**United States
Environmental Protection Agency**

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Office of Chemical Safety and
Pollution Prevention**

Draft Risk Evaluation for 1,1-Dichloroethane

Supplemental File:

Supplemental Information on Environmental Release and Occupational Exposure Assessment

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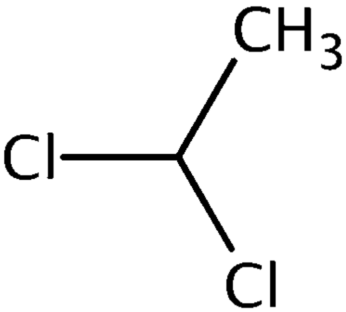

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KEY ABBREVIATIONS AND ACRONYMS

CAA	Clean Air Act
CASRN	Chemical Abstracts Service Registry Number
CBI	Confidential Business Information
CDR	Chemical Data Reporting
CEHD	Chemical Exposure Health Data
CFR	Code of Federal Regulations
CWA	Clean Water Act
DMR	Discharge Monitoring Report
ECHO	Enforcement and Compliance History Online
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ESD	Emission Scenario Document
GS	Generic Scenario
HAP	Hazardous Air Pollutant
LOD	Limit of detection
NAICS	North American Industry Classification System
ND	Non-detect
NEI	National Emissions Inventory
NESHAP	National Emission Standards for Hazardous Air Pollutants
NIOSH	National Institute for Occupational Safety and Health
NPDES	National Pollutant Discharge Elimination System
NPDWR	National Primary Drinking Water Regulation
OECD	Organisation for Economic Co-operation and Development
OEL	Occupational exposure limit
OES	Occupational exposure scenario
ONU	Occupational non-user
OPPT	Office of Pollution Prevention and Toxics
OSHA	Occupational Safety and Health Administration
PBZ	Personal breathing zone
PEL	Permissible Exposure Limit
POTW	Publicly owned treatment works
PPE	Personal protective equipment
PV	Production volume
QC	Quality control
RCRA	Resource Conservation and Recovery Act
REL	Recommended Exposure Limit
SDS	Safety data sheet
SDWA	Safe Drinking Water Act
SpERC	Specific Environmental Release Categories
TLV	Threshold Limit Value
TRI	Toxics Release Inventory
TSCA	Toxic Substances Control Act
TWA	Time-weighted average
U.S.	United States
VOC	Volatile organic compound

1 INTRODUCTION

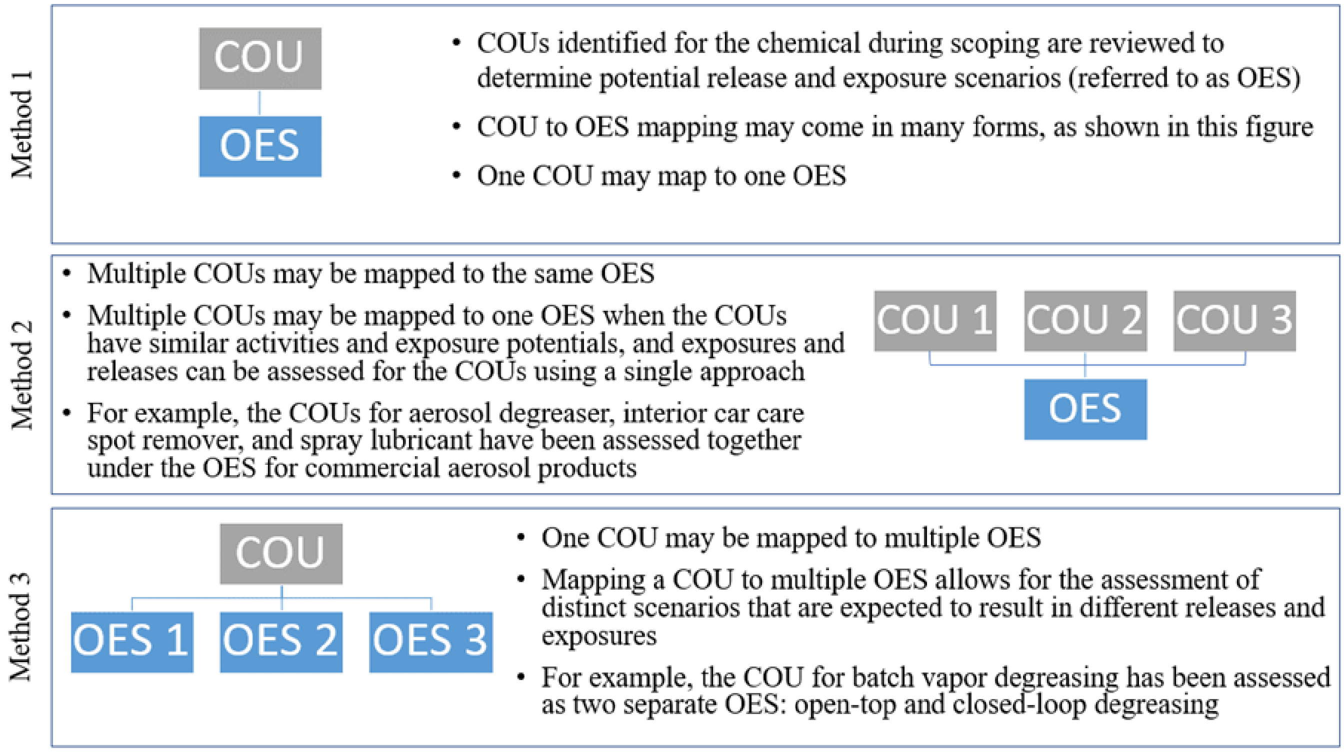
1.1 Overview

This document provides details on the occupational exposure and environmental release assessment and supplements the risk evaluation for 1,1-dichloroethane under the Frank R. Lautenberg Chemical Safety for the 21st Century Act amended the Toxic Substances Control Act (TSCA). TSCA section 6(b)(4) requires the United States Environmental Protection Agency (EPA) to establish a risk evaluation process. In performing risk evaluations for existing chemicals, EPA is directed to "determine whether a chemical substance presents an unreasonable risk of injury to health or the environment, without consideration of costs or other non-risk factors, including an unreasonable risk to a potentially exposed or susceptible subpopulation identified as relevant to the risk evaluation by the Administrator under the conditions of use." In December of 2019, EPA published a list of 20 chemical substances that are the subject of the Agency's initial chemical risk evaluations (81 FR 91927), as required by TSCA section 6(b)(2)(A). 1,1-Dichloroethane was one of these chemicals.

1,1-Dichloroethane, is a colorless oily liquid with characteristic (chloroform-like) odor that is used primarily as a reactant and a laboratory chemical. All uses are subject to federal and state reporting requirements. 1,1-Dichloroethane is a Toxics Release Inventory (TRI)-reportable substance effective January 1, 1994. It is also on EPA's initial list of hazardous air pollutant (HAPs) under the Clean Air Act (CAA), is a designated toxic pollutant under the Clean Water Act (CWA), and subject to National Primary Drinking Water Regulations (NPDWR) under the Safe Drinking Water Act (SDWA).

1.2 Scope

EPA assessed environmental releases and occupational exposures for conditions of use (COUs) as described in Table 3-1 of the *Draft Risk Evaluation for 1,1-Dichloroethane* . To estimate environmental releases and occupational exposures, EPA first developed occupational exposure scenarios (OESs) related to the conditions of use of 1,1-dichloroethane. An OES is based on a set of facts, assumptions, and inferences that describe how releases and exposures takes place within an occupational condition of use. EPA developed the OESs to group processes or applications with similar sources of release and occupational exposures that occur at industrial and commercial workplaces within the scope of the risk evaluation. For each OES, occupational exposure and environmental release results are provided and are expected to be representative of the entire population of workers and sites involved for the given OES in the United States. EPA may define only a single OES for multiple COUs, while in other cases multiple OESs may be developed for a single COU. EPA will make this determination by considering variability in release and use conditions and whether the variability can be captured as a distribution of exposure or instead requires discrete scenarios. Figure 1-1 depicts the ways that COUs may be mapped to OESs.



- COUs identified for the chemical during scoping are reviewed to determine potential release and exposure scenarios (referred to as OES)
- COU to OES mapping may come in many forms, as shown in this figure
- One COU may map to one OES

- Multiple COUs may be mapped to the same OES
- Multiple COUs may be mapped to one OES when the COUs have similar activities and exposure potentials, and exposures and releases can be assessed for the COUs using a single approach
- For example, the COUs for aerosol degreaser, interior car care spot remover, and spray lubricant have been assessed together under the OES for commercial aerosol products

- One COU may be mapped to multiple OES
- Mapping a COU to multiple OES allows for the assessment of distinct scenarios that are expected to result in different releases and exposures
- For example, the COU for batch vapor degreasing has been assessed as two separate OES: open-top and closed-loop degreasing

Figure 1-1. Condition of Use to Occupational Exposure Mapping

Table 1-1 shows mapping between the conditions of use in Table 3-1 of the *Draft Risk Evaluation for 1,1-Dichloroethane* to the OESs assessed in this report. For 1,1-dichloroethane, EPA mapped OESs to condition of uses using professional judgment based on available data and information. Several of the condition of use categories and subcategories were grouped and assessed together in a single OES due to similarities in the processes or lack of data to differentiate between them. This grouping minimized repetitive assessments. In other cases, conditions of use subcategories were further delineated into multiple OES based on expected differences in process equipment and associated releases/exposure potentials between facilities.

Table 1-1. Crosswalk of Subcategories of Use Listed in the Final Scope Document to Occupational Exposure Scenarios Assessed in the Risk Evaluation

Conditions of Use			Occupational Exposure Scenarios
Life Cycle Stage	**Category**[a]	**Subcategory**[b]	
Manufacture	Domestic Manufacturing	Domestic manufacturing	Manufacturing[c]
Processing	As a reactant	Intermediate in all other basic organic chemical manufacturing	Processing as a reactive intermediate
	As a reactant	Intermediate in all other chemical product and preparation manufacturing	
	Recycling	Recycling	
	Processing–repackaging	Processing–repackaging	Processing–repackaging[d]
Distribution in Commerce	Distribution in commerce	Distribution in commerce	Distribution in commerce[e]
Commercial use	Other use	Laboratory chemical	Commercial use as a laboratory chemical
Disposal[f]	Disposal	Disposal	General waste handling, treatment, and disposal
			Waste handling, treatment, and disposal (POTW)
			Waste handling, treatment, and disposal (remediation)

[a] These categories of conditions of use reflect CDR codes and broadly represent conditions of use for 1,1-dichloroethane in industrial and/or commercial settings.
[b] These subcategories reflect more specific uses of 1,1-dichloroethane.
[c] The manufacturing OES reflects intentional manufacturing of 1,1-dichloroethane. Manufacturing of 1,1-dichloroethane as a byproduct or impurity will be assessed in the Risk Evaluation for 1,2-Dichloroethane.
[d] New COU and associated OES where 1,1-dichloroethane is repackaged. This OES was not included in the final scope document.
[e] EPA considers the activities of loading and unloading of chemical product part of distribution in commerce. These activities were assessed as part of the OES of: Manufacturing, processing as a reactive intermediate, Processing–repackaging, and commercial use in laboratory chemicals. EPA's current approach for quantitively assessing releases and exposures for the remaining aspects of distribution in commerce consists of searching DOT and NRC data for incident reports pertaining to 1,1-dichloroethane distribution.
[f] Each of the conditions of use of 1,1-dichloroethane may generate waste streams of the chemical that are collected and transported to third-party sites for disposal, treatment, or recycling. Industrial sites that treat, dispose, or directly discharge onsite wastes that they themselves generate are assessed in each condition of use assessment. This section only assesses wastes of 1,1-dichloroethane that are generated during a condition of use and sent to a third-party site for treatment, disposal, or recycling.

EPA's assessment of releases includes quantifying annual and daily releases of 1,1-dichloroethane to air, water, and land. Releases to air include both fugitive and stack air emissions and emissions resulting from on-site waste treatment equipment, such as incinerators. For purposes of this report, releases to water include both direct discharges to surface water and indirect discharges to publicly owned treatment works (POTW) or non-POTW wastewater treatment (WWT). It should be noted that for purposes of this risk evaluation, discharges to POTW and non-POTW WWT are not evaluated the same as discharges to surface water. EPA considers removal efficiencies of POTWs and WWT plants and environmental fate and transport properties when evaluating risks from indirect discharges. Releases to land include any disposal of liquid or solids wastes containing 1,1-dichloroethane into landfills, land treatment, surface impoundments, or other land applications. The purpose of this supplemental report is only to quantify releases; therefore, downstream environmental fate and transport factors used to estimate exposures to the general population and ecological species are not discussed. The details on how these factors were considered when determining risk are described in the *Draft Risk Evaluation for 1,1-Dichloroethane* .

