI41565 | Carbon tetrachloride | 1.24E-05 | 8.43E-08 | 1.97E-08 | 1.82E-07 | 3.75E-08 |
| 28077NEI11172 | 1,1,1-Trichloroethane | 1.23E-05 | 6.41E-07 | 2.53E-07 | 4.39E-07 | 2.19E-07 |
| 13051NEI8186 | 1,2-Dimethoxyethane | 1.22E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45079NEI46760 | Xylenes (mixed) | 1.21E-05 | 4.74E-07 | 6.63E-08 | 0.00E+00 | 0.00E+00 |
| 22069NEI33025 | Methyl bromide | 1.20E-05 | 0.00E+00 | 5.71E-08 | 0.00E+00 | 2.46E-07 |
| 41007NEI40554 | Styrene | 1.20E-05 | 2.96E-06 | 4.57E-07 | 1.20E-06 | 2.29E-07 |
| 23009NEI6284 | Carbon tetrachloride | 1.18E-05 | 7.99E-08 | 1.86E-08 | 1.72E-07 | 3.55E-08 |
| 28087NEI34064 | Carbon tetrachloride | 1.17E-05 | 7.97E-08 | 1.86E-08 | 1.72E-07 | 3.54E-08 |
| 48067NEI41628 | Mercury (elemental) | 1.16E-05 | 0.00E+00 | 4.08E-09 | 0.00E+00 | 3.47E-09 |
| 05081NEI18660 | Xylenes (mixed) | 1.15E-05 | 4.53E-07 | 6.35E-08 | 0.00E+00 | 0.00E+00 |
| 47085NEI46866 | Styrene | 1.15E-05 | 2.84E-06 | 4.39E-07 | 1.15E-06 | 2.20E-07 |
| 55069NEI46750 | o-Xylene | 1.14E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27137NEIMN14904 | Arsenic compounds | 1.13E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55009NEI42482 | Styrene | 1.11E-05 | 2.75E-06 | 4.26E-07 | 1.11E-06 | 2.13E-07 |
| 13103NEI8178 | Xylenes (mixed) | 1.11E-05 | 4.36E-07 | 6.11E-08 | 0.00E+00 | 0.00E+00 |
| 27145NEI12407 | Styrene | 1.11E-05 | 2.74E-06 | 4.24E-07 | 1.11E-06 | 2.12E-07 |
| 37049NEI45206 | Toluene | 1.11E-05 | 5.47E-07 | 9.12E-08 | 2.16E-06 | 3.73E-07 |
| 22117NEI46814 | 1,1,1-Trichloroethane | 1.11E-05 | 5.78E-07 | 2.28E-07 | 3.96E-07 | 1.98E-07 |
| 23017NEI6273 | Nickel compounds | 1.08E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01131NEI8619 | Methyl bromide | 1.07E-05 | 0.00E+00 | 5.10E-08 | 0.00E+00 | 2.20E-07 |
| 26041NEI33883 | Styrene | 1.07E-05 | 2.64E-06 | 4.08E-07 | 1.07E-06 | 2.04E-07 |
| 13245NEI26514 | Xylenes (mixed) | 1.07E-05 | 4.20E-07 | 5.88E-08 | 0.00E+00 | 0.00E+00 |
| 36031NEI35908 | Styrene | 1.07E-05 | 2.63E-06 | 4.07E-07 | 1.07E-06 | 2.04E-07 |
| 45041NEI7933 | Carbon tetrachloride | 1.04E-05 | 7.09E-08 | 1.65E-08 | 1.53E-07 | 3.15E-08 |
| 45069NEI47074 | Phenol | 1.04E-05 | 1.04E-06 | 6.77E-07 | 1.59E-06 | 3.17E-07 |
| 13185NEI26504 | Styrene | 1.04E-05 | 2.56E-06 | 3.95E-07 | 1.04E-06 | 1.98E-07 |
| 42131NEI40738 | Benzene | 1.03E-05 | 7.91E-08 | 5.17E-09 | 8.41E-08 | 2.80E-08 |
| 45091NEI47077 | m-Xylene | 1.03E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45091NEI47077 | p-Xylene | 1.03E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23017NEI6273 | Xylenes (mixed) | 1.03E-05 | 4.04E-07 | 5.65E-08 | 0.00E+00 | 0.00E+00 |
| 47107NEI41565 | Xylenes (mixed) | 1.01E-05 | 3.98E-07 | 5.57E-08 | 0.00E+00 | 0.00E+00 |
| 28111NEI34066 | Xylenes (mixed) | 1.00E-05 | 3.94E-07 | 5.51E-08 | 0.00E+00 | 0.00E+00 |

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| 42133NEI7181 | Tetrachloroethene | 9.90E-06 | 8.25E-07 | 1.24E-07 | 2.91E-07 | 1.41E-07 |
| 28149NEI34070 | 1,1,1-Trichloroethane | 9.70E-06 | 5.08E-07 | 2.00E-07 | 3.47E-07 | 1.74E-07 |
| 55009NEI42482 | Methylene chloride | 9.57E-06 | 1.94E-07 | 7.05E-08 | 1.34E-07 | 5.15E-08 |
| 36031NEI35908 | Xylenes (mixed) | 9.52E-06 | 3.74E-07 | 5.24E-08 | 0.00E+00 | 0.00E+00 |
| 45041NEI7933 | 1,1,1-Trichloroethane | 9.52E-06 | 4.98E-07 | 1.96E-07 | 3.41E-07 | 1.70E-07 |
| 55073NEI42689 | Toluene | 9.50E-06 | 4.69E-07 | 7.81E-08 | 1.85E-06 | 3.20E-07 |
| 47163NEI41599 | Tetrachloroethene | 9.36E-06 | 7.80E-07 | 1.17E-07 | 2.75E-07 | 1.34E-07 |
| 37087NEI40282 | Nickel compounds | 9.24E-06 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53009NEI42329 | Benzene | 9.23E-06 | 7.06E-08 | 4.61E-09 | 7.50E-08 | 2.50E-08 |
| 27071NEI12411 | o-Xylene | 9.14E-06 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01099NEI18373 | Styrene | 9.12E-06 | 2.25E-06 | 3.48E-07 | 9.12E-07 | 1.74E-07 |
| 27071NEI12411 | Phenol | 9.05E-06 | 9.05E-07 | 5.90E-07 | 1.38E-06 | 2.76E-07 |
| 01071NEI18347 | Styrene | 9.01E-06 | 2.23E-06 | 3.44E-07 | 9.01E-07 | 1.72E-07 |
| 47163NEI41599 | Toluene | 8.95E-06 | 4.42E-07 | 7.36E-08 | 1.74E-06 | 3.01E-07 |
| 39113NEI11645 | Benzene | 8.83E-06 | 6.75E-08 | 4.41E-09 | 7.17E-08 | 2.39E-08 |
| 36031NEI35908 | Toluene | 8.76E-06 | 4.32E-07 | 7.21E-08 | 1.71E-06 | 2.95E-07 |
| 26043NEI33887 | Tetrachloroethene | 8.69E-06 | 7.24E-07 | 1.09E-07 | 2.56E-07 | 1.24E-07 |
| 13051NEI8186 | 1,1,1-Trichloroethane | 8.63E-06 | 4.51E-07 | 1.78E-07 | 3.09E-07 | 1.54E-07 |
| 27061NEI34030 | Tetrachloroethene | 8.56E-06 | 7.13E-07 | 1.07E-07 | 2.52E-07 | 1.22E-07 |
| 01121NEI18390 | Styrene | 8.43E-06 | 2.08E-06 | 3.22E-07 | 8.43E-07 | 1.61E-07 |
| 12031NEI26304 | Toluene | 8.31E-06 | 4.10E-07 | 6.84E-08 | 1.62E-06 | 2.80E-07 |
| 47163NEI41599 | Styrene | 8.06E-06 | 1.99E-06 | 3.08E-07 | 8.06E-07 | 1.54E-07 |
| 28149NEI34070 | Carbon tetrachloride | 8.04E-06 | 5.46E-08 | 1.27E-08 | 1.18E-07 | 2.42E-08 |
| 28087NEI34064 | m-Xylene | 7.81E-06 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22031NEI33013 | 1,1,1-Trichloroethane | 7.79E-06 | 4.07E-07 | 1.60E-07 | 2.79E-07 | 1.39E-07 |
| 55141NEI46739 | Toluene | 7.73E-06 | 3.81E-07 | 6.35E-08 | 1.50E-06 | 2.60E-07 |
| 41043NEI13340 | Carbon disulfide | 7.65E-06 | 1.19E-06 | 9.49E-08 | 1.53E-05 | 2.97E-07 |
| 22031NEI33013 | Nickel compounds | 7.59E-06 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37049NEI45206 | m-Xylene | 7.59E-06 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37049NEI45206 | p-Xylene | 7.59E-06 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 21007NEI11338 | 1,1,1-Trichloroethane | 7.38E-06 | 3.86E-07 | 1.52E-07 | 2.64E-07 | 1.32E-07 |
| 22073NEI6057 | 1,1,1-Trichloroethane | 7.36E-06 | 3.85E-07 | 1.52E-07 | 2.63E-07 | 1.32E-07 |
| 37117NEI9201 | Styrene | 7.32E-06 | 1.81E-06 | 2.79E-07 | 7.32E-07 | 1.40E-07 |
| 13127NEI8196 | Nickel compounds | 7.20E-06 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55073NEI42689 | 1,1,1-Trichloroethane | 7.16E-06 | 3.75E-07 | 1.48E-07 | 2.56E-07 | 1.28E-07 |
| 55069NEI46750 | Toluene | 7.16E-06 | 3.53E-07 | 5.89E-08 | 1.39E-06 | 2.41E-07 |
| 22069NEI33025 | 1,1,1-Trichloroethane | 7.11E-06 | 3.72E-07 | 1.47E-07 | 2.55E-07 | 1.27E-07 |
| 47085NEI46866 | Methylene chloride | 7.06E-06 | 1.43E-07 | 5.20E-08 | 9.89E-08 | 3.80E-08 |
| 45079NEI46760 | Toluene | 7.06E-06 | 3.48E-07 | 5.81E-08 | 1.38E-06 | 2.38E-07 |
| 37049NEI45206 | o-Xylene | 7.05E-06 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 54057NEI706 | 1,1,1-Trichloroethane | 6.95E-06 | 3.64E-07 | 1.43E-07 | 2.49E-07 | 1.24E-07 |
| 13185NEI26504 | o-Xylene | 6.90E-06 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12089NEI8261 | 1,1,1-Trichloroethane | 6.87E-06 | 3.59E-07 | 1.41E-07 | 2.46E-07 | 1.23E-07 |
| 27017NEI12368 | Toluene | 6.86E-06 | 3.38E-07 | 5.64E-08 | 1.34E-06 | 2.31E-07 |
| 26101NEI33945 | o-Xylene | 6.85E-06 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55073NEI42690 | Benzene | 6.81E-06 | 5.21E-08 | 3.40E-09 | 5.53E-08 | 1.84E-08 |
| 01131NEI8619 | Nickel compounds | 6.75E-06 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41007NEI40554 | Tetrachloroethene | 6.73E-06 | 5.61E-07 | 8.41E-08 | 1.98E-07 | 9.61E-08 |
| 13185NEI26504 | Methyl bromide | 6.72E-06 | 0.00E+00 | 3.19E-08 | 0.00E+00 | 1.38E-07 |
| 23017NEI6273 | Mercury (elemental) | 6.71E-06 | 0.00E+00 | 2.37E-09 | 0.00E+00 | 2.01E-09 |
| 13179NEI8177 | Toluene | 6.68E-06 | 3.30E-07 | 5.50E-08 | 1.30E-06 | 2.25E-07 |
| 37117NEI9201 | Xylenes (mixed) | 6.67E-06 | 2.62E-07 | 3.67E-08 | 0.00E+00 | 0.00E+00 |
| 12033NEI26309 | Tetrachloroethene | 6.53E-06 | 5.44E-07 | 8.16E-08 | 1.92E-07 | 9.33E-08 |
| 51670NEI42317 | o-Xylene | 6.44E-06 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27071NEI12411 | Tetrachloroethene | 6.43E-06 | 5.36E-07 | 8.04E-08 | 1.89E-07 | 9.19E-08 |

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| 45079NEI46760 | 1,2-Dimethoxyethane | 6.42E-06 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12089NEI26382 | Methylene chloride | 6.37E-06 | 1.29E-07 | 4.69E-08 | 8.92E-08 | 3.43E-08 |
| 26041NEI33883 | Hydrochloric acid | 6.34E-06 | 4.93E-06 | 4.04E-07 | 2.96E-06 | 4.44E-07 |
| 41009NEI40553 | Nickel compounds | 6.24E-06 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01079NEI18357 | Carbon tetrachloride | 6.13E-06 | 4.16E-08 | 9.70E-09 | 8.95E-08 | 1.85E-08 |
| 22031NEI33013 | Tetrachloroethene | 6.10E-06 | 5.08E-07 | 7.62E-08 | 1.79E-07 | 8.71E-08 |
| 55087NEI42710 | Benzene | 6.09E-06 | 4.66E-08 | 3.05E-09 | 4.95E-08 | 1.65E-08 |
| 28043NEI11108 | Toluene | 5.92E-06 | 2.92E-07 | 4.87E-08 | 1.15E-06 | 1.99E-07 |
| 27061NEI34030 | 1,1,1-Trichloroethane | 5.91E-06 | 3.09E-07 | 1.22E-07 | 2.11E-07 | 1.06E-07 |
| 01131NEI8619 | Carbon tetrachloride | 5.78E-06 | 3.93E-08 | 9.16E-09 | 8.45E-08 | 1.74E-08 |
| 12089NEI26382 | Xylenes (mixed) | 5.77E-06 | 2.27E-07 | 3.18E-08 | 0.00E+00 | 0.00E+00 |
| 37087NEI40282 | Mercury (elemental) | 5.72E-06 | 0.00E+00 | 2.02E-09 | 0.00E+00 | 1.72E-09 |
| 22073NEI6057 | Methylene chloride | 5.71E-06 | 1.16E-07 | 4.21E-08 | 7.99E-08 | 3.07E-08 |
| 26043NEI33887 | Styrene | 5.71E-06 | 1.41E-06 | 2.18E-07 | 5.71E-07 | 1.09E-07 |
| 28087NEI34064 | Toluene | 5.52E-06 | 2.72E-07 | 4.54E-08 | 1.08E-06 | 1.86E-07 |
| 12005NEI8278 | 1,1,1-Trichloroethane | 5.50E-06 | 2.88E-07 | 1.13E-07 | 1.97E-07 | 9.85E-08 |
| 05081NEI18660 | Tetrachloroethene | 5.36E-06 | 4.46E-07 | 6.70E-08 | 1.58E-07 | 7.65E-08 |
| 22117NEI46814 | Methyl bromide | 5.33E-06 | 0.00E+00 | 2.53E-08 | 0.00E+00 | 1.09E-07 |
| 12089NEI26382 | Styrene | 5.31E-06 | 1.31E-06 | 2.03E-07 | 5.31E-07 | 1.01E-07 |
| 53015NEI42341A | Toluene | 5.27E-06 | 2.60E-07 | 4.33E-08 | 1.03E-06 | 1.77E-07 |
| 55069NEI46750 | Xylenes (mixed) | 5.27E-06 | 2.07E-07 | 2.90E-08 | 0.00E+00 | 0.00E+00 |
| 48361NEI12492 | Methylene chloride | 5.21E-06 | 1.06E-07 | 3.84E-08 | 7.30E-08 | 2.81E-08 |
| 40101NEI12980 | Benzene | 5.16E-06 | 3.95E-08 | 2.58E-09 | 4.19E-08 | 1.40E-08 |
| 23007NEI6261 | Toluene | 5.04E-06 | 2.49E-07 | 4.15E-08 | 9.82E-07 | 1.70E-07 |
| 27145NEI12407 | Xylenes (mixed) | 4.89E-06 | 1.92E-07 | 2.69E-08 | 0.00E+00 | 0.00E+00 |
| 45079NEI46760 | Tetrachloroethene | 4.89E-06 | 4.07E-07 | 6.11E-08 | 1.44E-07 | 6.98E-08 |
| 12107NEI8265 | 1,1,1-Trichloroethane | 4.79E-06 | 2.51E-07 | 9.88E-08 | 1.72E-07 | 8.58E-08 |
| 22031NEI33013 | Mercury (elemental) | 4.70E-06 | 0.00E+00 | 1.66E-09 | 0.00E+00 | 1.41E-09 |
| 40101NEI12980 | Styrene | 4.61E-06 | 1.14E-06 | 1.76E-07 | 4.61E-07 | 8.81E-08 |
| 23009NEI6284 | Styrene | 4.58E-06 | 1.13E-06 | 1.75E-07 | 4.58E-07 | 8.74E-08 |
| 01121NEI18390 | Tetrachloroethene | 4.57E-06 | 3.81E-07 | 5.71E-08 | 1.34E-07 | 6.53E-08 |
| 55073NEI42689 | Nickel compounds | 4.54E-06 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55141NEI42695 | 1,1,1-Trichloroethane | 4.51E-06 | 2.36E-07 | 9.29E-08 | 1.61E-07 | 8.07E-08 |
| 13127NEI8196 | Mercury (elemental) | 4.46E-06 | 0.00E+00 | 1.57E-09 | 0.00E+00 | 1.34E-09 |
| 55085NEI43202 | Xylenes (mixed) | 4.44E-06 | 1.75E-07 | 2.44E-08 | 0.00E+00 | 0.00E+00 |
| 13179NEI8177 | Carbon tetrachloride | 4.41E-06 | 2.99E-08 | 6.98E-09 | 6.45E-08 | 1.33E-08 |
| 13099NEI26491 | 1,1,1-Trichloroethane | 4.30E-06 | 2.25E-07 | 8.86E-08 | 1.54E-07 | 7.69E-08 |
| 13099NEI26491 | Vinyl chloride | 4.20E-06 | 1.18E-06 | 2.44E-07 | 5.81E-07 | 5.81E-08 |
| 26101NEI33945 | Styrene | 4.20E-06 | 1.04E-06 | 1.60E-07 | 4.20E-07 | 8.01E-08 |
| 13179NEI8177 | Styrene | 3.96E-06 | 9.78E-07 | 1.51E-07 | 3.96E-07 | 7.56E-08 |
| 41009NEI40553 | Mercury (elemental) | 3.86E-06 | 0.00E+00 | 1.36E-09 | 0.00E+00 | 1.16E-09 |
| 13185NEI26504 | Xylenes (mixed) | 3.83E-06 | 1.51E-07 | 2.11E-08 | 0.00E+00 | 0.00E+00 |
| 12123NEI47091 | 1,1,1-Trichloroethane | 3.77E-06 | 1.97E-07 | 7.78E-08 | 1.35E-07 | 6.75E-08 |
| 53015NEI42341A | Tetrachloroethene | 3.74E-06 | 3.11E-07 | 4.67E-08 | 1.10E-07 | 5.34E-08 |
| 39141NEI40488 | Benzene | 3.64E-06 | 2.79E-08 | 1.82E-09 | 2.96E-08 | 9.87E-09 |
| 12107NEI8265 | Methyl bromide | 3.64E-06 | 0.00E+00 | 1.73E-08 | 0.00E+00 | 7.46E-08 |
| 40101NEI12980 | o-Xylene | 3.53E-06 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01131NEI8619 | Mercury (elemental) | 3.42E-06 | 0.00E+00 | 1.21E-09 | 0.00E+00 | 1.02E-09 |
| 37049NEI45206 | Xylenes (mixed) | 3.35E-06 | 1.32E-07 | 1.84E-08 | 0.00E+00 | 0.00E+00 |
| 01131NEI8619 | 1,1,1-Trichloroethane | 3.33E-06 | 1.74E-07 | 6.87E-08 | 1.19E-07 | 5.97E-08 |
| 18165NEI2INT16350 | Toluene | 3.25E-06 | 1.60E-07 | 2.67E-08 | 6.33E-07 | 1.09E-07 |
| 12089NEI26382 | Toluene | 3.25E-06 | 1.60E-07 | 2.67E-08 | 6.32E-07 | 1.09E-07 |
| 26101NEI33945 | Carbon tetrachloride | 3.12E-06 | 2.12E-08 | 4.94E-09 | 4.56E-08 | 9.41E-09 |
| 39031NEI11461 | Tetrachloroethene | 3.02E-06 | 2.52E-07 | 3.78E-08 | 8.89E-08 | 4.32E-08 |
| 36031NEI35908 | Tetrachloroethene | 3.00E-06 | 2.50E-07 | 3.75E-08 | 8.83E-08 | 4.29E-08 |

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| 54057NEI706 | Methylene chloride | 3.00E-06 | 6.09E-08 | 2.21E-08 | 4.20E-08 | 1.62E-08 |
| 53015NEI42341A | Xylenes (mixed) | 2.95E-06 | 1.16E-07 | 1.62E-08 | 0.00E+00 | 0.00E+00 |
| 45041NEI7933 | Vinyl chloride | 2.85E-06 | 8.01E-07 | 1.65E-07 | 3.94E-07 | 3.94E-08 |
| 45043NEI41314 | Mercury (elemental) | 2.81E-06 | 0.00E+00 | 9.92E-10 | 0.00E+00 | 8.43E-10 |
| 40101NEI12980 | Methylene chloride | 2.77E-06 | 5.63E-08 | 2.04E-08 | 3.88E-08 | 1.49E-08 |
| 26043NEI33887 | Xylenes (mixed) | 2.77E-06 | 1.09E-07 | 1.52E-08 | 0.00E+00 | 0.00E+00 |
| 05003NEI54342 | 1,1,1-Trichloroethane | 2.73E-06 | 1.43E-07 | 5.62E-08 | 9.77E-08 | 4.88E-08 |
| 21091NEI32869A | 1,1,1-Trichloroethane | 2.73E-06 | 1.43E-07 | 5.62E-08 | 9.76E-08 | 4.88E-08 |
| 53009NEI42329 | Carbon disulfide | 2.70E-06 | 4.18E-07 | 3.35E-08 | 5.40E-06 | 1.05E-07 |
| 41039NEI45182 | 1,1,1-Trichloroethane | 2.69E-06 | 1.40E-07 | 5.53E-08 | 9.61E-08 | 4.81E-08 |
| 13179NEI8177 | Xylenes (mixed) | 2.65E-06 | 1.04E-07 | 1.46E-08 | 0.00E+00 | 0.00E+00 |
| 47163NEI41599 | Xylenes (mixed) | 2.61E-06 | 1.03E-07 | 1.44E-08 | 0.00E+00 | 0.00E+00 |
| 47071NEI41552 | o-Xylene | 2.61E-06 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55141NEI46739 | Carbon disulfide | 2.57E-06 | 3.98E-07 | 3.19E-08 | 5.14E-06 | 9.96E-08 |
| 48361NEI12492 | 1,1,1-Trichloroethane | 2.53E-06 | 1.32E-07 | 5.21E-08 | 9.05E-08 | 4.52E-08 |
| 26101NEI33945 | Xylenes (mixed) | 2.45E-06 | 9.61E-08 | 1.35E-08 | 0.00E+00 | 0.00E+00 |
| 13305NEI26526 | 1,1,1-Trichloroethane | 2.41E-06 | 1.26E-07 | 4.97E-08 | 8.64E-08 | 4.32E-08 |
| 45031NEI43472 | Toluene | 2.36E-06 | 1.16E-07 | 1.94E-08 | 4.60E-07 | 7.94E-08 |
| 55069NEI46750 | m-Xylene | 2.33E-06 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 51670NEI42317 | Vinyl chloride | 2.26E-06 | 6.36E-07 | 1.31E-07 | 3.13E-07 | 3.13E-08 |
| 53009NEI42329 | Styrene | 2.25E-06 | 5.55E-07 | 8.58E-08 | 2.25E-07 | 4.29E-08 |
| 05069NEI18658 | Vinyl chloride | 2.15E-06 | 6.06E-07 | 1.25E-07 | 2.98E-07 | 2.98E-08 |
| 37087NEI40282 | 1,1,1-Trichloroethane | 2.11E-06 | 1.11E-07 | 4.35E-08 | 7.56E-08 | 3.78E-08 |
| 51085NEI208 | Styrene | 2.07E-06 | 5.12E-07 | 7.91E-08 | 2.07E-07 | 3.96E-08 |
| 26043NEI33887 | Benzene | 2.06E-06 | 1.57E-08 | 1.03E-09 | 1.67E-08 | 5.57E-09 |
| 23009NEI6284 | Xylenes (mixed) | 2.05E-06 | 8.06E-08 | 1.13E-08 | 0.00E+00 | 0.00E+00 |
| 12089NEI26382 | 1,1,1-Trichloroethane | 2.05E-06 | 1.07E-07 | 4.23E-08 | 7.34E-08 | 3.67E-08 |
| 40089NEI11251 | Vinyl chloride | 2.03E-06 | 5.70E-07 | 1.18E-07 | 2.81E-07 | 2.81E-08 |
| 47105NEITN1050093 | Benzene | 1.99E-06 | 1.52E-08 | 9.96E-10 | 1.62E-08 | 5.40E-09 |
| 26043NEI33887 | Toluene | 1.92E-06 | 9.45E-08 | 1.57E-08 | 3.73E-07 | 6.44E-08 |
| 42133NEI7181 | 1,1,1-Trichloroethane | 1.85E-06 | 9.68E-08 | 3.81E-08 | 6.62E-08 | 3.31E-08 |
| 36113NEI39968 | Carbon tetrachloride | 1.79E-06 | 1.21E-08 | 2.83E-09 | 2.61E-08 | 5.39E-09 |
| 22011NEI7559 | 1,1,1-Trichloroethane | 1.78E-06 | 9.32E-08 | 3.67E-08 | 6.38E-08 | 3.19E-08 |
| 36031NEI35908 | Carbon tetrachloride | 1.74E-06 | 1.18E-08 | 2.75E-09 | 2.54E-08 | 5.24E-09 |
| 12089NEI26382 | Tetrachloroethene | 1.73E-06 | 1.44E-07 | 2.17E-08 | 5.10E-08 | 2.48E-08 |
| 12005NEI8278 | Vinyl chloride | 1.71E-06 | 4.81E-07 | 9.92E-08 | 2.37E-07 | 2.37E-08 |
| 23025NEI33118 | Toluene | 1.62E-06 | 7.98E-08 | 1.33E-08 | 3.15E-07 | 5.44E-08 |
| 47085NEI46866 | Tetrachloroethene | 1.61E-06 | 1.34E-07 | 2.02E-08 | 4.74E-08 | 2.30E-08 |
| 37117NEI9201 | Hydrochloric acid | 1.59E-06 | 1.24E-06 | 1.01E-07 | 7.43E-07 | 1.12E-07 |
| 42047NEI40686 | o-Xylene | 1.57E-06 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 26101NEI33945 | Tetrachloroethene | 1.55E-06 | 1.29E-07 | 1.94E-08 | 4.57E-08 | 2.22E-08 |
| 37083NEI47104 | Carbon disulfide | 1.54E-06 | 2.38E-07 | 1.91E-08 | 3.08E-06 | 5.96E-08 |
| 13179NEI8177 | Tetrachloroethene | 1.52E-06 | 1.27E-07 | 1.90E-08 | 4.47E-08 | 2.17E-08 |
| 13175NEIGAT$3911 | Xylenes (mixed) | 1.51E-06 | 5.94E-08 | 8.31E-09 | 0.00E+00 | 0.00E+00 |
| 36115NEINY5533400 | Methanol | 1.50E-06 | 6.10E-08 | 1.56E-08 | 1.62E-07 | 3.24E-08 |
| 39141NEI40488 | o-Xylene | 1.42E-06 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05081NEI18660 | Vinyl chloride | 1.40E-06 | 3.95E-07 | 8.15E-08 | 1.94E-07 | 1.94E-08 |
| 22049NEI33023 | Vinyl chloride | 1.40E-06 | 3.93E-07 | 8.11E-08 | 1.93E-07 | 1.93E-08 |
| 45019NEI41252 | Carbon tetrachloride | 1.39E-06 | 9.46E-09 | 2.21E-09 | 2.04E-08 | 4.20E-09 |
| 37117NEI9201 | Toluene | 1.38E-06 | 6.82E-08 | 1.14E-08 | 2.69E-07 | 4.65E-08 |
| 13245NEI26514 | Vinyl chloride | 1.36E-06 | 3.83E-07 | 7.92E-08 | 1.89E-07 | 1.89E-08 |
| 48361NEI12492 | Vinyl chloride | 1.35E-06 | 3.80E-07 | 7.84E-08 | 1.87E-07 | 1.87E-08 |
| 37047NEI40247 | Vinyl chloride | 1.34E-06 | 3.76E-07 | 7.75E-08 | 1.85E-07 | 1.85E-08 |
| 55087NEI43207 | Formaldehyde | 1.33E-06 | 6.67E-08 | 4.32E-09 | 6.12E-08 | 6.12E-09 |
| 51580NEI759 | Arsenic compounds | 1.30E-06 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

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| 13245NEI26514 | Carbon tetrachloride | 1.30E-06 | 8.80E-09 | 2.05E-09 | 1.90E-08 | 3.91E-09 |
| 01047NEI18335 | Methyl bromide | 1.29E-06 | 0.00E+00 | 6.14E-09 | 0.00E+00 | 2.65E-08 |
| 51101NEI42254 | 1,1,1-Trichloroethane | 1.23E-06 | 6.41E-08 | 2.53E-08 | 4.39E-08 | 2.19E-08 |
| 36115NEINY5532600 | Methanol | 1.22E-06 | 4.93E-08 | 1.26E-08 | 1.31E-07 | 2.62E-08 |
| 13099NEI26491 | Xylenes (mixed) | 1.21E-06 | 4.74E-08 | 6.63E-09 | 0.00E+00 | 0.00E+00 |
| 27145NEI12407 | Tetrachloroethene | 1.19E-06 | 9.90E-08 | 1.48E-08 | 3.49E-08 | 1.70E-08 |
| 53011NEI46599 | o-Xylene | 1.17E-06 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 40101NEI12980 | Tetrachloroethene | 1.15E-06 | 9.57E-08 | 1.44E-08 | 3.38E-08 | 1.64E-08 |
| 48361NEI12492 | Tetrachloroethene | 1.01E-06 | 8.42E-08 | 1.26E-08 | 2.97E-08 | 1.44E-08 |
| 28077NEI11172 | Vinyl chloride | 1.01E-06 | 2.84E-07 | 5.86E-08 | 1.40E-07 | 1.40E-08 |
| 47085NEI46866 | Carbon tetrachloride | 1.01E-06 | 6.83E-09 | 1.59E-09 | 1.47E-08 | 3.04E-09 |
| 12031NEI26304 | Benzene | 9.85E-07 | 7.54E-09 | 4.93E-10 | 8.01E-09 | 2.67E-09 |
| 16069NEI26581 | 1,1,1-Trichloroethane | 9.56E-07 | 5.00E-08 | 1.97E-08 | 3.42E-08 | 1.71E-08 |
| 12031NEI26304 | Styrene | 9.31E-07 | 2.30E-07 | 3.55E-08 | 9.31E-08 | 1.78E-08 |
| 01131NEI8619 | Vinyl chloride | 9.21E-07 | 2.59E-07 | 5.35E-08 | 1.28E-07 | 1.28E-08 |
| 53015NEI42341A | Carbon tetrachloride | 8.89E-07 | 6.04E-09 | 1.41E-09 | 1.30E-08 | 2.68E-09 |
| 42133NEI7181 | o-Xylene | 8.77E-07 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41071NEI40648 | Xylenes (mixed) | 8.70E-07 | 3.42E-08 | 4.78E-09 | 0.00E+00 | 0.00E+00 |
| 12089NEI8261 | Vinyl chloride | 8.70E-07 | 2.45E-07 | 5.05E-08 | 1.20E-07 | 1.20E-08 |
| 47163NEI41599 | 1,1,1-Trichloroethane | 8.59E-07 | 4.50E-08 | 1.77E-08 | 3.08E-08 | 1.54E-08 |
| 45079NEI46760 | Carbon tetrachloride | 8.19E-07 | 5.56E-09 | 1.30E-09 | 1.20E-08 | 2.47E-09 |
| 47107NEI41565 | 1,1,1-Trichloroethane | 8.06E-07 | 4.22E-08 | 1.66E-08 | 2.88E-08 | 1.44E-08 |
| 53009NEI42329 | Xylenes (mixed) | 7.89E-07 | 3.10E-08 | 4.34E-09 | 0.00E+00 | 0.00E+00 |
| 12031NEI26304 | Xylenes (mixed) | 7.89E-07 | 3.10E-08 | 4.34E-09 | 0.00E+00 | 0.00E+00 |
| 05081NEI18660 | Carbon tetrachloride | 7.67E-07 | 5.21E-09 | 1.21E-09 | 1.12E-08 | 2.31E-09 |
| 22069NEI33025 | Vinyl chloride | 7.61E-07 | 2.14E-07 | 4.42E-08 | 1.05E-07 | 1.05E-08 |
| 42047NEI40686 | 1,1,1-Trichloroethane | 7.59E-07 | 3.97E-08 | 1.56E-08 | 2.72E-08 | 1.36E-08 |
| 28111NEI34066 | 1,1,1-Trichloroethane | 7.57E-07 | 3.96E-08 | 1.56E-08 | 2.71E-08 | 1.35E-08 |
| 22073NEI6057 | Vinyl chloride | 7.44E-07 | 2.09E-07 | 4.32E-08 | 1.03E-07 | 1.03E-08 |
| 27071NEI12411 | 1,1,1-Trichloroethane | 7.41E-07 | 3.88E-08 | 1.53E-08 | 2.65E-08 | 1.33E-08 |
| 05081NEI18660 | 1,1,1-Trichloroethane | 6.47E-07 | 3.38E-08 | 1.33E-08 | 2.32E-08 | 1.16E-08 |
| 51085NEI208 | 1,1,1-Trichloroethane | 6.40E-07 | 3.35E-08 | 1.32E-08 | 2.29E-08 | 1.15E-08 |
| 55073NEI42689 | Xylenes (mixed) | 6.34E-07 | 2.49E-08 | 3.49E-09 | 0.00E+00 | 0.00E+00 |
| 26041NEI33883 | 1,1,1-Trichloroethane | 6.21E-07 | 3.25E-08 | 1.28E-08 | 2.22E-08 | 1.11E-08 |
| 26043NEI33887 | Carbon tetrachloride | 6.15E-07 | 4.17E-09 | 9.73E-10 | 8.98E-09 | 1.85E-09 |
| 13127NEI8196 | Methyl bromide | 5.93E-07 | 0.00E+00 | 2.82E-09 | 0.00E+00 | 1.22E-08 |
| 22049NEI33023 | o-Xylene | 5.87E-07 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12123NEI47091 | Vinyl chloride | 5.58E-07 | 1.57E-07 | 3.24E-08 | 7.73E-08 | 7.73E-09 |
| 55009NEIWI4050324 | Benzene | 5.54E-07 | 4.24E-09 | 2.77E-10 | 4.50E-09 | 1.50E-09 |
| 22031NEI33013 | Carbon tetrachloride | 5.54E-07 | 3.76E-09 | 8.77E-10 | 8.09E-09 | 1.67E-09 |
| 39061NEI11610 | Benzene | 5.17E-07 | 3.96E-09 | 2.59E-10 | 4.20E-09 | 1.40E-09 |
| 13179NEI8177 | Vinyl chloride | 5.10E-07 | 1.43E-07 | 2.96E-08 | 7.06E-08 | 7.06E-09 |
| 39113NEI11645 | Toluene | 5.02E-07 | 2.48E-08 | 4.13E-09 | 9.78E-08 | 1.69E-08 |
| 37083NEI47104 | 1,1,1-Trichloroethane | 4.83E-07 | 2.53E-08 | 9.96E-09 | 1.73E-08 | 8.65E-09 |
| 47085NEI46866 | Vinyl chloride | 4.66E-07 | 1.31E-07 | 2.70E-08 | 6.45E-08 | 6.45E-09 |
| 41041NEI40600 | Vinyl chloride | 4.56E-07 | 1.28E-07 | 2.65E-08 | 6.31E-08 | 6.31E-09 |
| 37047NEI40247 | 1,1,1-Trichloroethane | 4.52E-07 | 2.36E-08 | 9.31E-09 | 1.62E-08 | 8.09E-09 |
| 23009NEI6284 | 1,1,1-Trichloroethane | 4.42E-07 | 2.31E-08 | 9.11E-09 | 1.58E-08 | 7.91E-09 |
| 23009NEI6284 | Tetrachloroethene | 4.42E-07 | 3.68E-08 | 5.52E-09 | 1.30E-08 | 6.31E-09 |
| 55009NEI42482 | o-Xylene | 4.26E-07 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23025NEI33118 | Methylene chloride | 4.26E-07 | 8.65E-09 | 3.14E-09 | 5.97E-09 | 2.29E-09 |
| 48241NEI6450 | Methylene chloride | 4.22E-07 | 8.55E-09 | 3.11E-09 | 5.90E-09 | 2.27E-09 |
| 01091NEI45474 | o-Xylene | 4.18E-07 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 51580NEI759 | Nickel compounds | 4.14E-07 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 16069NEI26581 | Vinyl chloride | 4.09E-07 | 1.15E-07 | 2.38E-08 | 5.67E-08 | 5.67E-09 |

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| 55009NEI42482 | 1,1,1-Trichloroethane | 4.07E-07 | 2.13E-08 | 8.39E-09 | 1.46E-08 | 7.28E-09 |
| 40101NEI12980 | Xylenes (mixed) | 3.88E-07 | 1.52E-08 | 2.13E-09 | 0.00E+00 | 0.00E+00 |
| 37117NEI9201 | Methyl bromide | 3.82E-07 | 0.00E+00 | 1.82E-09 | 0.00E+00 | 7.84E-09 |
| 45091NEI47077 | Xylenes (mixed) | 3.75E-07 | 1.47E-08 | 2.06E-09 | 0.00E+00 | 0.00E+00 |
| 41007NEI40554 | o-Xylene | 3.52E-07 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01091NEI45474 | 1,1,1-Trichloroethane | 3.40E-07 | 1.78E-08 | 7.01E-09 | 1.22E-08 | 6.09E-09 |
| 01071NEI18347 | Tetrachloroethene | 3.11E-07 | 2.59E-08 | 3.88E-09 | 9.13E-09 | 4.44E-09 |
| 55009NEIWI4050324 | Toluene | 2.99E-07 | 1.47E-08 | 2.45E-09 | 5.81E-08 | 1.00E-08 |
| 36113NEI39968 | Toluene | 2.75E-07 | 1.36E-08 | 2.26E-09 | 5.36E-08 | 9.26E-09 |
| 51580NEI759 | Mercury (elemental) | 2.56E-07 | 0.00E+00 | 9.05E-11 | 0.00E+00 | 7.69E-11 |
| 51670NEI42317 | 1,1,1-Trichloroethane | 2.51E-07 | 1.31E-08 | 5.18E-09 | 8.99E-09 | 4.50E-09 |
| 12031NEI26304 | Tetrachloroethene | 2.32E-07 | 1.93E-08 | 2.90E-09 | 6.81E-09 | 3.31E-09 |
| 37117NEI9201 | 1,1,1-Trichloroethane | 2.20E-07 | 1.15E-08 | 4.54E-09 | 7.89E-09 | 3.94E-09 |
| 27071NEI12411 | Vinyl chloride | 2.16E-07 | 6.09E-08 | 1.26E-08 | 3.00E-08 | 3.00E-09 |
| 12033NEI26309 | 1,1,1-Trichloroethane | 2.11E-07 | 1.10E-08 | 4.34E-09 | 7.54E-09 | 3.77E-09 |
| 01025NEI8601 | Styrene | 2.02E-07 | 4.99E-08 | 7.71E-09 | 2.02E-08 | 3.85E-09 |
| 45091NEI47077 | 1,1,1-Trichloroethane | 2.00E-07 | 1.04E-08 | 4.11E-09 | 7.15E-09 | 3.57E-09 |
| 01079NEI18357 | 1,1,1-Trichloroethane | 1.99E-07 | 1.04E-08 | 4.09E-09 | 7.11E-09 | 3.55E-09 |
| 45043NEI41314 | Methyl bromide | 1.92E-07 | 0.00E+00 | 9.12E-10 | 0.00E+00 | 3.93E-09 |
| 53011NEI46599 | 1,1,1-Trichloroethane | 1.87E-07 | 9.76E-09 | 3.84E-09 | 6.68E-09 | 3.34E-09 |
| 41039NEI45182 | Vinyl chloride | 1.83E-07 | 5.15E-08 | 1.06E-08 | 2.54E-08 | 2.54E-09 |
| 39141NEI40488 | Carbon tetrachloride | 1.82E-07 | 1.24E-09 | 2.88E-10 | 2.66E-09 | 5.49E-10 |
| 55139NEIWI4710355 | Benzene | 1.82E-07 | 1.39E-09 | 9.09E-11 | 1.48E-09 | 4.93E-10 |
| 47071NEI41552 | Tetrachloroethene | 1.72E-07 | 1.44E-08 | 2.15E-09 | 5.07E-09 | 2.46E-09 |
| 12089NEI26382 | Carbon disulfide | 1.67E-07 | 2.59E-08 | 2.07E-09 | 3.34E-07 | 6.46E-09 |
| 42131NEI40738 | Toluene | 1.59E-07 | 7.84E-09 | 1.31E-09 | 3.10E-08 | 5.35E-09 |
| 28087NEI34064 | 1,1,1-Trichloroethane | 1.48E-07 | 7.76E-09 | 3.06E-09 | 5.31E-09 | 2.66E-09 |
| 53011NEI46599 | Vinyl chloride | 1.14E-07 | 3.20E-08 | 6.62E-09 | 1.58E-08 | 1.58E-09 |
| 47105NEITN1050093 | Toluene | 1.13E-07 | 5.59E-09 | 9.32E-10 | 2.21E-08 | 3.81E-09 |
| 36113NEI39968 | Methylene chloride | 1.06E-07 | 2.14E-09 | 7.78E-10 | 1.48E-09 | 5.68E-10 |
| 55009NEI42482 | Tetrachloroethene | 1.02E-07 | 8.48E-09 | 1.27E-09 | 2.99E-09 | 1.45E-09 |
| 41007NEI40554 | 1,1,1-Trichloroethane | 1.01E-07 | 5.30E-09 | 2.09E-09 | 3.63E-09 | 1.81E-09 |
| 23025NEI33118 | 1,1,1-Trichloroethane | 9.82E-08 | 5.13E-09 | 2.02E-09 | 3.51E-09 | 1.76E-09 |
| 21007NEI11338 | o-Xylene | 9.63E-08 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12107NEI8265 | o-Xylene | 9.18E-08 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45043NEI41314 | 1,1,1-Trichloroethane | 8.94E-08 | 4.67E-09 | 1.84E-09 | 3.20E-09 | 1.60E-09 |
| 39141NEI40488 | Toluene | 8.92E-08 | 4.40E-09 | 7.34E-10 | 1.74E-08 | 3.00E-09 |
| 13051NEI8186 | Vinyl chloride | 8.80E-08 | 2.48E-08 | 5.11E-09 | 1.22E-08 | 1.22E-09 |
| 55073NEI42689 | Carbon disulfide | 7.39E-08 | 1.15E-08 | 9.16E-10 | 1.48E-07 | 2.86E-09 |
| 36113NEI39968 | Styrene | 7.04E-08 | 1.74E-08 | 2.69E-09 | 7.04E-09 | 1.34E-09 |
| 51670NEI42317 | Methyl bromide | 6.70E-08 | 0.00E+00 | 3.19E-10 | 0.00E+00 | 1.38E-09 |
| 39141NEI40488 | Carbon disulfide | 6.32E-08 | 9.79E-09 | 7.83E-10 | 1.26E-07 | 2.45E-09 |
| 47085NEI46866 | 1,1,1-Trichloroethane | 6.24E-08 | 3.26E-09 | 1.28E-09 | 2.23E-09 | 1.12E-09 |
| 28111NEI34066 | o-Xylene | 5.63E-08 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 36115NEINY5532600 | Formaldehyde | 5.52E-08 | 2.76E-09 | 1.79E-10 | 2.53E-09 | 2.53E-10 |
| 01047NEI18335 | Vinyl chloride | 5.14E-08 | 1.45E-08 | 2.99E-09 | 7.12E-09 | 7.12E-10 |
| 40089NEI11251 | Methyl bromide | 5.07E-08 | 0.00E+00 | 2.41E-10 | 0.00E+00 | 1.04E-09 |
| 13179NEI8177 | 1,1,1-Trichloroethane | 4.74E-08 | 2.48E-09 | 9.77E-10 | 1.70E-09 | 8.48E-10 |
| 53015NEI42338 | Vinyl chloride | 4.40E-08 | 1.24E-08 | 2.56E-09 | 6.10E-09 | 6.10E-10 |
| 21007NEI11338 | Mercury (elemental) | 4.34E-08 | 0.00E+00 | 1.53E-11 | 0.00E+00 | 1.30E-11 |
| 13245NEI26514 | o-Xylene | 4.10E-08 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41009NEI40553 | Benzene | 2.88E-08 | 2.20E-10 | 1.44E-11 | 2.34E-10 | 7.80E-11 |
| 55097NEIWI7500086 | Mercury (elemental) | 2.68E-08 | 0.00E+00 | 9.47E-12 | 0.00E+00 | 8.05E-12 |
| 01047NEI18335 | 1,1,1-Trichloroethane | 2.61E-08 | 1.37E-09 | 5.38E-10 | 9.35E-10 | 4.67E-10 |
| 23007NEI6261 | Vinyl chloride | 2.61E-08 | 7.33E-09 | 1.51E-09 | 3.61E-09 | 3.61E-10 |

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| 39141NEI40488 | Tetrachloroethene | 2.41E-08 | 2.01E-09 | 3.01E-10 | 7.09E-10 | 3.44E-10 |
| 12031NEI26304 | o-Xylene | 2.00E-08 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 51580NEI759 | Vinyl chloride | 1.87E-08 | 5.27E-09 | 1.09E-09 | 2.59E-09 | 2.59E-10 |
| 27137NEIMN14904 | Benzene | 1.66E-08 | 1.27E-10 | 8.31E-12 | 1.35E-10 | 4.50E-11 |
| 01071NEI18347 | 1,1,1-Trichloroethane | 1.64E-08 | 8.59E-10 | 3.38E-10 | 5.88E-10 | 2.94E-10 |
| 26101NEI33945 | 1,1,1-Trichloroethane | 1.43E-08 | 7.50E-10 | 2.96E-10 | 5.13E-10 | 2.57E-10 |
| 36031NEI35908 | 1,1,1-Trichloroethane | 1.38E-08 | 7.21E-10 | 2.84E-10 | 4.93E-10 | 2.47E-10 |
| 22031NEI33013 | Triethylamine | 1.37E-08 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41043NEI13340 | o-Xylene | 1.23E-08 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53009NEI42329 | Tetrachloroethene | 1.19E-08 | 9.91E-10 | 1.49E-10 | 3.50E-10 | 1.70E-10 |
| 37049NEI45206 | 1,1,1-Trichloroethane | 1.09E-08 | 5.72E-10 | 2.25E-10 | 3.91E-10 | 1.96E-10 |
| 55139NEIWI4710355 | Toluene | 1.03E-08 | 5.10E-10 | 8.51E-11 | 2.01E-09 | 3.48E-10 |
| 13245NEI26514 | 1,1,1-Trichloroethane | 9.72E-09 | 5.09E-10 | 2.00E-10 | 3.48E-10 | 1.74E-10 |
| 48361NEI12492 | o-Xylene | 7.66E-09 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 28149NEI34070 | Vinyl chloride | 6.15E-09 | 1.73E-09 | 3.57E-10 | 8.52E-10 | 8.52E-11 |
| 26043NEI33887 | Chlorine | 6.09E-09 | 8.52E-10 | 2.20E-10 | 4.41E-10 | 1.47E-10 |
| 45079NEI46760 | 1,1,1-Trichloroethane | 5.75E-09 | 3.01E-10 | 1.18E-10 | 2.06E-10 | 1.03E-10 |
| 23017NEI6273 | Toluene | 2.86E-09 | 1.41E-10 | 2.35E-11 | 5.56E-10 | 9.61E-11 |
| 26043NEI33887 | 1,1,1-Trichloroethane | 2.75E-09 | 1.44E-10 | 5.67E-11 | 9.85E-11 | 4.93E-11 |
| 01071NEI18347 | Carbon tetrachloride | 2.42E-09 | 1.64E-11 | 3.83E-12 | 3.53E-11 | 7.29E-12 |
| 41009NEI40553 | Toluene | 1.64E-09 | 8.09E-11 | 1.35E-11 | 3.19E-10 | 5.51E-11 |
| 27137NEIMN14904 | Mercury (elemental) | 1.29E-09 | 0.00E+00 | 4.54E-13 | 0.00E+00 | 3.86E-13 |
| 48067NEI41628 | Vinyl chloride | 1.18E-09 | 3.31E-10 | 6.82E-11 | 1.63E-10 | 1.63E-11 |
| 53071NEI42410 | Chlorine | 1.00E-09 | 1.41E-10 | 3.64E-11 | 7.27E-11 | 2.42E-11 |
| 36115NEINY5532600 | Phenol | 5.24E-10 | 5.24E-11 | 3.41E-11 | 8.00E-11 | 1.60E-11 |
| 01023NEI18334 | o-Xylene | 1.35E-10 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53015NEI42341A | 1,1,1-Trichloroethane | 3.07E-11 | 1.60E-12 | 6.32E-13 | 1.10E-12 | 5.49E-13 |
| 01001NEI8560 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01001NEI8560 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01001NEI8560 | 1,3-Butadiene | 0.00E+00 | 5.95E-09 | 7.44E-10 | 4.06E-07 | 2.03E-08 |
| 01001NEI8560 | Biphenyl | 0.00E+00 | 0.00E+00 | 7.19E-07 | 0.00E+00 | 0.00E+00 |
| 01001NEI8560 | Chlorobenzene | 0.00E+00 | 1.10E-05 | 7.31E-07 | 0.00E+00 | 0.00E+00 |
| 01001NEI8560 | Cumene | 0.00E+00 | 2.30E-08 | 3.83E-09 | 0.00E+00 | 0.00E+00 |
| 01001NEI8560 | Ethyl benzene | 0.00E+00 | 5.93E-08 | 1.73E-09 | 0.00E+00 | 0.00E+00 |
| 01001NEI8560 | Ethylene dibromide | 0.00E+00 | 2.84E-09 | 2.05E-09 | 0.00E+00 | 0.00E+00 |
| 01001NEI8560 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 9.14E-10 | 2.26E-10 |
| 01001NEI8560 | Methyl chloride | 0.00E+00 | 0.00E+00 | 8.73E-07 | 0.00E+00 | 2.00E-06 |
| 01001NEI8560 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01001NEI8560 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01001NEI8560 | n-Hexane | 0.00E+00 | 0.00E+00 | 1.13E-07 | 0.00E+00 | 0.00E+00 |
| 01001NEI8560 | Propionaldehyde | 0.00E+00 | 2.32E-05 | 4.12E-06 | 0.00E+00 | 0.00E+00 |
| 01001NEI8560 | Trichloroethylene | 0.00E+00 | 3.61E-06 | 1.05E-06 | 4.68E-06 | 9.36E-07 |
| 01023NEI18334 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01023NEI18334 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01023NEI18334 | 1,3-Butadiene | 0.00E+00 | 1.13E-06 | 1.41E-07 | 7.72E-05 | 3.86E-06 |
| 01023NEI18334 | Acetophenone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01023NEI18334 | Biphenyl | 0.00E+00 | 0.00E+00 | 1.23E-03 | 0.00E+00 | 0.00E+00 |
| 01023NEI18334 | Chlorobenzene | 0.00E+00 | 2.25E-04 | 1.50E-05 | 0.00E+00 | 0.00E+00 |
| 01023NEI18334 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01023NEI18334 | Cumene | 0.00E+00 | 7.42E-04 | 1.24E-04 | 0.00E+00 | 0.00E+00 |
| 01023NEI18334 | Ethyl benzene | 0.00E+00 | 1.55E-02 | 4.53E-04 | 0.00E+00 | 0.00E+00 |
| 01023NEI18334 | Ethylene dibromide | 0.00E+00 | 5.49E-06 | 3.97E-06 | 0.00E+00 | 0.00E+00 |
| 01023NEI18334 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.29E-04 | 3.19E-05 |
| 01023NEI18334 | Ethylene glycol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01023NEI18334 | Hexachloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

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|---|---|---|---|---|---|---|
| 01023NEI18334 | Methyl chloride | 0.00E+00 | 0.00E+00 | 3.81E-06 | 0.00E+00 | 8.71E-06 |
| 01023NEI18334 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01023NEI18334 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01023NEI18334 | n-Hexane | 0.00E+00 | 0.00E+00 | 1.49E-06 | 0.00E+00 | 0.00E+00 |
| 01023NEI18334 | o-Cresol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01023NEI18334 | Propionaldehyde | 0.00E+00 | 1.32E-03 | 2.34E-04 | 0.00E+00 | 0.00E+00 |
| 01023NEI18334 | Trichloroethylene | 0.00E+00 | 1.44E-05 | 4.19E-06 | 1.86E-05 | 3.73E-06 |
| 01025NEI8601 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01025NEI8601 | Cumene | 0.00E+00 | 6.40E-06 | 1.07E-06 | 0.00E+00 | 0.00E+00 |
| 01025NEI8601 | Methyl chloride | 0.00E+00 | 0.00E+00 | 4.08E-07 | 0.00E+00 | 9.34E-07 |
| 01025NEI8601 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01025NEI8601 | n-Hexane | 0.00E+00 | 0.00E+00 | 3.27E-08 | 0.00E+00 | 0.00E+00 |
| 01025NEI8601 | Propionaldehyde | 0.00E+00 | 4.72E-06 | 8.38E-07 | 0.00E+00 | 0.00E+00 |
| 01047NEI18335 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01047NEI18335 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01047NEI18335 | 1,3-Butadiene | 0.00E+00 | 2.80E-09 | 3.50E-10 | 1.91E-07 | 9.55E-09 |
| 01047NEI18335 | Beryllium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.83E-05 |
| 01047NEI18335 | Biphenyl | 0.00E+00 | 0.00E+00 | 2.33E-05 | 0.00E+00 | 0.00E+00 |
| 01047NEI18335 | Cadmium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01047NEI18335 | Chlorobenzene | 0.00E+00 | 2.49E-05 | 1.66E-06 | 0.00E+00 | 0.00E+00 |
| 01047NEI18335 | Chromium (III) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01047NEI18335 | Chromium (VI) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01047NEI18335 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01047NEI18335 | Cumene | 0.00E+00 | 1.15E-07 | 1.91E-08 | 0.00E+00 | 0.00E+00 |
| 01047NEI18335 | Ethyl benzene | 0.00E+00 | 3.84E-08 | 1.12E-09 | 0.00E+00 | 0.00E+00 |
| 01047NEI18335 | Ethylene dibromide | 0.00E+00 | 2.05E-10 | 1.48E-10 | 0.00E+00 | 0.00E+00 |
| 01047NEI18335 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.82E-09 | 1.44E-09 |
| 01047NEI18335 | Hexachloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01047NEI18335 | Lead compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01047NEI18335 | Manganese compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01047NEI18335 | Mercuric chloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01047NEI18335 | Methyl chloride | 0.00E+00 | 0.00E+00 | 5.92E-07 | 0.00E+00 | 1.35E-06 |
| 01047NEI18335 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01047NEI18335 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01047NEI18335 | n-Hexane | 0.00E+00 | 0.00E+00 | 1.30E-08 | 0.00E+00 | 0.00E+00 |
| 01047NEI18335 | o-Cresol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01047NEI18335 | Propionaldehyde | 0.00E+00 | 9.34E-05 | 1.66E-05 | 0.00E+00 | 0.00E+00 |
| 01047NEI18335 | Selenium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01047NEI18335 | Trichloroethylene | 0.00E+00 | 3.07E-07 | 8.95E-08 | 3.98E-07 | 7.96E-08 |
| 01053NEI18338 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01053NEI18338 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01053NEI18338 | 1,3-Butadiene | 0.00E+00 | 4.79E-08 | 5.99E-09 | 3.27E-06 | 1.63E-07 |
| 01053NEI18338 | Biphenyl | 0.00E+00 | 0.00E+00 | 6.31E-06 | 0.00E+00 | 0.00E+00 |
| 01053NEI18338 | Chlorobenzene | 0.00E+00 | 8.94E-06 | 5.96E-07 | 0.00E+00 | 0.00E+00 |
| 01053NEI18338 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01053NEI18338 | Cumene | 0.00E+00 | 8.38E-04 | 1.40E-04 | 0.00E+00 | 0.00E+00 |
| 01053NEI18338 | Ethyl benzene | 0.00E+00 | 2.47E-07 | 7.20E-09 | 0.00E+00 | 0.00E+00 |
| 01053NEI18338 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.94E-08 | 1.71E-08 |
| 01053NEI18338 | Ethylene glycol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01053NEI18338 | Hexachloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01053NEI18338 | Methyl chloride | 0.00E+00 | 0.00E+00 | 1.93E-06 | 0.00E+00 | 4.41E-06 |
| 01053NEI18338 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01053NEI18338 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01053NEI18338 | n-Hexane | 0.00E+00 | 0.00E+00 | 3.92E-06 | 0.00E+00 | 0.00E+00 |
| 01053NEI18338 | o-Cresol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

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| 01053NEI18338 | Propionaldehyde | 0.00E+00 | 3.66E-05 | 6.50E-06 | 0.00E+00 | 0.00E+00 |
| 01053NEI18338 | Trichloroethylene | 0.00E+00 | 3.16E-07 | 9.21E-08 | 4.10E-07 | 8.19E-08 |
| 01071NEI18347 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01071NEI18347 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01071NEI18347 | 1,3-Butadiene | 0.00E+00 | 3.09E-12 | 3.86E-13 | 2.11E-10 | 1.05E-11 |
| 01071NEI18347 | Biphenyl | 0.00E+00 | 0.00E+00 | 6.72E-05 | 0.00E+00 | 0.00E+00 |
| 01071NEI18347 | Chlorobenzene | 0.00E+00 | 3.20E-08 | 2.14E-09 | 0.00E+00 | 0.00E+00 |
| 01071NEI18347 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01071NEI18347 | Cumene | 0.00E+00 | 1.92E-06 | 3.19E-07 | 0.00E+00 | 0.00E+00 |
| 01071NEI18347 | Ethyl benzene | 0.00E+00 | 2.16E-11 | 6.30E-13 | 0.00E+00 | 0.00E+00 |
| 01071NEI18347 | Methyl chloride | 0.00E+00 | 0.00E+00 | 1.20E-10 | 0.00E+00 | 2.74E-10 |
| 01071NEI18347 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01071NEI18347 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01071NEI18347 | n-Hexane | 0.00E+00 | 0.00E+00 | 1.38E-09 | 0.00E+00 | 0.00E+00 |
| 01071NEI18347 | o-Cresol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01071NEI18347 | Propionaldehyde | 0.00E+00 | 5.13E-06 | 9.10E-07 | 0.00E+00 | 0.00E+00 |
| 01071NEI18347 | Trichloroethylene | 0.00E+00 | 9.23E-09 | 2.69E-09 | 1.20E-08 | 2.39E-09 |
| 01079NEI18357 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01079NEI18357 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01079NEI18357 | Acetophenone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01079NEI18357 | Biphenyl | 0.00E+00 | 0.00E+00 | 1.04E-09 | 0.00E+00 | 0.00E+00 |
| 01079NEI18357 | Carbonyl sulfide | 0.00E+00 | 0.00E+00 | 5.76E-08 | 0.00E+00 | 0.00E+00 |
| 01079NEI18357 | Chlorobenzene | 0.00E+00 | 5.20E-06 | 3.47E-07 | 0.00E+00 | 0.00E+00 |
| 01079NEI18357 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01079NEI18357 | Cumene | 0.00E+00 | 1.42E-07 | 2.36E-08 | 0.00E+00 | 0.00E+00 |
| 01079NEI18357 | Dibutylphthalate | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01079NEI18357 | Ethyl benzene | 0.00E+00 | 1.05E-07 | 3.07E-09 | 0.00E+00 | 0.00E+00 |
| 01079NEI18357 | Ethylene dibromide | 0.00E+00 | 2.99E-09 | 2.16E-09 | 0.00E+00 | 0.00E+00 |
| 01079NEI18357 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.19E-08 | 2.94E-09 |
| 01079NEI18357 | Hexachloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01079NEI18357 | Methyl chloride | 0.00E+00 | 0.00E+00 | 9.21E-07 | 0.00E+00 | 2.11E-06 |
| 01079NEI18357 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01079NEI18357 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01079NEI18357 | n-Hexane | 0.00E+00 | 0.00E+00 | 1.06E-07 | 0.00E+00 | 0.00E+00 |
| 01079NEI18357 | Propionaldehyde | 0.00E+00 | 1.33E-04 | 2.36E-05 | 0.00E+00 | 0.00E+00 |
| 01079NEI18357 | Trichloroethylene | 0.00E+00 | 8.37E-08 | 2.44E-08 | 1.08E-07 | 2.17E-08 |
| 01091NEI45474 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01091NEI45474 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01091NEI45474 | 1,3-Butadiene | 0.00E+00 | 1.92E-08 | 2.40E-09 | 1.31E-06 | 6.54E-08 |
| 01091NEI45474 | Biphenyl | 0.00E+00 | 0.00E+00 | 3.35E-09 | 0.00E+00 | 0.00E+00 |
| 01091NEI45474 | Chlorobenzene | 0.00E+00 | 7.02E-06 | 4.68E-07 | 0.00E+00 | 0.00E+00 |
| 01091NEI45474 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01091NEI45474 | Cumene | 0.00E+00 | 1.54E-06 | 2.57E-07 | 0.00E+00 | 0.00E+00 |
| 01091NEI45474 | Ethyl benzene | 0.00E+00 | 2.40E-06 | 7.01E-08 | 0.00E+00 | 0.00E+00 |
| 01091NEI45474 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.39E-06 | 5.89E-07 |
| 01091NEI45474 | Hexachloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01091NEI45474 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01091NEI45474 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01091NEI45474 | n-Hexane | 0.00E+00 | 0.00E+00 | 3.28E-08 | 0.00E+00 | 0.00E+00 |
| 01091NEI45474 | Propionaldehyde | 0.00E+00 | 4.77E-05 | 8.47E-06 | 0.00E+00 | 0.00E+00 |
| 01091NEI45474 | Trichloroethylene | 0.00E+00 | 4.96E-08 | 1.45E-08 | 6.43E-08 | 1.29E-08 |
| 01099NEI18373 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01099NEI18373 | Cumene | 0.00E+00 | 3.73E-05 | 6.21E-06 | 0.00E+00 | 0.00E+00 |
| 01099NEI18373 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01099NEI18373 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

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| 01099NEI18373 | n-Hexane | 0.00E+00 | 0.00E+00 | 1.64E-07 | 0.00E+00 | 0.00E+00 |
| 01099NEI18373 | Propionaldehyde | 0.00E+00 | 7.31E-06 | 1.30E-06 | 0.00E+00 | 0.00E+00 |
| 01113NEI46931 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01113NEI46931 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01113NEI46931 | 1,3-Butadiene | 0.00E+00 | 3.48E-09 | 4.34E-10 | 2.37E-07 | 1.18E-08 |
| 01113NEI46931 | Biphenyl | 0.00E+00 | 0.00E+00 | 6.93E-06 | 0.00E+00 | 0.00E+00 |
| 01113NEI46931 | Chlorobenzene | 0.00E+00 | 1.45E-05 | 9.68E-07 | 0.00E+00 | 0.00E+00 |
| 01113NEI46931 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01113NEI46931 | Cumene | 0.00E+00 | 2.59E-05 | 4.31E-06 | 0.00E+00 | 0.00E+00 |
| 01113NEI46931 | Ethyl benzene | 0.00E+00 | 1.58E-07 | 4.60E-09 | 0.00E+00 | 0.00E+00 |
| 01113NEI46931 | Ethylene dibromide | 0.00E+00 | 5.17E-09 | 3.73E-09 | 0.00E+00 | 0.00E+00 |
| 01113NEI46931 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.20E-06 | 1.29E-06 |
| 01113NEI46931 | Methyl chloride | 0.00E+00 | 0.00E+00 | 1.59E-06 | 0.00E+00 | 3.64E-06 |
| 01113NEI46931 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01113NEI46931 | n-Hexane | 0.00E+00 | 0.00E+00 | 1.58E-07 | 0.00E+00 | 0.00E+00 |
| 01113NEI46931 | Propionaldehyde | 0.00E+00 | 5.24E-05 | 9.30E-06 | 0.00E+00 | 0.00E+00 |
| 01113NEI46931 | Trichloroethylene | 0.00E+00 | 2.08E-06 | 6.08E-07 | 2.70E-06 | 5.40E-07 |
| 01121NEI18390 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01121NEI18390 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01121NEI18390 | Cumene | 0.00E+00 | 6.02E-06 | 1.00E-06 | 0.00E+00 | 0.00E+00 |
| 01121NEI18390 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01121NEI18390 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01121NEI18390 | n-Hexane | 0.00E+00 | 0.00E+00 | 3.27E-08 | 0.00E+00 | 0.00E+00 |
| 01121NEI18390 | Propionaldehyde | 0.00E+00 | 2.35E-06 | 4.18E-07 | 0.00E+00 | 0.00E+00 |
| 01131NEI8619 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01131NEI8619 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01131NEI8619 | 1,3-Butadiene | 0.00E+00 | 1.96E-08 | 2.45E-09 | 1.34E-06 | 6.68E-08 |
| 01131NEI8619 | Biphenyl | 0.00E+00 | 0.00E+00 | 1.10E-06 | 0.00E+00 | 0.00E+00 |
| 01131NEI8619 | Chlorobenzene | 0.00E+00 | 2.21E-06 | 1.47E-07 | 0.00E+00 | 0.00E+00 |
| 01131NEI8619 | Chromium (III) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01131NEI8619 | Chromium (VI) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01131NEI8619 | Cobalt compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01131NEI8619 | Cumene | 0.00E+00 | 3.12E-08 | 5.20E-09 | 0.00E+00 | 0.00E+00 |
| 01131NEI8619 | Ethyl benzene | 0.00E+00 | 1.12E-07 | 3.25E-09 | 0.00E+00 | 0.00E+00 |
| 01131NEI8619 | Ethylene dibromide | 0.00E+00 | 1.71E-09 | 1.23E-09 | 0.00E+00 | 0.00E+00 |
| 01131NEI8619 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.86E-09 | 1.94E-09 |
| 01131NEI8619 | Lead compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01131NEI8619 | Manganese compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01131NEI8619 | Mercuric chloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01131NEI8619 | Methyl chloride | 0.00E+00 | 0.00E+00 | 7.00E-07 | 0.00E+00 | 1.60E-06 |
| 01131NEI8619 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01131NEI8619 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01131NEI8619 | n-Hexane | 0.00E+00 | 0.00E+00 | 6.46E-08 | 0.00E+00 | 0.00E+00 |
| 01131NEI8619 | o-Cresol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01131NEI8619 | POM 72002 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 01131NEI8619 | Propionaldehyde | 0.00E+00 | 1.49E-05 | 2.64E-06 | 0.00E+00 | 0.00E+00 |
| 01131NEI8619 | Trichloroethylene | 0.00E+00 | 7.05E-07 | 2.06E-07 | 9.14E-07 | 1.83E-07 |
| 04017NEI13216 | Acrylamide | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 04017NEI13216 | Biphenyl | 0.00E+00 | 0.00E+00 | 2.91E-05 | 0.00E+00 | 0.00E+00 |
| 04017NEI13216 | Cumene | 0.00E+00 | 9.08E-06 | 1.51E-06 | 0.00E+00 | 0.00E+00 |
| 04017NEI13216 | N,N-dimethylaniline | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 04017NEI13216 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 04017NEI13216 | Propionaldehyde | 0.00E+00 | 5.63E-06 | 1.00E-06 | 0.00E+00 | 0.00E+00 |
| 05003NEI54342 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05003NEI54342 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