EPA's assessment of occupational exposures includes quantifying inhalation and dermal exposures to 1,1-dichloroethane. EPA categorizes occupational exposures into exposures to 'workers' and exposures to 'ONUs'. Generally, EPA distinguishes workers as directly handling 1,1-dichloroethane as part of their duties and have direct contact with the chemical, while ONUs are working in the general vicinity of workers but do not handle 1,1-dichloroethane and do not have direct contact with 1,1-dichloroethane being handled by the workers. EPA evaluated inhalation exposures to both workers and ONUs and dermal exposures to workers.

2 COMPONENTS OF AN OCCUPATIONAL EXPOSURE AND RELEASE ASSESSMENT

The occupational exposure and environmental release assessment of each condition of use comprises the following components:

- **Process Description:** A description of the OES, including the function of the chemical in the OES; physical forms and weight fractions of the chemical throughout the process; the total production volume associated with the OES; per site throughputs/use rates of the chemical; operating schedules; and process vessels, equipment, and tools used during the condition of use.
- **Estimates of Number of Facilities:** An estimate of the number of sites that use 1,1-dichloroethane for the given OES.
- **Environmental Release Sources:** A description of each of the potential sources of environmental releases in the process and their expected media of release for the given OES.
- **Environmental Release Assessment Results:** Estimates of chemical released into each environmental media (surface water, POTW, non-POTW WWT, fugitive air, stack air, and each type of land disposal).
- **Worker Activities:** A description of the worker activities, including an assessment for potential points of worker and occupational non-user (ONU) exposure.
- **Number of Workers and ONUs:** An estimate of the number of workers and occupational non-users potentially exposed to the chemical for the given OES.
- **Occupational Inhalation Exposure Results:** Central tendency and high-end estimates of inhalation exposure to workers and ONUs. See Section 2.4.3 for a discussion of EPA's statistical analysis approach for assessing inhalation exposure.
- **Occupational Dermal Exposure Results:** Central tendency and high-end estimates of dermal exposure to workers. See Section 2.4.4 for a discussion of EPA's approach for assessing dermal exposure.

2.1 Approach and Methodology for Process Descriptions

EPA performed a literature search to find descriptions of processes involved in each OES. Where data were available to do so, EPA included the following information in each process description:

- Total production volume associated with the OES;
- Name and location of sites the OES occurs;
- Facility operating schedules (*e.g.*, year-round, 5 days/week, batch process, continuous process, multiple shifts)
- Key process steps;
- Physical form and weight fraction of the chemical throughout the process steps;
- Information on receiving and shipping containers; and
- Ultimate destination of chemical leaving the facility.

Where 1,1-dichloroethane-specific process descriptions were unclear or not available, EPA referenced generic process descriptions from literature, including relevant Emission Scenario Documents (ESD) or Generic Scenarios (GS). Process descriptions for each OES can be found in Section 5.

2.2 Approach and Methodology for Estimating Number of Facilities

To estimate the number of facilities within each OES, EPA used a combination of bottom-up analyses of EPA reporting programs and top-down analyses of U.S. economic data and industry-specific data. Generally, EPA used the following steps to develop facility estimates:

1. Identify or "map" each facility reporting for 1,1-dichloroethane in the 2016 and 2020 CDR (U.S. EPA, 2020b, 2019), 2015 to 2020 TRI (U.S. EPA, 2022d), 2015 to 2020 Discharge Monitoring Report (DMR) (U.S. EPA, 2022b) and 2014 and 2017 National Emissions Inventory (NEI) (U.S. EPA, 2022c) to an OES. The full details of the methodology for mapping facilities from EPA reporting programs is described in Appendix G. In brief, mapping consists of using facility reported industry sectors (typically reported as either North American Industry Classification System (NAICS) or Standard Industrial Classification (SIC) codes), and chemical activity, processing, and use information to assign the most likely OES to each facility.
2. Based on the reporting thresholds and requirements of each data set, evaluate whether the data in the reporting programs is expected to cover most or all of the facilities within the OES. If so, no further action was required, and EPA assessed the total number of facilities in the OES as equal to the count of facilities mapped to the OES from each data set. If not, EPA proceeded to Step 3.
3. Supplement the available reporting data with U.S. economic and market data using the following method:
    a. Identify the NAICS codes for the industry sectors associated with the OES.
    b. Estimate total number of facilities using the U.S. Census' Statistics of US Businesses (SUSB) data on total establishments by 6-digit NAICS.
    c. Use market penetration data to estimate the percentage of establishments likely to be using 1,1-dichloroethane instead of other chemicals.
    d. Combine the data generated in Steps 3.a through 3.c to produce an estimate of the number of facilities using 1,1-dichloroethane in each 6-digit NAICS code and sum across all applicable NAICS codes for the OES to arrive at a total estimate of the number of facilities within the OES. Typically, EPA assumed this estimate encompasses the facilities identified in Step 1; therefore, EPA assessed the total number of facilities for the OES as the total generated from this analysis.
4. If market penetration data required for Step 3.c. are not available, use generic industry data from GSs, ESDs, and other literature sources on typical throughputs/use rates, operating schedules, and the 1,1-dichloroethane production volume used within the OES to estimate the number of facilities. In cases where EPA identified a range of operating data in the literature for an OES, EPA used stochastic modeling to provide a range of estimates for the number of facilities within an OES. EPA provided the details of the approaches, equations, and input parameters used in stochastic modeling in the relevant OES sections throughout this report.

2.3 Environmental Releases Approach and Methodology

Releases to the environment are a component of potential exposure and may be derived from reported data that are obtained through direct measurement via monitoring, calculations based on empirical data, and/or assumptions and models. For each OES, EPA attempted to provide annual releases, high-end and central tendency daily releases, and the number of release days per year for each media of release (air, water, and land).

EPA used the following hierarchy in selecting data and approaches for assessing environmental releases:

1. Monitoring and measured data:
    a. Releases calculated from site-specific concentration in medium and flow rate data
    b. Releases calculated from mass balances or emission factor methods using site-specific measured data

2. Modeling approaches:
    a. Surrogate release data
    b. Fundamental modeling approaches
    c. Statistical regression modeling approaches
3. Release limits:
    a. Company-specific limits
    b. Regulatory limits (*e.g.*, National Emission Standards for Hazardous Air Pollutants [NESHAPs] or effluent limitations/requirements)

EPA's preference was to rely on facility-specific release data reported in TRI (U.S. EPA, 2022d), DMR (U.S. EPA, 2022b), and NEI (U.S. EPA, 2022c), where available. Where releases are expected for an OES but TRI, DMR, and NEI data were not available or where EPA determined TRI, DMR, and/or NEI data did not capture the entirety of environmental releases for an OES, releases were estimated using data from literature, relevant ESDs or GSs, and/or existing EPA models. EPA's general approach to estimating releases from these sources is described in Sections 2.3.1 through 2.3.6. Specific details related to the use of release data or models for each OES can be found in Section 5.

The final release results may be described as a point estimate (*i.e.*, a single descriptor or statistic, such as central tendency or high-end) or a full distribution. EPA considered three general approaches for estimating the final release result:

- **Deterministic calculations:** EPA used combinations of point estimates of each input parameter to estimate a central tendency and high-end for each final release result. The Agency documented the method and rationale for selecting parametric combinations to be representative of central tendency and high-end in the relevant OES subsections in Section 5.
- **Probabilistic (stochastic) calculations:** EPA used Monte Carlo simulations using the full distribution of each input parameter to calculate a full distribution of the final release results and selecting the 50th and 95th percentiles of this resulting distribution as the central tendency and high-end, respectively.
- **Combination of deterministic and probabilistic calculations:** EPA had full distributions for some parameters but point estimates of the remaining parameters. For example, the Agency used Monte Carlo modeling to estimate annual throughputs and emission factors, but only had point estimates of release frequency and production volume. In this case, EPA documented the approach and rationale for combining point estimates with distribution results for estimating central tendency and high-end results in the relevant OES subsections in Section 5.

2.3.1 Identifying Release Sources

EPA performed a literature search to identify process operations that could potentially result in releases of 1,1-dichloroethane to air, water, or land from each OES. For each OES, EPA identified the release sources and the associated media of release. Where 1,1-dichloroethane-specific release sources were unclear or not available, EPA referenced relevant ESD's or GS's. Descriptions of release sources for each OES can be found in Section 5.

2.3.2 Estimating Release Days per Year

EPA typically assumed the number of release days per year from any release source will be equal to the number of operating days at the facility unless information is available to indicate otherwise. To estimate the number of operating days, EPA used the following hierarchy:

1. **Facility-specific data:** EPA used facility-specific operating days per year data if available. If facility-specific data was not available for one facility of interest but was available for other facilities within the same OES, EPA estimated the operating days per year using one of the following approaches:
    a. If other facilities have known or estimated average daily use rates, EPA calculated the days per year as: Days/year = Estimated Annual Use Rate for the facility (kg/year) / average daily use rate from facilities with available data (kg/day).
    b. If facilities with days per year data do not have known or estimate average daily use rates, EPA used the average number of days per year from the facilities with such data available.
2. **Industry-specific data:** EPA used industry-specific data available from GSs, ESDs, trade publications, or other relevant literature.
3. **Manufacture of large-production volume (PV) commodity chemicals:** For the manufacture of the large-PV commodity chemicals, EPA used a value of 350 days per year. This assumes the plant runs seven days per week and 50 weeks per year (with two weeks down for turnaround) and assumes that the plant is always producing the chemical.
4. **Manufacture of lower-PV specialty chemicals:** For the manufacture of lower-PV specialty chemicals, it is unlikely the chemical is being manufactured continuously throughout the year. Therefore, EPA used a value of 250 days per year. This assumes the plant manufactures the chemical five days per week and 50 weeks per year (with two weeks down for turnaround).
5. **Processing as reactant (intermediate use) in the manufacture of commodity chemicals:** Similar to #3, EPA assumed the manufacture of commodity chemicals occurs 350 days per year such that the use of a chemicals as a reactant to manufacture a commodity chemical would also occur 350 days per year.
6. **Processing as reactant (intermediate use) in the manufacture of specialty chemicals:** Similar to #4, the manufacture of specialty chemicals is not likely to occur continuously throughout the year. Therefore, EPA used a value of 250 days per year.
7. **Other chemical plant OES (*e.g.*, processing into formulation and use of industrial processing aids):** For these OES, EPA assumed that the chemical of interest is not always in use at the facility, even if the facility operates 24/7. Therefore, in general, EPA used a value of 300 days/year based on the "SpERC fact sheet—Formulation & (re)packing of substances and mixtures—Industrial (Solvent-borne)" which uses a default of 300 days/year for the chemical industry (ESIG, 2012). However, in instances where the OES uses a low volume of the chemical of interest, EPA used 250 days per year as a lower estimate.
8. **POTWs:** Although EPA expects POTWs to operate continuously over 365 days per year, the discharge frequency of the chemical of interest from a POTW will be dependent on the discharge patterns of the chemical from the upstream facilities discharging to the POTW. However, there can be multiple upstream facilities (possibly with different OES) discharging to the same POTW and information to determine when the discharges from each facility occur on the same day or separate days is typically not available. Therefore, EPA could not determine an exact number of days per year the chemical of interest is discharged from the POTW and used a value of 365 days per year. For more details on discharge frequencies for POTWs, refer to Section 2.3.3.1

9. **All other OES:** Regardless of what the facility operating schedule is, other OES are unlikely to use the chemical of interest every day. Therefore, EPA used a value of 250 days per year for these OES.

2.3.3 Estimating Releases from Data Reported to EPA

Generally, EPA used the facility-specific release data reported in TRI, DMR, and NEI as annual releases in each data set for each site and estimated the daily release by averaging the annual release over the expected release days per year. EPA's approach to estimating release days per year is described in Section 2.3.2.