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| 05003NEI54342 | 1,3-Butadiene | 0.00E+00 | 3.09E-08 | 3.86E-09 | 2.11E-06 | 1.05E-07 |
| 05003NEI54342 | 2,4-Toluene diamine | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05003NEI54342 | Acetophenone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05003NEI54342 | Biphenyl | 0.00E+00 | 0.00E+00 | 2.85E-04 | 0.00E+00 | 0.00E+00 |
| 05003NEI54342 | Cadmium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05003NEI54342 | Chlorobenzene | 0.00E+00 | 1.08E-05 | 7.19E-07 | 0.00E+00 | 0.00E+00 |
| 05003NEI54342 | Chromium (III) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05003NEI54342 | Chromium (VI) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05003NEI54342 | Cobalt compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05003NEI54342 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05003NEI54342 | Cumene | 0.00E+00 | 1.90E-05 | 3.17E-06 | 0.00E+00 | 0.00E+00 |
| 05003NEI54342 | Ethyl benzene | 0.00E+00 | 2.13E-07 | 6.22E-09 | 0.00E+00 | 0.00E+00 |
| 05003NEI54342 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.94E-07 | 4.80E-08 |
| 05003NEI54342 | Ethylene glycol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05003NEI54342 | Hexachloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05003NEI54342 | Lead compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05003NEI54342 | Manganese compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05003NEI54342 | Mercuric chloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05003NEI54342 | Methyl chloride | 0.00E+00 | 0.00E+00 | 1.57E-07 | 0.00E+00 | 3.60E-07 |
| 05003NEI54342 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05003NEI54342 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05003NEI54342 | n-Hexane | 0.00E+00 | 0.00E+00 | 9.18E-08 | 0.00E+00 | 0.00E+00 |
| 05003NEI54342 | o-Cresol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05003NEI54342 | p-Dichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05003NEI54342 | POM 72002 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05003NEI54342 | Propionaldehyde | 0.00E+00 | 1.87E-04 | 3.32E-05 | 0.00E+00 | 0.00E+00 |
| 05003NEI54342 | Trichloroethylene | 0.00E+00 | 4.18E-07 | 1.22E-07 | 5.41E-07 | 1.08E-07 |
| 05029NEI46852 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05029NEI46852 | Biphenyl | 0.00E+00 | 0.00E+00 | 3.07E-05 | 0.00E+00 | 0.00E+00 |
| 05029NEI46852 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05029NEI46852 | Trichloroethylene | 0.00E+00 | 5.73E-06 | 1.67E-06 | 7.42E-06 | 1.48E-06 |
| 05041NEI18652 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05069NEI18657 | Diethanolamine | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05069NEI18657 | o-Cresol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05069NEI18657 | Vinyl acetate | 0.00E+00 | 1.03E-03 | 3.94E-05 | 1.38E-03 | 9.54E-05 |
| 05069NEI18658 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05069NEI18658 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05069NEI18658 | 1,3-Butadiene | 0.00E+00 | 4.20E-07 | 5.25E-08 | 2.86E-05 | 1.43E-06 |
| 05069NEI18658 | 2,4,5-Trichlorophenol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05069NEI18658 | Acetophenone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05069NEI18658 | Acrylonitrile | 0.00E+00 | 1.02E-05 | 7.81E-07 | 4.62E-06 | 1.32E-06 |
| 05069NEI18658 | Aniline | 0.00E+00 | 9.63E-10 | 6.28E-10 | 0.00E+00 | 0.00E+00 |
| 05069NEI18658 | Biphenyl | 0.00E+00 | 0.00E+00 | 3.54E-05 | 0.00E+00 | 0.00E+00 |
| 05069NEI18658 | Carbonyl sulfide | 0.00E+00 | 0.00E+00 | 3.03E-04 | 0.00E+00 | 0.00E+00 |
| 05069NEI18658 | Catechol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05069NEI18658 | Chlorobenzene | 0.00E+00 | 8.10E-05 | 5.40E-06 | 0.00E+00 | 0.00E+00 |
| 05069NEI18658 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05069NEI18658 | Cumene | 0.00E+00 | 2.88E-05 | 4.80E-06 | 0.00E+00 | 0.00E+00 |
| 05069NEI18658 | Ethyl benzene | 0.00E+00 | 9.32E-06 | 2.72E-07 | 0.00E+00 | 0.00E+00 |
| 05069NEI18658 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.57E-05 | 8.81E-06 |
| 05069NEI18658 | Hexachlorocyclopentadiene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05069NEI18658 | Hexachloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05069NEI18658 | m-Cresol (3-methylphenol) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05069NEI18658 | Methyl chloride | 0.00E+00 | 0.00E+00 | 3.39E-08 | 0.00E+00 | 7.75E-08 |
| 05069NEI18658 | Methyl iodide | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.76E-07 | 1.43E-07 |

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| 05069NEI18658 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05069NEI18658 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05069NEI18658 | n-Hexane | 0.00E+00 | 0.00E+00 | 2.72E-07 | 0.00E+00 | 0.00E+00 |
| 05069NEI18658 | o-Cresol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05069NEI18658 | Pentachlorophenol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05069NEI18658 | Propionaldehyde | 0.00E+00 | 3.05E-04 | 5.41E-05 | 0.00E+00 | 0.00E+00 |
| 05069NEI18658 | Trichloroethylene | 0.00E+00 | 4.60E-06 | 1.34E-06 | 5.96E-06 | 1.19E-06 |
| 05081NEI18660 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05081NEI18660 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05081NEI18660 | 1,3-Butadiene | 0.00E+00 | 1.26E-08 | 1.57E-09 | 8.56E-07 | 4.28E-08 |
| 05081NEI18660 | Acetophenone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05081NEI18660 | Biphenyl | 0.00E+00 | 0.00E+00 | 8.76E-07 | 0.00E+00 | 0.00E+00 |
| 05081NEI18660 | Chlorobenzene | 0.00E+00 | 3.56E-06 | 2.37E-07 | 0.00E+00 | 0.00E+00 |
| 05081NEI18660 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05081NEI18660 | Cumene | 0.00E+00 | 2.53E-07 | 4.21E-08 | 0.00E+00 | 0.00E+00 |
| 05081NEI18660 | Ethyl benzene | 0.00E+00 | 5.26E-08 | 1.53E-09 | 0.00E+00 | 0.00E+00 |
| 05081NEI18660 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.88E-08 | 1.45E-08 |
| 05081NEI18660 | Hexachloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05081NEI18660 | Methyl chloride | 0.00E+00 | 0.00E+00 | 1.46E-08 | 0.00E+00 | 3.35E-08 |
| 05081NEI18660 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05081NEI18660 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05081NEI18660 | n-Hexane | 0.00E+00 | 0.00E+00 | 8.47E-09 | 0.00E+00 | 0.00E+00 |
| 05081NEI18660 | o-Cresol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 05081NEI18660 | Propionaldehyde | 0.00E+00 | 4.35E-06 | 7.71E-07 | 0.00E+00 | 0.00E+00 |
| 05081NEI18660 | Trichloroethylene | 0.00E+00 | 2.66E-08 | 7.75E-09 | 3.44E-08 | 6.89E-09 |
| 12005NEI8278 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12005NEI8278 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12005NEI8278 | 1,3-Butadiene | 0.00E+00 | 2.99E-08 | 3.74E-09 | 2.04E-06 | 1.02E-07 |
| 12005NEI8278 | Acetophenone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12005NEI8278 | Biphenyl | 0.00E+00 | 0.00E+00 | 1.17E-06 | 0.00E+00 | 0.00E+00 |
| 12005NEI8278 | Chlorobenzene | 0.00E+00 | 5.49E-06 | 3.66E-07 | 0.00E+00 | 0.00E+00 |
| 12005NEI8278 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12005NEI8278 | Cumene | 0.00E+00 | 1.73E-06 | 2.88E-07 | 0.00E+00 | 0.00E+00 |
| 12005NEI8278 | Ethyl benzene | 0.00E+00 | 9.53E-08 | 2.78E-09 | 0.00E+00 | 0.00E+00 |
| 12005NEI8278 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.31E-07 | 1.06E-07 |
| 12005NEI8278 | Hexachloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12005NEI8278 | Methyl chloride | 0.00E+00 | 0.00E+00 | 1.78E-08 | 0.00E+00 | 4.07E-08 |
| 12005NEI8278 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12005NEI8278 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12005NEI8278 | n-Hexane | 0.00E+00 | 0.00E+00 | 2.52E-08 | 0.00E+00 | 0.00E+00 |
| 12005NEI8278 | o-Cresol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12005NEI8278 | Propionaldehyde | 0.00E+00 | 3.94E-05 | 6.98E-06 | 0.00E+00 | 0.00E+00 |
| 12005NEI8278 | Trichloroethylene | 0.00E+00 | 1.76E-06 | 5.12E-07 | 2.28E-06 | 4.55E-07 |
| 12031NEI26304 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12031NEI26304 | Biphenyl | 0.00E+00 | 0.00E+00 | 1.87E-05 | 0.00E+00 | 0.00E+00 |
| 12031NEI26304 | Chlorobenzene | 0.00E+00 | 2.43E-08 | 1.62E-09 | 0.00E+00 | 0.00E+00 |
| 12031NEI26304 | Cumene | 0.00E+00 | 5.61E-07 | 9.35E-08 | 0.00E+00 | 0.00E+00 |
| 12031NEI26304 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12031NEI26304 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12031NEI26304 | n-Hexane | 0.00E+00 | 0.00E+00 | 1.03E-09 | 0.00E+00 | 0.00E+00 |
| 12031NEI26304 | Propionaldehyde | 0.00E+00 | 1.83E-06 | 3.24E-07 | 0.00E+00 | 0.00E+00 |
| 12031NEI26304 | Trichloroethylene | 0.00E+00 | 6.36E-09 | 1.85E-09 | 8.24E-09 | 1.65E-09 |
| 12033NEI26309 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12033NEI26309 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12033NEI26309 | 1,3-Butadiene | 0.00E+00 | 2.46E-08 | 3.07E-09 | 1.68E-06 | 8.38E-08 |

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|---|---|---|---|---|---|---|
| 12033NEI26309 | Biphenyl | 0.00E+00 | 0.00E+00 | 4.72E-10 | 0.00E+00 | 0.00E+00 |
| 12033NEI26309 | Chlorobenzene | 0.00E+00 | 6.47E-07 | 4.31E-08 | 0.00E+00 | 0.00E+00 |
| 12033NEI26309 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12033NEI26309 | Cumene | 0.00E+00 | 7.92E-08 | 1.32E-08 | 0.00E+00 | 0.00E+00 |
| 12033NEI26309 | Ethyl benzene | 0.00E+00 | 1.64E-07 | 4.78E-09 | 0.00E+00 | 0.00E+00 |
| 12033NEI26309 | Ethylene dibromide | 0.00E+00 | 4.57E-09 | 3.30E-09 | 0.00E+00 | 0.00E+00 |
| 12033NEI26309 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.23E-09 | 1.29E-09 |
| 12033NEI26309 | Hexachloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12033NEI26309 | Methyl chloride | 0.00E+00 | 0.00E+00 | 1.40E-06 | 0.00E+00 | 3.22E-06 |
| 12033NEI26309 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12033NEI26309 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12033NEI26309 | n-Hexane | 0.00E+00 | 0.00E+00 | 1.58E-07 | 0.00E+00 | 0.00E+00 |
| 12033NEI26309 | o-Cresol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12033NEI26309 | Propionaldehyde | 0.00E+00 | 1.92E-05 | 3.41E-06 | 0.00E+00 | 0.00E+00 |
| 12033NEI26309 | Trichloroethylene | 0.00E+00 | 1.14E-07 | 3.31E-08 | 1.47E-07 | 2.95E-08 |
| 12089NEI26382 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12089NEI26382 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12089NEI26382 | Chlorobenzene | 0.00E+00 | 2.60E-07 | 1.74E-08 | 0.00E+00 | 0.00E+00 |
| 12089NEI26382 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12089NEI26382 | Ethyl benzene | 0.00E+00 | 6.77E-08 | 1.98E-09 | 0.00E+00 | 0.00E+00 |
| 12089NEI26382 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.29E-09 | 3.19E-10 |
| 12089NEI26382 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12089NEI26382 | n-Hexane | 0.00E+00 | 0.00E+00 | 2.18E-09 | 0.00E+00 | 0.00E+00 |
| 12089NEI26382 | Trichloroethylene | 0.00E+00 | 8.15E-08 | 2.38E-08 | 1.06E-07 | 2.11E-08 |
| 12089NEI8261 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12089NEI8261 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12089NEI8261 | 1,3-Butadiene | 0.00E+00 | 6.06E-08 | 7.58E-09 | 4.13E-06 | 2.07E-07 |
| 12089NEI8261 | Acetophenone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12089NEI8261 | Biphenyl | 0.00E+00 | 0.00E+00 | 7.08E-06 | 0.00E+00 | 0.00E+00 |
| 12089NEI8261 | Chlorobenzene | 0.00E+00 | 7.55E-06 | 5.04E-07 | 0.00E+00 | 0.00E+00 |
| 12089NEI8261 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12089NEI8261 | Cumene | 0.00E+00 | 2.19E-05 | 3.64E-06 | 0.00E+00 | 0.00E+00 |
| 12089NEI8261 | Ethyl benzene | 0.00E+00 | 2.51E-07 | 7.31E-09 | 0.00E+00 | 0.00E+00 |
| 12089NEI8261 | Ethylene dibromide | 0.00E+00 | 3.54E-09 | 2.55E-09 | 0.00E+00 | 0.00E+00 |
| 12089NEI8261 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.34E-06 | 3.31E-07 |
| 12089NEI8261 | Methyl chloride | 0.00E+00 | 0.00E+00 | 1.10E-06 | 0.00E+00 | 2.51E-06 |
| 12089NEI8261 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12089NEI8261 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12089NEI8261 | n-Hexane | 0.00E+00 | 0.00E+00 | 9.87E-08 | 0.00E+00 | 0.00E+00 |
| 12089NEI8261 | o-Cresol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12089NEI8261 | Propionaldehyde | 0.00E+00 | 3.73E-05 | 6.62E-06 | 0.00E+00 | 0.00E+00 |
| 12089NEI8261 | Trichloroethylene | 0.00E+00 | 1.40E-06 | 4.08E-07 | 1.81E-06 | 3.62E-07 |
| 12107NEI8265 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12107NEI8265 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12107NEI8265 | 2,4-Toluene diamine | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12107NEI8265 | Acetophenone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12107NEI8265 | Biphenyl | 0.00E+00 | 0.00E+00 | 2.28E-04 | 0.00E+00 | 0.00E+00 |
| 12107NEI8265 | Cadmium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12107NEI8265 | Carbonyl sulfide | 0.00E+00 | 0.00E+00 | 1.14E-05 | 0.00E+00 | 0.00E+00 |
| 12107NEI8265 | Catechol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12107NEI8265 | Chlorobenzene | 0.00E+00 | 9.29E-06 | 6.19E-07 | 0.00E+00 | 0.00E+00 |
| 12107NEI8265 | Chromium (III) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12107NEI8265 | Cobalt compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12107NEI8265 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12107NEI8265 | Cumene | 0.00E+00 | 1.49E-05 | 2.48E-06 | 0.00E+00 | 0.00E+00 |

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|---|---|---|---|---|---|---|
| 12107NEI8265 | Ethyl benzene | 0.00E+00 | 4.36E-10 | 1.27E-11 | 0.00E+00 | 0.00E+00 |
| 12107NEI8265 | Ethylene dibromide | 0.00E+00 | 5.79E-10 | 4.18E-10 | 0.00E+00 | 0.00E+00 |
| 12107NEI8265 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.57E-07 | 6.34E-08 |
| 12107NEI8265 | Hexachloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12107NEI8265 | Lead compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12107NEI8265 | Manganese compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12107NEI8265 | Mercuric chloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12107NEI8265 | Methyl chloride | 0.00E+00 | 0.00E+00 | 2.93E-07 | 0.00E+00 | 6.70E-07 |
| 12107NEI8265 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12107NEI8265 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12107NEI8265 | n-Hexane | 0.00E+00 | 0.00E+00 | 8.92E-08 | 0.00E+00 | 0.00E+00 |
| 12107NEI8265 | o-Cresol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12107NEI8265 | p-Dichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12107NEI8265 | POM 72002 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12107NEI8265 | Propionaldehyde | 0.00E+00 | 3.25E-07 | 5.77E-08 | 0.00E+00 | 0.00E+00 |
| 12107NEI8265 | Trichloroethylene | 0.00E+00 | 1.75E-06 | 5.09E-07 | 2.26E-06 | 4.53E-07 |
| 12123NEI47091 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12123NEI47091 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12123NEI47091 | 1,3-Butadiene | 0.00E+00 | 7.11E-08 | 8.88E-09 | 4.85E-06 | 2.42E-07 |
| 12123NEI47091 | Acetophenone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12123NEI47091 | Biphenyl | 0.00E+00 | 0.00E+00 | 7.91E-07 | 0.00E+00 | 0.00E+00 |
| 12123NEI47091 | Bromoform | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12123NEI47091 | Carbonyl sulfide | 0.00E+00 | 0.00E+00 | 1.02E-05 | 0.00E+00 | 0.00E+00 |
| 12123NEI47091 | Chlorobenzene | 0.00E+00 | 2.21E-05 | 1.48E-06 | 0.00E+00 | 0.00E+00 |
| 12123NEI47091 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12123NEI47091 | Cumene | 0.00E+00 | 1.06E-05 | 1.77E-06 | 0.00E+00 | 0.00E+00 |
| 12123NEI47091 | Ethyl benzene | 0.00E+00 | 1.86E-07 | 5.43E-09 | 0.00E+00 | 0.00E+00 |
| 12123NEI47091 | Ethylene dibromide | 0.00E+00 | 1.79E-09 | 1.29E-09 | 0.00E+00 | 0.00E+00 |
| 12123NEI47091 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.34E-06 | 1.32E-06 |
| 12123NEI47091 | Hexachloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12123NEI47091 | Methyl chloride | 0.00E+00 | 0.00E+00 | 5.56E-07 | 0.00E+00 | 1.27E-06 |
| 12123NEI47091 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12123NEI47091 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12123NEI47091 | n-Hexane | 0.00E+00 | 0.00E+00 | 1.03E-07 | 0.00E+00 | 0.00E+00 |
| 12123NEI47091 | o-Cresol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 12123NEI47091 | Propionaldehyde | 0.00E+00 | 1.03E-04 | 1.83E-05 | 0.00E+00 | 0.00E+00 |
| 12123NEI47091 | Trichloroethylene | 0.00E+00 | 3.07E-06 | 8.95E-07 | 3.98E-06 | 7.95E-07 |
| 13021NEI26471 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13021NEI26471 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13021NEI26471 | Chlorobenzene | 0.00E+00 | 9.14E-06 | 6.09E-07 | 0.00E+00 | 0.00E+00 |
| 13021NEI26471 | Cumene | 0.00E+00 | 4.12E-05 | 6.86E-06 | 0.00E+00 | 0.00E+00 |
| 13021NEI26471 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.53E-06 | 1.12E-06 |
| 13021NEI26471 | Methyl chloride | 0.00E+00 | 0.00E+00 | 8.84E-06 | 0.00E+00 | 2.02E-05 |
| 13021NEI26471 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13021NEI26471 | n-Hexane | 0.00E+00 | 0.00E+00 | 3.75E-07 | 0.00E+00 | 0.00E+00 |
| 13021NEI26471 | Propionaldehyde | 0.00E+00 | 1.01E-05 | 1.80E-06 | 0.00E+00 | 0.00E+00 |
| 13021NEI26471 | Trichloroethylene | 0.00E+00 | 2.09E-07 | 6.08E-08 | 2.70E-07 | 5.41E-08 |
| 13021NEI26471 | Vinyl acetate | 0.00E+00 | 9.13E-04 | 3.48E-05 | 1.22E-03 | 8.43E-05 |
| 13051NEI26476 | Lead compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13051NEI8186 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13051NEI8186 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13051NEI8186 | 1,3-Butadiene | 0.00E+00 | 3.04E-08 | 3.81E-09 | 2.08E-06 | 1.04E-07 |
| 13051NEI8186 | Biphenyl | 0.00E+00 | 0.00E+00 | 1.91E-07 | 0.00E+00 | 0.00E+00 |
| 13051NEI8186 | Chlorobenzene | 0.00E+00 | 5.53E-06 | 3.69E-07 | 0.00E+00 | 0.00E+00 |
| 13051NEI8186 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

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|---|---|---|---|---|---|---|
| 13051NEI8186 | Cumene | 0.00E+00 | 1.28E-07 | 2.14E-08 | 0.00E+00 | 0.00E+00 |
| 13051NEI8186 | Ethyl benzene | 0.00E+00 | 4.49E-08 | 1.31E-09 | 0.00E+00 | 0.00E+00 |
| 13051NEI8186 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.87E-08 | 7.09E-09 |
| 13051NEI8186 | Methyl chloride | 0.00E+00 | 0.00E+00 | 9.32E-08 | 0.00E+00 | 2.13E-07 |
| 13051NEI8186 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13051NEI8186 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13051NEI8186 | n-Hexane | 0.00E+00 | 0.00E+00 | 1.93E-08 | 0.00E+00 | 0.00E+00 |
| 13051NEI8186 | Propionaldehyde | 0.00E+00 | 3.78E-06 | 6.71E-07 | 0.00E+00 | 0.00E+00 |
| 13051NEI8186 | Trichloroethylene | 0.00E+00 | 1.79E-06 | 5.21E-07 | 2.32E-06 | 4.63E-07 |
| 13095NEI26487 | Lead compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13099NEI26491 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13099NEI26491 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13099NEI26491 | Acetophenone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13099NEI26491 | Biphenyl | 0.00E+00 | 0.00E+00 | 1.46E-06 | 0.00E+00 | 0.00E+00 |
| 13099NEI26491 | Chlorobenzene | 0.00E+00 | 1.84E-06 | 1.23E-07 | 0.00E+00 | 0.00E+00 |
| 13099NEI26491 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13099NEI26491 | Cumene | 0.00E+00 | 2.65E-05 | 4.41E-06 | 0.00E+00 | 0.00E+00 |
| 13099NEI26491 | Ethyl benzene | 0.00E+00 | 9.45E-06 | 2.76E-07 | 0.00E+00 | 0.00E+00 |
| 13099NEI26491 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.38E-07 | 1.08E-07 |
| 13099NEI26491 | Methyl chloride | 0.00E+00 | 0.00E+00 | 3.63E-06 | 0.00E+00 | 8.32E-06 |
| 13099NEI26491 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13099NEI26491 | n-Hexane | 0.00E+00 | 0.00E+00 | 1.58E-08 | 0.00E+00 | 0.00E+00 |
| 13099NEI26491 | o-Cresol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13099NEI26491 | Propionaldehyde | 0.00E+00 | 2.97E-05 | 5.26E-06 | 0.00E+00 | 0.00E+00 |
| 13099NEI26491 | Trichloroethylene | 0.00E+00 | 1.04E-06 | 3.03E-07 | 1.35E-06 | 2.70E-07 |
| 13103NEI8178 | 2-Nitropropane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13103NEI8178 | Acetophenone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13103NEI8178 | Acrylonitrile | 0.00E+00 | 2.44E-04 | 1.88E-05 | 1.11E-04 | 3.17E-05 |
| 13103NEI8178 | Biphenyl | 0.00E+00 | 0.00E+00 | 1.47E-03 | 0.00E+00 | 0.00E+00 |
| 13103NEI8178 | Cadmium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13103NEI8178 | Cobalt compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13103NEI8178 | Ethyl benzene | 0.00E+00 | 6.87E-07 | 2.00E-08 | 0.00E+00 | 0.00E+00 |
| 13103NEI8178 | Lead compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13103NEI8178 | Manganese compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13103NEI8178 | Mercuric chloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13103NEI8178 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13103NEI8178 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13103NEI8178 | Nitrobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13103NEI8178 | POM 72002 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13103NEI8178 | Propionaldehyde | 0.00E+00 | 2.35E-06 | 4.17E-07 | 0.00E+00 | 0.00E+00 |
| 13115NEI26495 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13115NEI26495 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13115NEI26495 | 1,3-Butadiene | 0.00E+00 | 6.42E-08 | 8.03E-09 | 4.38E-06 | 2.19E-07 |
| 13115NEI26495 | Biphenyl | 0.00E+00 | 0.00E+00 | 4.71E-05 | 0.00E+00 | 0.00E+00 |
| 13115NEI26495 | Chlorobenzene | 0.00E+00 | 5.39E-05 | 3.59E-06 | 0.00E+00 | 0.00E+00 |
| 13115NEI26495 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13115NEI26495 | Cumene | 0.00E+00 | 2.19E-04 | 3.65E-05 | 0.00E+00 | 0.00E+00 |
| 13115NEI26495 | Ethyl benzene | 0.00E+00 | 4.94E-07 | 1.44E-08 | 0.00E+00 | 0.00E+00 |
| 13115NEI26495 | Ethylene dibromide | 0.00E+00 | 4.32E-08 | 3.12E-08 | 0.00E+00 | 0.00E+00 |
| 13115NEI26495 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 9.26E-07 | 2.29E-07 |
| 13115NEI26495 | Methyl chloride | 0.00E+00 | 0.00E+00 | 1.33E-05 | 0.00E+00 | 3.04E-05 |
| 13115NEI26495 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13115NEI26495 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13115NEI26495 | n-Hexane | 0.00E+00 | 0.00E+00 | 9.81E-07 | 0.00E+00 | 0.00E+00 |
| 13115NEI26495 | Propionaldehyde | 0.00E+00 | 9.09E-05 | 1.61E-05 | 0.00E+00 | 0.00E+00 |

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|---|---|---|---|---|---|---|
| 13115NEI26495 | Trichloroethylene | 0.00E+00 | 6.29E-06 | 1.84E-06 | 8.16E-06 | 1.63E-06 |
| 13127NEI8196 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13127NEI8196 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13127NEI8196 | 2,4-Toluene diamine | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13127NEI8196 | 3-Methylcholanthrene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13127NEI8196 | 7,12-Dimethylbenz[a]Anthracene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13127NEI8196 | Acetophenone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13127NEI8196 | Benz[a]anthracene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13127NEI8196 | Benzo[a]pyrene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13127NEI8196 | Benzo[b]fluoranthene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13127NEI8196 | Benzo[k]fluoranthene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13127NEI8196 | Beryllium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 9.88E-09 |
| 13127NEI8196 | Biphenyl | 0.00E+00 | 0.00E+00 | 3.39E-07 | 0.00E+00 | 0.00E+00 |
| 13127NEI8196 | Cadmium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13127NEI8196 | Carbonyl sulfide | 0.00E+00 | 0.00E+00 | 1.71E-06 | 0.00E+00 | 0.00E+00 |
| 13127NEI8196 | Chlorobenzene | 0.00E+00 | 6.50E-05 | 4.33E-06 | 0.00E+00 | 0.00E+00 |
| 13127NEI8196 | Chromium (III) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13127NEI8196 | Chromium (VI) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13127NEI8196 | Chrysene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13127NEI8196 | Cobalt compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13127NEI8196 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13127NEI8196 | Cumene | 0.00E+00 | 1.54E-05 | 2.57E-06 | 0.00E+00 | 0.00E+00 |
| 13127NEI8196 | Dibenzo[a,h]anthracene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13127NEI8196 | Ethyl benzene | 0.00E+00 | 1.56E-06 | 4.54E-08 | 0.00E+00 | 0.00E+00 |
| 13127NEI8196 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.94E-06 | 1.96E-06 |
| 13127NEI8196 | Indeno[1,2,3-c,d]pyrene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13127NEI8196 | Manganese compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13127NEI8196 | Mercuric chloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13127NEI8196 | Methyl chloride | 0.00E+00 | 0.00E+00 | 2.90E-08 | 0.00E+00 | 6.65E-08 |
| 13127NEI8196 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13127NEI8196 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13127NEI8196 | n-Hexane | 0.00E+00 | 0.00E+00 | 2.76E-07 | 0.00E+00 | 0.00E+00 |
| 13127NEI8196 | p-Dichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13127NEI8196 | POM 72002 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13127NEI8196 | Propionaldehyde | 0.00E+00 | 4.20E-06 | 7.46E-07 | 0.00E+00 | 0.00E+00 |
| 13127NEI8196 | Selenium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13127NEI8196 | Trichloroethylene | 0.00E+00 | 2.38E-06 | 6.93E-07 | 3.08E-06 | 6.16E-07 |
| 13175NEIGAT$3911 | Biphenyl | 0.00E+00 | 0.00E+00 | 7.03E-06 | 0.00E+00 | 0.00E+00 |
| 13175NEIGAT$3911 | Methyl chloride | 0.00E+00 | 0.00E+00 | 2.14E-06 | 0.00E+00 | 4.91E-06 |
| 13175NEIGAT$3911 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13175NEIGAT$3911 | Propionaldehyde | 0.00E+00 | 7.72E-06 | 1.37E-06 | 0.00E+00 | 0.00E+00 |
| 13179NEI8177 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13179NEI8177 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13179NEI8177 | 1,3-Butadiene | 0.00E+00 | 9.14E-10 | 1.14E-10 | 6.23E-08 | 3.12E-09 |
| 13179NEI8177 | Acetophenone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13179NEI8177 | Biphenyl | 0.00E+00 | 0.00E+00 | 1.18E-05 | 0.00E+00 | 0.00E+00 |
| 13179NEI8177 | Chlorobenzene | 0.00E+00 | 2.32E-07 | 1.54E-08 | 0.00E+00 | 0.00E+00 |
| 13179NEI8177 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13179NEI8177 | Cumene | 0.00E+00 | 1.26E-06 | 2.10E-07 | 0.00E+00 | 0.00E+00 |
| 13179NEI8177 | Ethyl benzene | 0.00E+00 | 3.49E-09 | 1.02E-10 | 0.00E+00 | 0.00E+00 |
| 13179NEI8177 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 8.34E-08 | 2.06E-08 |
| 13179NEI8177 | Methyl chloride | 0.00E+00 | 0.00E+00 | 1.11E-07 | 0.00E+00 | 2.54E-07 |
| 13179NEI8177 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13179NEI8177 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13179NEI8177 | n-Hexane | 0.00E+00 | 0.00E+00 | 7.50E-09 | 0.00E+00 | 0.00E+00 |

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|---|---|---|---|---|---|---|
| 13179NEI8177 | o-Cresol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13179NEI8177 | Propionaldehyde | 0.00E+00 | 6.43E-06 | 1.14E-06 | 0.00E+00 | 0.00E+00 |
| 13179NEI8177 | Trichloroethylene | 0.00E+00 | 1.62E-08 | 4.73E-09 | 2.10E-08 | 4.20E-09 |
| 13185NEI26504 | 1,3-Butadiene | 0.00E+00 | 7.15E-09 | 8.94E-10 | 4.87E-07 | 2.44E-08 |
| 13185NEI26504 | Biphenyl | 0.00E+00 | 0.00E+00 | 5.83E-10 | 0.00E+00 | 0.00E+00 |
| 13185NEI26504 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13185NEI26504 | Cumene | 0.00E+00 | 5.58E-06 | 9.29E-07 | 0.00E+00 | 0.00E+00 |
| 13185NEI26504 | Ethyl benzene | 0.00E+00 | 1.38E-07 | 4.02E-09 | 0.00E+00 | 0.00E+00 |
| 13185NEI26504 | Ethylene dibromide | 0.00E+00 | 1.07E-09 | 7.73E-10 | 0.00E+00 | 0.00E+00 |
| 13185NEI26504 | Methyl chloride | 0.00E+00 | 0.00E+00 | 3.29E-07 | 0.00E+00 | 7.53E-07 |
| 13185NEI26504 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13185NEI26504 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13185NEI26504 | n-Hexane | 0.00E+00 | 0.00E+00 | 3.89E-08 | 0.00E+00 | 0.00E+00 |
| 13185NEI26504 | o-Cresol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13185NEI26504 | Propionaldehyde | 0.00E+00 | 1.03E-05 | 1.82E-06 | 0.00E+00 | 0.00E+00 |
| 13193NEI26506 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13245NEI26514 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13245NEI26514 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13245NEI26514 | 1,3-Butadiene | 0.00E+00 | 8.57E-09 | 1.07E-09 | 5.84E-07 | 2.92E-08 |
| 13245NEI26514 | Biphenyl | 0.00E+00 | 0.00E+00 | 8.52E-07 | 0.00E+00 | 0.00E+00 |
| 13245NEI26514 | Chlorobenzene | 0.00E+00 | 3.64E-07 | 2.43E-08 | 0.00E+00 | 0.00E+00 |
| 13245NEI26514 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13245NEI26514 | Cumene | 0.00E+00 | 1.73E-07 | 2.89E-08 | 0.00E+00 | 0.00E+00 |
| 13245NEI26514 | Ethyl benzene | 0.00E+00 | 6.18E-08 | 1.80E-09 | 0.00E+00 | 0.00E+00 |
| 13245NEI26514 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.14E-08 | 2.83E-09 |
| 13245NEI26514 | Hexachloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13245NEI26514 | Methyl chloride | 0.00E+00 | 0.00E+00 | 2.96E-07 | 0.00E+00 | 6.78E-07 |
| 13245NEI26514 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13245NEI26514 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13245NEI26514 | n-Hexane | 0.00E+00 | 0.00E+00 | 3.32E-09 | 0.00E+00 | 0.00E+00 |
| 13245NEI26514 | Propionaldehyde | 0.00E+00 | 2.77E-05 | 4.91E-06 | 0.00E+00 | 0.00E+00 |
| 13245NEI26514 | Trichloroethylene | 0.00E+00 | 3.83E-08 | 1.12E-08 | 4.96E-08 | 9.92E-09 |
| 13245NEI8122 | Biphenyl | 0.00E+00 | 0.00E+00 | 8.80E-05 | 0.00E+00 | 0.00E+00 |
| 13245NEI8122 | Cumene | 0.00E+00 | 3.52E-05 | 5.87E-06 | 0.00E+00 | 0.00E+00 |
| 13245NEI8122 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13245NEI8122 | Propionaldehyde | 0.00E+00 | 5.71E-05 | 1.01E-05 | 0.00E+00 | 0.00E+00 |
| 13305NEI26526 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13305NEI26526 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13305NEI26526 | Biphenyl | 0.00E+00 | 0.00E+00 | 1.04E-06 | 0.00E+00 | 0.00E+00 |
| 13305NEI26526 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13305NEI26526 | Cumene | 0.00E+00 | 1.59E-06 | 2.64E-07 | 0.00E+00 | 0.00E+00 |
| 13305NEI26526 | Ethyl benzene | 0.00E+00 | 5.05E-06 | 1.47E-07 | 0.00E+00 | 0.00E+00 |
| 13305NEI26526 | Methyl chloride | 0.00E+00 | 0.00E+00 | 3.61E-07 | 0.00E+00 | 8.27E-07 |
| 13305NEI26526 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13305NEI26526 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 13305NEI26526 | n-Hexane | 0.00E+00 | 0.00E+00 | 2.15E-08 | 0.00E+00 | 0.00E+00 |
| 13305NEI26526 | Propionaldehyde | 0.00E+00 | 7.07E-05 | 1.25E-05 | 0.00E+00 | 0.00E+00 |
| 13305NEI26526 | Trichloroethylene | 0.00E+00 | 2.19E-07 | 6.38E-08 | 2.84E-07 | 5.67E-08 |
| 16069NEI26581 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 16069NEI26581 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 16069NEI26581 | 1,3-Butadiene | 0.00E+00 | 2.87E-08 | 3.59E-09 | 1.96E-06 | 9.80E-08 |
| 16069NEI26581 | Acetophenone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 16069NEI26581 | Biphenyl | 0.00E+00 | 0.00E+00 | 2.67E-07 | 0.00E+00 | 0.00E+00 |
| 16069NEI26581 | Chlorobenzene | 0.00E+00 | 7.06E-06 | 4.71E-07 | 0.00E+00 | 0.00E+00 |
| 16069NEI26581 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

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|---|---|---|---|---|---|---|
| 16069NEI26581 | Cumene | 0.00E+00 | 1.88E-06 | 3.14E-07 | 0.00E+00 | 0.00E+00 |
| 16069NEI26581 | Ethyl benzene | 0.00E+00 | 8.72E-08 | 2.54E-09 | 0.00E+00 | 0.00E+00 |
| 16069NEI26581 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.60E-07 | 1.13E-07 |
| 16069NEI26581 | Hexachloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 16069NEI26581 | Methyl chloride | 0.00E+00 | 0.00E+00 | 4.28E-09 | 0.00E+00 | 9.79E-09 |
| 16069NEI26581 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 16069NEI26581 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 16069NEI26581 | n-Hexane | 0.00E+00 | 0.00E+00 | 7.46E-08 | 0.00E+00 | 0.00E+00 |
| 16069NEI26581 | o-Cresol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 16069NEI26581 | p-Dichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 16069NEI26581 | POM 72002 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 16069NEI26581 | Propionaldehyde | 0.00E+00 | 2.42E-05 | 4.29E-06 | 0.00E+00 | 0.00E+00 |
| 16069NEI26581 | Trichloroethylene | 0.00E+00 | 6.37E-07 | 1.86E-07 | 8.25E-07 | 1.65E-07 |
| 18165NEI2INT16350 | Biphenyl | 0.00E+00 | 0.00E+00 | 2.35E-05 | 0.00E+00 | 0.00E+00 |
| 18165NEI2INT16350 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 18165NEI2INT16350 | Propionaldehyde | 0.00E+00 | 1.07E-05 | 1.90E-06 | 0.00E+00 | 0.00E+00 |
| 21007NEI11338 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 21007NEI11338 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 21007NEI11338 | 1,3-Butadiene | 0.00E+00 | 9.71E-10 | 1.21E-10 | 6.62E-08 | 3.31E-09 |
| 21007NEI11338 | Biphenyl | 0.00E+00 | 0.00E+00 | 4.72E-08 | 0.00E+00 | 0.00E+00 |
| 21007NEI11338 | Chloroacetic acid | 0.00E+00 | 0.00E+00 | 1.41E-05 | 0.00E+00 | 0.00E+00 |
| 21007NEI11338 | Chlorobenzene | 0.00E+00 | 5.22E-07 | 3.48E-08 | 0.00E+00 | 0.00E+00 |
| 21007NEI11338 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 21007NEI11338 | Cumene | 0.00E+00 | 1.40E-06 | 2.34E-07 | 0.00E+00 | 0.00E+00 |
| 21007NEI11338 | Ethyl benzene | 0.00E+00 | 2.30E-09 | 6.71E-11 | 0.00E+00 | 0.00E+00 |
| 21007NEI11338 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.01E-09 | 7.44E-10 |
| 21007NEI11338 | Lead compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 21007NEI11338 | Mercuric chloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 21007NEI11338 | Methyl chloride | 0.00E+00 | 0.00E+00 | 1.30E-08 | 0.00E+00 | 2.97E-08 |
| 21007NEI11338 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 21007NEI11338 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 21007NEI11338 | n-Hexane | 0.00E+00 | 0.00E+00 | 7.30E-09 | 0.00E+00 | 0.00E+00 |
| 21007NEI11338 | Propionaldehyde | 0.00E+00 | 2.99E-05 | 5.31E-06 | 0.00E+00 | 0.00E+00 |
| 21007NEI11338 | Trichloroethylene | 0.00E+00 | 7.74E-07 | 2.26E-07 | 1.00E-06 | 2.01E-07 |
| 21091NEI32869A | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 21091NEI32869A | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 21091NEI32869A | 1,3-Butadiene | 0.00E+00 | 5.68E-08 | 7.10E-09 | 3.88E-06 | 1.94E-07 |
| 21091NEI32869A | Acetophenone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 21091NEI32869A | Acrylonitrile | 0.00E+00 | 2.03E-06 | 1.56E-07 | 9.21E-07 | 2.63E-07 |
| 21091NEI32869A | Aniline | 0.00E+00 | 1.92E-10 | 1.25E-10 | 0.00E+00 | 0.00E+00 |
| 21091NEI32869A | Biphenyl | 0.00E+00 | 0.00E+00 | 1.72E-05 | 0.00E+00 | 0.00E+00 |
| 21091NEI32869A | Carbonyl sulfide | 0.00E+00 | 0.00E+00 | 7.65E-06 | 0.00E+00 | 0.00E+00 |
| 21091NEI32869A | Catechol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 21091NEI32869A | Chlorobenzene | 0.00E+00 | 3.75E-06 | 2.50E-07 | 0.00E+00 | 0.00E+00 |
| 21091NEI32869A | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 21091NEI32869A | Cumene | 0.00E+00 | 2.87E-04 | 4.79E-05 | 0.00E+00 | 0.00E+00 |
| 21091NEI32869A | Ethyl benzene | 0.00E+00 | 1.48E-05 | 4.33E-07 | 0.00E+00 | 0.00E+00 |
| 21091NEI32869A | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.76E-07 | 1.18E-07 |
| 21091NEI32869A | Ethylene glycol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 21091NEI32869A | Hexachlorocyclopentadiene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 21091NEI32869A | Hexachloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 21091NEI32869A | Methyl iodide | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.51E-08 | 2.85E-08 |
| 21091NEI32869A | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 21091NEI32869A | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 21091NEI32869A | n-Hexane | 0.00E+00 | 0.00E+00 | 1.49E-08 | 0.00E+00 | 0.00E+00 |

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| 21091NEI32869A | o-Cresol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 21091NEI32869A | Propionaldehyde | 0.00E+00 | 4.69E-05 | 8.33E-06 | 0.00E+00 | 0.00E+00 |
| 21091NEI32869A | Trichloroethylene | 0.00E+00 | 1.58E-06 | 4.62E-07 | 2.05E-06 | 4.10E-07 |
| 21107NEI11367 | Vinyl acetate | 0.00E+00 | 4.40E-04 | 1.68E-05 | 5.87E-04 | 4.06E-05 |
| 22011NEI7559 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22011NEI7559 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22011NEI7559 | Biphenyl | 0.00E+00 | 0.00E+00 | 7.96E-06 | 0.00E+00 | 0.00E+00 |
| 22011NEI7559 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22011NEI7559 | Cumene | 0.00E+00 | 1.30E-05 | 2.16E-06 | 0.00E+00 | 0.00E+00 |
| 22011NEI7559 | Methyl chloride | 0.00E+00 | 0.00E+00 | 7.46E-07 | 0.00E+00 | 1.71E-06 |
| 22011NEI7559 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22011NEI7559 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22011NEI7559 | n-Hexane | 0.00E+00 | 0.00E+00 | 1.96E-07 | 0.00E+00 | 0.00E+00 |
| 22011NEI7559 | Propionaldehyde | 0.00E+00 | 8.33E-06 | 1.48E-06 | 0.00E+00 | 0.00E+00 |
| 22011NEI7559 | Trichloroethylene | 0.00E+00 | 7.43E-07 | 2.17E-07 | 9.64E-07 | 1.93E-07 |
| 22031NEI33013 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22031NEI33013 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22031NEI33013 | 1,3-Butadiene | 0.00E+00 | 1.19E-08 | 1.49E-09 | 8.11E-07 | 4.06E-08 |
| 22031NEI33013 | Biphenyl | 0.00E+00 | 0.00E+00 | 4.22E-05 | 0.00E+00 | 0.00E+00 |
| 22031NEI33013 | Cadmium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22031NEI33013 | Chlorobenzene | 0.00E+00 | 3.83E-07 | 2.55E-08 | 0.00E+00 | 0.00E+00 |
| 22031NEI33013 | Chromium (III) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22031NEI33013 | Cobalt compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22031NEI33013 | Cumene | 0.00E+00 | 9.42E-07 | 1.57E-07 | 0.00E+00 | 0.00E+00 |
| 22031NEI33013 | Ethyl benzene | 0.00E+00 | 9.00E-08 | 2.63E-09 | 0.00E+00 | 0.00E+00 |
| 22031NEI33013 | Ethylene dibromide | 0.00E+00 | 3.04E-09 | 2.19E-09 | 0.00E+00 | 0.00E+00 |
| 22031NEI33013 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.64E-09 | 8.99E-10 |
| 22031NEI33013 | Ethylene oxide | 0.00E+00 | 0.00E+00 | 1.82E-08 | 0.00E+00 | 1.63E-08 |
| 22031NEI33013 | Lead compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22031NEI33013 | Manganese compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22031NEI33013 | Mercuric chloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22031NEI33013 | Methyl chloride | 0.00E+00 | 0.00E+00 | 9.34E-07 | 0.00E+00 | 2.14E-06 |
| 22031NEI33013 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22031NEI33013 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22031NEI33013 | n-Hexane | 0.00E+00 | 0.00E+00 | 1.64E-07 | 0.00E+00 | 0.00E+00 |
| 22031NEI33013 | POM 72002 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22031NEI33013 | Propionaldehyde | 0.00E+00 | 2.94E-05 | 5.21E-06 | 0.00E+00 | 0.00E+00 |
| 22031NEI33013 | Propylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22031NEI33013 | Trichloroethylene | 0.00E+00 | 6.97E-08 | 2.03E-08 | 9.04E-08 | 1.81E-08 |
| 22033NEI46817 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22033NEI46817 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22033NEI46817 | 1,3-Butadiene | 0.00E+00 | 4.69E-08 | 5.86E-09 | 3.20E-06 | 1.60E-07 |
| 22033NEI46817 | Biphenyl | 0.00E+00 | 0.00E+00 | 5.28E-07 | 0.00E+00 | 0.00E+00 |
| 22033NEI46817 | Chlorobenzene | 0.00E+00 | 1.07E-04 | 7.13E-06 | 0.00E+00 | 0.00E+00 |
| 22033NEI46817 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22033NEI46817 | Cumene | 0.00E+00 | 1.82E-06 | 3.03E-07 | 0.00E+00 | 0.00E+00 |
| 22033NEI46817 | Diethanolamine | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22033NEI46817 | Ethyl benzene | 0.00E+00 | 7.54E-07 | 2.20E-08 | 0.00E+00 | 0.00E+00 |
| 22033NEI46817 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.56E-06 | 3.84E-07 |
| 22033NEI46817 | Hexachloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22033NEI46817 | Methyl chloride | 0.00E+00 | 0.00E+00 | 3.49E-08 | 0.00E+00 | 7.99E-08 |
| 22033NEI46817 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22033NEI46817 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22033NEI46817 | n-Hexane | 0.00E+00 | 0.00E+00 | 2.04E-07 | 0.00E+00 | 0.00E+00 |
| 22033NEI46817 | Propionaldehyde | 0.00E+00 | 1.38E-04 | 2.45E-05 | 0.00E+00 | 0.00E+00 |

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| 22033NEI46817 | Trichloroethylene | 0.00E+00 | 6.94E-07 | 2.02E-07 | 9.00E-07 | 1.80E-07 |
| 22033NEI46817 | Vinyl acetate | 0.00E+00 | 2.64E-06 | 1.00E-07 | 3.52E-06 | 2.43E-07 |
| 22049NEI33023 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22049NEI33023 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22049NEI33023 | Biphenyl | 0.00E+00 | 0.00E+00 | 1.31E-05 | 0.00E+00 | 0.00E+00 |
| 22049NEI33023 | Chlorobenzene | 0.00E+00 | 5.06E-06 | 3.37E-07 | 0.00E+00 | 0.00E+00 |
| 22049NEI33023 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22049NEI33023 | Cumene | 0.00E+00 | 1.67E-05 | 2.78E-06 | 0.00E+00 | 0.00E+00 |
| 22049NEI33023 | Ethyl benzene | 0.00E+00 | 3.55E-08 | 1.04E-09 | 0.00E+00 | 0.00E+00 |
| 22049NEI33023 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.51E-07 | 8.67E-08 |
| 22049NEI33023 | Methyl chloride | 0.00E+00 | 0.00E+00 | 1.46E-08 | 0.00E+00 | 3.35E-08 |
| 22049NEI33023 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22049NEI33023 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22049NEI33023 | n-Hexane | 0.00E+00 | 0.00E+00 | 3.84E-08 | 0.00E+00 | 0.00E+00 |
| 22049NEI33023 | o-Cresol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22049NEI33023 | Propionaldehyde | 0.00E+00 | 1.57E-05 | 2.79E-06 | 0.00E+00 | 0.00E+00 |
| 22049NEI33023 | Trichloroethylene | 0.00E+00 | 1.86E-06 | 5.42E-07 | 2.41E-06 | 4.82E-07 |
| 22069NEI33025 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22069NEI33025 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22069NEI33025 | 1,3-Butadiene | 0.00E+00 | 3.91E-08 | 4.89E-09 | 2.66E-06 | 1.33E-07 |
| 22069NEI33025 | Acetophenone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22069NEI33025 | Biphenyl | 0.00E+00 | 0.00E+00 | 2.34E-04 | 0.00E+00 | 0.00E+00 |
| 22069NEI33025 | Carbonyl sulfide | 0.00E+00 | 0.00E+00 | 1.12E-05 | 0.00E+00 | 0.00E+00 |
| 22069NEI33025 | Chlorobenzene | 0.00E+00 | 4.73E-06 | 3.15E-07 | 0.00E+00 | 0.00E+00 |
| 22069NEI33025 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22069NEI33025 | Cumene | 0.00E+00 | 3.46E-06 | 5.76E-07 | 0.00E+00 | 0.00E+00 |
| 22069NEI33025 | Ethyl benzene | 0.00E+00 | 1.12E-07 | 3.26E-09 | 0.00E+00 | 0.00E+00 |
| 22069NEI33025 | Ethylene dibromide | 0.00E+00 | 1.92E-09 | 1.38E-09 | 0.00E+00 | 0.00E+00 |
| 22069NEI33025 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.39E-08 | 1.08E-08 |
| 22069NEI33025 | Methyl chloride | 0.00E+00 | 0.00E+00 | 7.25E-07 | 0.00E+00 | 1.66E-06 |
| 22069NEI33025 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22069NEI33025 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22069NEI33025 | n-Hexane | 0.00E+00 | 0.00E+00 | 1.05E-07 | 0.00E+00 | 0.00E+00 |
| 22069NEI33025 | Propionaldehyde | 0.00E+00 | 4.46E-05 | 7.91E-06 | 0.00E+00 | 0.00E+00 |
| 22069NEI33025 | Trichloroethylene | 0.00E+00 | 1.52E-06 | 4.45E-07 | 1.98E-06 | 3.95E-07 |
| 22073NEI6057 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22073NEI6057 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22073NEI6057 | Acetophenone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22073NEI6057 | Acrylamide | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22073NEI6057 | Chlorobenzene | 0.00E+00 | 1.00E-05 | 6.67E-07 | 0.00E+00 | 0.00E+00 |
| 22073NEI6057 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22073NEI6057 | Cumene | 0.00E+00 | 4.76E-05 | 7.94E-06 | 0.00E+00 | 0.00E+00 |
| 22073NEI6057 | Ethyl benzene | 0.00E+00 | 2.25E-06 | 6.57E-08 | 0.00E+00 | 0.00E+00 |
| 22073NEI6057 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.40E-07 | 3.46E-08 |
| 22073NEI6057 | Methyl chloride | 0.00E+00 | 0.00E+00 | 7.77E-07 | 0.00E+00 | 1.78E-06 |
| 22073NEI6057 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22073NEI6057 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22073NEI6057 | n-Hexane | 0.00E+00 | 0.00E+00 | 2.16E-07 | 0.00E+00 | 0.00E+00 |
| 22073NEI6057 | Propionaldehyde | 0.00E+00 | 3.23E-04 | 5.73E-05 | 0.00E+00 | 0.00E+00 |
| 22073NEI6057 | Trichloroethylene | 0.00E+00 | 1.37E-05 | 4.00E-06 | 1.78E-05 | 3.56E-06 |
| 22117NEI46814 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22117NEI46814 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22117NEI46814 | 1,3-Butadiene | 0.00E+00 | 1.24E-08 | 1.55E-09 | 8.46E-07 | 4.23E-08 |
| 22117NEI46814 | Biphenyl | 0.00E+00 | 0.00E+00 | 1.13E-05 | 0.00E+00 | 0.00E+00 |
| 22117NEI46814 | Chlorobenzene | 0.00E+00 | 6.93E-06 | 4.62E-07 | 0.00E+00 | 0.00E+00 |

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| 22117NEI46814 | Cumene | 0.00E+00 | 4.72E-06 | 7.87E-07 | 0.00E+00 | 0.00E+00 |
| 22117NEI46814 | Ethyl benzene | 0.00E+00 | 2.68E-08 | 7.81E-10 | 0.00E+00 | 0.00E+00 |
| 22117NEI46814 | Ethylene dibromide | 0.00E+00 | 8.48E-10 | 6.13E-10 | 0.00E+00 | 0.00E+00 |
| 22117NEI46814 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.44E-07 | 3.56E-08 |
| 22117NEI46814 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22117NEI46814 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 22117NEI46814 | n-Hexane | 0.00E+00 | 0.00E+00 | 3.29E-08 | 0.00E+00 | 0.00E+00 |
| 22117NEI46814 | Propionaldehyde | 0.00E+00 | 1.73E-05 | 3.07E-06 | 0.00E+00 | 0.00E+00 |
| 22117NEI46814 | Trichloroethylene | 0.00E+00 | 2.30E-06 | 6.72E-07 | 2.99E-06 | 5.97E-07 |
| 23007NEI6261 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23007NEI6261 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23007NEI6261 | Beryllium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.95E-05 |
| 23007NEI6261 | Cadmium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23007NEI6261 | Chromium (III) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23007NEI6261 | Chromium (VI) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23007NEI6261 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23007NEI6261 | Cumene | 0.00E+00 | 3.40E-06 | 5.66E-07 | 0.00E+00 | 0.00E+00 |
| 23007NEI6261 | Lead compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23007NEI6261 | Manganese compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23007NEI6261 | Mercuric chloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23007NEI6261 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23007NEI6261 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23007NEI6261 | POM 72002 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23007NEI6261 | Propionaldehyde | 0.00E+00 | 5.50E-04 | 9.76E-05 | 0.00E+00 | 0.00E+00 |
| 23007NEI6261 | Selenium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23009NEI6284 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23009NEI6284 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23009NEI6284 | Biphenyl | 0.00E+00 | 0.00E+00 | 4.67E-06 | 0.00E+00 | 0.00E+00 |
| 23009NEI6284 | Cumene | 0.00E+00 | 3.36E-06 | 5.60E-07 | 0.00E+00 | 0.00E+00 |
| 23009NEI6284 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23009NEI6284 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23009NEI6284 | n-Hexane | 0.00E+00 | 0.00E+00 | 8.26E-09 | 0.00E+00 | 0.00E+00 |
| 23009NEI6284 | Propionaldehyde | 0.00E+00 | 9.81E-06 | 1.74E-06 | 0.00E+00 | 0.00E+00 |
| 23009NEI6284 | Trichloroethylene | 0.00E+00 | 1.12E-07 | 3.28E-08 | 1.46E-07 | 2.91E-08 |
| 23017NEI6273 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23017NEI6273 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23017NEI6273 | 3-Methylcholanthrene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23017NEI6273 | 7,12-Dimethylbenz[a]Anthracene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23017NEI6273 | Benz[a]anthracene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23017NEI6273 | Benzo[a]pyrene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23017NEI6273 | Benzo[b]fluoranthene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23017NEI6273 | Benzo[k]fluoranthene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23017NEI6273 | Cadmium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23017NEI6273 | Chromium (III) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23017NEI6273 | Chromium (VI) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23017NEI6273 | Chrysene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23017NEI6273 | Cobalt compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23017NEI6273 | Cumene | 0.00E+00 | 6.83E-07 | 1.14E-07 | 0.00E+00 | 0.00E+00 |
| 23017NEI6273 | Dibenzo[a,h]anthracene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23017NEI6273 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.26E-06 | 3.11E-07 |
| 23017NEI6273 | Indeno[1,2,3-c,d]pyrene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23017NEI6273 | Lead compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23017NEI6273 | Manganese compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23017NEI6273 | Mercuric chloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23017NEI6273 | Methyl chloride | 0.00E+00 | 0.00E+00 | 6.91E-08 | 0.00E+00 | 1.58E-07 |

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|---|---|---|---|---|---|---|
| 23017NEI6273 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23017NEI6273 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23017NEI6273 | n-Hexane | 0.00E+00 | 0.00E+00 | 4.65E-09 | 0.00E+00 | 0.00E+00 |
| 23017NEI6273 | POM 72002 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23017NEI6273 | Selenium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23019NEI33103 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23019NEI33103 | Acetophenone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23019NEI33103 | Chloroacetic acid | 0.00E+00 | 0.00E+00 | 2.39E-05 | 0.00E+00 | 0.00E+00 |
| 23019NEI33103 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23019NEI33103 | n-Hexane | 0.00E+00 | 0.00E+00 | 2.65E-08 | 0.00E+00 | 0.00E+00 |
| 23019NEI33104 | Cadmium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23019NEI33104 | Chromium (III) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23019NEI33104 | Chromium (VI) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23019NEI33104 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23019NEI33104 | Lead compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23019NEI33104 | Manganese compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23019NEI33104 | Mercuric chloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23019NEI33104 | POM 72002 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23025NEI33118 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23025NEI33118 | Cumene | 0.00E+00 | 6.36E-09 | 1.06E-09 | 0.00E+00 | 0.00E+00 |
| 23025NEI33118 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23025NEI33118 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23025NEI33118 | Trichloroethylene | 0.00E+00 | 7.12E-09 | 2.08E-09 | 9.23E-09 | 1.85E-09 |
| 23025NEIME0250002 | Biphenyl | 0.00E+00 | 0.00E+00 | 2.47E-02 | 0.00E+00 | 0.00E+00 |
| 23025NEIME0250002 | Cumene | 0.00E+00 | 7.05E-03 | 1.18E-03 | 0.00E+00 | 0.00E+00 |
| 23025NEIME0250002 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23025NEIME0250002 | Propionaldehyde | 0.00E+00 | 1.06E-02 | 1.88E-03 | 0.00E+00 | 0.00E+00 |
| 23029NEI46835 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23029NEI46835 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23029NEI46835 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23029NEI46835 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 23029NEI46835 | n-Hexane | 0.00E+00 | 0.00E+00 | 1.10E-08 | 0.00E+00 | 0.00E+00 |
| 23029NEI46835 | Trichloroethylene | 0.00E+00 | 7.91E-08 | 2.31E-08 | 1.02E-07 | 2.05E-08 |
| 24001NEI33135 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 24001NEI33135 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 24001NEI33135 | Biphenyl | 0.00E+00 | 0.00E+00 | 4.79E-06 | 0.00E+00 | 0.00E+00 |
| 24001NEI33135 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 24001NEI33135 | Cumene | 0.00E+00 | 7.60E-07 | 1.27E-07 | 0.00E+00 | 0.00E+00 |
| 24001NEI33135 | Methyl chloride | 0.00E+00 | 0.00E+00 | 1.57E-08 | 0.00E+00 | 3.59E-08 |
| 24001NEI33135 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 24001NEI33135 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 24001NEI33135 | n-Hexane | 0.00E+00 | 0.00E+00 | 2.85E-08 | 0.00E+00 | 0.00E+00 |
| 24001NEI33135 | Propionaldehyde | 0.00E+00 | 8.60E-04 | 1.53E-04 | 0.00E+00 | 0.00E+00 |
| 24001NEI33135 | Trichloroethylene | 0.00E+00 | 6.13E-05 | 1.79E-05 | 7.94E-05 | 1.59E-05 |
| 25017NEI6175 | Ethylene glycol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 26003NEI33866 | Propionaldehyde | 0.00E+00 | 3.84E-06 | 6.81E-07 | 0.00E+00 | 0.00E+00 |
| 26041NEI33883 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 26041NEI33883 | Methyl chloride | 0.00E+00 | 0.00E+00 | 3.79E-08 | 0.00E+00 | 8.67E-08 |
| 26041NEI33883 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 26041NEI33883 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 26041NEI33883 | POM 72002 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 26041NEI33883 | Propionaldehyde | 0.00E+00 | 1.26E-05 | 2.24E-06 | 0.00E+00 | 0.00E+00 |
| 26043NEI33887 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 26043NEI33887 | Chlorobenzene | 0.00E+00 | 7.21E-07 | 4.81E-08 | 0.00E+00 | 0.00E+00 |
| 26043NEI33887 | Chlorobenzilate | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

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|---|---|---|---|---|---|---|
| 26043NEI33887 | Ethylene dibromide | 0.00E+00 | 1.84E-09 | 1.33E-09 | 0.00E+00 | 0.00E+00 |
| 26043NEI33887 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 26043NEI33887 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 26043NEI33887 | n-Hexane | 0.00E+00 | 0.00E+00 | 2.19E-09 | 0.00E+00 | 0.00E+00 |
| 26043NEI33887 | Propionaldehyde | 0.00E+00 | 9.32E-06 | 1.65E-06 | 0.00E+00 | 0.00E+00 |
| 26043NEI33887 | Trichloroethylene | 0.00E+00 | 2.37E-09 | 6.91E-10 | 3.07E-09 | 6.14E-10 |
| 26101NEI33945 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 26101NEI33945 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 26101NEI33945 | 1,3-Butadiene | 0.00E+00 | 1.11E-08 | 1.39E-09 | 7.59E-07 | 3.79E-08 |
| 26101NEI33945 | Biphenyl | 0.00E+00 | 0.00E+00 | 1.87E-04 | 0.00E+00 | 0.00E+00 |
| 26101NEI33945 | Chlorobenzene | 0.00E+00 | 1.06E-07 | 7.07E-09 | 0.00E+00 | 0.00E+00 |
| 26101NEI33945 | Cumene | 0.00E+00 | 6.52E-06 | 1.09E-06 | 0.00E+00 | 0.00E+00 |
| 26101NEI33945 | Ethyl benzene | 0.00E+00 | 4.02E-08 | 1.17E-09 | 0.00E+00 | 0.00E+00 |
| 26101NEI33945 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.53E-07 | 6.25E-08 |
| 26101NEI33945 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 26101NEI33945 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 26101NEI33945 | n-Hexane | 0.00E+00 | 0.00E+00 | 3.26E-09 | 0.00E+00 | 0.00E+00 |
| 26101NEI33945 | Propionaldehyde | 0.00E+00 | 1.13E-05 | 2.00E-06 | 0.00E+00 | 0.00E+00 |
| 26101NEI33945 | Trichloroethylene | 0.00E+00 | 3.04E-08 | 8.85E-09 | 3.94E-08 | 7.87E-09 |
| 26147NEI33981 | Biphenyl | 0.00E+00 | 0.00E+00 | 9.38E-06 | 0.00E+00 | 0.00E+00 |
| 26147NEI33981 | Propionaldehyde | 0.00E+00 | 7.61E-06 | 1.35E-06 | 0.00E+00 | 0.00E+00 |
| 27017NEI12368 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27017NEI12368 | Cadmium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27017NEI12368 | Chlorobenzene | 0.00E+00 | 3.89E-06 | 2.59E-07 | 0.00E+00 | 0.00E+00 |
| 27017NEI12368 | Chromium (III) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27017NEI12368 | Chromium (VI) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27017NEI12368 | Cobalt compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27017NEI12368 | Manganese compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27017NEI12368 | Mercuric chloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27017NEI12368 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27017NEI12368 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27017NEI12368 | n-Hexane | 0.00E+00 | 0.00E+00 | 1.36E-08 | 0.00E+00 | 0.00E+00 |
| 27017NEI12368 | POM 72002 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27017NEI12368 | Vinylidene chloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27035NEI34020 | Biphenyl | 0.00E+00 | 0.00E+00 | 7.33E-06 | 0.00E+00 | 0.00E+00 |
| 27035NEI34020 | Propionaldehyde | 0.00E+00 | 5.94E-06 | 1.05E-06 | 0.00E+00 | 0.00E+00 |
| 27061NEI34030 | 1,3-Butadiene | 0.00E+00 | 3.66E-08 | 4.58E-09 | 2.50E-06 | 1.25E-07 |
| 27061NEI34030 | Acetonitrile | 0.00E+00 | 1.75E-04 | 7.15E-06 | 0.00E+00 | 0.00E+00 |
| 27061NEI34030 | Acetophenone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27061NEI34030 | Biphenyl | 0.00E+00 | 0.00E+00 | 1.29E-04 | 0.00E+00 | 0.00E+00 |
| 27061NEI34030 | Cumene | 0.00E+00 | 1.56E-05 | 2.59E-06 | 0.00E+00 | 0.00E+00 |
| 27061NEI34030 | Ethyl benzene | 0.00E+00 | 8.63E-07 | 2.52E-08 | 0.00E+00 | 0.00E+00 |
| 27061NEI34030 | Methyl chloride | 0.00E+00 | 0.00E+00 | 1.07E-07 | 0.00E+00 | 2.45E-07 |
| 27061NEI34030 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27061NEI34030 | n-Hexane | 0.00E+00 | 0.00E+00 | 8.76E-09 | 0.00E+00 | 0.00E+00 |
| 27061NEI34030 | Propionaldehyde | 0.00E+00 | 9.27E-06 | 1.64E-06 | 0.00E+00 | 0.00E+00 |
| 27061NEI34030 | Vinyl acetate | 0.00E+00 | 8.39E-05 | 3.20E-06 | 1.12E-04 | 7.74E-06 |
| 27071NEI12411 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27071NEI12411 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27071NEI12411 | Chlorobenzene | 0.00E+00 | 5.83E-07 | 3.89E-08 | 0.00E+00 | 0.00E+00 |
| 27071NEI12411 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27071NEI12411 | Cumene | 0.00E+00 | 1.02E-06 | 1.70E-07 | 0.00E+00 | 0.00E+00 |
| 27071NEI12411 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.31E-07 | 5.71E-08 |
| 27071NEI12411 | Methyl chloride | 0.00E+00 | 0.00E+00 | 9.42E-07 | 0.00E+00 | 2.16E-06 |
| 27071NEI12411 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

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|---|---|---|---|---|---|---|
| 27071NEI12411 | n-Hexane | 0.00E+00 | 0.00E+00 | 1.47E-08 | 0.00E+00 | 0.00E+00 |
| 27071NEI12411 | Propionaldehyde | 0.00E+00 | 7.45E-06 | 1.32E-06 | 0.00E+00 | 0.00E+00 |
| 27071NEI12411 | Trichloroethylene | 0.00E+00 | 3.14E-08 | 9.16E-09 | 4.07E-08 | 8.14E-09 |
| 27137NEIMN14904 | Benz[a]anthracene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27137NEIMN14904 | Benzo[a]pyrene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27137NEIMN14904 | Benzo[b]fluoranthene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27137NEIMN14904 | Biphenyl | 0.00E+00 | 0.00E+00 | 5.24E-05 | 0.00E+00 | 0.00E+00 |
| 27137NEIMN14904 | Cumene | 0.00E+00 | 1.46E-05 | 2.43E-06 | 0.00E+00 | 0.00E+00 |
| 27137NEIMN14904 | Dibenzo[a,h]anthracene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27137NEIMN14904 | Indeno[1,2,3-c,d]pyrene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27137NEIMN14904 | Lead compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27137NEIMN14904 | Manganese compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27137NEIMN14904 | Mercuric chloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27137NEIMN14904 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27137NEIMN14904 | n-Hexane | 0.00E+00 | 0.00E+00 | 1.54E-09 | 0.00E+00 | 0.00E+00 |
| 27137NEIMN14904 | POM 72002 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27137NEIMN14904 | Propionaldehyde | 0.00E+00 | 5.17E-06 | 9.17E-07 | 0.00E+00 | 0.00E+00 |
| 27145NEI12407 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27145NEI12407 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27145NEI12407 | 1,3-Butadiene | 0.00E+00 | 1.71E-09 | 2.14E-10 | 1.17E-07 | 5.84E-09 |
| 27145NEI12407 | 2,4,6-Trichlorophenol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27145NEI12407 | Biphenyl | 0.00E+00 | 0.00E+00 | 3.72E-05 | 0.00E+00 | 0.00E+00 |
| 27145NEI12407 | Bis(2-ethylhexyl)phthalate | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27145NEI12407 | Cadmium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27145NEI12407 | Chlorobenzene | 0.00E+00 | 1.83E-06 | 1.22E-07 | 0.00E+00 | 0.00E+00 |
| 27145NEI12407 | Chromium (III) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27145NEI12407 | Chromium (VI) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27145NEI12407 | Cobalt compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27145NEI12407 | Cumene | 0.00E+00 | 4.58E-06 | 7.63E-07 | 0.00E+00 | 0.00E+00 |
| 27145NEI12407 | Dibutylphthalate | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27145NEI12407 | Ethyl benzene | 0.00E+00 | 9.01E-06 | 2.63E-07 | 0.00E+00 | 0.00E+00 |
| 27145NEI12407 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.90E-07 | 7.17E-08 |
| 27145NEI12407 | Lead compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27145NEI12407 | Manganese compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27145NEI12407 | Mercuric chloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27145NEI12407 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27145NEI12407 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27145NEI12407 | n-Hexane | 0.00E+00 | 0.00E+00 | 1.30E-06 | 0.00E+00 | 0.00E+00 |
| 27145NEI12407 | Pentachlorophenol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 27145NEI12407 | Propionaldehyde | 0.00E+00 | 2.03E-05 | 3.60E-06 | 0.00E+00 | 0.00E+00 |
| 27145NEI12407 | Trichloroethylene | 0.00E+00 | 2.59E-06 | 7.57E-07 | 3.36E-06 | 6.73E-07 |
| 28043NEI11108 | Biphenyl | 0.00E+00 | 0.00E+00 | 3.18E-05 | 0.00E+00 | 0.00E+00 |
| 28043NEI11108 | Cumene | 0.00E+00 | 1.38E-05 | 2.31E-06 | 0.00E+00 | 0.00E+00 |
| 28043NEI11108 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 28043NEI11108 | Propionaldehyde | 0.00E+00 | 2.09E-05 | 3.70E-06 | 0.00E+00 | 0.00E+00 |
| 28077NEI11172 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 28077NEI11172 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 28077NEI11172 | 1,3-Butadiene | 0.00E+00 | 5.15E-08 | 6.44E-09 | 3.51E-06 | 1.76E-07 |
| 28077NEI11172 | Acetophenone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 28077NEI11172 | Biphenyl | 0.00E+00 | 0.00E+00 | 8.20E-07 | 0.00E+00 | 0.00E+00 |
| 28077NEI11172 | Chlorobenzene | 0.00E+00 | 2.36E-05 | 1.57E-06 | 0.00E+00 | 0.00E+00 |
| 28077NEI11172 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 28077NEI11172 | Cumene | 0.00E+00 | 3.86E-07 | 6.43E-08 | 0.00E+00 | 0.00E+00 |
| 28077NEI11172 | Ethyl benzene | 0.00E+00 | 8.53E-08 | 2.49E-09 | 0.00E+00 | 0.00E+00 |
| 28077NEI11172 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.41E-06 | 3.48E-07 |