Section 313 of the Emergency Planning and Community Right-to-Know Act (EPCRA) established the TRI. TRI tracks the waste management of designated toxic chemicals from facilities within certain industry sectors. Facilities are required to report to TRI if the facility has 10 or more full-time employees; is included in an applicable NAICS code; and manufactures, processes, or uses the chemical in quantities greater than a certain threshold (25,000 pounds [lb] for manufacturers and processors of PCE and 10,000 lb for users of 1,1-dichloroethane). EPA makes the reported information publicly available through TRI. Each facility subject to the rule must report either using a Form R or a Form A. Facilities reporting using a Form R must report annually the volume of chemical released to the environment (*i.e.*, surface water, air, or land) and/or managed through recycling, energy recovery, and treatment (*e.g.*, incineration) from the facility. Facilities may submit a Form A if the volume of chemical manufactured, processed, or otherwise used does not exceed 1,000,000 pounds per year (lb/year) and the total annual reportable releases do not exceed 500 lb/year. Facilities reporting using a Form A are not required to submit annual release and waste management volumes or use/sub-use information for the chemical. Due to reporting limitations, some sites that manufacture, process, or use 1,1-dichloroethane may not report to TRI and are therefore not included in EPA's assessment.

EPA included both TRI Form R and Form A submissions in the analysis of environmental releases. For Form Rs, EPA assessed releases using the reported annual release volumes from each media. For Form As, EPA attempted to estimate releases to each media using other approaches, where possible. Where no was approaches were available to estimate releases from facilities reporting using Form A's, EPA assessed releases using the 500 lb/year threshold for each release media; however, since this threshold is for total site releases, the 500 lb/year is attributed one release media—not all (to avoid over counting the releases and exceeding the total release threshold for Form A). For this draft risk evaluation, EPA used TRI data from reporting years 2015 to 2020 to provide a basis for estimating releases (U.S. EPA, 2022d). Further details on EPA's approach to using TRI data for estimating releases are described in Sections 2.3.3.1 through 2.3.3.3.

Under the Clean Water Act (CWA), EPA regulates the discharge of pollutants into receiving waters through National Pollutant Discharge Elimination System (NPDES). A NPDES permit authorizes discharging facilities to discharge pollutants to specified effluent limits. There are two types of effluent limits: (1) technology-based and (2) water quality-based. While the technology-based effluent limits are uniform across the country, the quality-based effluent limits vary and are more stringent in certain areas. NPDES permits may also contain requirements for sewage sludge management.

NPDES permits apply pollutant discharge limits to each outfall at a facility. For risk evaluation purposes, EPA was interested only on the outfalls to surface water bodies. NPDES permits also include internal outfalls, but they aren't included in this analysis. This is because these outfalls are internal monitoring points within the facility wastewater collection or treatment system, so they do not represent discharges from the facility. NPDES permits require facilities to monitor their discharges and report the results to EPA and the state regulatory agency. Facilities report these results in DMRs. EPA makes these reported data publicly available via EPA's Enforcement and Compliance History Online (ECHO) system and EPA's Water Pollutant Loading Tool (Loading Tool). The Loading Tool is a web-based tool that obtains DMR data through ECHO, presents data summaries and calculates pollutant loading (mass of pollutant discharged). For this risk evaluation, EPA queried DMRs for all 1,1-dichloroethane point source water discharges available for 2015 to 2020 (U.S. EPA, 2022b). Further details on EPA's approach to using DMR data for estimating releases are described in Sections 2.3.3.1 and Appendix H.

The NEI was established to track emissions of Criteria Air Pollutants (CAPs) and CAP precursors and assist with National Ambient Air Quality Standard (NAAQS) compliance under the Clean Air Act (CAA). Air emissions data for the NEI are collected at the state, local, and tribal (SLT) level. SLT air agencies then submit these data to EPA through the Emissions Inventory System (EIS). In addition to CAP data, many SLT air agencies voluntarily submit data for pollutants on EPA's list of HAPs. EPA uses the data collected from SLT air agencies, in conjunction with supplemental HAP data, to build the NEI. EPA makes an updated NEI publicly available every 3 years. For this risk evaluation, EPA used NEI data for reporting years 2014 and 2017 data to provide a basis for estimating releases (U.S. EPA, 2022c)

NEI emissions data is categorized into (1) point source data, (2) area or nonpoint source data, (3) onroad mobile source data, and (4) nonroad mobile source data. EPA included all four data categories in the assessment of environmental releases in this risk evaluation. Point sources are stationary sources of air emissions from facilities with operating permits under Title V of the CAA, also called "major sources". Major sources are defined as having actual or potential emissions at or above the major source thresholds. While thresholds can vary for certain chemicals in NAAQS non-attainment areas, the default threshold is 100 tons/year for non-HAPs, 10 tons per year for a single HAP, or 25 tons per year for any combination of HAPs. Point source facilities include large energy and industrial sites and are reported at the emission unit- and release point-level.

Area or nonpoint sources are stationary sources that do not qualify as major sources. The nonpoint data are aggregated and reported at the county-level and include emissions from smaller facilities as well as agricultural emissions, construction dust, and open burning. Industrial and commercial/institutional fuel combustion, gasoline distribution, oil and gas production and extraction, publicly owned treatment works, and solvent emissions may be reported in the point or nonpoint source categories depending upon source size.

Onroad mobile sources include emissions from onroad vehicles that combust liquid fuels during operation, including passenger cars, motorcycles, trucks, and buses. The nonroad mobiles sources data include emissions from other mobile sources that are not typically operated on public roadways, such as locomotives, aircraft, commercial marine vessels, recreational equipment, and landscaping equipment. Onroad and nonroad mobile data is reported in the same format as nonpoint data; however, it is not available for every chemical. For 1,1-dichloroethane, onroad and nonroad mobile data is available and was used in the air release assessment. Further details on EPA's approach to using NEI data for estimating releases are described in Section 2.3.3.2.

2.3.3.1 Estimating Wastewater Discharges from TRI and DMR

Where available, EPA used TRI and DMR data to estimate annual wastewater discharges, average daily wastewater discharges, high-end daily wastewater discharges, and 1-day maximum wastewater discharges. The estimates of high-end daily and 1-day maximums are based on data availability in DMR as described in this section.

Annual Wastewater Discharges

For TRI, annual discharges are reported directly by facilities. For DMR, annual discharges are automatically calculated by the Loading Tool based on the sum of the discharges associated with each monitoring period in DMR. Monitoring periods in DMR are set by each facility's NPDES permit and can vary between facilities. Typical monitoring periods in DMR include monthly, bimonthly, quarterly, biannual, and annual reporting. In instances where a facility reports a period's monitoring results as below the limit of detection (LOD) (also referred to as a non-detect or ND) for a pollutant, the Loading Tool applies a hybrid method to estimate the wastewater discharge for the period. The hybrid method sets the values to half of the LOD if there was at least one detected value in the facility's DMRs in a calendar year. If all values were less than the LOD in a calendar year, the annual load is set to zero.

Average Daily Wastewater Discharges

To estimate average daily discharges, EPA used the following steps:

1. Obtain total annual loads calculated from the Loading Tool and reported annual direct surface water discharges and indirect discharges to POTW and non-POTW WWT in TRI.
2. For TRI reporters using a Form A, estimate annual releases using an alternative approach (see Sections 2.3.4, 2.3.5, and 2.3.6) or at the threshold of 500 pounds per year.
3. Determine if any of the facilities receiving indirect discharges reported in TRI have reported DMRs for the corresponding TRI reporting year, if so, exclude these indirect discharges from further analysis. The associated surface water release (after any treatment at the receiving facility) will be incorporated as part of the receiving facility's DMR.
4. Divide the annual discharges over the number of estimated operating days (estimated as described in Section 2.3.2).

High-End Daily Wastewater Discharges

High-end daily wastewater discharges are an estimate of the high-end daily discharge rate that may take place for a single monitoring period during the year for the facility as needed. As a first step, EPA only analyzed high-end daily discharges for the facilities with DMRs accounting for the top 90% of non-POTW annual discharges and the top 90% of POTW discharges. EPA analyzed high-end discharges from the bottom 10% only in the case where unreasonable risk was found for facilities in the top 90% with the smallest annual discharges. For 1,1-dichloroethane, facilities accounting for the top 95% discharges were analyzed for high-end daily discharges.

EPA used the following steps to estimate high-end discharges for facilities <u>with DMR data</u>:

1. Identify the facilities that represent the top 90% of annual discharges for non-POTWs in the DMRs and the top 90% of annual discharges for POTWs. Note: If EPA found unreasonable risks for facilities in the top 90%, a second tier of facilities was evaluated. EPA continued to evaluate additional tiers as needed.
2. Use the Loading Tool to obtain the reporting periods (*e.g.*, monthly, bimonthly, quarterly, biannually, annually) and required reporting statistics (*e.g.*, average monthly concentration, max daily concentration) for each external outfall at each facility identified in Step 1. When there is one outfall reported in the Loading Tool, EPA assumed it is an external outfall. If multiple outfalls are reported in the Loading Tool, EPA determined the external outfall by reviewing the facility's permits.
3. For each external outfall at each facility, calculate the average daily load for each reporting period by multiplying the period average concentration by the period average wastewater flowrate.

4. Sum the average daily loads from each external outfall for each period.
5. Select the period with the highest average daily load across all external outfalls as an estimate of the high-end daily discharge assessed over the number of days in the period. The number of days in the reporting period does not necessarily equate to the number of operating days in the reporting period. For example, for a plant that operates 200 days/year, EPA used 200 rather than 365 days per year for average daily discharge. Therefore, discharges will not occur every day of the reporting period, but only for a fraction estimated as: 200/365 = 68%. EPA multiplied the number of days of the reporting period by this factor to maintain consistency between operating days per year and operating days per reporting period.

EPA used the following steps to estimate high-end discharges for facilities <u>without DMR data</u> (*e.g.*, facilities with TRI data but no DMR data):

1. Identify facilities that report under the NPDES program for the same chemical, same year, and same OES as the TRI facility and report DMRs monthly. Note: if no monthly reporters exist, reporters with less frequent reporting can be substituted provided the number of release days per year are adjusted in subsequent steps. In such cases, the period data need to be normalized to monthly averages by dividing the period load by the number of months in the period. EPA used 30.4167 days per month to normalize the period discharges (*i.e.*, 365 days/12 months).
2. For each facility identified in #1, calculate the percentage of the total annual discharge that occurred in the highest one-month period.
3. Calculate a generic factor for the OES as the average of the percentages calculated in #2.
4. Estimate the high-end daily discharge for each facility without DMRs by multiplying the annual discharge by the generic factor from #3. For example, a facility reports 500 pounds (lb) released per year and has a generic factor of 15% for the OES from #3. The estimated high-end chronic daily discharge for the facility would be: 500 lb × 15% = 75 lb/month.
5. Use the value calculated in #4 as an estimate of the high-end daily discharge assessed over 30.4167 days per year (consistent with the normalization from step 1). For example, the high-end daily discharge assessed over 30.4167 days per year for the facility with the estimated high-end chronic daily discharge of 75 lb/month (from #4 above) is: 75 lb/month / 30.4167 days = 2.47 lb/day for 30.4167 days.

1-Day Maximum Wastewater Discharges

One-day maximum discharge rates estimate a discharge rate that may represent a 1-day maximum rate for the facility as needed. Facilities required to report DMRs under the NPDES may sometimes be required to report a daily maximum discharge concentration for the period. EPA used these values to estimate 1-day maximum discharges by multiplying the maximum daily concentration by the corresponding month’s maximum daily wastewater flow rate. Where no such data existed for a facility (*i.e.*, facilities without DMRs or facilities with DMRs whose permits do not require reporting of 1-day maximums), EPA did not have data to estimate a 1-day maximum discharge rate.

2.3.3.2 Estimating Air Emissions from TRI and NEI

Where available, EPA used TRI and NEI data to estimate annual and average daily fugitive and stack air emissions. For air emissions, EPA attempted to estimate both release patterns (*i.e.*, days per year of release) and release durations (*i.e.*, hours per day the release occurs).

Annual Emissions

Facility-level annual emissions are available for TRI reporters and major sources in NEI. EPA used the reported annual emissions directly as reported in TRI and NEI for major sources. NEI also includes annual emissions for area sources that are aggregated at the county-level. Area source data in NEI is not divided between sites or between stack and fugitive sources. Therefore, EPA only presented annual and average daily emissions for each county-OES combination.

Average Daily Emissions

To estimate average daily emissions for TRI reporters and major sources in NEI, EPA used the following steps:

1. Obtain total annual fugitive and stack emissions for each TRI reporter and major sources in NEI.
2. For TRI reporters using a Form A, estimate annual releases using an alternative approach (see Sections 2.3.4, 2.3.5, and 2.3.6) or at the threshold of 500 pounds per year.
3. Divide the annual stack and fugitive emissions over the number of estimated operating days (note: NEI data includes operating schedules for many facilities that can be used to estimate facility-specific days per year).
4. Estimate a release duration using facility-specific data available in NEI, models, and/or literature sources. If no data is available, list as "unknown".

To estimate average daily emissions from area sources, EPA followed a very similar approach as described for TRI reporters and major sources in NEI; however, area source data in NEI is not divided between sites or between stack and fugitive sources. Area data also does not include release duration data as the emissions are aggregated at the county-level rather than facility level. Therefore, EPA only presented average daily emissions for each county-OES combination by dividing the annual emissions for the county by the estimated number of operating days.

2.3.3.3 Estimating Land Disposals from TRI

Where available, EPA used TRI data to estimate annual and average daily land disposal volumes. TRI includes reporting of disposal volumes for a variety of land disposal methods, including underground injection, RCRA Subtitle C landfills, land treatment, RCRA Subtitle C surface impoundments, other surface impoundments, and other land disposal. EPA provided estimates for both a total aggregated land disposal volume and disposal volumes for each disposal method reported in TRI.

Annual Land Disposal

Facility-level annual disposal volumes are available directly for TRI reporters. EPA used the reported annual land disposal volumes directly as reported in TRI for each land disposal method. EPA combined totals from all land disposal methods from each facility to estimate a total annual aggregate disposal volume to land.

Average Daily Land Disposal

To estimate average daily disposal volumes, EPA used the following steps:

1. Obtain total annual disposal volumes for each land disposal method for each TRI reporter.
2. For TRI reporters using a Form A, estimate annual releases using an alternative approach (see Sections 2.3.4, 2.3.5, and 2.3.6) or at the threshold of 500 pounds per year.
3. Divide the annual disposal volumes for each land disposal method over the number of estimated operating days.
4. Combine totals from all land disposal methods from each facility to estimate a total aggregate disposal volume to land.

2.3.4 Estimating Releases from Models

Where releases were expected for an OES but TRI, DMR, and/or NEI data were not available or where EPA determined they did not capture the entirety of environmental releases for an OES, EPA utilized models to estimate environmental releases. Outputs from models may be the result of deterministic calculations, stochastic calculations, or a combination of both deterministic and stochastic calculations. For each OES with modeled releases, EPA followed these steps to estimate releases:

1. Identify release sources from process and associated release media.
2. Identify or develop model equations for estimating releases from each release source.
3. Identify model input parameter values from relevant literature sources.
4. If a range of input values is available for an input parameter, determine the associated distribution of input values.
5. Calculate annual and daily release volumes for each release source using input values and model equations.
6. Aggregate release volumes by release media and report total releases to each media from each facility.

For release models that utilized stochastic calculations, EPA performed a Monte Carlo simulation using the Palisade @Risk software[1] with 100,000 iterations and the Latin Hypercube sampling method. Detailed descriptions of the model approaches used for each OES, model equations, input parameter values and associated distributions are provided in Section 5.

2.3.5 Estimating Releases Using Literature Data

Where available, EPA used data identified from literature sources to estimate releases. Literature data may include directly measured release data or information useful for release modeling. Therefore, EPA's approach to literature data differs depending on the type of literature data available. For example, if facility-specific release data is available, EPA may use that data directly to estimate releases for that facility. If facility-specific data is available for only a subset of the facilities within an OES, EPA may also build a distribution of the available data and estimate releases from facilities within the OES using central tendency and high-end values from the distribution. If facility-specific data is not available, but industry- or chemical-specific emission factors are available, EPA may use those directly to calculate releases for an OES or incorporate the emission factors into release models to develop a distribution of potential releases for the OES. Detailed descriptions of how various literature data was incorporated into release estimates for each OES are described in Section 5.

2.3.6 Estimating Releases from Regulatory Limits

If EPA did not have data or models to estimate environmental releases from an OES, EPA relied on relevant regulatory limits, where available. Relevant regulatory limits may include Effluent Limitation Guidelines (ELGs) and NESHAPs. ELGs are national regulatory standards set forth by EPA for wastewater discharges to surface water and municipal sewage treatment plants. NESHAPs stationary source standards for hazardous air pollutants. Both ELGs and NESHAPs are typically issued for specific industries and may have chemical-specific or generic limits (*e.g.*, limits on total organic carbon [TOC] or volatile organic compounds [VOCs]). When utilizing regulatory limits, EPA gave preference to chemical-specific limits and assumed facilities subject to the limit operate at the limit throughout the year. EPA then assessed annual and daily releases at the regulatory limit.

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[1] *@Risk*; Palisade; https://www.palisade.com/risk/.

2.4 Occupational Exposure Approach and Methodology

For workplace exposures, EPA considered exposures to both workers who directly handle 1,1-dichloroethane and ONUs who do not directly handle 1,1-dichloroethane but may be exposed to vapors, particulates, or mists that enter their breathing zone while working in locations in close proximity to where 1,1-dichloroethane is being used. EPA evaluated inhalation exposures to both workers and ONUs and dermal exposures to workers.

EPA provided occupational inhalation and dermal exposure results representative of *central tendency* conditions *and high-end* conditions. A central tendency is assumed to be representative of occupational exposures in the center of the distribution for a given condition of use. For risk evaluation, EPA used the 50th percentile (median), mean (arithmetic or geometric), mode, or midpoint values of a distribution as representative of the central tendency scenario. EPA's preference is to provide the 50th percentile of the distribution. However, if the full distribution is not known, EPA may assume that the mean, mode, or midpoint of the distribution represents the central tendency depending on the statistics available for the distribution.

A high-end is assumed to be representative of occupational exposures that occur at probabilities above the 90th percentile but below the exposure of the individual with the highest exposure (U.S. EPA, 1992a). For risk evaluation, EPA provided high-end results at the 95th percentile. If the 95th percentile is not available, EPA used a different percentile greater than or equal to the 90th percentile but less than or equal to the 99.9th percentile, depending on the statistics available for the distribution. If the full distribution is not known and the preferred statistics are not available, EPA estimated a maximum or bounding estimate in lieu of the high-end.

For each OES, EPA attempted to provide high-end and central tendency full-shift time-weighted averages (TWAs) (typically as 8-hour TWAs) inhalation exposure concentrations and high-end and central tendency acute potential dermal dose rates (APDR). EPA follows the following hierarchy in selecting data and approaches for assessing occupational exposures:

1. Monitoring data:
    a. Personal and directly applicable
    b. Area and directly applicable
    c. Personal and potentially applicable or similar
    d. Area and potentially applicable or similar
2. Modeling approaches:
    a. Surrogate monitoring data
    b. Fundamental modeling approaches
    c. Statistical regression modeling approaches
3. Occupational exposure limits:
    a. Company-specific occupational exposure limits (OELs) (for site-specific exposure assessments, *e.g.*, there is only one manufacturer who provides to EPA their internal OEL but does not provide monitoring data)
    b. Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PEL)
    c. Voluntary limits (American Conference of Governmental Industrial Hygienists [ACGIH] Threshold Limit Values [TLV], National Institute for Occupational Safety and Health [NIOSH] Recommended Exposure Limits [REL], Occupational Alliance for Risk Science (OARS) workplace environmental exposure level (WEEL) [formerly by AIHA])

EPA used the estimated high-end and central tendency full-shift TWA inhalation exposure concentrations and APDR to calculate exposure metrics required for risk evaluation. Exposure metrics for inhalation exposures include acute concentrations (AC), subchronic average daily concentrations (SCDC), average daily concentrations (ADC), and lifetime average daily concentrations (LADC). Exposure metrics for dermal exposures include acute potential dose rate (APDR), acute retained dose (ARD), chronic retained dose (CRD) non-cancer, and chronic retained dose (CRD) cancer. The approach to estimating each exposure metric is described in Section 2.4.5.

2.4.1 Identifying Worker Activities

EPA performed a literature search to identify worker activities that could potentially result in occupational exposures. Where worker activities were unclear or not available, EPA referenced relevant ESD's or GS's. Worker activities for each condition of use can be found in Sections 5.1.4.1 through 5.6.4.1.

2.4.2 Estimating Number of Workers and Occupational Non-users

Where available, EPA used CDR data to provide a basis to estimate the number of workers and ONUs. EPA supplemented the available CDR data with U.S. economic data using the following method:

1. Identify the North American Industry Classification System (NAICS) codes for the industry sectors associated with these uses.
2. Estimate total employment by industry/occupation combination using the Bureau of Labor Statistics' Occupational Employment Statistics (OES) data (BLS Data).
3. Refine the OES estimates where they are not sufficiently granular by using the U.S. Census' Statistics of US Businesses (SUSB) (SUSB Data) data on total employment by 6-digit NAICS.
4. Use market penetration data to estimate the percentage of employees likely to be using 1,1-dichloroethane instead of other chemicals.
5. Where market penetration data are not available, use the estimated workers/ONUs per site in the 6-digit NAICS code and multiply by the number of sites estimated from CDR, TRI, DMR and/or NEI. In DMR data, sites report Standard Industrial Classification (SIC) codes rather than NAICS codes; therefore, EPA mapped each reported SIC code to a NAICS code for use in this analysis.
6. Combine the data generated in Steps 1 through 5 to produce an estimate of the number of employees using 1,1-dichloroethane in each industry/occupation combination and sum these to arrive at a total estimate of the number of employees with exposure within the condition of use.

2.4.3 Estimating Inhalation Exposures

2.4.3.1 Inhalation Monitoring Data

EPA reviewed workplace inhalation monitoring data collected by government agencies such as OSHA and NIOSH, monitoring data found in published literature (*i.e.*, personal exposure monitoring data and area monitoring data), and monitoring data submitted via public comments. Studies were evaluated using the evaluation strategies laid out in the *Application of Systematic Review in TSCA Risk Evaluations* (U.S. EPA, 2018a).

Exposures are calculated from the monitoring data sets provided in the sources depending on the size of the data set. For data sets with six or more data points, central tendency and high-end exposures were estimated using the 50th percentile and 95th percentile. For data sets with three to five data points, central tendency exposure was calculated using the 50th percentile and the maximum was presented as the high-end exposure estimate. For data sets with two data points, the midpoint was presented as a midpoint value and the higher of the two values was presented as a higher value. Finally, data sets with only one data point presented the single exposure value. For data sets including exposure data that were reported as below the limit of detection (LOD), EPA estimated the exposure concentrations for these data, following EPA's *Guidelines for Statistical Analysis of Occupational Exposure Data* (U.S. EPA, 1994) which recommends using the $\frac{LOD}{\sqrt{2}}$ if the geometric standard deviation of the data is less than 3.0 and $\frac{LOD}{2}$ if the geometric standard deviation is 3.0 or greater.

A key source of monitoring data is samples collected by OSHA during facility inspections. OSHA inspection data are compiled in an agency information system (OIS) for internal use. Air sampling data records from inspections are entered into the OSHA Chemical Exposure Health Database (CEHD) that can be accessed on the agency website (https://www.osha.gov/opengov/healthsamples.html). The database includes personal breathing zone (PBZ) monitoring data, area monitoring data, bulk samples, wipe samples, and serum samples. The collected samples are used for comparing to OSHA's Permissible Exposure Limits (PEL). OSHA's CEHD website indicates that they do not: perform routine inspections at every business that uses toxic/hazardous chemicals, completely characterize all exposures for all employees every day, or always obtain a sample for an entire shift. Rather, OSHA performs targeted inspections of certain industries based on National and regional emphasis programs, often attempts to evaluate worst case chemical exposure scenarios, and develop "snapshots" of chemical exposures and assess their significance (*e.g.*, comparing measured concentrations to PELs).

EPA took the following approach to analyzing OSHA CEHD:

1. Download all data for 1,1-dichloroethane from all available years in the CEHD (generally 1984-present).
2. Organize data by site (group data collected at the same site together).
3. Remove data in which all measurements taken at the site were recorded as "0" or below the limit of detection as EPA could not be certain the chemical of interest was at the site at the time of the inspection (Note: sites where bulk samples were collected that indicate 1,1-dichloroethane was present were not removed from the data set).
4. Remove serum samples, bulk samples, wipe samples, and blanks. These data are not used in EPA's assessment.
5. Assign each data point to an OES. Review NAICS codes, SIC codes, and as needed, company information available online, to map each sample to an OES. In some instances, EPA was not able to determine the OES from the information in the CEHD; in such cases, EPA did not use the data in the assessment. EPA also removed data determined to be for non-TSCA uses or otherwise out of scope.
6. Combine samples from the same worker. In some instances, OSHA inspectors will collect multiple samples from the same worker on the same day (these are indicated by sample ID numbers). In these cases, EPA combined results from each sample to construct an exposure concentration based on the totality of exposures from each sample.
7. Occasionally, one or all the samples associated with a single sample number measured below the limit of detection. Because the samples were often on different time scales (*e.g.*, one hour vs four hours), EPA did not include these data in the statistical analysis to estimate values below the LOD as described previously in this section. Sample results from different time scales may vary greatly as short activities my cause a large, short-term exposure that when averaged over a full-shift are comparable to other full-shift data. Therefore, including data of different time scales in the analysis may give the appearance of highly skewed data when in fact the full-shift data is not skewed. Therefore, EPA performed the statistical analysis (as needed) using all the non-OSHA CEHD data for each OES and applied the approach determined by the analysis to the non-detects

in the OSHA CEHD data. Where all the exposure data for an OES came from CEHD, EPA used only the 8-hr TWAs that did not include samples that measured below the LOD to perform the statistical analysis.