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| 28077NEI11172 | Methyl chloride | 0.00E+00 | 0.00E+00 | 1.45E-08 | 0.00E+00 | 3.31E-08 |
| 28077NEI11172 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 28077NEI11172 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 28077NEI11172 | n-Hexane | 0.00E+00 | 0.00E+00 | 1.80E-08 | 0.00E+00 | 0.00E+00 |
| 28077NEI11172 | o-Cresol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 28077NEI11172 | Propionaldehyde | 0.00E+00 | 3.99E-05 | 7.08E-06 | 0.00E+00 | 0.00E+00 |
| 28077NEI11172 | Trichloroethylene | 0.00E+00 | 2.07E-06 | 6.05E-07 | 2.69E-06 | 5.38E-07 |
| 28087NEI34064 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 28087NEI34064 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 28087NEI34064 | Chlorobenzene | 0.00E+00 | 4.87E-06 | 3.25E-07 | 0.00E+00 | 0.00E+00 |
| 28087NEI34064 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 28087NEI34064 | Cumene | 0.00E+00 | 3.59E-09 | 5.99E-10 | 0.00E+00 | 0.00E+00 |
| 28087NEI34064 | m-Cresol (3-methylphenol) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 28087NEI34064 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 28087NEI34064 | n-Hexane | 0.00E+00 | 0.00E+00 | 5.46E-09 | 0.00E+00 | 0.00E+00 |
| 28087NEI34064 | Propionaldehyde | 0.00E+00 | 3.54E-07 | 6.27E-08 | 0.00E+00 | 0.00E+00 |
| 28087NEI34064 | Trichloroethylene | 0.00E+00 | 3.95E-09 | 1.15E-09 | 5.13E-09 | 1.03E-09 |
| 28111NEI34066 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 28111NEI34066 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 28111NEI34066 | 1,3-Butadiene | 0.00E+00 | 1.90E-08 | 2.37E-09 | 1.29E-06 | 6.47E-08 |
| 28111NEI34066 | Acetophenone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 28111NEI34066 | Biphenyl | 0.00E+00 | 0.00E+00 | 1.51E-06 | 0.00E+00 | 0.00E+00 |
| 28111NEI34066 | Chlorobenzene | 0.00E+00 | 5.77E-07 | 3.85E-08 | 0.00E+00 | 0.00E+00 |
| 28111NEI34066 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 28111NEI34066 | Cumene | 0.00E+00 | 5.37E-05 | 8.94E-06 | 0.00E+00 | 0.00E+00 |
| 28111NEI34066 | Ethyl benzene | 0.00E+00 | 1.37E-07 | 3.99E-09 | 0.00E+00 | 0.00E+00 |
| 28111NEI34066 | Ethylene dibromide | 0.00E+00 | 9.50E-09 | 6.86E-09 | 0.00E+00 | 0.00E+00 |
| 28111NEI34066 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.09E-08 | 1.50E-08 |
| 28111NEI34066 | Hexachloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 28111NEI34066 | Methyl chloride | 0.00E+00 | 0.00E+00 | 2.96E-06 | 0.00E+00 | 6.77E-06 |
| 28111NEI34066 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 28111NEI34066 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 28111NEI34066 | n-Hexane | 0.00E+00 | 0.00E+00 | 2.05E-07 | 0.00E+00 | 0.00E+00 |
| 28111NEI34066 | o-Cresol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 28111NEI34066 | Propionaldehyde | 0.00E+00 | 6.92E-06 | 1.23E-06 | 0.00E+00 | 0.00E+00 |
| 28111NEI34066 | Trichloroethylene | 0.00E+00 | 1.22E-07 | 3.55E-08 | 1.58E-07 | 3.16E-08 |
| 28149NEI34070 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 28149NEI34070 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 28149NEI34070 | 1,3-Butadiene | 0.00E+00 | 1.37E-08 | 1.71E-09 | 9.32E-07 | 4.66E-08 |
| 28149NEI34070 | Biphenyl | 0.00E+00 | 0.00E+00 | 2.00E-08 | 0.00E+00 | 0.00E+00 |
| 28149NEI34070 | Chlorobenzene | 0.00E+00 | 6.47E-06 | 4.31E-07 | 0.00E+00 | 0.00E+00 |
| 28149NEI34070 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 28149NEI34070 | Cumene | 0.00E+00 | 1.68E-07 | 2.80E-08 | 0.00E+00 | 0.00E+00 |
| 28149NEI34070 | Ethyl benzene | 0.00E+00 | 9.85E-08 | 2.87E-09 | 0.00E+00 | 0.00E+00 |
| 28149NEI34070 | Ethylene dibromide | 0.00E+00 | 3.25E-09 | 2.35E-09 | 0.00E+00 | 0.00E+00 |
| 28149NEI34070 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.45E-09 | 8.52E-10 |
| 28149NEI34070 | Methyl chloride | 0.00E+00 | 0.00E+00 | 9.98E-07 | 0.00E+00 | 2.29E-06 |
| 28149NEI34070 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 28149NEI34070 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 28149NEI34070 | n-Hexane | 0.00E+00 | 0.00E+00 | 1.33E-07 | 0.00E+00 | 0.00E+00 |
| 28149NEI34070 | o-Cresol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 28149NEI34070 | Propionaldehyde | 0.00E+00 | 2.94E-05 | 5.21E-06 | 0.00E+00 | 0.00E+00 |
| 28149NEI34070 | Trichloroethylene | 0.00E+00 | 2.07E-06 | 6.03E-07 | 2.68E-06 | 5.36E-07 |
| 36031NEI35908 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 36031NEI35908 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

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| 36031NEI35908 | 1,3-Butadiene | 0.00E+00 | 8.00E-09 | 1.00E-09 | 5.46E-07 | 2.73E-08 |
| 36031NEI35908 | Biphenyl | 0.00E+00 | 0.00E+00 | 4.78E-09 | 0.00E+00 | 0.00E+00 |
| 36031NEI35908 | Chlorobenzene | 0.00E+00 | 2.67E-07 | 1.78E-08 | 0.00E+00 | 0.00E+00 |
| 36031NEI35908 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 36031NEI35908 | Cumene | 0.00E+00 | 1.98E-07 | 3.30E-08 | 0.00E+00 | 0.00E+00 |
| 36031NEI35908 | Ethyl benzene | 0.00E+00 | 6.61E-08 | 1.93E-09 | 0.00E+00 | 0.00E+00 |
| 36031NEI35908 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.27E-09 | 3.15E-10 |
| 36031NEI35908 | Hexachloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 36031NEI35908 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 36031NEI35908 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 36031NEI35908 | n-Hexane | 0.00E+00 | 0.00E+00 | 2.95E-09 | 0.00E+00 | 0.00E+00 |
| 36031NEI35908 | Propionaldehyde | 0.00E+00 | 8.30E-06 | 1.47E-06 | 0.00E+00 | 0.00E+00 |
| 36031NEI35908 | Trichloroethylene | 0.00E+00 | 4.55E-08 | 1.33E-08 | 5.90E-08 | 1.18E-08 |
| 36045NEI36019 | Biphenyl | 0.00E+00 | 0.00E+00 | 3.88E-06 | 0.00E+00 | 0.00E+00 |
| 36045NEI36019 | Vinyl acetate | 0.00E+00 | 7.21E-07 | 2.75E-08 | 9.61E-07 | 6.65E-08 |
| 36113NEI39968 | 2,4,6-Trichlorophenol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 36113NEI39968 | Bis(2-ethylhexyl)phthalate | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 36113NEI39968 | Propylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37047NEI40247 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37047NEI40247 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37047NEI40247 | 1,3-Butadiene | 0.00E+00 | 2.09E-08 | 2.62E-09 | 1.43E-06 | 7.13E-08 |
| 37047NEI40247 | Biphenyl | 0.00E+00 | 0.00E+00 | 9.18E-07 | 0.00E+00 | 0.00E+00 |
| 37047NEI40247 | Chlorobenzene | 0.00E+00 | 1.51E-06 | 1.01E-07 | 0.00E+00 | 0.00E+00 |
| 37047NEI40247 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37047NEI40247 | Cumene | 0.00E+00 | 5.71E-06 | 9.51E-07 | 0.00E+00 | 0.00E+00 |
| 37047NEI40247 | Ethyl benzene | 0.00E+00 | 1.22E-07 | 3.56E-09 | 0.00E+00 | 0.00E+00 |
| 37047NEI40247 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.24E-08 | 5.53E-09 |
| 37047NEI40247 | Hexachloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37047NEI40247 | Methyl chloride | 0.00E+00 | 0.00E+00 | 2.93E-07 | 0.00E+00 | 6.72E-07 |
| 37047NEI40247 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37047NEI40247 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37047NEI40247 | n-Hexane | 0.00E+00 | 0.00E+00 | 3.67E-09 | 0.00E+00 | 0.00E+00 |
| 37047NEI40247 | o-Cresol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37047NEI40247 | POM 72002 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37047NEI40247 | Propionaldehyde | 0.00E+00 | 3.32E-05 | 5.88E-06 | 0.00E+00 | 0.00E+00 |
| 37047NEI40247 | Trichloroethylene | 0.00E+00 | 3.49E-07 | 1.02E-07 | 4.52E-07 | 9.05E-08 |
| 37049NEI45206 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37049NEI45206 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37049NEI45206 | 1,3-Butadiene | 0.00E+00 | 1.04E-08 | 1.29E-09 | 7.06E-07 | 3.53E-08 |
| 37049NEI45206 | Biphenyl | 0.00E+00 | 0.00E+00 | 4.75E-09 | 0.00E+00 | 0.00E+00 |
| 37049NEI45206 | Chlorobenzene | 0.00E+00 | 1.37E-06 | 9.16E-08 | 0.00E+00 | 0.00E+00 |
| 37049NEI45206 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37049NEI45206 | Cumene | 0.00E+00 | 6.15E-07 | 1.03E-07 | 0.00E+00 | 0.00E+00 |
| 37049NEI45206 | Ethyl benzene | 0.00E+00 | 3.26E-08 | 9.50E-10 | 0.00E+00 | 0.00E+00 |
| 37049NEI45206 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.31E-07 | 3.22E-08 |
| 37049NEI45206 | Hexachloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37049NEI45206 | m-Cresol (3-methylphenol) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37049NEI45206 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37049NEI45206 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37049NEI45206 | n-Hexane | 0.00E+00 | 0.00E+00 | 2.33E-08 | 0.00E+00 | 0.00E+00 |
| 37049NEI45206 | o-Cresol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37049NEI45206 | p-Cresol (4-methy phenol) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37049NEI45206 | Propionaldehyde | 0.00E+00 | 2.35E-05 | 4.17E-06 | 0.00E+00 | 0.00E+00 |
| 37049NEI45206 | Trichloroethylene | 0.00E+00 | 1.29E-08 | 3.76E-09 | 1.67E-08 | 3.34E-09 |
| 37083NEI47104 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

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|---|---|---|---|---|---|---|
| 37083NEI47104 | Chlorobenzene | 0.00E+00 | 9.22E-05 | 6.15E-06 | 0.00E+00 | 0.00E+00 |
| 37083NEI47104 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37083NEI47104 | Methyl chloride | 0.00E+00 | 0.00E+00 | 3.32E-08 | 0.00E+00 | 7.60E-08 |
| 37083NEI47104 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37083NEI47104 | n-Hexane | 0.00E+00 | 0.00E+00 | 1.53E-08 | 0.00E+00 | 0.00E+00 |
| 37083NEI47104 | Propionaldehyde | 0.00E+00 | 4.20E-04 | 7.44E-05 | 0.00E+00 | 0.00E+00 |
| 37087NEI40282 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37087NEI40282 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37087NEI40282 | Chlorobenzene | 0.00E+00 | 1.66E-05 | 1.11E-06 | 0.00E+00 | 0.00E+00 |
| 37087NEI40282 | Chromium (III) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37087NEI40282 | Chromium (VI) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37087NEI40282 | Cobalt compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37087NEI40282 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37087NEI40282 | Cumene | 0.00E+00 | 4.17E-05 | 6.94E-06 | 0.00E+00 | 0.00E+00 |
| 37087NEI40282 | Ethyl benzene | 0.00E+00 | 5.07E-08 | 1.48E-09 | 0.00E+00 | 0.00E+00 |
| 37087NEI40282 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.55E-05 | 8.77E-06 |
| 37087NEI40282 | Manganese compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37087NEI40282 | Mercuric chloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37087NEI40282 | Methyl chloride | 0.00E+00 | 0.00E+00 | 9.12E-07 | 0.00E+00 | 2.09E-06 |
| 37087NEI40282 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37087NEI40282 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37087NEI40282 | n-Hexane | 0.00E+00 | 0.00E+00 | 1.33E-06 | 0.00E+00 | 0.00E+00 |
| 37087NEI40282 | POM 71002 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37087NEI40282 | POM 72002 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37087NEI40282 | Propionaldehyde | 0.00E+00 | 2.09E-05 | 3.71E-06 | 0.00E+00 | 0.00E+00 |
| 37087NEI40282 | Trichloroethylene | 0.00E+00 | 9.88E-07 | 2.88E-07 | 1.28E-06 | 2.56E-07 |
| 37117NEI9201 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37117NEI9201 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37117NEI9201 | 1,3-Butadiene | 0.00E+00 | 4.48E-09 | 5.60E-10 | 3.06E-07 | 1.53E-08 |
| 37117NEI9201 | Bromoform | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37117NEI9201 | Chlorobenzene | 0.00E+00 | 6.87E-07 | 4.58E-08 | 0.00E+00 | 0.00E+00 |
| 37117NEI9201 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37117NEI9201 | Cumene | 0.00E+00 | 2.72E-07 | 4.54E-08 | 0.00E+00 | 0.00E+00 |
| 37117NEI9201 | Ethyl benzene | 0.00E+00 | 3.94E-08 | 1.15E-09 | 0.00E+00 | 0.00E+00 |
| 37117NEI9201 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.15E-07 | 7.78E-08 |
| 37117NEI9201 | Ethylidene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37117NEI9201 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37117NEI9201 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37117NEI9201 | n-Hexane | 0.00E+00 | 0.00E+00 | 1.06E-08 | 0.00E+00 | 0.00E+00 |
| 37117NEI9201 | Propionaldehyde | 0.00E+00 | 4.28E-05 | 7.59E-06 | 0.00E+00 | 0.00E+00 |
| 37117NEI9201 | Propylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 37117NEI9201 | Trichloroethylene | 0.00E+00 | 1.03E-07 | 3.01E-08 | 1.34E-07 | 2.68E-08 |
| 37117NEI9201 | Vinylidene chloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39031NEI11461 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39031NEI11461 | Biphenyl | 0.00E+00 | 0.00E+00 | 3.19E-05 | 0.00E+00 | 0.00E+00 |
| 39031NEI11461 | Chlorobenzene | 0.00E+00 | 3.18E-07 | 2.12E-08 | 0.00E+00 | 0.00E+00 |
| 39031NEI11461 | Cumene | 0.00E+00 | 9.67E-07 | 1.61E-07 | 0.00E+00 | 0.00E+00 |
| 39031NEI11461 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39031NEI11461 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39031NEI11461 | n-Hexane | 0.00E+00 | 0.00E+00 | 1.35E-08 | 0.00E+00 | 0.00E+00 |
| 39031NEI11461 | Propionaldehyde | 0.00E+00 | 2.07E-05 | 3.67E-06 | 0.00E+00 | 0.00E+00 |
| 39031NEI11461 | Trichloroethylene | 0.00E+00 | 8.30E-08 | 2.42E-08 | 1.08E-07 | 2.15E-08 |
| 39061NEI11610 | Benz[a]anthracene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39061NEI11610 | Benzo[a]pyrene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39061NEI11610 | Benzo[b]fluoranthene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

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|---|---|---|---|---|---|---|
| 39061NEI11610 | Benzo[k]fluoranthene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39061NEI11610 | Beryllium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.69E-08 |
| 39061NEI11610 | Cadmium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39061NEI11610 | Chromium (III) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39061NEI11610 | Chromium (VI) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39061NEI11610 | Chrysene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39061NEI11610 | Cobalt compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39061NEI11610 | Dibenzo[a,h]anthracene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39061NEI11610 | Indeno[1,2,3-c,d]pyrene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39061NEI11610 | Lead compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39061NEI11610 | Manganese compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39061NEI11610 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39061NEI11610 | n-Hexane | 0.00E+00 | 0.00E+00 | 4.80E-08 | 0.00E+00 | 0.00E+00 |
| 39061NEI11610 | POM 72002 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39061NEI11610 | Selenium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39113NEI11645 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39113NEI11645 | n-Hexane | 0.00E+00 | 0.00E+00 | 8.20E-07 | 0.00E+00 | 0.00E+00 |
| 39113NEI11645 | POM 72002 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39141NEI40488 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39141NEI40488 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39141NEI40488 | 3-Methylcholanthrene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39141NEI40488 | 7,12-Dimethylbenz[a]Anthracene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39141NEI40488 | Benz[a]anthracene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39141NEI40488 | Benzo[a]pyrene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39141NEI40488 | Benzo[b]fluoranthene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39141NEI40488 | Benzo[k]fluoranthene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39141NEI40488 | Beryllium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.41E-08 |
| 39141NEI40488 | Cadmium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39141NEI40488 | Chromium (III) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39141NEI40488 | Chromium (VI) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39141NEI40488 | Chrysene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39141NEI40488 | Cobalt compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39141NEI40488 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39141NEI40488 | Cumene | 0.00E+00 | 7.24E-09 | 1.21E-09 | 0.00E+00 | 0.00E+00 |
| 39141NEI40488 | Dibenzo[a,h]anthracene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39141NEI40488 | Indeno[1,2,3-c,d]pyrene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39141NEI40488 | Lead compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39141NEI40488 | Manganese compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39141NEI40488 | Mercuric chloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39141NEI40488 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39141NEI40488 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39141NEI40488 | n-Hexane | 0.00E+00 | 0.00E+00 | 1.52E-08 | 0.00E+00 | 0.00E+00 |
| 39141NEI40488 | POM 72002 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39141NEI40488 | Selenium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 39141NEI40488 | Trichloroethylene | 0.00E+00 | 5.28E-10 | 1.54E-10 | 6.85E-10 | 1.37E-10 |
| 40089NEI11251 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 40089NEI11251 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 40089NEI11251 | 1,3-Butadiene | 0.00E+00 | 1.64E-08 | 2.05E-09 | 1.12E-06 | 5.59E-08 |
| 40089NEI11251 | Biphenyl | 0.00E+00 | 0.00E+00 | 3.07E-05 | 0.00E+00 | 0.00E+00 |
| 40089NEI11251 | Chlorobenzene | 0.00E+00 | 1.01E-05 | 6.72E-07 | 0.00E+00 | 0.00E+00 |
| 40089NEI11251 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 40089NEI11251 | Cumene | 0.00E+00 | 3.54E-10 | 5.90E-11 | 0.00E+00 | 0.00E+00 |
| 40089NEI11251 | Ethyl benzene | 0.00E+00 | 8.00E-08 | 2.33E-09 | 0.00E+00 | 0.00E+00 |
| 40089NEI11251 | Ethylene dibromide | 0.00E+00 | 8.07E-12 | 5.83E-12 | 0.00E+00 | 0.00E+00 |
| 40089NEI11251 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.31E-08 | 1.31E-08 |

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|---|---|---|---|---|---|---|
| 40089NEI11251 | Methyl chloride | 0.00E+00 | 0.00E+00 | 4.42E-07 | 0.00E+00 | 1.01E-06 |
| 40089NEI11251 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 40089NEI11251 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 40089NEI11251 | n-Hexane | 0.00E+00 | 0.00E+00 | 2.32E-08 | 0.00E+00 | 0.00E+00 |
| 40089NEI11251 | o-Cresol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 40089NEI11251 | Propionaldehyde | 0.00E+00 | 2.78E-05 | 4.93E-06 | 0.00E+00 | 0.00E+00 |
| 40089NEI11251 | Trichloroethylene | 0.00E+00 | 3.35E-06 | 9.76E-07 | 4.34E-06 | 8.67E-07 |
| 40101NEI12980 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 40101NEI12980 | Biphenyl | 0.00E+00 | 0.00E+00 | 3.02E-04 | 0.00E+00 | 0.00E+00 |
| 40101NEI12980 | Cadmium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 40101NEI12980 | Chlorobenzene | 0.00E+00 | 1.21E-07 | 8.05E-09 | 0.00E+00 | 0.00E+00 |
| 40101NEI12980 | Chromium (III) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 40101NEI12980 | Chromium (VI) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 40101NEI12980 | Cobalt compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 40101NEI12980 | Manganese compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 40101NEI12980 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 40101NEI12980 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 40101NEI12980 | n-Hexane | 0.00E+00 | 0.00E+00 | 3.10E-08 | 0.00E+00 | 0.00E+00 |
| 40101NEI12980 | p-Dichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 40101NEI12980 | POM 72002 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 40101NEI12980 | Propionaldehyde | 0.00E+00 | 8.65E-06 | 1.53E-06 | 0.00E+00 | 0.00E+00 |
| 40101NEI12980 | Trichloroethylene | 0.00E+00 | 3.15E-08 | 9.19E-09 | 4.09E-08 | 8.17E-09 |
| 41007NEI40554 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41007NEI40554 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41007NEI40554 | 1,3-Butadiene | 0.00E+00 | 6.34E-09 | 7.92E-10 | 4.32E-07 | 2.16E-08 |
| 41007NEI40554 | Biphenyl | 0.00E+00 | 0.00E+00 | 4.59E-07 | 0.00E+00 | 0.00E+00 |
| 41007NEI40554 | Cadmium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41007NEI40554 | Chlorobenzene | 0.00E+00 | 7.11E-07 | 4.74E-08 | 0.00E+00 | 0.00E+00 |
| 41007NEI40554 | Chromium (III) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41007NEI40554 | Chromium (VI) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41007NEI40554 | Cobalt compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41007NEI40554 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41007NEI40554 | Cumene | 0.00E+00 | 1.70E-07 | 2.83E-08 | 0.00E+00 | 0.00E+00 |
| 41007NEI40554 | Dibenzo[a,h]anthracene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41007NEI40554 | Ethyl benzene | 0.00E+00 | 1.64E-08 | 4.77E-10 | 0.00E+00 | 0.00E+00 |
| 41007NEI40554 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.76E-09 | 1.92E-09 |
| 41007NEI40554 | Hexachloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41007NEI40554 | Indeno[1,2,3-c,d]pyrene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41007NEI40554 | Lead compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41007NEI40554 | Manganese compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41007NEI40554 | Mercuric chloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41007NEI40554 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41007NEI40554 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41007NEI40554 | n-Hexane | 0.00E+00 | 0.00E+00 | 1.12E-07 | 0.00E+00 | 0.00E+00 |
| 41007NEI40554 | o-Cresol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41007NEI40554 | POM 72002 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41007NEI40554 | Propionaldehyde | 0.00E+00 | 1.44E-05 | 2.56E-06 | 0.00E+00 | 0.00E+00 |
| 41007NEI40554 | Selenium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41007NEI40554 | Trichloroethylene | 0.00E+00 | 1.09E-07 | 3.18E-08 | 1.41E-07 | 2.83E-08 |
| 41009NEI40553 | Benzo[b]fluoranthene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41009NEI40553 | Cadmium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41009NEI40553 | Chromium (III) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41009NEI40553 | Chromium (VI) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41009NEI40553 | Chrysene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41009NEI40553 | Cobalt compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

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| 41009NEI40553 | Manganese compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41009NEI40553 | Mercuric chloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41009NEI40553 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41009NEI40553 | n-Hexane | 0.00E+00 | 0.00E+00 | 2.68E-09 | 0.00E+00 | 0.00E+00 |
| 41009NEI40553 | p-Dichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41009NEI40553 | POM 72002 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41039NEI45182 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41039NEI45182 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41039NEI45182 | 1,3-Butadiene | 0.00E+00 | 7.35E-09 | 9.18E-10 | 5.01E-07 | 2.50E-08 |
| 41039NEI45182 | Acetophenone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41039NEI45182 | Biphenyl | 0.00E+00 | 0.00E+00 | 1.53E-06 | 0.00E+00 | 0.00E+00 |
| 41039NEI45182 | Carbonyl sulfide | 0.00E+00 | 0.00E+00 | 4.07E-07 | 0.00E+00 | 0.00E+00 |
| 41039NEI45182 | Chlorobenzene | 0.00E+00 | 1.70E-06 | 1.14E-07 | 0.00E+00 | 0.00E+00 |
| 41039NEI45182 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41039NEI45182 | Cumene | 0.00E+00 | 1.83E-09 | 3.04E-10 | 0.00E+00 | 0.00E+00 |
| 41039NEI45182 | Ethyl benzene | 0.00E+00 | 2.68E-08 | 7.81E-10 | 0.00E+00 | 0.00E+00 |
| 41039NEI45182 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.60E-09 | 1.38E-09 |
| 41039NEI45182 | Ethylidene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41039NEI45182 | Methyl chloride | 0.00E+00 | 0.00E+00 | 3.98E-08 | 0.00E+00 | 9.11E-08 |
| 41039NEI45182 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41039NEI45182 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41039NEI45182 | n-Hexane | 0.00E+00 | 0.00E+00 | 1.63E-08 | 0.00E+00 | 0.00E+00 |
| 41039NEI45182 | Propionaldehyde | 0.00E+00 | 7.25E-05 | 1.29E-05 | 0.00E+00 | 0.00E+00 |
| 41039NEI45182 | Trichloroethylene | 0.00E+00 | 5.58E-07 | 1.63E-07 | 7.23E-07 | 1.45E-07 |
| 41041NEI40600 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41041NEI40600 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41041NEI40600 | 1,3-Butadiene | 0.00E+00 | 1.76E-07 | 2.20E-08 | 1.20E-05 | 6.00E-07 |
| 41041NEI40600 | Acetophenone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41041NEI40600 | Biphenyl | 0.00E+00 | 0.00E+00 | 7.36E-06 | 0.00E+00 | 0.00E+00 |
| 41041NEI40600 | Carbonyl sulfide | 0.00E+00 | 0.00E+00 | 3.22E-05 | 0.00E+00 | 0.00E+00 |
| 41041NEI40600 | Chlorobenzene | 0.00E+00 | 1.43E-05 | 9.52E-07 | 0.00E+00 | 0.00E+00 |
| 41041NEI40600 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41041NEI40600 | Cumene | 0.00E+00 | 1.61E-05 | 2.69E-06 | 0.00E+00 | 0.00E+00 |
| 41041NEI40600 | Ethyl benzene | 0.00E+00 | 5.96E-07 | 1.74E-08 | 0.00E+00 | 0.00E+00 |
| 41041NEI40600 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.43E-06 | 1.09E-06 |
| 41041NEI40600 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41041NEI40600 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41041NEI40600 | n-Hexane | 0.00E+00 | 0.00E+00 | 3.48E-08 | 0.00E+00 | 0.00E+00 |
| 41041NEI40600 | Propionaldehyde | 0.00E+00 | 6.07E-05 | 1.08E-05 | 0.00E+00 | 0.00E+00 |
| 41041NEI40600 | Trichloroethylene | 0.00E+00 | 3.88E-06 | 1.13E-06 | 5.03E-06 | 1.01E-06 |
| 41041NEI40600 | Vinylidene chloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41043NEI13340 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41043NEI13340 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41043NEI13340 | Acetophenone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41043NEI13340 | Carbonyl sulfide | 0.00E+00 | 0.00E+00 | 5.53E-04 | 0.00E+00 | 0.00E+00 |
| 41043NEI13340 | Chlorobenzene | 0.00E+00 | 3.29E-05 | 2.19E-06 | 0.00E+00 | 0.00E+00 |
| 41043NEI13340 | Cumene | 0.00E+00 | 1.01E-03 | 1.68E-04 | 0.00E+00 | 0.00E+00 |
| 41043NEI13340 | Ethyl benzene | 0.00E+00 | 6.02E-04 | 1.76E-05 | 0.00E+00 | 0.00E+00 |
| 41043NEI13340 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.34E-05 | 1.81E-05 |
| 41043NEI13340 | Hexachloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41043NEI13340 | Methyl chloride | 0.00E+00 | 0.00E+00 | 3.06E-05 | 0.00E+00 | 7.00E-05 |
| 41043NEI13340 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41043NEI13340 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41043NEI13340 | n-Hexane | 0.00E+00 | 0.00E+00 | 1.21E-07 | 0.00E+00 | 0.00E+00 |
| 41043NEI13340 | o-Cresol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

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|---|---|---|---|---|---|---|
| 41043NEI13340 | Propionaldehyde | 0.00E+00 | 1.28E-03 | 2.26E-04 | 0.00E+00 | 0.00E+00 |
| 41043NEI13340 | Trichloroethylene | 0.00E+00 | 7.45E-05 | 2.17E-05 | 9.66E-05 | 1.93E-05 |
| 41071NEI40648 | Biphenyl | 0.00E+00 | 0.00E+00 | 2.74E-03 | 0.00E+00 | 0.00E+00 |
| 41071NEI40648 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41071NEI40648 | Cumene | 0.00E+00 | 3.50E-06 | 5.83E-07 | 0.00E+00 | 0.00E+00 |
| 41071NEI40648 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41071NEI40648 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 41071NEI40648 | n-Hexane | 0.00E+00 | 0.00E+00 | 7.09E-10 | 0.00E+00 | 0.00E+00 |
| 41071NEI40648 | Propionaldehyde | 0.00E+00 | 5.48E-05 | 9.72E-06 | 0.00E+00 | 0.00E+00 |
| 41071NEI40648 | Trichloroethylene | 0.00E+00 | 2.10E-05 | 6.12E-06 | 2.72E-05 | 5.44E-06 |
| 42013NEI7104 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 42013NEI7104 | Acetophenone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 42013NEI7104 | Chlorobenzene | 0.00E+00 | 9.40E-05 | 6.26E-06 | 0.00E+00 | 0.00E+00 |
| 42013NEI7104 | Ethyl benzene | 0.00E+00 | 2.88E-05 | 8.40E-07 | 0.00E+00 | 0.00E+00 |
| 42013NEI7104 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 42013NEI7104 | n-Hexane | 0.00E+00 | 0.00E+00 | 2.63E-07 | 0.00E+00 | 0.00E+00 |
| 42013NEI7104 | o-Cresol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 42013NEI7104 | Trichloroethylene | 0.00E+00 | 6.99E-06 | 2.04E-06 | 9.06E-06 | 1.81E-06 |
| 42047NEI40686 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 42047NEI40686 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 42047NEI40686 | 1,3-Butadiene | 0.00E+00 | 2.61E-08 | 3.27E-09 | 1.78E-06 | 8.91E-08 |
| 42047NEI40686 | Chlorobenzene | 0.00E+00 | 6.39E-06 | 4.26E-07 | 0.00E+00 | 0.00E+00 |
| 42047NEI40686 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 42047NEI40686 | Cumene | 0.00E+00 | 6.99E-07 | 1.17E-07 | 0.00E+00 | 0.00E+00 |
| 42047NEI40686 | Ethyl benzene | 0.00E+00 | 1.13E-07 | 3.29E-09 | 0.00E+00 | 0.00E+00 |
| 42047NEI40686 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.54E-08 | 1.37E-08 |
| 42047NEI40686 | Hexachloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 42047NEI40686 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 42047NEI40686 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 42047NEI40686 | n-Hexane | 0.00E+00 | 0.00E+00 | 2.99E-08 | 0.00E+00 | 0.00E+00 |
| 42047NEI40686 | Propionaldehyde | 0.00E+00 | 8.06E-05 | 1.43E-05 | 0.00E+00 | 0.00E+00 |
| 42047NEI40686 | Trichloroethylene | 0.00E+00 | 5.17E-08 | 1.51E-08 | 6.70E-08 | 1.34E-08 |
| 42131NEI40738 | Cadmium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 42131NEI40738 | Chromium (III) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 42131NEI40738 | Chromium (VI) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 42131NEI40738 | Lead compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 42131NEI40738 | Manganese compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 42131NEI40738 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 42131NEI40738 | n-Hexane | 0.00E+00 | 0.00E+00 | 3.30E-07 | 0.00E+00 | 0.00E+00 |
| 42133NEI7181 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 42133NEI7181 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 42133NEI7181 | 1,3-Butadiene | 0.00E+00 | 1.49E-08 | 1.87E-09 | 1.02E-06 | 5.09E-08 |
| 42133NEI7181 | Acetophenone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 42133NEI7181 | Acrylonitrile | 0.00E+00 | 1.85E-06 | 1.42E-07 | 8.42E-07 | 2.41E-07 |
| 42133NEI7181 | Aniline | 0.00E+00 | 1.76E-10 | 1.15E-10 | 0.00E+00 | 0.00E+00 |
| 42133NEI7181 | Biphenyl | 0.00E+00 | 0.00E+00 | 3.64E-06 | 0.00E+00 | 0.00E+00 |
| 42133NEI7181 | Carbonyl sulfide | 0.00E+00 | 0.00E+00 | 5.65E-06 | 0.00E+00 | 0.00E+00 |
| 42133NEI7181 | Catechol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 42133NEI7181 | Chlorobenzene | 0.00E+00 | 5.68E-06 | 3.79E-07 | 0.00E+00 | 0.00E+00 |
| 42133NEI7181 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 42133NEI7181 | Cumene | 0.00E+00 | 1.52E-06 | 2.53E-07 | 0.00E+00 | 0.00E+00 |
| 42133NEI7181 | Ethyl benzene | 0.00E+00 | 1.94E-06 | 5.66E-08 | 0.00E+00 | 0.00E+00 |
| 42133NEI7181 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.99E-07 | 7.38E-08 |
| 42133NEI7181 | Hexachlorocyclopentadiene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 42133NEI7181 | Hexachloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

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|---|---|---|---|---|---|---|
| 42133NEI7181 | Methyl iodide | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.04E-08 | 2.61E-08 |
| 42133NEI7181 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 42133NEI7181 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 42133NEI7181 | n-Hexane | 0.00E+00 | 0.00E+00 | 7.86E-09 | 0.00E+00 | 0.00E+00 |
| 42133NEI7181 | o-Cresol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 42133NEI7181 | Propionaldehyde | 0.00E+00 | 2.10E-05 | 3.73E-06 | 0.00E+00 | 0.00E+00 |
| 42133NEI7181 | Trichloroethylene | 0.00E+00 | 8.19E-08 | 2.39E-08 | 1.06E-07 | 2.12E-08 |
| 45019NEI41252 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45019NEI41252 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45019NEI41252 | Chlorobenzene | 0.00E+00 | 1.34E-05 | 8.92E-07 | 0.00E+00 | 0.00E+00 |
| 45019NEI41252 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45019NEI41252 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 9.93E-08 | 2.45E-08 |
| 45019NEI41252 | Methyl chloride | 0.00E+00 | 0.00E+00 | 5.10E-09 | 0.00E+00 | 1.17E-08 |
| 45019NEI41252 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45019NEI41252 | n-Hexane | 0.00E+00 | 0.00E+00 | 3.00E-08 | 0.00E+00 | 0.00E+00 |
| 45019NEI41252 | Trichloroethylene | 0.00E+00 | 1.43E-08 | 4.18E-09 | 1.86E-08 | 3.71E-09 |
| 45041NEI7933 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45041NEI7933 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45041NEI7933 | 1,3-Butadiene | 0.00E+00 | 1.53E-08 | 1.91E-09 | 1.04E-06 | 5.21E-08 |
| 45041NEI7933 | Acetophenone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45041NEI7933 | Biphenyl | 0.00E+00 | 0.00E+00 | 2.55E-05 | 0.00E+00 | 0.00E+00 |
| 45041NEI7933 | Chlorobenzene | 0.00E+00 | 6.58E-06 | 4.38E-07 | 0.00E+00 | 0.00E+00 |
| 45041NEI7933 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45041NEI7933 | Cumene | 0.00E+00 | 9.44E-07 | 1.57E-07 | 0.00E+00 | 0.00E+00 |
| 45041NEI7933 | Ethyl benzene | 0.00E+00 | 4.15E-08 | 1.21E-09 | 0.00E+00 | 0.00E+00 |
| 45041NEI7933 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.28E-07 | 3.17E-08 |
| 45041NEI7933 | Methyl chloride | 0.00E+00 | 0.00E+00 | 2.97E-08 | 0.00E+00 | 6.80E-08 |
| 45041NEI7933 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45041NEI7933 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45041NEI7933 | n-Hexane | 0.00E+00 | 0.00E+00 | 4.92E-08 | 0.00E+00 | 0.00E+00 |
| 45041NEI7933 | o-Cresol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45041NEI7933 | Propionaldehyde | 0.00E+00 | 5.46E-05 | 9.69E-06 | 0.00E+00 | 0.00E+00 |
| 45041NEI7933 | Trichloroethylene | 0.00E+00 | 2.19E-06 | 6.38E-07 | 2.84E-06 | 5.67E-07 |
| 45043NEI41314 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45043NEI41314 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45043NEI41314 | 1,3-Butadiene | 0.00E+00 | 2.46E-08 | 3.07E-09 | 1.67E-06 | 8.37E-08 |
| 45043NEI41314 | Acetophenone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45043NEI41314 | Biphenyl | 0.00E+00 | 0.00E+00 | 7.46E-07 | 0.00E+00 | 0.00E+00 |
| 45043NEI41314 | Cadmium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45043NEI41314 | Carbonyl sulfide | 0.00E+00 | 0.00E+00 | 3.75E-06 | 0.00E+00 | 0.00E+00 |
| 45043NEI41314 | Chlorobenzene | 0.00E+00 | 8.96E-06 | 5.97E-07 | 0.00E+00 | 0.00E+00 |
| 45043NEI41314 | Chromium (III) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45043NEI41314 | Chromium (VI) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45043NEI41314 | Cobalt compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45043NEI41314 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45043NEI41314 | Cumene | 0.00E+00 | 2.02E-07 | 3.36E-08 | 0.00E+00 | 0.00E+00 |
| 45043NEI41314 | Dibutylphthalate | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45043NEI41314 | Diethanolamine | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45043NEI41314 | Ethyl benzene | 0.00E+00 | 1.57E-07 | 4.57E-09 | 0.00E+00 | 0.00E+00 |
| 45043NEI41314 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.77E-08 | 1.42E-08 |
| 45043NEI41314 | Ethylene glycol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45043NEI41314 | Hexachloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45043NEI41314 | Lead compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45043NEI41314 | Manganese compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45043NEI41314 | Mercuric chloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

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| 45043NEI41314 | Methyl chloride | 0.00E+00 | 0.00E+00 | 3.03E-08 | 0.00E+00 | 6.93E-08 |
| 45043NEI41314 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45043NEI41314 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45043NEI41314 | n-Hexane | 0.00E+00 | 0.00E+00 | 1.99E-08 | 0.00E+00 | 0.00E+00 |
| 45043NEI41314 | POM 72002 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45043NEI41314 | Propionaldehyde | 0.00E+00 | 7.53E-05 | 1.34E-05 | 0.00E+00 | 0.00E+00 |
| 45043NEI41314 | Trichloroethylene | 0.00E+00 | 4.64E-06 | 1.35E-06 | 6.01E-06 | 1.20E-06 |
| 45069NEI47074 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45069NEI47074 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45069NEI47074 | Chlorobenzene | 0.00E+00 | 7.08E-05 | 4.72E-06 | 0.00E+00 | 0.00E+00 |
| 45069NEI47074 | Cumene | 0.00E+00 | 8.89E-05 | 1.48E-05 | 0.00E+00 | 0.00E+00 |
| 45069NEI47074 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.08E-05 | 5.13E-06 |
| 45069NEI47074 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45069NEI47074 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45069NEI47074 | n-Hexane | 0.00E+00 | 0.00E+00 | 7.11E-08 | 0.00E+00 | 0.00E+00 |
| 45069NEI47074 | Propionaldehyde | 0.00E+00 | 8.51E-06 | 1.51E-06 | 0.00E+00 | 0.00E+00 |
| 45069NEI47074 | Trichloroethylene | 0.00E+00 | 5.46E-06 | 1.59E-06 | 7.07E-06 | 1.41E-06 |
| 45079NEI46760 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45079NEI46760 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45079NEI46760 | 1,3-Butadiene | 0.00E+00 | 2.47E-09 | 3.08E-10 | 1.68E-07 | 8.41E-09 |
| 45079NEI46760 | Biphenyl | 0.00E+00 | 0.00E+00 | 9.29E-08 | 0.00E+00 | 0.00E+00 |
| 45079NEI46760 | Chlorobenzene | 0.00E+00 | 4.96E-07 | 3.31E-08 | 0.00E+00 | 0.00E+00 |
| 45079NEI46760 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45079NEI46760 | Cumene | 0.00E+00 | 1.30E-07 | 2.16E-08 | 0.00E+00 | 0.00E+00 |
| 45079NEI46760 | Ethyl benzene | 0.00E+00 | 3.21E-08 | 9.37E-10 | 0.00E+00 | 0.00E+00 |
| 45079NEI46760 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.76E-10 | 1.67E-10 |
| 45079NEI46760 | Hexachloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45079NEI46760 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45079NEI46760 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45079NEI46760 | n-Hexane | 0.00E+00 | 0.00E+00 | 7.51E-09 | 0.00E+00 | 0.00E+00 |
| 45079NEI46760 | Propionaldehyde | 0.00E+00 | 1.47E-05 | 2.61E-06 | 0.00E+00 | 0.00E+00 |
| 45079NEI46760 | Trichloroethylene | 0.00E+00 | 3.99E-08 | 1.16E-08 | 5.17E-08 | 1.03E-08 |
| 45091NEI47077 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45091NEI47077 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45091NEI47077 | Acetophenone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45091NEI47077 | Beryllium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.27E-07 |
| 45091NEI47077 | Biphenyl | 0.00E+00 | 0.00E+00 | 2.14E-05 | 0.00E+00 | 0.00E+00 |
| 45091NEI47077 | Cadmium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45091NEI47077 | Carbonyl sulfide | 0.00E+00 | 0.00E+00 | 3.15E-09 | 0.00E+00 | 0.00E+00 |
| 45091NEI47077 | Chlorobenzene | 0.00E+00 | 6.62E-06 | 4.42E-07 | 0.00E+00 | 0.00E+00 |
| 45091NEI47077 | Chromium (III) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45091NEI47077 | Chromium (VI) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45091NEI47077 | Cobalt compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45091NEI47077 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45091NEI47077 | Cumene | 0.00E+00 | 5.36E-06 | 8.93E-07 | 0.00E+00 | 0.00E+00 |
| 45091NEI47077 | Ethyl benzene | 0.00E+00 | 3.19E-09 | 9.31E-11 | 0.00E+00 | 0.00E+00 |
| 45091NEI47077 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 8.88E-08 | 2.19E-08 |
| 45091NEI47077 | Hexachlorocyclopentadiene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45091NEI47077 | Hexachloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45091NEI47077 | Lead compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45091NEI47077 | Manganese compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45091NEI47077 | m-Cresol (3-methylphenol) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45091NEI47077 | Mercuric chloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45091NEI47077 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45091NEI47077 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

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| 45091NEI47077 | n-Hexane | 0.00E+00 | 0.00E+00 | 2.39E-08 | 0.00E+00 | 0.00E+00 |
| 45091NEI47077 | o-Cresol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45091NEI47077 | p-Cresol (4-methy phenol) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45091NEI47077 | Propionaldehyde | 0.00E+00 | 1.87E-05 | 3.32E-06 | 0.00E+00 | 0.00E+00 |
| 45091NEI47077 | Selenium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 45091NEI47077 | Trichloroethylene | 0.00E+00 | 2.26E-08 | 6.59E-09 | 2.93E-08 | 5.86E-09 |
| 47071NEI41552 | Biphenyl | 0.00E+00 | 0.00E+00 | 1.22E-05 | 0.00E+00 | 0.00E+00 |
| 47071NEI41552 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 47071NEI41552 | Cumene | 0.00E+00 | 1.55E-05 | 2.59E-06 | 0.00E+00 | 0.00E+00 |
| 47071NEI41552 | Ethyl benzene | 0.00E+00 | 7.24E-09 | 2.11E-10 | 0.00E+00 | 0.00E+00 |
| 47071NEI41552 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 47071NEI41552 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 47071NEI41552 | n-Hexane | 0.00E+00 | 0.00E+00 | 1.49E-07 | 0.00E+00 | 0.00E+00 |
| 47071NEI41552 | o-Cresol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 47071NEI41552 | Propionaldehyde | 0.00E+00 | 4.34E-06 | 7.69E-07 | 0.00E+00 | 0.00E+00 |
| 47071NEI41552 | Trichloroethylene | 0.00E+00 | 1.80E-09 | 5.24E-10 | 2.33E-09 | 4.66E-10 |
| 47085NEI46866 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 47085NEI46866 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 47085NEI46866 | 1,3-Butadiene | 0.00E+00 | 3.79E-08 | 4.74E-09 | 2.58E-06 | 1.29E-07 |
| 47085NEI46866 | Acetophenone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 47085NEI46866 | Biphenyl | 0.00E+00 | 0.00E+00 | 2.90E-07 | 0.00E+00 | 0.00E+00 |
| 47085NEI46866 | Chlorobenzene | 0.00E+00 | 8.35E-08 | 5.56E-09 | 0.00E+00 | 0.00E+00 |
| 47085NEI46866 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 47085NEI46866 | Cumene | 0.00E+00 | 8.91E-07 | 1.48E-07 | 0.00E+00 | 0.00E+00 |
| 47085NEI46866 | Ethyl benzene | 0.00E+00 | 4.03E-08 | 1.18E-09 | 0.00E+00 | 0.00E+00 |
| 47085NEI46866 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.15E-07 | 5.31E-08 |
| 47085NEI46866 | Methyl chloride | 0.00E+00 | 0.00E+00 | 1.01E-07 | 0.00E+00 | 2.31E-07 |
| 47085NEI46866 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 47085NEI46866 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 47085NEI46866 | n-Hexane | 0.00E+00 | 0.00E+00 | 5.10E-09 | 0.00E+00 | 0.00E+00 |
| 47085NEI46866 | Propionaldehyde | 0.00E+00 | 5.32E-05 | 9.44E-06 | 0.00E+00 | 0.00E+00 |
| 47085NEI46866 | Trichloroethylene | 0.00E+00 | 7.47E-08 | 2.18E-08 | 9.68E-08 | 1.94E-08 |
| 47105NEITN1050093 | Cadmium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 47105NEITN1050093 | Chromium (III) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 47105NEITN1050093 | Chromium (VI) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 47105NEITN1050093 | Cobalt compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 47105NEITN1050093 | Lead compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 47105NEITN1050093 | Manganese compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 47105NEITN1050093 | Mercuric chloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 47105NEITN1050093 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 47105NEITN1050093 | POM 72002 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 47107NEI41565 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 47107NEI41565 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 47107NEI41565 | Acetophenone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 47107NEI41565 | Biphenyl | 0.00E+00 | 0.00E+00 | 8.87E-05 | 0.00E+00 | 0.00E+00 |
| 47107NEI41565 | Chlorobenzene | 0.00E+00 | 3.11E-05 | 2.08E-06 | 0.00E+00 | 0.00E+00 |
| 47107NEI41565 | Cumene | 0.00E+00 | 2.21E-05 | 3.68E-06 | 0.00E+00 | 0.00E+00 |
| 47107NEI41565 | Cyanide compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 47107NEI41565 | Diethanolamine | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 47107NEI41565 | Ethyl benzene | 0.00E+00 | 7.85E-10 | 2.29E-11 | 0.00E+00 | 0.00E+00 |
| 47107NEI41565 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.16E-07 | 2.85E-08 |
| 47107NEI41565 | Hexachlorocyclopentadiene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 47107NEI41565 | Hexachloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 47107NEI41565 | Methyl chloride | 0.00E+00 | 0.00E+00 | 3.15E-11 | 0.00E+00 | 7.20E-11 |
| 47107NEI41565 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

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| 47107NEI41565 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 47107NEI41565 | n-Hexane | 0.00E+00 | 0.00E+00 | 2.15E-08 | 0.00E+00 | 0.00E+00 |
| 47107NEI41565 | o-Cresol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 47107NEI41565 | p-Cresol (4-methy phenol) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 47107NEI41565 | Propionaldehyde | 0.00E+00 | 4.11E-05 | 7.30E-06 | 0.00E+00 | 0.00E+00 |
| 47107NEI41565 | Trichloroethylene | 0.00E+00 | 6.72E-09 | 1.96E-09 | 8.72E-09 | 1.74E-09 |
| 47163NEI41599 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 47163NEI41599 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 47163NEI41599 | 1,3-Butadiene | 0.00E+00 | 2.55E-08 | 3.19E-09 | 1.74E-06 | 8.70E-08 |
| 47163NEI41599 | Acetophenone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 47163NEI41599 | Biphenyl | 0.00E+00 | 0.00E+00 | 3.46E-09 | 0.00E+00 | 0.00E+00 |
| 47163NEI41599 | Chlorobenzene | 0.00E+00 | 1.62E-06 | 1.08E-07 | 0.00E+00 | 0.00E+00 |
| 47163NEI41599 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 47163NEI41599 | Cumene | 0.00E+00 | 1.39E-06 | 2.31E-07 | 0.00E+00 | 0.00E+00 |
| 47163NEI41599 | Ethyl benzene | 0.00E+00 | 1.10E-07 | 3.20E-09 | 0.00E+00 | 0.00E+00 |
| 47163NEI41599 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.60E-07 | 6.42E-08 |
| 47163NEI41599 | Hexachloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 47163NEI41599 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 47163NEI41599 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 47163NEI41599 | n-Hexane | 0.00E+00 | 0.00E+00 | 1.13E-08 | 0.00E+00 | 0.00E+00 |
| 47163NEI41599 | o-Cresol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 47163NEI41599 | Propionaldehyde | 0.00E+00 | 2.22E-05 | 3.93E-06 | 0.00E+00 | 0.00E+00 |
| 47163NEI41599 | Trichloroethylene | 0.00E+00 | 8.67E-08 | 2.53E-08 | 1.12E-07 | 2.25E-08 |
| 48067NEI41628 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 48067NEI41628 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 48067NEI41628 | 1,3-Butadiene | 0.00E+00 | 3.60E-08 | 4.50E-09 | 2.46E-06 | 1.23E-07 |
| 48067NEI41628 | Acetophenone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 48067NEI41628 | Biphenyl | 0.00E+00 | 0.00E+00 | 2.71E-06 | 0.00E+00 | 0.00E+00 |
| 48067NEI41628 | Cadmium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 48067NEI41628 | Chlorobenzene | 0.00E+00 | 1.82E-06 | 1.21E-07 | 0.00E+00 | 0.00E+00 |
| 48067NEI41628 | Chromium (III) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 48067NEI41628 | Chromium (VI) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 48067NEI41628 | Cobalt compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 48067NEI41628 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 48067NEI41628 | Cumene | 0.00E+00 | 9.25E-06 | 1.54E-06 | 0.00E+00 | 0.00E+00 |
| 48067NEI41628 | Ethyl benzene | 0.00E+00 | 1.44E-05 | 4.19E-07 | 0.00E+00 | 0.00E+00 |
| 48067NEI41628 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.42E-08 | 1.09E-08 |
| 48067NEI41628 | Hexachloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 48067NEI41628 | Lead compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 48067NEI41628 | Manganese compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 48067NEI41628 | Mercuric chloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 48067NEI41628 | Methyl chloride | 0.00E+00 | 0.00E+00 | 2.55E-10 | 0.00E+00 | 5.84E-10 |
| 48067NEI41628 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 48067NEI41628 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 48067NEI41628 | n-Hexane | 0.00E+00 | 0.00E+00 | 1.68E-07 | 0.00E+00 | 0.00E+00 |
| 48067NEI41628 | o-Cresol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 48067NEI41628 | POM 72002 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 48067NEI41628 | Propionaldehyde | 0.00E+00 | 9.72E-05 | 1.72E-05 | 0.00E+00 | 0.00E+00 |
| 48067NEI41628 | Trichloroethylene | 0.00E+00 | 1.93E-07 | 5.62E-08 | 2.50E-07 | 5.00E-08 |
| 48241NEI6450 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 48241NEI6450 | Chlorobenzene | 0.00E+00 | 5.35E-05 | 3.57E-06 | 0.00E+00 | 0.00E+00 |
| 48241NEI6450 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 48241NEI6450 | Dibutylphthalate | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 48241NEI6450 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.31E-05 | 8.16E-06 |
| 48241NEI6450 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

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| 48241NEI6450 | n-Hexane | 0.00E+00 | 0.00E+00 | 5.30E-08 | 0.00E+00 | 0.00E+00 |
| 48241NEI6450 | Trichloroethylene | 0.00E+00 | 4.42E-09 | 1.29E-09 | 5.74E-09 | 1.15E-09 |
| 48361NEI12492 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 48361NEI12492 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 48361NEI12492 | 1,3-Butadiene | 0.00E+00 | 1.19E-08 | 1.49E-09 | 8.13E-07 | 4.07E-08 |
| 48361NEI12492 | Acetophenone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 48361NEI12492 | Biphenyl | 0.00E+00 | 0.00E+00 | 2.51E-05 | 0.00E+00 | 0.00E+00 |
| 48361NEI12492 | Chlorobenzene | 0.00E+00 | 2.07E-07 | 1.38E-08 | 0.00E+00 | 0.00E+00 |
| 48361NEI12492 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 48361NEI12492 | Cumene | 0.00E+00 | 1.47E-06 | 2.45E-07 | 0.00E+00 | 0.00E+00 |
| 48361NEI12492 | Ethyl benzene | 0.00E+00 | 3.72E-08 | 1.09E-09 | 0.00E+00 | 0.00E+00 |
| 48361NEI12492 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.07E-07 | 5.12E-08 |
| 48361NEI12492 | Methyl chloride | 0.00E+00 | 0.00E+00 | 2.94E-07 | 0.00E+00 | 6.72E-07 |
| 48361NEI12492 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 48361NEI12492 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 48361NEI12492 | n-Hexane | 0.00E+00 | 0.00E+00 | 4.42E-09 | 0.00E+00 | 0.00E+00 |
| 48361NEI12492 | Propionaldehyde | 0.00E+00 | 3.62E-05 | 6.43E-06 | 0.00E+00 | 0.00E+00 |
| 48361NEI12492 | Trichloroethylene | 0.00E+00 | 2.03E-08 | 5.91E-09 | 2.63E-08 | 5.25E-09 |
| 51019NEI42211 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 51019NEI42211 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 51019NEI42211 | Biphenyl | 0.00E+00 | 0.00E+00 | 9.75E-05 | 0.00E+00 | 0.00E+00 |
| 51019NEI42211 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 51019NEI42211 | n-Hexane | 0.00E+00 | 0.00E+00 | 1.08E-07 | 0.00E+00 | 0.00E+00 |
| 51019NEI42211 | Propionaldehyde | 0.00E+00 | 4.37E-05 | 7.75E-06 | 0.00E+00 | 0.00E+00 |
| 51019NEI42211 | Trichloroethylene | 0.00E+00 | 3.75E-06 | 1.09E-06 | 4.87E-06 | 9.73E-07 |
| 51085NEI208 | n-Hexane | 0.00E+00 | 0.00E+00 | 7.25E-09 | 0.00E+00 | 0.00E+00 |
| 51101NEI42254 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 51101NEI42254 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 51101NEI42254 | 1,3-Butadiene | 0.00E+00 | 3.41E-07 | 4.26E-08 | 2.33E-05 | 1.16E-06 |
| 51101NEI42254 | Biphenyl | 0.00E+00 | 0.00E+00 | 3.07E-05 | 0.00E+00 | 0.00E+00 |
| 51101NEI42254 | Chlorobenzene | 0.00E+00 | 2.75E-06 | 1.83E-07 | 0.00E+00 | 0.00E+00 |
| 51101NEI42254 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 51101NEI42254 | Cumene | 0.00E+00 | 4.21E-05 | 7.01E-06 | 0.00E+00 | 0.00E+00 |
| 51101NEI42254 | Ethyl benzene | 0.00E+00 | 9.31E-07 | 2.71E-08 | 0.00E+00 | 0.00E+00 |
| 51101NEI42254 | Ethylene dibromide | 0.00E+00 | 6.17E-09 | 4.46E-09 | 0.00E+00 | 0.00E+00 |
| 51101NEI42254 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.43E-06 | 1.09E-06 |
| 51101NEI42254 | Methyl chloride | 0.00E+00 | 0.00E+00 | 1.90E-06 | 0.00E+00 | 4.34E-06 |
| 51101NEI42254 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 51101NEI42254 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 51101NEI42254 | n-Hexane | 0.00E+00 | 0.00E+00 | 1.59E-07 | 0.00E+00 | 0.00E+00 |
| 51101NEI42254 | o-Cresol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 51101NEI42254 | Propionaldehyde | 0.00E+00 | 1.47E-04 | 2.62E-05 | 0.00E+00 | 0.00E+00 |
| 51101NEI42254 | Trichloroethylene | 0.00E+00 | 5.40E-07 | 1.58E-07 | 7.00E-07 | 1.40E-07 |
| 51580NEI759 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 51580NEI759 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 51580NEI759 | 1,3-Butadiene | 0.00E+00 | 1.11E-07 | 1.38E-08 | 7.54E-06 | 3.77E-07 |
| 51580NEI759 | Acetophenone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 51580NEI759 | Biphenyl | 0.00E+00 | 0.00E+00 | 2.74E-06 | 0.00E+00 | 0.00E+00 |
| 51580NEI759 | Cadmium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 51580NEI759 | Carbonyl sulfide | 0.00E+00 | 0.00E+00 | 3.75E-08 | 0.00E+00 | 0.00E+00 |
| 51580NEI759 | Chlorobenzene | 0.00E+00 | 1.43E-04 | 9.54E-06 | 0.00E+00 | 0.00E+00 |
| 51580NEI759 | Chromium (III) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 51580NEI759 | Chromium (VI) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 51580NEI759 | Cobalt compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 51580NEI759 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

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| 51580NEI759 | Cumene | 0.00E+00 | 6.87E-07 | 1.15E-07 | 0.00E+00 | 0.00E+00 |
| 51580NEI759 | Ethyl benzene | 0.00E+00 | 2.09E-07 | 6.09E-09 | 0.00E+00 | 0.00E+00 |
| 51580NEI759 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.80E-07 | 6.91E-08 |
| 51580NEI759 | Hexachloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 51580NEI759 | Lead compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 51580NEI759 | Manganese compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 51580NEI759 | Mercuric chloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 51580NEI759 | Methyl chloride | 0.00E+00 | 0.00E+00 | 1.99E-10 | 0.00E+00 | 4.57E-10 |
| 51580NEI759 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 51580NEI759 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 51580NEI759 | n-Hexane | 0.00E+00 | 0.00E+00 | 2.32E-07 | 0.00E+00 | 0.00E+00 |
| 51580NEI759 | o-Cresol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 51580NEI759 | POM 72002 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 51580NEI759 | Propionaldehyde | 0.00E+00 | 1.44E-04 | 2.55E-05 | 0.00E+00 | 0.00E+00 |
| 51580NEI759 | Trichloroethylene | 0.00E+00 | 1.91E-06 | 5.56E-07 | 2.47E-06 | 4.94E-07 |
| 51670NEI42317 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 51670NEI42317 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 51670NEI42317 | 1,3-Butadiene | 0.00E+00 | 4.05E-09 | 5.06E-10 | 2.76E-07 | 1.38E-08 |
| 51670NEI42317 | Biphenyl | 0.00E+00 | 0.00E+00 | 1.41E-06 | 0.00E+00 | 0.00E+00 |
| 51670NEI42317 | Chlorobenzene | 0.00E+00 | 2.05E-06 | 1.36E-07 | 0.00E+00 | 0.00E+00 |
| 51670NEI42317 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 51670NEI42317 | Cumene | 0.00E+00 | 3.88E-08 | 6.46E-09 | 0.00E+00 | 0.00E+00 |
| 51670NEI42317 | Ethyl benzene | 0.00E+00 | 9.59E-08 | 2.80E-09 | 0.00E+00 | 0.00E+00 |
| 51670NEI42317 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.44E-07 | 1.59E-07 |
| 51670NEI42317 | Methyl chloride | 0.00E+00 | 0.00E+00 | 2.36E-08 | 0.00E+00 | 5.40E-08 |
| 51670NEI42317 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 51670NEI42317 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 51670NEI42317 | n-Hexane | 0.00E+00 | 0.00E+00 | 2.15E-08 | 0.00E+00 | 0.00E+00 |
| 51670NEI42317 | Propionaldehyde | 0.00E+00 | 3.50E-05 | 6.22E-06 | 0.00E+00 | 0.00E+00 |
| 51670NEI42317 | Trichloroethylene | 0.00E+00 | 7.40E-07 | 2.16E-07 | 9.59E-07 | 1.92E-07 |
| 53009NEI42329 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53009NEI42329 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53009NEI42329 | 1,3-Butadiene | 0.00E+00 | 5.37E-09 | 6.71E-10 | 3.66E-07 | 1.83E-08 |
| 53009NEI42329 | Biphenyl | 0.00E+00 | 0.00E+00 | 3.24E-05 | 0.00E+00 | 0.00E+00 |
| 53009NEI42329 | Chlorobenzene | 0.00E+00 | 2.65E-08 | 1.76E-09 | 0.00E+00 | 0.00E+00 |
| 53009NEI42329 | Cumene | 0.00E+00 | 3.50E-06 | 5.83E-07 | 0.00E+00 | 0.00E+00 |
| 53009NEI42329 | Ethyl benzene | 0.00E+00 | 4.42E-08 | 1.29E-09 | 0.00E+00 | 0.00E+00 |
| 53009NEI42329 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.56E-08 | 3.85E-09 |
| 53009NEI42329 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53009NEI42329 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53009NEI42329 | n-Hexane | 0.00E+00 | 0.00E+00 | 1.08E-08 | 0.00E+00 | 0.00E+00 |
| 53009NEI42329 | Propionaldehyde | 0.00E+00 | 2.58E-05 | 4.57E-06 | 0.00E+00 | 0.00E+00 |
| 53009NEI42329 | Trichloroethylene | 0.00E+00 | 4.57E-09 | 1.33E-09 | 5.92E-09 | 1.18E-09 |
| 53011NEI46599 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53011NEI46599 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53011NEI46599 | 1,3-Butadiene | 0.00E+00 | 1.50E-08 | 1.88E-09 | 1.02E-06 | 5.12E-08 |
| 53011NEI46599 | Acetophenone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53011NEI46599 | Biphenyl | 0.00E+00 | 0.00E+00 | 7.12E-08 | 0.00E+00 | 0.00E+00 |
| 53011NEI46599 | Chlorobenzene | 0.00E+00 | 4.41E-06 | 2.94E-07 | 0.00E+00 | 0.00E+00 |
| 53011NEI46599 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53011NEI46599 | Cumene | 0.00E+00 | 8.76E-07 | 1.46E-07 | 0.00E+00 | 0.00E+00 |
| 53011NEI46599 | Ethyl benzene | 0.00E+00 | 1.33E-07 | 3.87E-09 | 0.00E+00 | 0.00E+00 |
| 53011NEI46599 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.54E-08 | 1.86E-08 |
| 53011NEI46599 | Hexachloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53011NEI46599 | Methyl chloride | 0.00E+00 | 0.00E+00 | 8.41E-08 | 0.00E+00 | 1.93E-07 |

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| 53011NEI46599 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53011NEI46599 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53011NEI46599 | n-Hexane | 0.00E+00 | 0.00E+00 | 6.96E-09 | 0.00E+00 | 0.00E+00 |
| 53011NEI46599 | o-Cresol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53011NEI46599 | Propionaldehyde | 0.00E+00 | 1.28E-05 | 2.27E-06 | 0.00E+00 | 0.00E+00 |
| 53011NEI46599 | Trichloroethylene | 0.00E+00 | 8.04E-08 | 2.34E-08 | 1.04E-07 | 2.08E-08 |
| 53015NEI42338 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53015NEI42338 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53015NEI42338 | 1,3-Butadiene | 0.00E+00 | 8.25E-09 | 1.03E-09 | 5.63E-07 | 2.81E-08 |
| 53015NEI42338 | Biphenyl | 0.00E+00 | 0.00E+00 | 3.55E-07 | 0.00E+00 | 0.00E+00 |
| 53015NEI42338 | Carbonyl sulfide | 0.00E+00 | 0.00E+00 | 3.64E-05 | 0.00E+00 | 0.00E+00 |
| 53015NEI42338 | Chlorobenzene | 0.00E+00 | 1.49E-03 | 9.96E-05 | 0.00E+00 | 0.00E+00 |
| 53015NEI42338 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53015NEI42338 | Cumene | 0.00E+00 | 7.04E-07 | 1.17E-07 | 0.00E+00 | 0.00E+00 |
| 53015NEI42338 | Ethyl benzene | 0.00E+00 | 6.76E-08 | 1.97E-09 | 0.00E+00 | 0.00E+00 |
| 53015NEI42338 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.72E-04 | 4.24E-05 |
| 53015NEI42338 | Hexachlorocyclopentadiene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53015NEI42338 | Hexachloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53015NEI42338 | Methyl chloride | 0.00E+00 | 0.00E+00 | 4.60E-10 | 0.00E+00 | 1.05E-09 |
| 53015NEI42338 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53015NEI42338 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53015NEI42338 | n-Hexane | 0.00E+00 | 0.00E+00 | 2.22E-08 | 0.00E+00 | 0.00E+00 |
| 53015NEI42338 | Propionaldehyde | 0.00E+00 | 4.26E-05 | 7.56E-06 | 0.00E+00 | 0.00E+00 |
| 53015NEI42338 | Trichloroethylene | 0.00E+00 | 4.95E-05 | 1.44E-05 | 6.41E-05 | 1.28E-05 |
| 53015NEI42341A | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53015NEI42341A | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53015NEI42341A | 1,3-Butadiene | 0.00E+00 | 4.61E-09 | 5.76E-10 | 3.14E-07 | 1.57E-08 |
| 53015NEI42341A | Biphenyl | 0.00E+00 | 0.00E+00 | 3.46E-10 | 0.00E+00 | 0.00E+00 |
| 53015NEI42341A | Carbonyl sulfide | 0.00E+00 | 0.00E+00 | 2.52E-07 | 0.00E+00 | 0.00E+00 |
| 53015NEI42341A | Chlorobenzene | 0.00E+00 | 3.51E-07 | 2.34E-08 | 0.00E+00 | 0.00E+00 |
| 53015NEI42341A | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53015NEI42341A | Cumene | 0.00E+00 | 3.37E-09 | 5.62E-10 | 0.00E+00 | 0.00E+00 |
| 53015NEI42341A | Ethyl benzene | 0.00E+00 | 8.72E-09 | 2.54E-10 | 0.00E+00 | 0.00E+00 |
| 53015NEI42341A | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.67E-10 | 1.40E-10 |
| 53015NEI42341A | Ethylene glycol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53015NEI42341A | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53015NEI42341A | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53015NEI42341A | n-Hexane | 0.00E+00 | 0.00E+00 | 7.51E-09 | 0.00E+00 | 0.00E+00 |
| 53015NEI42341A | Propionaldehyde | 0.00E+00 | 1.15E-05 | 2.04E-06 | 0.00E+00 | 0.00E+00 |
| 53015NEI42341A | Trichloroethylene | 0.00E+00 | 1.09E-08 | 3.17E-09 | 1.41E-08 | 2.82E-09 |
| 53031NEI42357 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53031NEI42357 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53031NEI42357 | Propionaldehyde | 0.00E+00 | 1.70E-04 | 3.02E-05 | 0.00E+00 | 0.00E+00 |
| 53053NEI13363 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53053NEI13363 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53053NEI13363 | 1,3-Butadiene | 0.00E+00 | 9.05E-09 | 1.13E-09 | 6.17E-07 | 3.09E-08 |
| 53053NEI13363 | Biphenyl | 0.00E+00 | 0.00E+00 | 1.98E-06 | 0.00E+00 | 0.00E+00 |
| 53053NEI13363 | Chlorobenzene | 0.00E+00 | 1.30E-05 | 8.64E-07 | 0.00E+00 | 0.00E+00 |
| 53053NEI13363 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53053NEI13363 | Cumene | 0.00E+00 | 6.58E-07 | 1.10E-07 | 0.00E+00 | 0.00E+00 |
| 53053NEI13363 | Ethyl benzene | 0.00E+00 | 1.15E-07 | 3.35E-09 | 0.00E+00 | 0.00E+00 |
| 53053NEI13363 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.75E-07 | 4.33E-08 |
| 53053NEI13363 | Hexachloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53053NEI13363 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53053NEI13363 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

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| 53053NEI13363 | n-Hexane | 0.00E+00 | 0.00E+00 | 2.93E-08 | 0.00E+00 | 0.00E+00 |
| 53053NEI13363 | o-Cresol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53053NEI13363 | Propionaldehyde | 0.00E+00 | 1.41E-05 | 2.50E-06 | 0.00E+00 | 0.00E+00 |
| 53053NEI13363 | Trichloroethylene | 0.00E+00 | 4.14E-06 | 1.21E-06 | 5.37E-06 | 1.07E-06 |
| 53071NEI42410 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53071NEI42410 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53071NEI42410 | 1,3-Butadiene | 0.00E+00 | 1.36E-09 | 1.70E-10 | 9.28E-08 | 4.64E-09 |
| 53071NEI42410 | Acetophenone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53071NEI42410 | Biphenyl | 0.00E+00 | 0.00E+00 | 1.37E-09 | 0.00E+00 | 0.00E+00 |
| 53071NEI42410 | Carbonyl sulfide | 0.00E+00 | 0.00E+00 | 1.30E-11 | 0.00E+00 | 0.00E+00 |
| 53071NEI42410 | Chlorobenzene | 0.00E+00 | 3.10E-06 | 2.06E-07 | 0.00E+00 | 0.00E+00 |
| 53071NEI42410 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53071NEI42410 | Cumene | 0.00E+00 | 8.79E-09 | 1.47E-09 | 0.00E+00 | 0.00E+00 |
| 53071NEI42410 | Dibutylphthalate | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53071NEI42410 | Ethyl benzene | 0.00E+00 | 2.32E-04 | 6.77E-06 | 0.00E+00 | 0.00E+00 |
| 53071NEI42410 | Ethyl Mercaptan | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53071NEI42410 | Ethyl Methyl Sulfide | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53071NEI42410 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.16E-07 | 2.87E-08 |
| 53071NEI42410 | Ethylidene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53071NEI42410 | Isobutyl Mercaptan | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53071NEI42410 | Isopropyl Mercaptan | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53071NEI42410 | Methyl chloride | 0.00E+00 | 0.00E+00 | 3.82E-07 | 0.00E+00 | 8.76E-07 |
| 53071NEI42410 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53071NEI42410 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53071NEI42410 | n-Butyl Mercaptan | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53071NEI42410 | n-Hexane | 0.00E+00 | 0.00E+00 | 1.82E-08 | 0.00E+00 | 0.00E+00 |
| 53071NEI42410 | n-Propyl Mercaptan | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53071NEI42410 | o-Cresol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53071NEI42410 | Propionaldehyde | 0.00E+00 | 2.67E-05 | 4.74E-06 | 0.00E+00 | 0.00E+00 |
| 53071NEI42410 | Tert-Butyl Mercaptan | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 53071NEI42410 | Trichloroethylene | 0.00E+00 | 1.27E-06 | 3.70E-07 | 1.64E-06 | 3.29E-07 |
| 54057NEI706 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 54057NEI706 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 54057NEI706 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.48E-07 | 3.65E-08 |
| 54057NEI706 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 54057NEI706 | n-Hexane | 0.00E+00 | 0.00E+00 | 8.76E-10 | 0.00E+00 | 0.00E+00 |
| 54057NEI706 | Trichloroethylene | 0.00E+00 | 4.28E-08 | 1.25E-08 | 5.54E-08 | 1.11E-08 |
| 55009NEI42482 | 1,1,2,2-Tetrachloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55009NEI42482 | 2-Nitropropane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55009NEI42482 | Acetonitrile | 0.00E+00 | 5.09E-05 | 2.07E-06 | 0.00E+00 | 0.00E+00 |
| 55009NEI42482 | Acetophenone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55009NEI42482 | Biphenyl | 0.00E+00 | 0.00E+00 | 6.06E-04 | 0.00E+00 | 0.00E+00 |
| 55009NEI42482 | Cadmium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55009NEI42482 | Chromium (III) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55009NEI42482 | Chromium (VI) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55009NEI42482 | Cobalt compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55009NEI42482 | Ethyl benzene | 0.00E+00 | 7.77E-07 | 2.27E-08 | 0.00E+00 | 0.00E+00 |
| 55009NEI42482 | Lead compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55009NEI42482 | Manganese compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55009NEI42482 | Mercuric chloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55009NEI42482 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55009NEI42482 | n-Hexane | 0.00E+00 | 0.00E+00 | 6.45E-08 | 0.00E+00 | 0.00E+00 |
| 55009NEI42482 | Nitrobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55009NEI42482 | p-Dichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55009NEI42482 | POM 72002 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