8. Calculate 8-hr TWA results from combined samples. Where the total sample time was less than eight hours, EPA calculated an 8-hr TWA by assuming exposures were zero for the remainder of the shift.

It should be noted that the OSHA CEHD does not provide job titles or worker activities associated with the samples; therefore, EPA assumed all data were collected on workers and not ONUs.

Specific details related to the use of monitoring data for each condition of use can be found in Section 5.

2.4.3.2 Inhalation Exposure Modeling

Where inhalation exposures are expected for an OES but monitoring data were not available or where EPA determined monitoring data did not sufficiently capture the exposures for an OES, EPA attempted to utilize models to estimate inhalation exposures. Outputs from models may be the result of deterministic calculations, stochastic calculations, or a combination of both deterministic and stochastic calculations. For each OES with modeled inhalation exposures, EPA followed these steps to estimate exposures:

1. Identify worker activities/sources of exposures from process.
2. Identify or develop model equations for estimating exposures from each source.
3. Identify model input parameter values from relevant literature sources, including activity durations associated with sources of exposures.
4. If a range of input values is available for an input parameter, determine the associated distribution of input values.
5. Calculate exposure concentrations associated with each activity.
6. Calculate full-shift TWAs based on the exposure concentration and activity duration associated with each exposure source.
7. Calculate exposure metrics (AC, SCDC, ADC, LADC) from full-shift TWAs.

For exposure models that utilize stochastic calculations, EPA performed a Monte Carlo simulation using the Palisade @Risk software with 100,000 iterations and the Latin Hypercube sampling method. Detailed descriptions of the model approaches used for each OES, model equations, input parameter values and associated distributions are provided in Section 5.

2.4.3.3 Occupational Exposure Limits

If monitoring data or models were not available to estimate inhalation exposures from an OES, EPA relied on relevant occupational exposure limits, where available. Relevant limits may include company-specific limits, OSHA PELs, or voluntary limits, such as NIOSH RELs. When utilizing exposure limits, EPA assumed facilities operate such that the workers are exposed at the limit every day of the work year. If EPA used occupational exposure limits, an explanation of the use of this limit is included in Section 5 for the relevant COU.

2.4.4 Estimating Dermal Exposures

Dermal exposure data was not reasonably available for the conditions of use in the assessment. Because 1,1-dichloroethane is a volatile liquid that readily evaporates from the skin, EPA estimated dermal exposures using the Dermal Exposure to Volatile Liquids Model. This model determines an APDR based on an assumed amount of liquid on skin during one contact event per day and the theoretical steady-state fractional absorption for 1,1-dichloroethane. The exposure concentration is determined based on EPA's review of currently available products and formulations containing 1,1-dichloroethane. The dose estimates assume one dermal exposure event (applied dose) per workday and approximately 0.3 percent of the applied dose is absorbed through the skin, for 1,1-dichloroethane in neat form. Specific details of the dermal exposure assessment for each OES can be found in Section 5 and equations for estimating dermal exposures can be found in Appendix E.

2.4.5 Estimating Acute, Subchronic and Chronic (Non-cancer and Cancer) Exposures

For each condition of use, the estimated exposures were used to calculate acute, subchronic, and chronic (non-cancer and cancer) inhalation exposures and dermal doses. These calculations require additional parameter inputs, such as years of exposure, exposure duration and frequency, and lifetime years.

For the final exposure result metrics, each of the input parameters (*e.g.*, air concentrations, dermal doses, working years, exposure frequency, lifetime years) may be a point estimate (*i.e.*, a single descriptor or statistic, such as central tendency or high-end) or a full distribution. EPA considered three general approaches for estimating the final exposure result metrics:

- Deterministic calculations: EPA used combinations of point estimates of each parameter to estimate a central tendency and high-end for each final exposure metric result. EPA documented the method and rationale for selecting parametric combinations to be representative of central tendency and high-end.
- Probabilistic (stochastic) calculations: EPA used Monte Carlo simulations using the full distribution of each parameter to calculate a full distribution of the final exposure metric results and selecting the 50th and 95th percentiles of this resulting distribution as the central tendency and high-end, respectively.
- Combination of deterministic and probabilistic calculations: EPA had full distributions for some parameters but point estimates of the remaining parameters. For example, EPA used Monte Carlo modeling to estimate exposure concentrations, but only had point estimates of exposure duration and frequency, and lifetime years. In this case, EPA documented the approach and rationale for combining point estimates with distribution results for estimating central tendency and high-end results.

Equations and sample calculations for these exposures can be found in Appendix B and Appendix C, respectively.

2.5 Evidence Integration for Environmental Releases and Occupational Exposures

Evidence integration for the environmental release and occupational exposure assessment includes analysis, synthesis and integration of information and data to produce estimates of environmental releases and occupational inhalation and dermal exposures. During evidence integration, EPA considered the likely location, duration, intensity, frequency, and quantity of releases and exposures while also considering factors that increase or decrease the strength of evidence when analyzing and integrating the data. Key factors EPA considered when integrating evidence includes the following:

1. **Data Quality**: EPA only integrated data or information rated as *high*, *medium, or low* obtained during the data evaluation phase. Data and information rated as *uninformative* are not used in exposure evidence integration. In general, higher rankings are given preference over lower ratings; however, lower ranked data may be used over higher ranked data when specific aspects of the data are carefully examined and compared. For example, a lower ranked data set that precisely matches the OES of interest may be used over a higher ranked study that does not as closely match the OES of interest.

2. **Data Hierarchy**: EPA used both measured and modeled data to obtain accurate and representative estimates (*e.g.*, central-tendency, high-end) of the environmental releases and occupational exposures resulting directly from a specific source, medium, or product. If available, measured release and exposure data are given preference over modeled data, with the highest preference given to data that are both chemical-specific and directly representative of the OES/exposure source.

EPA considered both data quality and data hierarchy when determining evidence integration strategies. For example, EPA may have given preference to high quality modeled data directly applicable to the OES being assessed over low quality measured data that is not specific to the OES. The final integration of the environmental release and occupational exposure evidence combined decisions regarding the strength of the available information, including information on plausibility and coherence across each evidence stream.

2.6 Weight of Scientific Evidence Ratings for Environmental Release and Occupational Exposure Estimates

For each OES, EPA considered the assessment approach, the quality of the data and models, and the strengths, limitations, assumptions, and key sources of uncertainties in the assessment results to determine a weight of scientific evidence rating. EPA considered factors that increase or decrease the strength of the evidence supporting the release estimate—including quality of the data/information, applicability of the release or exposure data to the OES (including considerations of temporal relevance, locational relevance) and the representativeness of the estimate for the whole industry. The best professional judgment is summarized using the descriptors of robust, moderate, slight, or indeterminant, according to EPA's Application of Systematic Review in TSCA Risk Evaluations (U.S. EPA, 2021). For example, a conclusion of moderate is appropriate where there is measured release data from a limited number of sources such that there is a limited number of data points that may not cover most or all the sites within the OES. A conclusion of slight is appropriate where there is limited information that does not sufficiently cover all sites within the OES, and the assumptions and uncertainties are not fully known or documented. See EPA's Application of Systematic Review in TSCA Risk Evaluations (U.S. EPA, 2021) for additional information on weight of scientific evidence conclusions.

Weight of scientific evidence ratings for the environmental release and occupational exposure estimates for each OES, including details on the basis EPA used to determine the rating, are provided in Section 5 for each OES. Weight of scientific evidence ratings for all OES are also summarized in tables in Section 5.8.

3 SUMMARY OF OCCUPATIONAL EXPOSURE ESTIMATES

Table 3-1 summarizes the occupational inhalation exposure and dermal loading results for each OES. EPA's general approach for estimating occupational exposures is explained in Section 2.4 and the specific basis for each estimate is discussed in the relevant subsection of Section 5.

Table 3-1. Summary of EPA's Occupational Inhalation and Dermal Exposure Estimates

Occupational Exposure Scenario (OES)	Worker Description	Exposure Days (day/yr)	Worker Inhalation Estimates (ppm)		ONU Inhalation Estimates (ppm)		Worker Dermal Exposure Estimates (mg/day)	
			High-End	Central Tendency	High-End	Central Tendency	High-End	Central Tendency
Manufacturing	Operator/process technician	250	1.1	4.7E−03	2.0E−02	3.2E−03	6.7	2.3
	Maintenance technician	250	0.41	7.9E−02				
	Laboratory technician	250	2.4E−02	1.1E−03				
Processing as a Reactive Intermediate	Operator/process technician	250	1.1	4.7E−03	2.0E−02	3.2E−03	6.7	2.3
	Maintenance technician	250	0.41	7.9E−02				
	Laboratory technician	250	2.4E−02	1.1E−03				
Processing–Repackaging	–	250	13	3.5	3.5		6.7	2.3
Recycling	–	250	1.1	7.9E−02	2.0E−02	3.2E−03	6.7	2.3
Commercial Use as a Laboratory Chemical	Laboratory technician	250	2.4E−02	1.1E−03	1.1E−03		6.7	2.3
Distribution in Commerce	Not Estimated							
General Waste Handling, Treatment and Disposal	–	250	10	0.30	0.30		6.7	2.3
Waste Handling, Treatment and Disposal (POTW)	–	250	0.68	0.25	0.25		6.7	2.3

Where EPA was not able to estimate ONU inhalation exposure from monitoring data or models, this was assumed equivalent to the central tendency experienced by workers for the corresponding OES; dermal exposure for ONUs was not evaluated because they are not expected to be in direct contact with 1,1-dichloroethane.

4 SUMMARY OF ENVIRONMENTAL RELEASE ESTIMATES

In Table 4-1, EPA provides a summary for each of the occupational exposure scenarios (OESs) by indicating the media of release and number of facilities. EPA provides high-end and central tendency daily and yearly release estimates.

Table 4-1. Summary of EPA's Daily Release Estimates for Each OES and EPA's Overall Confidence in These Estimates

Occupational Exposure Scenario (OES)	Estimated Annual Release (kg/site-yr)		Type of Discharge[b], Air Emission[c], or Transfer for Disposal[d]	Estimated Daily Release (kg/site-day)[e]		Number of Facilities	Source(s)
	Central Tendency	High-End [a]		Central Tendency	High-End		
Manufacturing	1.6	1,299	Surface water	4.7E–03	3.7	3	TRI/DMR
	8.4	2,184	Fugitive air	2.4E–02	6.2	8	TRI
	34	74	Fugitive air	9.5E–02	0.20	4	NEI
	45	499	Stack air	0.13	1.4	9	TRI
	33		Stack air	9.1E–02		1	NEI
	1.4	2.1	Land	3.9E–03	6.0E–03	1	TRI
Processing as a reactive intermediate	3.8E−03	7.5E−02	Surface water	1.1E–05	2.1E–04	60	TRI/DMR
	2.3	155	Fugitive air	0.01	0.44	5	TRI
	4.1	327	Fugitive air	1.2E–02	0.93	16	NEI
	14	610	Stack air	0.04	1.7	4	TRI
	3.8	526	Stack air	1.1E–02	1.5	23	NEI
	0.45		Land	1.3E–02		1	TRI
Processing–repackaging	1.7E–02	0.40	Surface Water	5.0E−05	1.1E−03	3	DMR
	11	19	Fugitive or stack air	0.24	0.46	2 generic sites	Environmental Release Modeling
	275	320	Hazardous landfill or incineration	6.0	9.4		
Commercial use as a laboratory chemical	1.1E–03	9.4E–03	Surface water	4.3E–06	3.7E–05	2	DMR
	3.4	6.2	Fugitive air	9.5E–03	1.7E–02	2	NEI
	2.0E–03	2.0E–03	Stack air	7.9E–06	7.9E–06	2	NEI
	17	32	Fugitive or stack air	7.2E–02	0.14	43 to 138 generic sites	Environmental Release Modeling
	504	882	Hazardous landfill or incineration	2.2	3.7		

Occupational Exposure Scenario (OES)	Estimated Annual Release (kg/site-yr)		Type of Discharge[b], Air Emission[c], or Transfer for Disposal[d]	Estimated Daily Release (kg/site-day)[e]		Number of Facilities	Source(s)
	Central Tendency	High-End [a]		Central Tendency	High-End		
Waste Handling, Treatment and Disposal (non-POTW)	9.3E–04	6.0E–03	Surface water	3.7E–06	2.4E–05	22	TRI/DMR
	0.63	7.3	Fugitive air	2.5E–03	2.9E–02	7	TRI
	34	202	Fugitive air	0.14	0.81	575	NEI
	1.8E–02	0.82	Stack air	7.3E–05	3.3E–03	8	TRI
	2.5	134	Stack air	1.0E–02	0.54	153	NEI
Waste Handling, Treatment and Disposal (POTW)	5.1E−03	8.9E−02	Surface water	1.4E–05	2.4E–04	126	DMR
Waste Handling, Treatment and Disposal (Remediation)	2.9E–04	8.5E−03	Surface water	8.0E−07	2.3E−05	42	DMR
Distribution in Commerce	N/A[f]						

[a] "High-end" are defined as 95th percentile releases

[b] Direct discharge to surface water; indirect discharge to non-POTW; indirect discharge to POTW

[c] Emissions via fugitive air; stack air; or treatment via incineration

[d] Transfer to surface impoundment, land application, or landfills

[e] Where available, EPA used peer-reviewed literature (*e.g.*, Generic Scenarios (GSs) or Emission Scenario Documents (ESDs) to provide a basis to estimate the number of release days of 1,1-dichloroethane within a condition of use.