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| 55009NEI42482 | Propionaldehyde | 0.00E+00 | 2.63E-09 | 4.67E-10 | 0.00E+00 | 0.00E+00 |
| 55009NEI42486 | Biphenyl | 0.00E+00 | 0.00E+00 | 3.65E-05 | 0.00E+00 | 0.00E+00 |
| 55009NEIWI4050324 | Biphenyl | 0.00E+00 | 0.00E+00 | 2.92E-07 | 0.00E+00 | 0.00E+00 |
| 55009NEIWI4050324 | Cadmium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55009NEIWI4050324 | Chromium (III) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55009NEIWI4050324 | Chromium (VI) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55009NEIWI4050324 | Cobalt compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55009NEIWI4050324 | Lead compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55009NEIWI4050324 | Manganese compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55009NEIWI4050324 | Mercuric chloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55009NEIWI4050324 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55009NEIWI4050324 | n-Hexane | 0.00E+00 | 0.00E+00 | 5.16E-08 | 0.00E+00 | 0.00E+00 |
| 55009NEIWI4050324 | POM 72002 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55009NEIWI4050324 | Propionaldehyde | 0.00E+00 | 1.17E-06 | 2.08E-07 | 0.00E+00 | 0.00E+00 |
| 55073NEI42689 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55073NEI42689 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55073NEI42689 | Cadmium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55073NEI42689 | Cumene | 0.00E+00 | 2.28E-08 | 3.80E-09 | 0.00E+00 | 0.00E+00 |
| 55073NEI42689 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55073NEI42689 | n-Hexane | 0.00E+00 | 0.00E+00 | 8.99E-09 | 0.00E+00 | 0.00E+00 |
| 55073NEI42689 | POM 72002 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55073NEI42689 | Propionaldehyde | 0.00E+00 | 1.75E-06 | 3.11E-07 | 0.00E+00 | 0.00E+00 |
| 55073NEI42689 | Trichloroethylene | 0.00E+00 | 1.48E-06 | 4.32E-07 | 1.92E-06 | 3.84E-07 |
| 55079NEIWI0793640 | Biphenyl | 0.00E+00 | 0.00E+00 | 1.07E-04 | 0.00E+00 | 0.00E+00 |
| 55085NEI43202 | Beryllium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.70E-07 |
| 55085NEI43202 | Cadmium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55085NEI43202 | Chromium (III) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55085NEI43202 | Chromium (VI) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55085NEI43202 | Cobalt compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55085NEI43202 | Manganese compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55085NEI43202 | Mercuric chloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55085NEI43202 | Selenium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55097NEIWI7500086 | Lead compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55097NEIWI7500086 | Mercuric chloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55097NEIWIT$8597 | Ethylene glycol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55139NEIWI4710355 | Biphenyl | 0.00E+00 | 0.00E+00 | 4.33E-04 | 0.00E+00 | 0.00E+00 |
| 55139NEIWI4710355 | Cadmium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55139NEIWI4710355 | Chlorine | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55139NEIWI4710355 | Chromium (III) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55139NEIWI4710355 | Chromium (VI) compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55139NEIWI4710355 | Cobalt compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55139NEIWI4710355 | Lead compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55139NEIWI4710355 | Manganese compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55139NEIWI4710355 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55139NEIWI4710355 | n-Hexane | 0.00E+00 | 0.00E+00 | 1.58E-08 | 0.00E+00 | 0.00E+00 |
| 55139NEIWI4710355 | POM 72002 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55141NEI42695 | Antimony compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55141NEI42695 | Beryllium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 8.49E-03 |
| 55141NEI42695 | Biphenyl | 0.00E+00 | 0.00E+00 | 1.98E-05 | 0.00E+00 | 0.00E+00 |
| 55141NEI42695 | Cadmium compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55141NEI42695 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55141NEI42695 | Cumene | 0.00E+00 | 9.51E-06 | 1.58E-06 | 0.00E+00 | 0.00E+00 |
| 55141NEI42695 | Lead compounds | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55141NEI42695 | Methyl chloride | 0.00E+00 | 0.00E+00 | 1.94E-07 | 0.00E+00 | 4.43E-07 |
| 55141NEI42695 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

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|---|---|---|---|---|---|---|
| 55141NEI42695 | n-Hexane | 0.00E+00 | 0.00E+00 | 2.79E-08 | 0.00E+00 | 0.00E+00 |
| 55141NEI42695 | Propionaldehyde | 0.00E+00 | 7.52E-05 | 1.33E-05 | 0.00E+00 | 0.00E+00 |
| 55141NEI42963 | Benz[a]anthracene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55141NEI42963 | Benzo[a]pyrene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55141NEI42963 | Benzo[b]fluoranthene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55141NEI42963 | Benzo[k]fluoranthene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55141NEI42963 | Dibenzo[a,h]anthracene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55141NEI42963 | Indeno[1,2,3-c,d]pyrene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55141NEI42963 | Naphthalene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55141NEI42963 | n-Hexane | 0.00E+00 | 0.00E+00 | 6.85E-09 | 0.00E+00 | 0.00E+00 |
| 55141NEI46739 | 1,1,2-Trichloroethane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55141NEI46739 | 1,2,4-Trichlorobenzene | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55141NEI46739 | Acetophenone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55141NEI46739 | Carbonyl sulfide | 0.00E+00 | 0.00E+00 | 9.24E-08 | 0.00E+00 | 0.00E+00 |
| 55141NEI46739 | Chlorobenzene | 0.00E+00 | 2.40E-05 | 1.60E-06 | 0.00E+00 | 0.00E+00 |
| 55141NEI46739 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55141NEI46739 | Ethyl benzene | 0.00E+00 | 1.94E-07 | 5.67E-09 | 0.00E+00 | 0.00E+00 |
| 55141NEI46739 | Ethylene dichloride | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.14E-05 | 7.75E-06 |
| 55141NEI46739 | Methyl isobutyl ketone | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55141NEI46739 | n-Hexane | 0.00E+00 | 0.00E+00 | 4.01E-09 | 0.00E+00 | 0.00E+00 |
| 55141NEI46739 | Trichloroethylene | 0.00E+00 | 8.93E-07 | 2.61E-07 | 1.16E-06 | 2.32E-07 |
| 55141NEIWI7720116 | Catechol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55141NEIWI7720116 | Cresols (mixed) | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| 55141NEIWI7720116 | Ethylene glycol | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

[1] Some maximum acute impacts may be at onsite locations.
Note: **BOLD** indicates acute risks greater than 1

# Appendix 6 Acute Impacts Refined Analysis

## Refined Acute Modeling Approach

Initial acute screening risk calculations were performed with the HEM-3 model. HEM-3 estimates acute (1-hour) impacts at both polar and census block receptors. It is assumed for this short period of time that an exposed individual could be located at any off-site location. The lack of readily available detailed property boundary information for many of the facilities evaluated made it difficult to determine whether receptors were on- or off-site. In the absence of such information, the first ring of polar receptors was placed 100 meters from the plant center for many facilities. However, these polar rings often transected on-site locations, restricting public access to exposures at these levels and thereby overestimating exposures.

The screening approach used by HEM-3 to estimate maximum 1-hour exposures also likely overestimates. To estimate maximum 1-hour concentrations at each receptor, HEM-3 sums the maximum concentrations attributed to each source, regardless of whether those maximum concentrations occurred during the same hour. In other words, HEM-3 assumes that the maximum impact from each source at each receptor occurs at the same time. In actuality, maximum impacts from different sources may occur at different times.

This appendix includes the results of refined acute assessments performed for facilities that exceeded short-term health benchmarks using the HEM-3 approach. The refinements can address both areas of conservatism described above. The simplest refinement is to plot the HEM-3 polar grid results on aerial photographs of the facilities; This allows the assessment of off-site locations that may be accessible to the public (*e.g.,* roadways and public buildings.). In cases where this refinement results in lower acute risks no further refinement was conducted. However, if acute risk still remain at or near levels of concern a further refinement is conducted. This second refinement includes remodeling with the AERMOD model directly (instead of using HEM) to estimate maximum 1-hour concentrations at each receptor by pairing individual source impacts in time and space. The AERMOD results are then plotted on aerial photographs as noted above to determine off-site impacts. Modeling with AERMOD also allows the estimation of the frequency of higher impacts at or above the health levels of concern. The attached figures present the estimated hazard quotient values (the modeled 1-hour concentration of a pollutant divided by its short-term health benchmark) at the polar receptors near the facilities. Each set of figures is prefaced with a description of the maximum off-site hazard quotient value and where that value occurs. Refer to below for a brief summary;

- NEI46835; maximum offsite acute $HQ_{(REL)}$ for acetaldehyde of 20; northeast of facility
- NEI42338 chloroform acute $HQ_{(REL)}$ of 6, south of the facility
- NEITN1050093; maximum offsite acute $HQ_{(REL)}$ for chloroform of 5 to the north of facility
- NEI13363; maximum offsite acute $HQ_{(REL)}$ for formaldehyde of 5 to the northeast of facility
- NEI42341A; maximum offsite acute $HQ_{(REL)}$ for chloroform of 4 to the north of facility
- NEIWI7720116; maximum offsite acute $HQ_{(REL)}$ for acetaldehyde of 3, north of the facility
- NEIWI7720116; maximum offsite acute $HQ_{(REL)}$ for methanol of 2; southeast of facility
- NEIME0250002; maximum offsite acute $HQ_{(REL)}$ for acetaldehyde of 2 ; east of facility
- NEIWI7720116; maximum offsite acute $HQ_{(REL)}$ for chloroform of 2, southeast of the facility
- NEI47104; maximum offsite acute $HQ_{(REL)}$ for acetaldehyde of 2 to the northwest of the facility
- NEI41552; maximum offsite acute $HQ_{(REL)}$ for acetaldehyde of 2; northeast of facility

### Table 1 – Maximum Predicted Acute Risks Greater than 1 (Refined Approach)

| Facility NEI ID | Pollutant | Criteria | HEM-3 (Screening) | Refined Results | Refined Modeling Approach [1] |
|---|---|---|---|---|---|
| Pulp and Papermaking | | | | | |
| 23029NEI46835 | Acetaldehyde | REL | 15.2 | 15.2 | Max off-site HQ with emission specific multipliers |
| 53015NEI42338 | Chloroform | REL | 39.0 | 6 | Max off-site HQ with emission specific multipliers |
| 47105NEITN1050093 | Chloroform | REL | 5.2 | 5.2 | Max off-site HQ with emission specific multipliers |
| 53053NEI13363 | Formaldehyde | REL | 4.6 | 4.6 | Max off-site HQ with emission specific multipliers |
| 53015NEI42341A | Chloroform | REL | 4.1 | 4.1 | Max off-site HQ with emission specific multipliers |
| 55141NEIWI7720116 | Acetaldehyde | REL | 4.3 | 2.9 | Max off-site HQ with emission specific multipliers |
| 55141NEIWI7720116 | Methanol | REL | 3.4 | 2.3 | Max off-site HQ with emission specific multipliers |
| 23025NEIME0250002 | Acetaldehyde | REL | 1.6 | 2.3 | Max off-site HQ with emission specific multipliers; increase in HQ due to max acute multiplier = 3 for mechanical seperation of pulp versus use of screening multiplier of 2 |
| 55141NEIWI7720116 | Chloroform | REL | 3.1 | 2.1 | Max off-site HQ with emission specific multipliers |
| 37083NEI47104 | Acetaldehyde | REL | 9.3 | 1.6 | Max off-site HQ with emission specific multipliers |
| 47071NEI41552 | Acetaldehyde | REL | 2.1 | 1.5 | Max off-site HQ with emission specific multipliers |
| 05069NEI18657 | 1,2-Dimethoxyethane | REL | 8.5 | ≤ 1 | Max off-site HQ with emission specific multipliers |
| 01023NEI18334 | Formaldehyde | REL | 5.7 | ≤ 1 | Max off-site HQ with emission specific multipliers |
| 01023NEI18334 | Methanol | REL | 4.9 | ≤ 1 | Max off-site HQ with emission specific multipliers |
| 41043NEI13340 | Formaldehyde | REL | 4.7 | ≤ 1 | Max off-site HQ with emission specific multipliers |
| 01023NEI18334 | Acetaldehyde | REL | 4.7 | ≤ 1 | Max off-site HQ with emission specific multipliers |
| 51085NEI208 | Chloroform | REL | 4.2 | ≤ 1 | Max off-site HQ with emission specific multipliers |
| 41071NEI40648 | Chloroform | REL | 3.2 | ≤ 1 | Max off-site HQ with emission specific multipliers |
| 01023NEI18334 | Chloroform | REL | 2.9 | ≤ 1 | Max off-site HQ with emission specific multipliers |
| 05069NEI18658 | Chloroform | REL | 2.9 | ≤ 1 | Max off-site HQ with emission specific multipliers |
| 05069NEI18657 | Formaldehyde | REL | 2.8 | ≤ 1 | Max off-site HQ with emission specific multipliers |
| 41043NEI13340 | Acetaldehyde | REL | 2.6 | ≤ 1 | Max off-site HQ with emission specific multipliers |
| 21107NEI11367 | Formaldehyde | REL | 2.1 | ≤ 1 | Max off-site HQ with emission specific multipliers |
| 13127NEI8196 | Acetaldehyde | REL | 2.0 | ≤ 1 | Max off-site HQ with emission specific multipliers |
| 01091NEI45474 | Chlorine | REL | 1.9 | ≤ 1 | Max off-site HQ with emission specific multipliers |
| 39113NEI11645 | Chloroform | REL | 1.9 | ≤ 1 | Max off-site HQ with emission specific multipliers |
| 12123NEI47091 | Chloroform | REL | 1.7 | ≤ 1 | Max off-site HQ with emission specific multipliers |
| 41043NEI13340 | Methanol | REL | 1.6 | ≤ 1 | Max off-site HQ with emission specific multipliers |
| 13051NEI8186 | Formaldehyde | REL | 1.6 | ≤ 1 | Max off-site HQ with emission specific multipliers |

|  |  |  |  |  |  |
|---|---|---|---|---|---|
| 01099NEI18373 | Acetaldehyde | REL | 1.5 | ≤ 1 | Max off-site HQ with emission specific multipliers |

[1] Indicates modeling technique used to refined estimates; see Appendix 7 for figures depicting off-site impacts

# Pulp and Papermaking Facilities (Refined Acute Risk Assessment)

- Figure 1 – NEI46835; maximum offsite acute $HQ_{(REL)}$ for acetaldehyde of 20; northeast of facility
- Figure 2 – NEI42338 chloroform acute $HQ_{(REL)}$ of 6, south of the facility
- Figure 3 – NEITN1050093; maximum offsite acute $HQ_{(REL)}$ for chloroform of 5 to the north of facility
- Figure 4 – NEI13363; maximum offsite acute $HQ_{(REL)}$ for formaldehyde of 5 to the northeast of facility

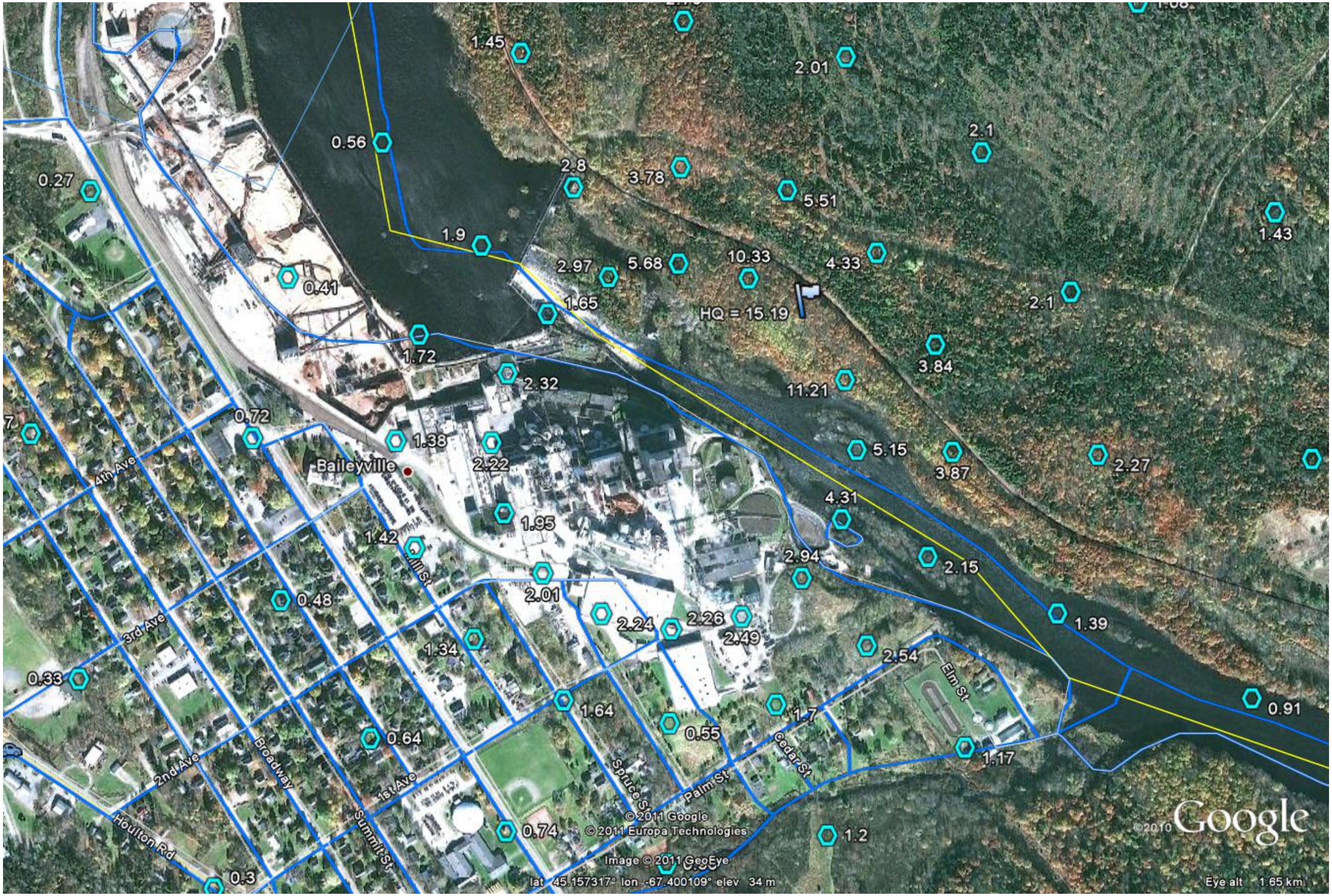
# Pulp and Papermaking Facilities (Refined Acute Risk Assessment)

- Figure 5 – NEI42341A; maximum offsite acute $HQ_{(REL)}$ for chloroform of 4 to the north of facility
- Figure 6 – NEIWI7720116; maximum offsite acute $HQ_{(REL)}$ for acetaldehyde of 3, north of the facility
- Figure 7– NEIWI7720116; maximum offsite acute $HQ_{(REL)}$ for methanol of 2; southeast of facility
- Figure 8 – NEIME0250002; maximum offsite acute $HQ_{(REL)}$ for acetaldehyde of 2 ; east of facility

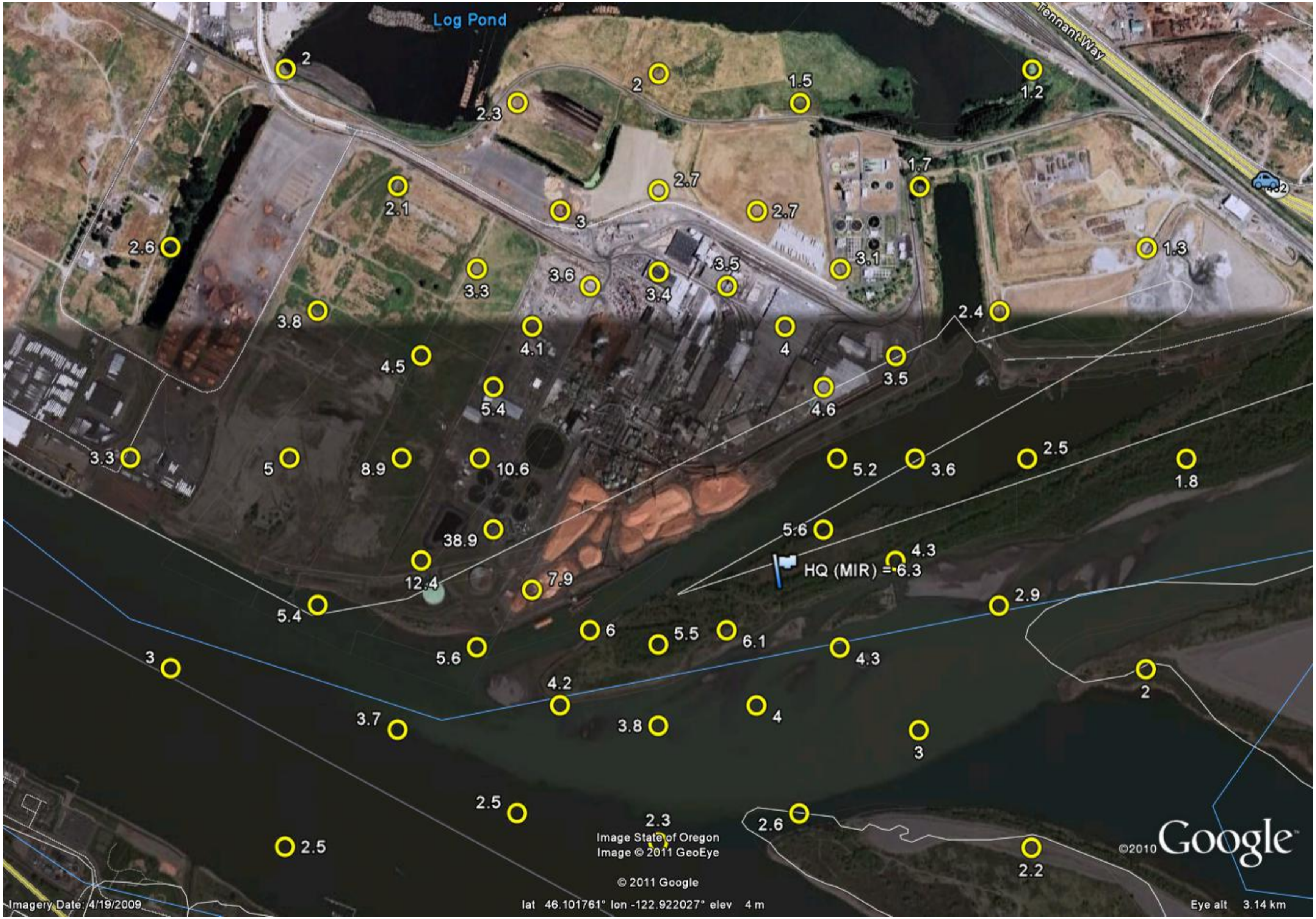
# Pulp and Papermaking Facilities (Refined Acute Risk Assessment)

- Figure 9 – NEIWI7720116; maximum offsite acute $HQ_{(REL)}$ for chloroform of 2, southeast of the facility
- Figure 10– NEI47104; maximum offsite acute $HQ_{(REL)}$ for acetaldehyde of 2 to the northwest of the facility
- Figure 11– NEI41552; maximum offsite acute $HQ_{(REL)}$ for acetaldehyde of 2; northeast of facility

Figure 1 – NEI46835 Acute Acetaldehyde HQ (REL)



# Figure 2 – NEI42338 Acute Chloroform HQ (REL)



# Figure 3 – NEITN1050093 Acute Chloroform HQ (REL)

# Figure 4 – NEI13363 Acute Formaldehyde HQ (REL)

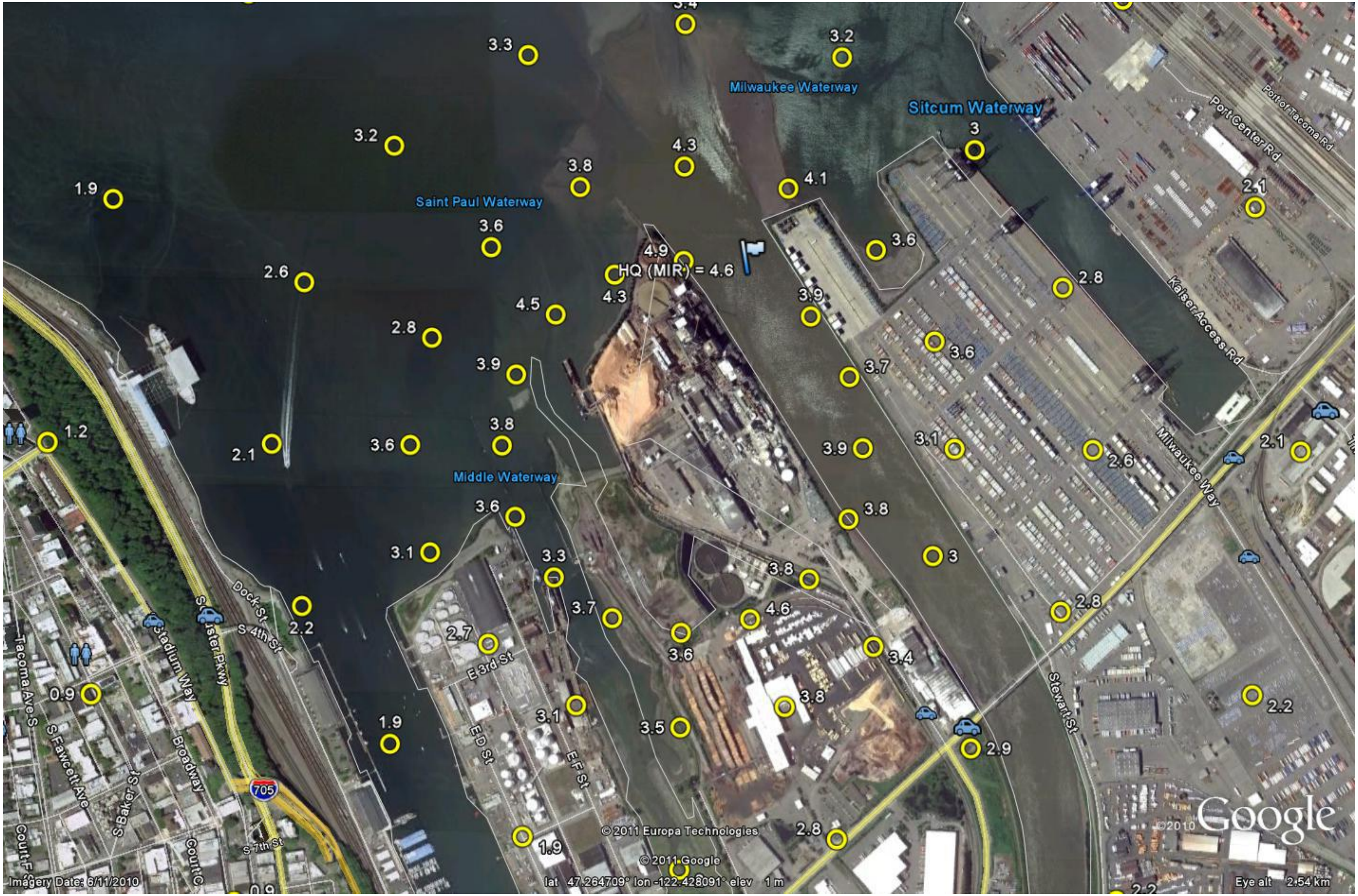


Figure 5– NEI42341A Acute Chloroform HQ (REL)

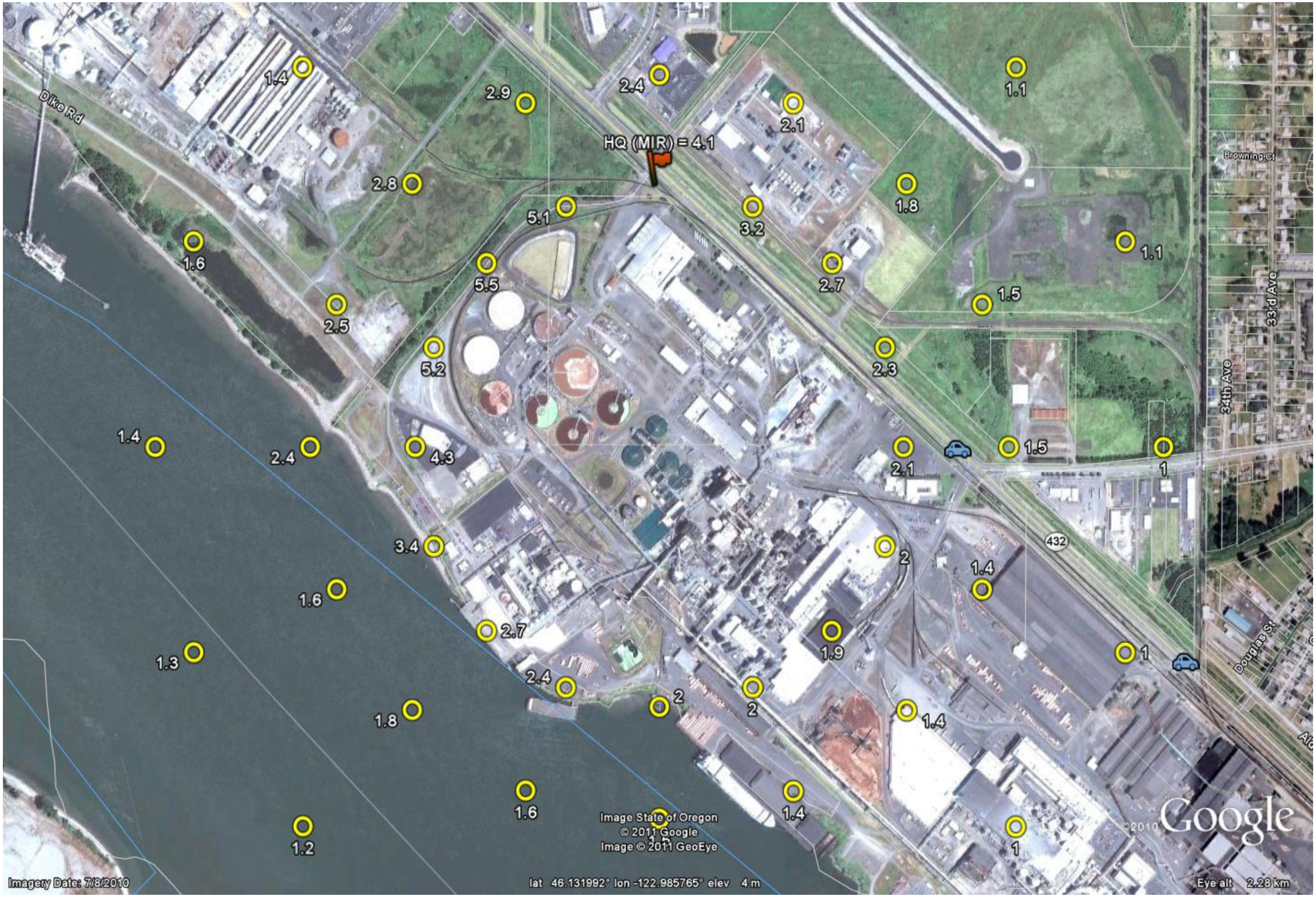


Figure 6 – NEIWI7720116 Acute Acetaldehyde HQ (REL)

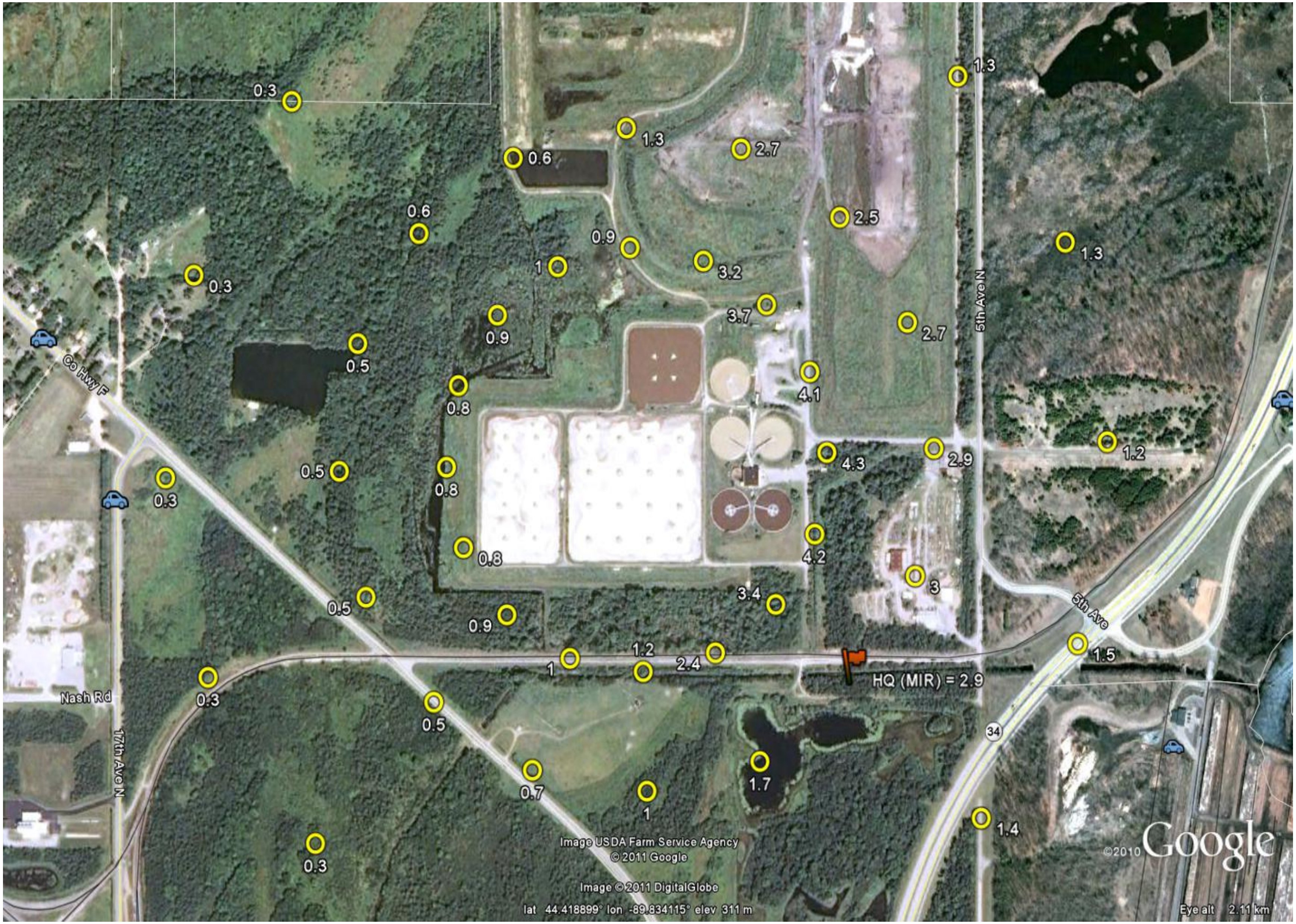


Figure 7 – NEIWI7720116 Acute Methanol HQ (REL)