[f] EPA reviewed NRC data and DOT data for the 2015 to 2020 calendar years for incident reports pertaining to distribution of 1,1-dichloroethane (NRC, 2009){DOT Hazmat Incident Report Data}. EPA did not identify reported releases for 1,1-dichloroethane during distribution of the chemical.

5 ENVIRONMENTAL RELEASE AND OCCUPATIONAL EXPOSURES ASSESSMENTS BY OES

The following sections contain process descriptions and the specific details (worker activities, analysis for determining number of workers, exposure assessment approach and results, release sources, media of release, and release assessment approach and results) for the assessment for each condition of use.

EPA assessed the conditions of use as stated in the *Final Scope of the Risk Evaluation for 1,1-Dichloroethane; CASRN 75-3-9* published by EPA in August 2020 (U.S. EPA, 2020c), with the addition of the Processing—Repackaging OES.

5.1 Manufacturing

5.1.1 Process Description

CDR data indicated that the manufacture of 1,1-dichloroethane is an in-scope, occupational exposure scenario that is performed in the United States (U.S. EPA, 2020a, 2016). Various methods for manufacture of 1,1-dichloroethane are discussed in the literature. 1,1-Dichloroethane may be produced by chlorination of ethane or chloroethane, addition of hydrogen chloride to acetylene, or oxychlorination with hydrogen chloride (NCBI, 2020; Dreher et al., 2014). Alternatively, 1,1-dichloroethane can be produced commercially through the reaction of hydrogen chloride and vinyl chloride at 20 to 55 °C in the presence of an aluminum, ferric, or zinc chloride catalyst. Other production methods include the direct chlorination of ethane, the reaction of ethylene and chlorine in the presence of calcium chloride, the reaction of phosphorus chloride and acetaldehyde, thermal chlorination, and photochlorination (NCBI, 2020; ATSDR, 2015).

1,1-Dichloroethane is also produced as a byproduct in the manufacture of 1,2-dichloroethane, which will be evaluated in the risk evaluation for 1,2-dichloroethane (U.S. EPA, 2020d). 1,1-Dichloroethane is produced as reagent grade liquid, 99.7% pure with the following impurities: ethyl chloride 0.02%, butylene oxide 0.08%, trichloroethylene 0.08%, ethylene dichloride 0.01%, unknown 0.14% (U.S. EPA, 2001). A portion of the volume of 1,1-dichloroethane produced is assumed to be repackaged and then distributed for laboratory use, while the majority of the product is sent for processing as a reactant. Figure 5-1 below highlights the typical process during the manufacture of 1,1-dichloroethane.

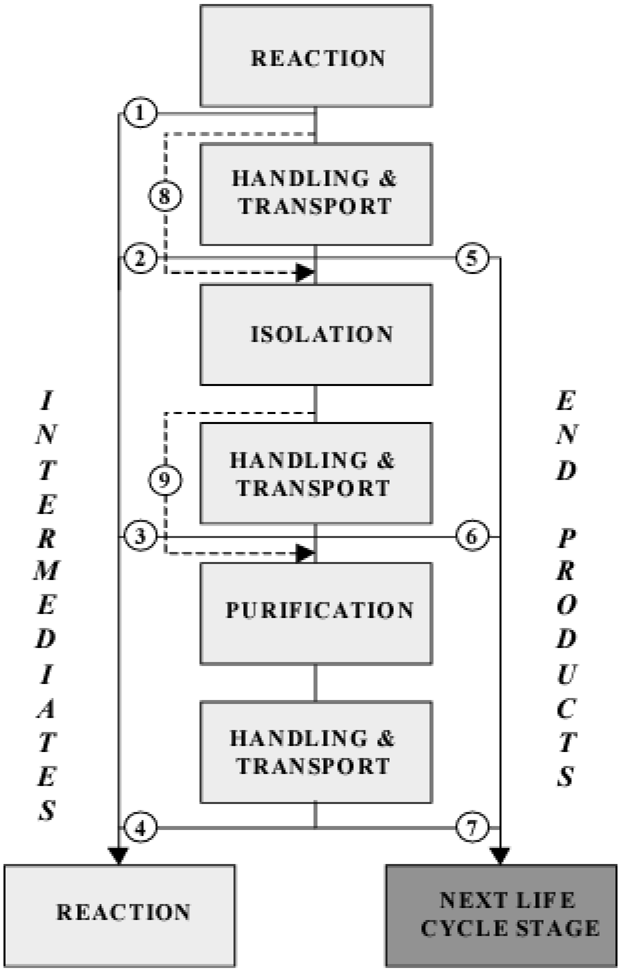

Figure 5-1. Typical Release and Exposure Points During the Manufacture of 1,1-Dichloroethane (OECD, 2011)

5.1.2 Facility Estimates

In the 2020 CDR, two companies, Geon Oxy Vinyl in Laporte, TX and Eagle US 2 LLC in Westlake, LA reported manufacturing liquid 1,1-dichloroethane (U.S. EPA, 2020a). According to the Study Plan for Inhalation and Dermal Monitoring submitted by the Vinyl Institute Consortium, eight additional facilities reported manufacture of 1,1-dichloroethane, although some of these facilities only manufacture 1,1-dichloroethane as a byproduct or isolated intermediate {EPA-HQ-OPPT-2018-0426-0032}. EPA identified all 10 sites in TRI, DMR, and NEI release data as well. In the 2020 CDR, the reported aggregated production volume was 100,000,000 to <1,000,000,000 pounds; although the exact PV is unknown due to CBI claims (U.S. EPA, 2020a). EPA did not identify data on facility operating schedules; therefore, EPA assumes 350 days/yr of operation as discussed in Section 2.3.2.

5.1.3 Release Assessment

5.1.3.1 Environmental Release Points

Potential releases to air, wastewater, and land include equipment cleaning, transport container cleaning and sampling waste. Additionally, releases may occur during leakage of pipes, flanges, and accessories used for transport. Fugitive emissions may occur at loading racks and container filling from equipment leaks and displaced vapor as containers are filled.

5.1.3.2 Environmental Release Assessment Results

EPA used 2015 to 2020 DMR, 2015 to 2020 TRI, and 2017 NEI to estimate environmental releases during the manufacture of 1,1-dichloroethane, as presented in Table 5-1. According to reported data, 1,1-dichloroethane is released through the following environmental media: surface water, fugitive air, stack air, and land disposal.

Table 5-1. Summary of Environmental Releases During the Manufacture of 1,1-Dichloroethane

Environmental Media	Estimated Yearly Release Range across Sites (kg/yr)		Number of Release Days	Daily Release (kg/site-day)		Number of Facilities	Source(s)
	Central Tendency	High-End		Central Tendency	High-End		
Surface water	1.6	1,299	350	4.7E–03	3.7	3	TRI/DMR
Fugitive air	8.4	2,184		2.4E–02	6.2	8	TRI
Fugitive air	34	74		9.5E–02	0.20	4	NEI
Stack air	45	499		0.13	1.4	9	TRI
Stack air	33			9.1E−02		1	NEI
Land	1.4	2.1		3.9E–03	6.0E–03	1	TRI

5.1.3.3 Weight of Scientific Evidence for Environmental Releases

Water releases are assessed using reported releases from 2015 to 2020 TRI and DMR. The primary strength of TRI data is that TRI compiles the best readily available release data for all reporting facilities. The primary limitation is that the water release assessment is based on three reporting sites, and EPA did not have additional sources to estimate water releases from this OES. Based on other reporting databases (CDR, NEI, etc.), there are seven additional manufacturing sites that are not accounted for in this assessment.

Air releases are assessed using reported releases from 2015 to 2020 TRI, and 2014 and 2017 NEI. A strength of NEI data is that NEI captures additional sources that are not included in TRI due to reporting thresholds. Factors that decrease the overall confidence for this OES include the uncertainty in the accuracy of reported releases, and the limitations in representativeness to all sites because TRI and NEI may not capture all relevant sites. Additionally, EPA made assumptions on the number of operating days to estimate daily releases.

Land releases are assessed using reported releases from 2015 to 2020 TRI. The primary limitation is that the land releases assessment is based on one reporting site, and EPA did not have additional sources to estimate land releases from this OES. Based on other reporting databases (CDR, DMR, NEI, etc.), there are nine additional manufacturing sites that are not accounted for in this assessment.

Based on this information, EPA has concluded that the weight of scientific evidence for this assessment is moderate to robust and provides a plausible estimate of releases in consideration of the strengths and limitations of reasonably available data.

5.1.4 Occupational Exposure Assessment

5.1.4.1 Worker Activities

Workers are potentially exposed to 1,1-dichloroethane during its manufacture from the cleaning of reaction equipment and storage containers. Additionally, workers are potentially exposed during the handling and transport of the reaction mixture.

Workers may connect transfer lines or manually load 1,1-dichloroethane into transport containers. Inhalation and dermal exposures are expected for both automated and manual loading and transfer activities. Workers may experience inhalation and dermal exposure to 1,1-dichloroethane while during the cleaning of reaction vessels and other equipment, as well as the rinsing of storage containers. According to the final study report published by the Vinyl Institute Consortium (Stantec ChemRisk, 2023), workers in production areas wear the following standard PPE: fire-resistant clothing, coveralls, hard hats, hearing protection, neoprene gloves, leather gloves, safety glasses, and steel toed boots. The report also mentioned task-specific PPE, such as chemical suits worn during process opening, chemical splash goggles, face shields, and full-face respirators.

ONUs include employees that work at the sites where 1,1-dichloroethane is manufactured, but they do not directly handle the chemical and are therefore expected to have lower inhalation exposures and are not expected to have dermal exposures through contact with liquids or solids. ONUs for this scenario include supervisors, managers, and other employees that may be in the production area but do not perform tasks that result in the same level of exposure as those workers that engage in tasks related to the manufacture of 1,1-dichloroethane.

5.1.4.2 Number of Workers and Occupational Non-users

EPA used data from the Bureau of Labor Statistics (BLS) and the U.S. Census' Statistics of US Businesses (SUSB) specific to the OES to estimate the number of workers and ONUs per site potentially exposed to 1,1-dichloroethane during manufacturing (U.S. BLS, 2016; U.S. Census Bureau, 2015). This approach involved the identification of relevant Standard Occupational Classification (SOC) codes within the BLS data for the identified NAICS codes. Appendix A includes further details regarding methodology for estimating the number of workers and ONUs per site. EPA assigned the following NAICS codes for this OES:

- 325199: All Other Basic Organic Chemical Manufacturing
- 325180: Other Basic Inorganic Chemical Manufacturing
- 325110: Petrochemical Manufacturing

Table 5-2 summarizes the per site estimates for this OES based on the methodology described, including the number of sites identified in Section 5.1.2.

Table 5-2. Estimated Number of Workers Potentially Exposed to 1,1-Dichloroethane During Manufacturing

Potential Number of Sites	NAICS Code	Exposed Workers per Site[a]	Exposed Occupational Non-users per Site[a]
10	325199: All Other Basic Organic Chemical Manufacturing	119	56
	325180: Other Basic Inorganic Chemical Manufacturing		
	325110: Petrochemical Manufacturing		

[a] Number of workers and occupational non-users per site are calculated by dividing the exposed number of workers or occupational non-users by the number of establishments.