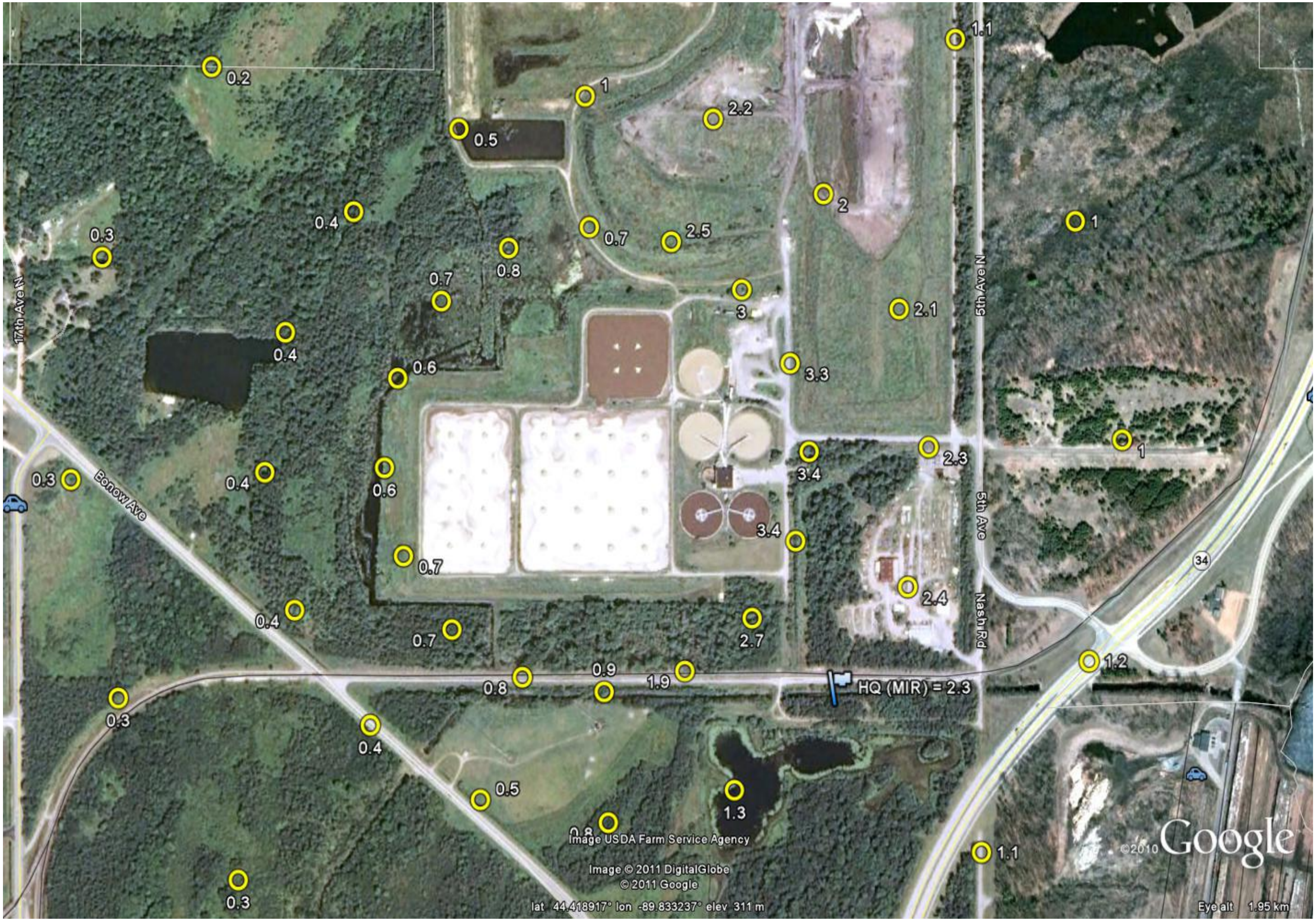
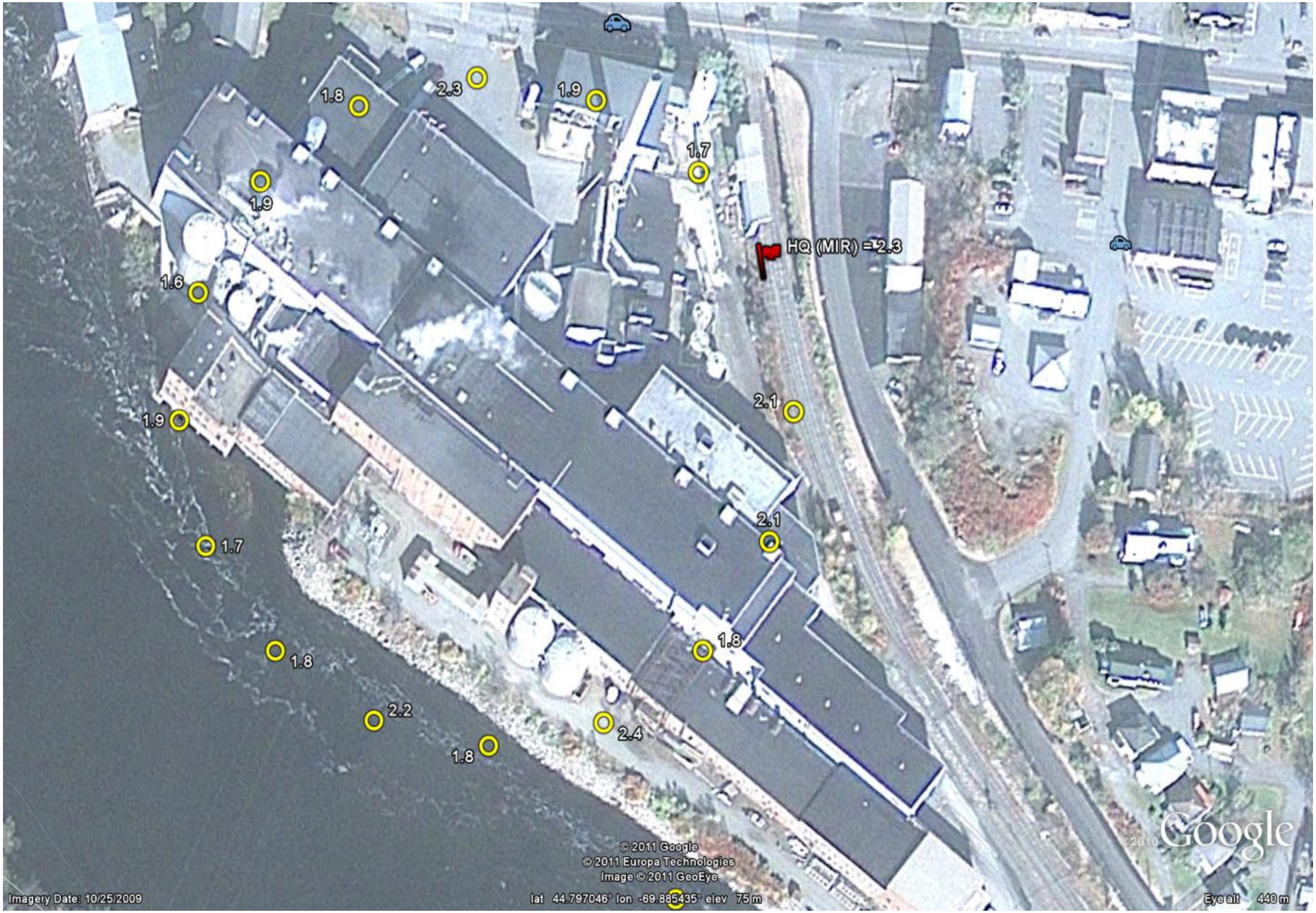
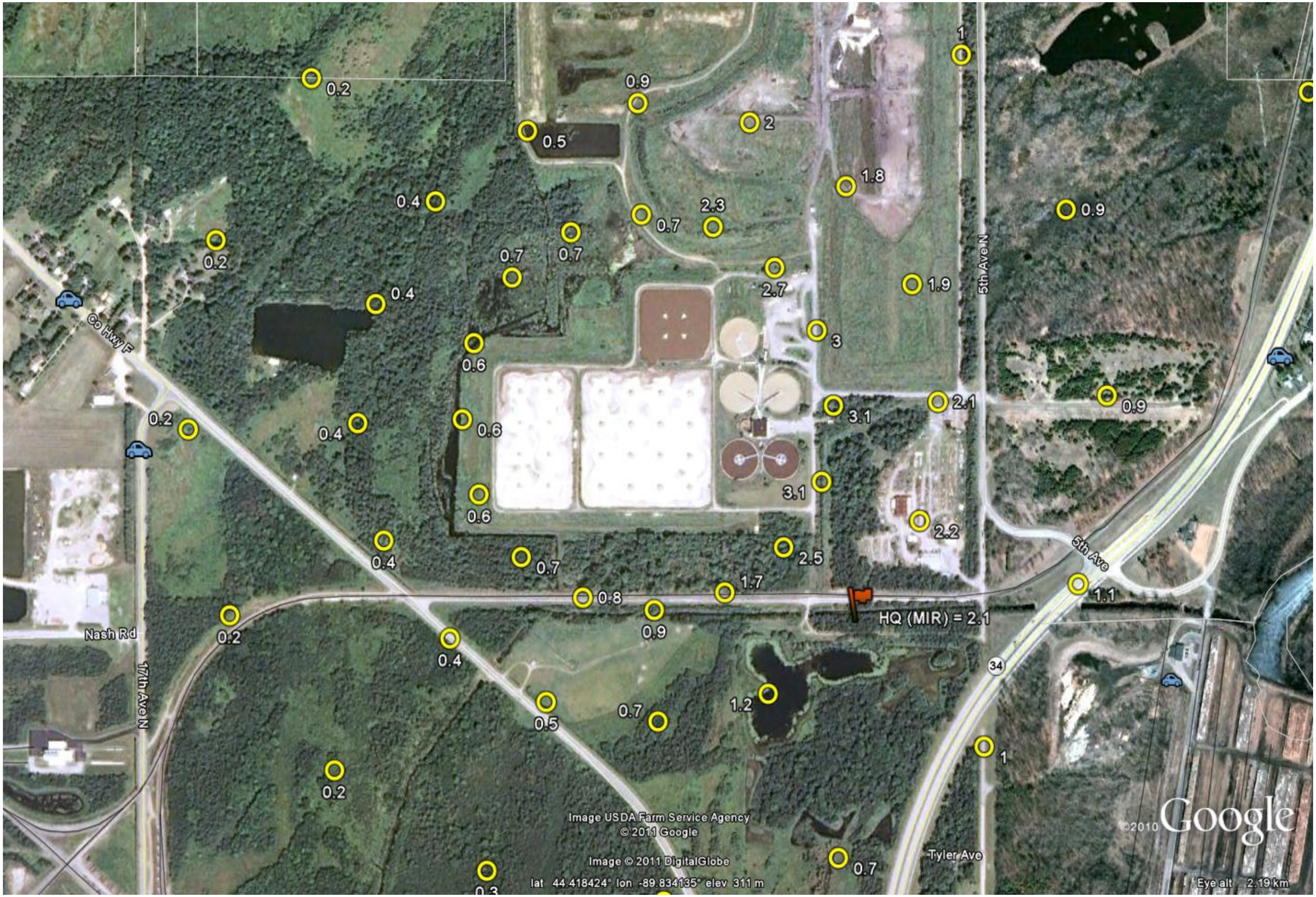


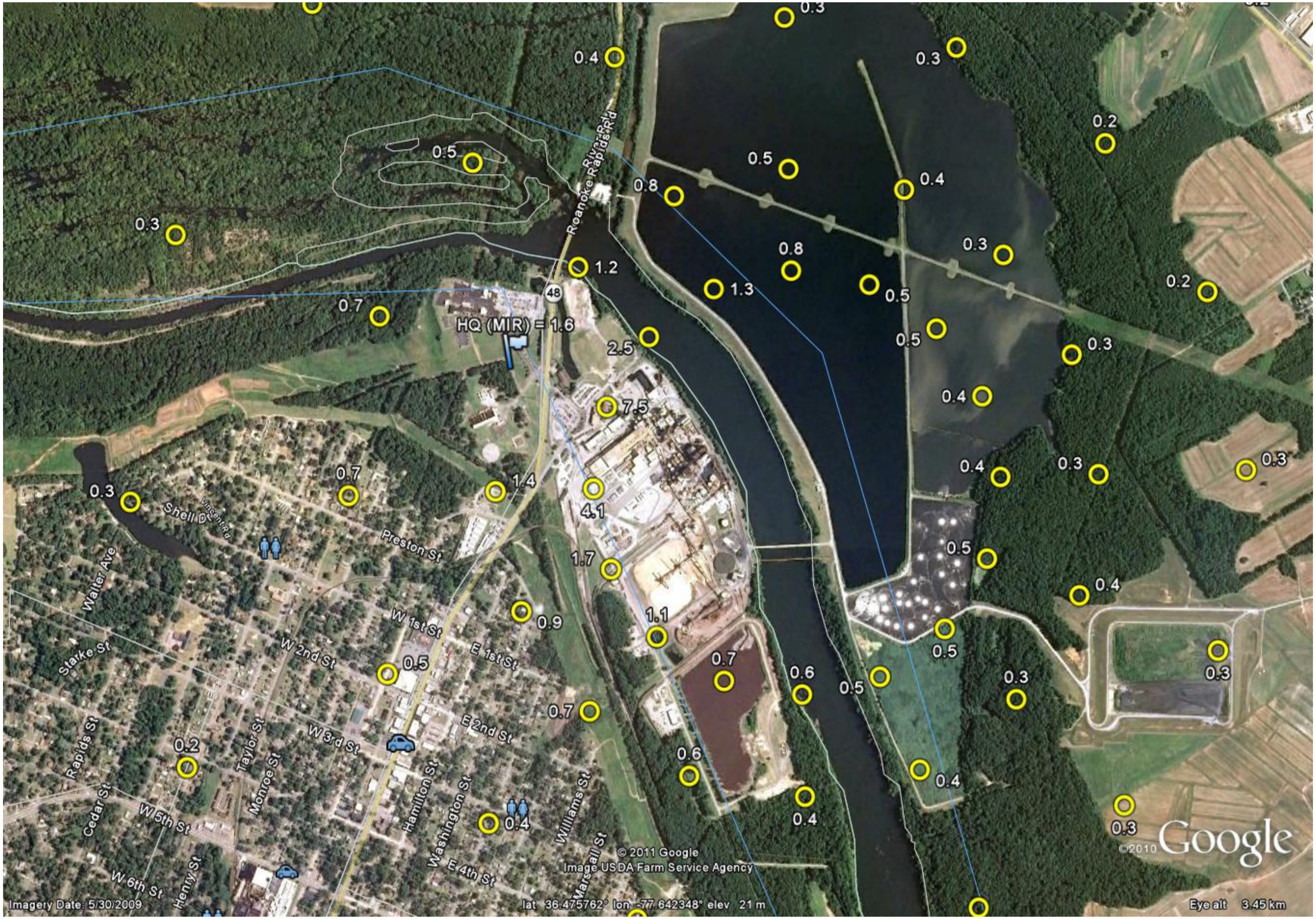
Figure 8 – NEIME0250002 Acute Acetaldehyde HQ (REL)



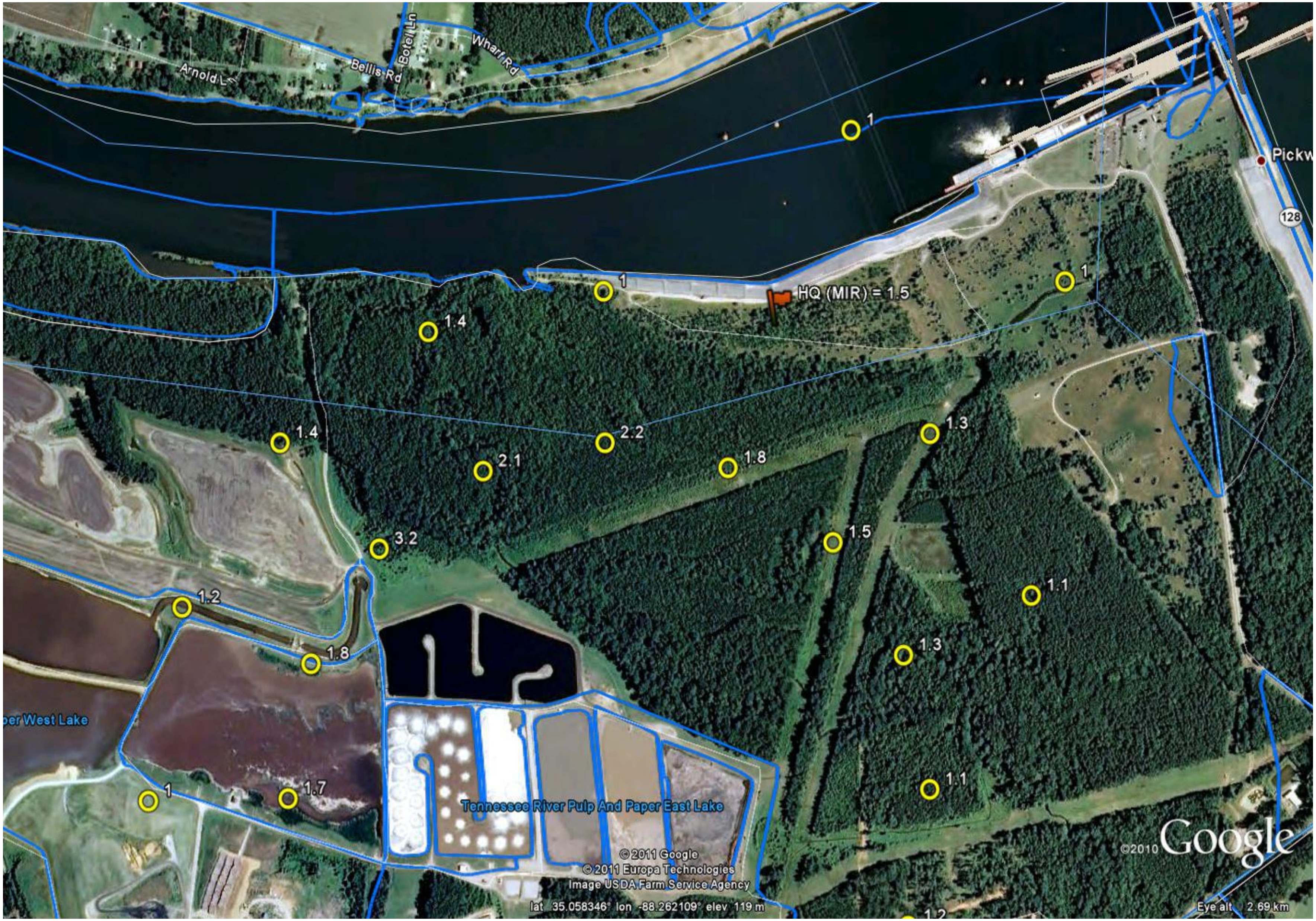
# Figure 9 – NEIWI7720116 Acute Chloroform HQ (REL)



# Figure 10 – NEI47104 Acute Acetaldehyde HQ (REL)



# Figure 11 – NEI41552 Acute Acetaldehyde HQ (REL)



# Appendix 7
# Dispersion Model Receptor Revisions and Additions for Pulp and Paper

# Dispersion Model Receptor Revisions and Additions for the Seven Chemical Sector Source Categories

To estimate ambient concentrations for evaluating long-term exposures, the HEM-3 model uses the geographic centroids of census blocks (currently utilizing the 2000 Census) as dispersion model receptors. The census block centroids are generally good surrogates for where people live within a census block. A census block generally encompasses about 40 people or 10-15 households. However, in cases where a block centroid is located on industrial property, or where a census block is large and the centroid less likely to be representative of the block's residential locations, the block centroid may not be an appropriate surrogate.

Census block centroids that are on facility property can sometimes be identified by their proximity to emission sources. In cases where a census block centroid was within 300 meters of any emission source, we viewed aerial images of the facility to determine whether the block centroid was likely located on facility property. The selection of the 300-meter distance reflects a compromise between too few and too many blocks identified as being potentially on facility property. Distances smaller than 300 meters would identify only block centroids near the emission sources and could exclude some block centroids that are still within facility boundaries, particularly for large facilities. Distances significantly larger than 300 meters would identify many block centroids that are outside facility boundaries, particularly for small facilities. Where we confirmed a block centroid on facility property, we moved the block centroid to a location that best represents the residential locations in the block.

In addition, census block centroids for blocks with large areas may not be representative of residential locations. Risk estimates based on such centroids can be understated if there are residences nearer to a facility than the centroid, and overstated if the residences are farther from the facility than the centroid. To avoid understating the maximum individual risk associated with a facility, in some cases we relocated block centroids, or added dispersion model receptors other than the block centroid. We examined aerial images of all large census blocks within one kilometer of any emission source. Experience from previous risks characterizations show that in most cases the MIR is generally located within 1 km of the facility boundary. If the block centroid did not represent the residential locations, we relocated it to better represent them. If residential locations could not be represented by a single receptor (that is, the residences were spread out over the block), we added additional receptors for residences nearer to the facility than the centroid.

For these source categories, the table below contains each census block for which we changed the centroid location because it was on facility property or was otherwise not representative of the residential locations in the block. The table also contains the locations of additional receptors that were included to represent residential locations nearer to the facility than the block centroid.

# Revised Census Block Centroid Locations and Additional Receptors for Pulp and Paper Source Category

## Centroid Revisions

| | | | Recommended Corr. | | |
|---|---|---|---|---|---|
| **Source Category** | **NEI ID** | **HEM Census Block** | **Latitude** | **Longitude** | **Note** |
| Pulp and Paper (MACT 1 and 3) | NEI8196 | 031270007006006 | 31.193187 | -81.506957 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEI26309 | 120330037002000 | 30.610445 | -87.321823 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEI26309 | 120330037002004 | 30.605553 | -87.329065 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEI8261 | 120890501001014 | 30.688076 | -81.456573 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEI8261 | 120890501001035 | 30.677285 | -81.458327 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEI8265 | 121079501002098 | 29.71139 | -81.71614 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEI8265 | 121079501002102 | 29.708550 | -81.716600 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEI47091 | 121239504001252 | 30.054765 | -83.530415 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEIIL0215971 | 170219585001011 | 39.55270 | -89.28170 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEI46835 | 230299554001015 | 45.155561 | -67.403942 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEI33945 | 261019907002048 | 44.216462 | -86.28748 | HEM Centroid on-site |

| | | | | | |
|---|---|---|---|---|---|
| Pulp and Paper (MACT 1 and 3) | NEI12411 | 270719902002036 | 48.603817 | -93.41346 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEI12411 | 270719902007009 | 48.594318 | -93.399499 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEI11172 | 280779601002062 | 31.620888 | -90.084459 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEI34064 | 280870011001039 | 33.3701 | -88.479896 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEI34070 | 281499501002027 | 32.523733 | -90.78031 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEI39968 | 360910602001001 | 43.304061 | -73.633324 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEI39968 | 361130705002019 | 43.310451 | -73.631706 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEINY5533400 | 361150890002065 | 43.099505 | -73.458657 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEI11600 | 390170008001024 | 39.405852 | -84.564164 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEI11602 | 390170128001000 | 39.51994 | -84.38576 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEI11461 | 390319913002001 | 40.278089 | -81.866312 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEI11610 | 390610054001006 | 39.160574 | -84.422065 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEIWI45005 | 391650325006004 | 39.550672 | -84.311252 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEI40553 | 410099707004000 | 45.853760 | -122.80624 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEI45182 | 410390019032005 | 44.048273 | -122.961822 | HEM Centroid on-site |

| | | | | | |
|---|---|---|---|---|---|
| Pulp and Paper (MACT 1 and 3) | NEI40648 | 410710302022001 | 45.290885 | -122.96266 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEI40648 | 410710302022002 | 45.290955 | -122.965094 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEI7106 | 420130101022000 | 40.677876 | -78.237306 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEI40686 | 420479905003005 | 41.491699 | -78.675082 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEI43472 | 450310103001019 | 34.390166 | -80.066199 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEI41552 | 470719806002011 | 35.045417 | -88.26225 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEI12492 | 483610211001001 | 30.231333 | -93.744831 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEI42211 | 510190303002000 | 37.533863 | -79.358067 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEI208 | 510853201001071 | 37.823909 | -77.448832 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEI42254 | 511019503002007 | 37.549069 | -76.813387 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEI42254 | 511019503002013 | 37.545667 | -76.806142 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEI42254 | 511019503002059 | 37.532944 | -76.79925 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEI42329 | 530099807001004 | 48.132684 | -123.474666 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEI46599 | 530110414003004 | 45.583321 | -122.414535 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEI42357 | 530319505002012 | 48.092833 | -122.808055 | HEM Centroid on-site |

| | | | | | |
|---|---|---|---|---|---|
| Pulp and Paper (MACT 1 and 3) | NEI2WAT18798 | 530519702003167 | 48.31204 | -117.28274 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEI42482 | 550090102011039 | 44.447553 | -88.068801 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEI42689 | 550730010001021 | 44.885043 | -89.632150 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEI42689 | 550730012012041 | 44.787667 | -89.690379 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEI43202 | 550859714004020 | 45.638895 | -89.424058 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEI43207 | 550870120001000 | 44.270007 | -88.29402 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEI43207 | 550870120001015 | 44.269413 | -88.30436 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEIWI7500086 | 550979611003006 | 44.520670 | -89.584477 | HEM Centroid on-site |
| Pulp and Paper (MACT 1 and 3) | NEIWI4710355 | 551390029001002 | 44.203319 | -88.458409 | HEM Centroid on-site |

## Additional Receptors

| | | Recommended Corr. | | |
|---|---|---|---|---|
| **Source Category** | **NEI ID** | **Latitude** | **Longitude** | **Note** |
| Pulp and Paper | 12089NEI8261 | 30.687903 | -81.45658 | Add User Defined Receptor |
| Pulp and Paper | 12089NEI8261 | 30.688298 | -81.45261 | Add User Defined Receptor |
| Pulp and Paper | 12123NEI47091 | 30.046987 | -83.539535 | Add User Defined Receptor |
| Pulp and Paper | 22011NEI7559 | 30.869429 | -93.356629 | Add User Defined Receptor |
| Pulp and Paper | 22011NEI7559 | 30.860808 | -93.383871 | Add User Defined Receptor |
| Pulp and Paper | 22011NEI7559 | 30.88408 | -93.38334 | Add User Defined Receptor |
| Pulp and Paper | 23017NEI6273 | 44.552802 | -70.536573 | Add User Defined Receptor |
| Pulp and Paper | 23019NEI33103 | 44.917033 | -68.639405 | Add User Defined Receptor |
| Pulp and Paper | 23019NEI33103 | 44.91869 | -68.640304 | Add User Defined Receptor |
| Pulp and Paper | 23019NEI33103 | 44.915477 | -68.639984 | Add User Defined Receptor |
| Pulp and Paper | 24001NEI33135 | 39.47489 | -79.05747 | Add User Defined Receptor |
| Pulp and Paper | 24001NEI33135 | 39.47384 | -79.05795 | Add User Defined Receptor |
| Pulp and Paper | 27061NEI34030 | 47.22971 | -93.53091 | Add User Defined Receptor |
| Pulp and Paper | 41009NEI40553 | 45.854133 | -122.804377 | Add User Defined Receptor |
| Pulp and Paper | 41009NEI40553 | 45.855088 | -122.80388 | Add User Defined Receptor |
| Pulp and Paper | 41039NEI45182 | 44.051448 | -122.970113 | Add User Defined Receptor |
| Pulp and Paper | 41041NEI40600 | 41.6555 | -123.932194 | Add User Defined Receptor |
| Pulp and Paper | 41041NEI40600 | 44.614793 | -123.931106 | Add User Defined Receptor |
| Pulp and Paper | 48361NEI12492 | 30.226318 | -93.738393 | Add User Defined Receptor |
| Pulp and Paper | 51019NEI42211 | 37.532709 | -79.357766 | Add User Defined Receptor |
| Pulp and Paper | 51085NEI208 | 37.819036 | -77.453027 | Add User Defined Receptor |
| Pulp and Paper | 51580NEI759 | 37.797843 | -79.99079 | Add User Defined Receptor |
| Pulp and Paper | 53009NEI42329 | 48.130770 | -123.470715 | Add User Defined Receptor |
| Pulp and Paper | 53011NEI46599 | 45.582800 | -122.415091 | Add User Defined Receptor |
| Pulp and Paper | 53031NEI42357 | 48.090916 | -122.804924 | Add User Defined Receptor |
| Pulp and Paper | 55073NEI42690 | 45.026841 | -89.651652 | Add User Defined Receptor |
| Pulp and Paper | 55079NEIWI0793640 | 43.062013 | -87.889484 | Add User Defined Receptor |
| Pulp and Paper | 55085NEI43202 | 45.638582 | -89.421621 | Add User Defined Receptor |
| Pulp and Paper | 55085NEI43202 | 45.639874 | -89.424034 | Add User Defined Receptor |
| Pulp and Paper | 55139NEIWI4710355 | 44.206271 | -88.4559 | Add User Defined Receptor |
| Pulp and Paper | 39165NEW45005 | 39.555043 | -84.304069 | Add User Defined Receptor |
| Pulp and Paper | 39165NEW45005 | 39.554643 | -84.304651 | Add User Defined Receptor |

# Appendix 8
# Development of the Chronic Screening Level for Carbonyl Sulfide

## Appendix 8 - Development of the Chronic Screening Level for Carbonyl Sulfide

Although the health effects data for carbonyl sulfide (COS) are very limited, a series of studies (ref 1,2,3) conducted by the National Toxicology Program have shown that the major concern regarding exposure to COS is its potential for neurotoxicity. These studies have shown consistently and at the same range of COS concentrations that the brain is a target organ for COS toxicity. A summary of the effects and levels at which they are observed is presented below. Since health appropriate effects benchmarks have not been derived by our preferred sources of dose-response data including IRIS, ATSDR and Cal EPA, the EPA has used the data from the above mentioned studies to derive a chronic screening benchmark level for COS. The rationale for this screening analysis is presented below.

A chronic screening level of 163 ug/m$^3$was developed for carbonyl sulfide (COS) from a No Observed Adverse Effects Level (NOAEL) of 200 ppm based on brain lesions and neurophysiological alterations in rodents as cited in the references below.

The NOAEL value of 200 ppm was converted to a value of 490,000 ug/m$^3$ as follows:

1 ppm of COS = 2.45 mg/m$^3$ (Molecular Weight = 60.08)

200 ppm x 2.45 mg/m$^3$ = 490 mg/m$^3$ = 490,000 ug/m$^3$

A total uncertainty factor (UF) of 3,000 was applied to this effect level: 10x for extrapolation for interspecies differences, 10x for consideration of intraspecies variability, 10x for extrapolation from subchronic to chronic duration, and 3x for database insufficiencies.

10 x 10 x 10 x 3 = 3,000

(490,000 ug/m$^3$) / 3,000 = 163 ug/m$^3$

Summary of Findings from NTP Studies on Carbonyl Sulfide (COS)

Experimental Design:

Several studies were conducted using F344 rats exposed to carbonyl sulfide (COS) by inhalation at various exposure concentrations and durations. Details are available in the references cited below.

Results Synopsis:

Pathology:

- Brain lesions at 400 and 500 ppm after exposure for 2 weeks. NOAEL = 300 ppm [Reference 1]
- Brain lesions at 400 ppm after exposure for 12 weeks. NOAEL = 300 ppm [Reference 1, Reference 3]

Biochemistry [Reference 1]:

- Inhibited cytochrome oxidase activity in posterior colliculus and parietal cortex at 200, 300, and 400 ppm COS after exposure for 3, 6, and 12 weeks.

Neurophysiology:

- Changes in Brainstem Auditory Evoked Responses (BAERs) at 400 ppm after 2 weeks exposure. [Reference 1]
- Changes in somatosensory evoked potentials (SEPs) at 400 ppm after 2 or 12 weeks. [Reference 2]
- Changes in BAERs at 300 and 400 ppm COS for 12 weeks. NOAEL = 200 ppm. [Reference 2]

Behavior:

- Changes in Functional Observational Battery (FOB) at 400 and 500 ppm with 2 week exposure [Reference 1], and motor activity and FOB altered by 400 ppm COS with 2 week exposure. [Reference 2]
- Some changes in FOB at 200, 300, and 400 ppm after 6 weeks exposure, with recovery indicated by 12 weeks. [Reference 1]

Summary

- NOAEL of 200-300 ppm selected based on brain pathological lesions and neurophysiological alterations.
- Behavioral effects were observed at 400 ppm, and observed in some studies but not others at 200-300 ppm.
- Biochemistry changes were observed in brains of rats at all dose levels including 200 ppm, the lowest dose evaluated. A NOAEL was not determined for biochemical changes.

References:

1. Morgan, D.L., Little, P.B., Herr, D.W., Moser, V.C., Collins, B., Herbert, R., Johnson, G.A., Maronpot, R.R., Harry, G.J., and Sills, R.C.: Neurotoxicity of carbonyl sulfide in F344 rats following inhalation exposure for up to 12 weeks. *Toxicol. Appl. Pharmacol*. 200(2):131-145, 2004.

2. Herr, D.W., Graff, J.E., Moser, V.C., Crofton, K.M., Little, P.B., Morgan, D.L., and Sills, R.C.: Inhalational exposure to carbonyl sulfide produced altered brainstem auditory and somatosensory-evoked potentials in Fischer 344N rats. *Toxicol. Sci.* 95(1):118-135, 2007.

3. Sills, R.C., Morgan, D.L., Herr, D.W., Little, P.B., George, N.M., Ton, T.V., Love, N.E., Maronpot, R.R., and Johnson, G.A.: Contribution of magnetic resonance microscopy in the 12-week neurotoxicity evaluation of carbonyl sulfide in Fischer 344 rats. *Toxicol. Pathol*. 32:501-510, 2004.

Other Studies:

1. Sills, R.C., Harry, G.J., Valentine, W.M., and Morgan, D.L.: Interdisciplinary neurotoxicity inhalation studies: Carbon disulfide and carbonyl sulfide research in F344 rats. *Toxicol. Appl. Pharmacol*. 207(Suppl 2):S245-S250, 2005.

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