5.1.4.3 Occupational Inhalation Exposure Results

Occupational inhalation data for 1,1-dichloroethane during manufacturing were provided via a Test Order submission from the Vinyl Institute), which includes manufacturers and processors of 1,1-dichloroethane (Stantec ChemRisk, 2023). EPA identified 57 worker and 5 ONU full-shift PBZ samples from the test order data to estimate inhalation exposures during the manufacturing process. The data included samples from the Westlake Chemical LCS Site in Westlake, LA, which manufactures 1,1-dichloroethane as an isolated intermediate. The worker samples collected were from operators/process technicians, maintenance technicians, and laboratory technicians at the site.

From this monitoring data, EPA calculated the 50th and 95th percentile 8-hr TWA concentrations to represent a central tendency and high-end estimate of potential occupational inhalation exposures, respectively, for this scenario. Using these 8-hr TWA exposure concentrations, EPA calculated the AC, $ADC_{subchronic}$, ADC, and LADC as described in Appendix B. The results of these calculations are shown in Table 5-3. In addition to the full-shift samples, the test order provided 36 task-length samples during the manufacture of 1,1-dichloroethane as an isolated intermediate. The samples were taken during routine tasks performed by operators/process technicians, maintenance technicians, and laboratory technicians at the site. High-end and central tendency inhalation exposure estimates are presented in Table 5-4.

For comparison, EPA also collected surrogate monitoring data from other chlorinated solvents: trans-1,2-dichloroethylene and 1,2-dichloroethane. The trans-1,2-dichloroethylene data was provided via a Vinyl Institute test order submission and contained 48 full-shift samples of workers during manufacturing of the chemical.

Table 5-3. Inhalation Exposures to 1,1-Dichloroethane During Manufacturing

Worker Description	8-hour TWA Exposure Concentrations		Acute Exposure Concentrations (AC)		Subchronic Average Daily Concentration ($ADC_{subchronic}$)		Average Daily Concentration (ADC)		Lifetime Average Daily Concentration (LADC)	
	High-End (ppm)	Central Tendency (ppm)	High-End (ppm)	Central Tendency (ppm)	High-End (ppm)	Central Tendency (ppm)	High-End (ppm)	Central Tendency (ppm)	High-End (ppm)	Central Tendency (ppm)
Operators/process technician	1.1	4.7E−03	0.72	3.2E−03	0.53	2.3E−03	0.49	2.2E−03	0.25	8.7E−04
Maintenance technician	0.41	7.9E−02	0.28	5.4E−02	0.21	4.0E−02	0.19	3.7E−02	9.9E−02	1.5E−02
Laboratory technician	2.4E−02	1.1E−03	1.6E−02	7.7E−04	1.0E−02	5.6E−04	1.1E−02	5.3E−04	5.6E−03	2.1E−04
ONU	2.0E−02	3.2E−03	1.4E−02	2.2E−03	1.0E−02	1.6E−03	9.4E−03	1.5E−03	4.8E−03	5.9E−04

Table 5-4. Task-Length Inhalation Exposures to 1,1-Dichloroethane During Manufacturing

Exposure Type	Worker Description	Number of Samples	Sample Duration (min)	Inhalation Estimates (ppm)	
				High-End	Central Tendency
Task-Length Exposure Concentrations	Operators/process technician	20	15 – 132	6.8	5.0E−03
	Maintenance technician	7	15 – 121	8.6E−02	1.9E−02
	Laboratory technician	9	33 – 176	7.2E−02	7.2E−03

In addition, EPA compiled surrogate monitoring data from other volatile liquids assessed in previous EPA Risk Evaluations. EPA identified a total of 397 full-shift worker samples from the following volatile liquids: 1,4-dioxane, 1-bromopropane (1-BP), carbon tetrachloride, methylene chloride, n-methylpyrrolidone (NMP), perchloroethylene (PCE), and trichloroethylene (TCE) (U.S. EPA, 2020e, f, g, h, i, j, k). A summary of the inhalation exposure estimates for the manufacturing OES using 1,1-dichloroethane test order and surrogate data is presented in Table 5-5. The surrogate monitoring data (no vapor correction) identified from other volatile chemicals resulted in a high-end inhalation estimate of 2.7 ppm, which is slightly higher but within the same order of magnitude.

Table 5-5. Inhalation Exposures to 1,1-Dichloroethane During Manufacturing using Surrogate Data

Exposure Type	Worker Inhalation Estimates (ppm)		ONU Inhalation Estimates (ppm)	
	High-End	Central Tendency	High-End	Central Tendency
8-hour TWA Exposure Concentrations	2.7	0.12	0.16	8.0E−02

5.1.4.4 Occupational Dermal Exposure Results

EPA estimated dermal exposures for this OES using the *Dermal Exposure to Volatile Liquid Model* and a fraction absorbed value of 0.3 percent. The maximum concentration evaluated for this dermal exposure is 100% since 1,1-dichloroethane is expected to be manufactured as a neat liquid. Table 5-5 summarizes the APDR, ARD, SCDD, CRD (non-cancer), and CRD (cancer) for 1,1-dichloroethane during manufacturing. The high-ends are based on a higher loading rate of 1,1-dichloroethane (2.1 mg per cm^2 per event) and two-hand contact, and the central tendencies are based on a lower loading rate of 1,1-dichloroethane (1.4 mg per cm^2 per event) and one-hand contact. OES-specific parameters for dermal exposures are described in Appendix D.

Table 5-6. Summary of Dermal Exposure Doses to 1,1-Dichloroethane for Manufacturing

Modeled Scenario	Exposure Concentration Type	High-End	Central Tendency
Average Adult Worker[a]	Acute Potential Dose Rate (APDR) (mg/day)	6.7	2.3
	Acute Retained Dose (ARD) (mg/kg-day)	8.0E−02	3.0E−02
	Subchronic Average Daily Dose (SCDD), non-cancer (mg/kg-day)	6.0E−02	2.0E−02
	Chronic Retained Dose (CRD), non-cancer (mg/kg-day)	6.0E−02	2.0E−02
	Chronic Retained Dose (CRD), cancer (mg/kg-day)	3.0E−02	1.0E−02

[a] Conditions where no gloves are used, or for any glove / gauntlet use without permeation data and without employee training (PF = 1).

5.1.4.5 Weight of Scientific Evidence for Occupational Exposures

EPA considered the assessment approach, the quality of the data, and uncertainties in assessment results to determine a weight of scientific evidence conclusion for the 8-hour TWA inhalation exposure estimates. EPA used 1,1-dichloroethane test order inhalation data to assess inhalation exposures. The primary strength of these data is the use of personal and directly applicable data, and the number of samples available for workers and ONUs. The primary limitation is that the data is from one site and may not be representative of all manufacturing sites. Additionally, EPA assumed 250 exposure days per year based on 1,1-dichloroethane exposure each working day for a typical worker schedule; it is uncertain whether this captures actual worker schedules and exposures. Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for the inhalation assessment is moderate to robust and provides a plausible estimate of exposures in consideration of the strengths and limitations of reasonably available data.

EPA estimated dermal exposures using modeling methodologies, which are supported by moderate evidence. EPA used the *EPA Dermal Exposure to Volatile Liquids* to calculate the dermal retained dose. This model modifies the *EPA/OPPT 2-Hand Dermal Exposure to Liquids Model* by incorporating a “fraction absorbed (f_{abs})” parameter to account for the evaporation of volatile chemicals. These modifications improve the modeling methodology; however, the modeling approach is still limited by the low variability for different worker activities/exposure scenarios. Therefore, the weight of scientific for the modeling methodologies is moderate.

The exposure scenarios and exposure factors underlying the dermal assessment are supported by moderate to robust evidence. Dermal exposure scenarios were informed by moderate to robust process information and GS/ESD. Exposure factors for occupational dermal exposure include amount of material on the skin, surface area of skin exposed, and absorption of 1,1-dichloroethane through the skin. These exposure factors were informed by literature sources, the ChemSTEER User Guide (U.S. EPA, 2015) for standard exposure parameters, and a European model, with ratings from moderate to robust. Based on these strengths and limitations, EPA concluded that the weight of scientific evidence for the dermal exposure assessment is moderate to robust for all OES.

5.2 Distribution in Commerce

5.2.1 Process Description

EPA expects that 1,1-dichloroethane and 1,1-dichloroethane-containing products are distributed throughout commerce from manufacturing sites to processing repackaging sites. Repackaging sites are expected to distribute 1,1-dichloroethane for laboratory use. Based on the information from the other conditions of use, 1,1-dichloroethane may be transported in pure liquid form and in various liquid formulations with a range of potential 1,1-dichloroethane concentrations.

Distribution of 1,1-dichloroethane in commerce may include loading and unloading activities that occur during other life cycle stages (*e.g.*, manufacturing, processing, repackaging, laboratory use, disposal), transit activities that involve the movement of the chemical (*e.g.*, via motor vehicles, railcars, water vessels), and temporary storage and warehousing of the chemical during distribution (excluding repackaging and other processing activities, which are included in other COUs). Therefore, EPA assessed the distribution in commerce activities resulting in releases and exposures (*e.g.*, loading, unloading) throughout the various life cycle stages and COUs rather than a single distribution scenario. Data for assessing releases and exposures occurring during transportation of 1,1-dichloroethane between facilities, such as those from accidental spills, are generally not available.

Figure 5-2 shows an illustration of the distribution in commerce. The illustration shows red shading indicating loading and unloading activities related to distribution in commerce included in the assessment of the COUs within other life cycle stages. The red arrows indicate transport activities of distribution in commerce, which include the transit via motor vehicles, railcars, water vessels, as examples, and any temporary storage or warehousing, relabeling, and redistribution. The transport activities are what connect the life cycle stages (manufacture, processing, use, and disposal) together.

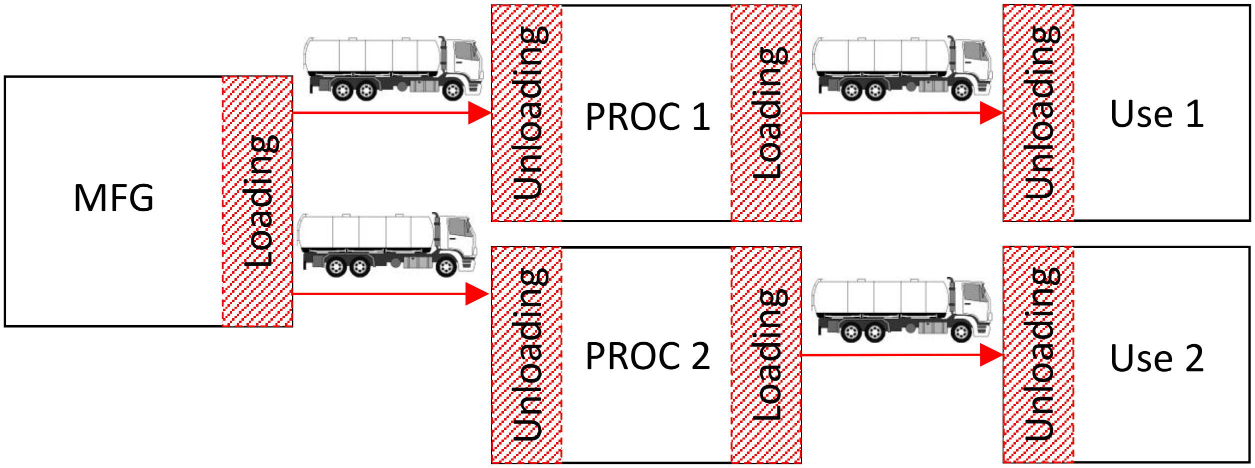

Figure 5-2. Illustration of Distribution in Commerce and its Relation to Other Life Cycle Stages

EPA did not identify data on the total volume of 1,1-dichloroethane distributed in commerce, nor volumes typically transported by a transportation company over any timeframe. As discussed above, since EPA is not separately assessing releases and exposures in a single distribution in commerce scenario, EPA did not estimate 1,1-dichloroethane volumes or operating days for this condition of use.

5.2.2 Facility Estimates

Distribution in commerce involves transportation of 1,1-dichloroethane between facilities that manage 1,1-dichloroethane at the various life cycle stages. Other OESs address the facility information relevant to handling 1,1-dichloroethane in each of these life cycle stages. EPA did not quantify the number of transportation/warehousing companies or facilities, volume of 1,1-dichloroethane transported, or number of transport vehicles. The amount of 1,1-dichloroethane distributed in commerce will scale with the demand for 1,1-dichloroethane and 1,1-dichloroethane-containing products.

5.2.3 Release Assessment

5.2.3.1 Environmental Release Points

The main release source of 1,1-dichloroethane during distribution in commerce is accidental releases of the compound during spill events. When a spill occurs, it must first be evaluated to determine a plan of action for clean-up. Spill response cleanup times may vary depending on the severity, location, and additional hazards associated with the spill which may require additional special measures to be taken. Spill response actions may include the following:[2]

- Installing fences, warning signs, or other security or site control precautions where humans or animals have access to the release;
- Drainage controls where needed to reduce migration of hazardous substances or pollutants off-site or to prevent precipitation or run-off from other sources;

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[2] 40 CFR 300.415 Hazardous Substance Response; https://www.govinfo.gov/content/pkg/CFR-2015-title40-vol28/xml/CFR-2015-title40-vol28-part300.xml#seqnum300.415

- Stabilization of berms, dikes, or impoundments or drainage or closing of lagoons where needed to maintain the integrity of the structures;
- Capping of contaminated soils or sludges—where needed to reduce migration of hazardous substances or pollutants or contaminants into soil, ground, or surface water, or air;
- Using chemicals and other materials to retard the spread of the release or to mitigate its effects—where the use of such chemicals will reduce the spread of the release;
- Excavation, consolidation, or removal of highly contaminated soils from drainage or other areas—where such actions will reduce the spread of, or direct contact with, the contamination;
- Removal of drums, barrels, tanks, or other bulk containers that contain or may contain hazardous substances or pollutants or contaminants—where it will reduce the likelihood of spillage; leakage; exposure to humans, animals, or food chain; or fire or explosion;
- Containment, treatment, disposal, or incineration of hazardous materials—where needed to reduce the likelihood of human, animal, or food chain exposure; or
- Provision of alternative water supply—where necessary immediately to reduce exposure to contaminated household water and continuing until such time as local authorities can satisfy the need for a permanent remedy.

Another strategy for spill cleanup, provided by the Department of Transportation (DOT), includes three main steps:[3]

1. Sizing-up the spill;
2. Containment and Confinement; and
3. Disposal.

The first step, sizing-up the spill, involves an assessment of the spill by response personnel to identify the hazardous substance and prevent the spill from spreading. This is a non-invasive attempt to gain an understanding of the severity of the event. Generally, responders would look for the following information:

- Identity of the materials;
- Amount of the release;
- Hazards associated with each material(s);
- Effects and risks on the public, property, and environment;
- Potential pathway of release—air, land, surface waters, or groundwater;
- Most appropriate measures for controlling the release to prevent/reduce the impact; and
- Safety measures to protect all response personnel.

To obtain this information, responders would use visual methods such as:

- Types and numbers of containers or cargo tanks;
- Placards, labels, and markings on containers or transportation vehicles;
- Vapors, clouds, run-offs, or suspicious substances;
- Biological indicators—dead vegetation, animals, insects, and fish; and
- Physical condition of containers.

In some cases, responders may need to utilize quantitative methods such as colorimetric tubes, pH paper, and Splifyter classifier strips to detect the presence or release of hazardous chemicals.

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[3] Traffic Incident Management in Hazardous Materials Spills in Incident Clearance. Chapter 4.0 Hazard Materials Incident Clearance Compliance Requirements. https://ops.fhwa.dot.gov/publications/fhwahop08058/40.htm

Once the hazardous substance release has been identified, first responders may perform limited cleanup activities by employing basic containment and confinement techniques. Spill containment involves methods used to restrict any hazardous material to its original container. These methods may include plugging, patching or overpacking the storage container. Spill confinement involves limiting the spread of the hazardous substance release. Spill confinement techniques include mist knockdown/vapor suppression, diversion of the spill, diking, booming, absorbing, fencing, and damming. For smaller vehicular spills, one of the easiest control methods is the use of granular absorbents, oil absorbent pads, or universal absorbent pads. These items are readily available and effective for smaller spills.

Once cleanup of the spill has occurred, professional licensed firms should be contracted to perform disposal of the hazardous substance. First responders may improve the disposal process by mitigating the spill following a standard operating procedure (SOP). The SOP should account for how to mitigate the spill, package the waste for transport, and secure the waste until a licensed transportation and disposal company can pick it up.

5.2.3.2 Environmental Release Assessment

When evaluating releases related to distribution in commerce of 1,1-dichloroethane, EPA considered two sources including Toxic Release Inventory (TRI) data and National Response Center (NRC) data. EPA examined data corresponding to the 2015 to 2020 calendar years for these data sources.

When evaluating the TRI data, EPA found that storage would not meet an activity threshold under EPCRA section 313.[4] Therefore, if a wholesale or warehouse facility reports to TRI, it is likely because they are conducting a manufacturing, processing, or otherwise use activity, in which case we appropriately map that facility to another OES (such as repackaging). If a wholesale or warehouse facility stores, relabels, or redistributes a chemical product without opening the containers or performing any processing activity, the facility likely is not required to report that chemical to TRI.

Since transit activities (transportation in tank trucks, railcars, etc) are not required to report to TRI, wholesale and warehouse operations are not likely to submit Form Rs under TRI, and wholesale and warehouse operations are less likely to have federally permitted releases subject to reporting (*e.g.*, NPDES permits, Clean Air Act permits), NRC data of CERCLA-reportable accidental releases may be the best option to quantify environmental releases during transport activities.

Section 103 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requires the person in charge of a vessel or an onshore or offshore facility immediately notify the NRC when a CERCLA hazardous substance is released at or above the reportable quantity (RQ) in any 24-hour period, unless the release is federally permitted.[5] The NRC is an emergency call center maintained and operated by the U.S. Coast Guard that fields initial reports for pollution and railroad incidents. Information reported to the NRC is available on the NRC website.[6]

EPA downloaded NRC data for the 2015 to 2020 calendar years and reviewed it for reports pertaining to distribution of 1,1-dichloroethane. Upon review, ERG found that none of the reported releases for 1,1-dichloroethane appeared to occur during distribution of the chemical. It is important to note that the data reported to NRC in the past does not correlate to possible spills in the future. Due to the lack of correlation, EPA is unable to estimate the frequency or volume of any spills that may occur in the future

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[4] *Question # 134*; TRI Program GuideMe Questions and Answers; EPA.
[5] CERCLA 103 – Release Notification; EPA.
[6] U.S. Coast Guard National Response Center.

or provide estimates representative of a "typical" spill, as each spill represents a unique scenario.

5.2.4 Occupational Exposure Assessment

5.2.4.1 Description of Exposure Sources and Methods of Mitigation

EPA gathered condition of use information from various literature sources that were evaluated through the systematic review process. The systematic review process yielded one peer-reviewed research article with information pertaining to the distribution of chemicals on Norwegian chemical tankers (Moen, 1991). Although the source did not contain any quantitative exposure data, it did state that workers may be exposed when repairing leakages in the storage tanks.

In addition to repairing leakages in storage tanks, workers may also be exposed during the cleanup of spills that may occur during transit activities, warehousing, or temporary storage. During spill cleanup workers may be exposed through inhalation of vapors from the volatilization of 1,1-dichloroethane or dermal contact with liquid or vapors of 1,1-dichloroethane. Typically, before spill cleanup occurs, workers evaluate the spill and determine the appropriate PPE for the cleanup activities. EPA expects that exposures may occur during cleanup activities listed in Section 5.2.3.1

5.2.4.2 Estimates of Exposures

From the examination of 2015 to 2020 NRC data, EPA did not identify any spill events occurred during the distribution in commerce of 1,1-dichloroethane. ERG also examined DOT data using the Hazmat Incident Report Search Tool.[7] ERG found that during the 2015 to 2020 timeframe, only one spill incident involving 1,1-dichloroethane had occurred. This incident occurred on a highway in Gardena, CA (Report number E-2020050431).[8] During the loading phase, 1,1-dichloroethane was incorrectly packed into a fiberboard box. When the compound was being transported by Saia Motor Freight Line, LLC, a rip/tear in the packaging caused a spill of 1,1-dichloroethane to occur. The incident caused a spill of about 1 liquid cup of 1,1-dichloroethane and was cleaned up by Premium Environmental Services, Inc. In addition to the Gardena, California spill event, EPA identified four additional spill events, all occurring in or before 2005. These reports may be viewed in the DOT's Hazmat Incident Report Search Tool.

EPA did not identify data to estimate the magnitude or frequency of worker exposures from spill cleanup activities occurring from distribution in commerce of 1,1-dichloroethane. EPA expects the magnitude of exposure to be dependent on the size and location of the spill and may have large variability. For example, the Gardena, CA spill cited above may have resulted in relatively low exposures due to the small volume of 1,1-dichloroethane spilled whereas a much larger spill (*e.g.*, whole drums or bulk containers spilling due to an accident during transit) may result in significantly higher exposures to cleanup workers.

EPA expects that individual workers would be exposed to clean-up of spills of any one chemical during distribution in commerce about once per year with a worst-case scenario involving the same worker performing multiple spill cleanups of the same chemical in a year. However, similar to the magnitude of exposures, the duration of spill cleanups is expected to be dependent on the specifics of each chemical spill and could take minutes or days after the spill event to complete.

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[7] DOT Hazmat Incident Report Search Tool.

[8] https://portal.phmsa.dot.gov/PDFGenerator/getPublicReport/OHMIR_5800-1?INCIDENTID=2078909.

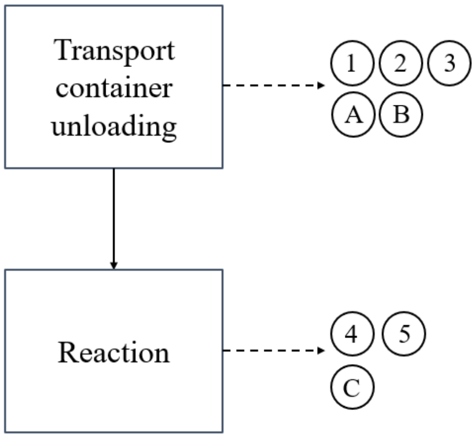
5.3 Processing as a Reactive Intermediate

As listed in Table 1-1, this OES includes the following conditions of use: intermediate in all other basic organic chemical manufacturing, intermediate in all other chemical product and preparation manufacturing, and recycling.

5.3.1 Process Description

CDR data indicated that processing 1,1-dichloroethane as a reactant or intermediate is an in-scope, occupational exposure scenario that is performed in the United States (U.S. EPA, 2020a, 2016). Processing as a reactant or intermediate is the use of 1,1-dichloroethane as a feedstock in the production of another chemical via a chemical reaction in which 1,1-dichloroethane is consumed to form the product. Nearly all of the manufactured 1,1-dichlorethane is used as an intermediate in the production of other chemicals, primarily 1,1,1-trichloroethane (Dreher et al., 2014; RIVM, 2007; U.S. EPA, 2000). Other uses of 1,1-dichloroethane as an intermediate are negligible (Dreher et al., 2014).

In the UK, liquid 1,1-dichloroethane is primarily shipped from manufacturing sites via pipelines, although rail tankers and road tankers may also be used (OECD, 2009; U.S. EPA, 2001). In the production of 1,1,1-trichloroethane (tri-ethane), vinyl chloride is hydrochlorinated in the presence of a catalyst to form 1,1-dichloroethane. After purification the 1,1-dichloroethane is then either thermally or photochemically chlorinated to form tri-ethane (Axiall Corporation, 2016; Marshall and Pottenger, 2016; Dreher et al., 2014; U.S. EPA, 2000). The concentration of 1,1-dichloroethane used in these processes is unknown, although EPA assumes that it is used at a concentration of 99.7% from the manufacturing process (U.S. EPA, 2001). Figure 5-3 below highlights the typical release and exposure points during the processing of 1,1-dichloroethane as a reactant or intermediate.



<u>Environmental Releases:</u>

1. Releases to air from transferring volatile chemicals from transport containers.
2. Releases to air, water, incineration, or landfill from unloading solids from transport containers.
3. Releases to air, water, incineration, or land from cleaning of transport containers.
4. Releases to water, incineration, or land from cleaning of reaction vessels and other equipment.
5. Releases to air from reaction of volatile chemicals.

<u>Occupational Exposures:</u>

A. Inhalation exposures to volatile liquids and dust and dermal exposure to solids and liquids from unloading transport containers.
B. Inhalation exposures to volatile liquids and dermal exposures to solids and liquids from transport container cleaning.
C. Inhalation exposures to volatile liquids and dermal exposure to solids and liquids from reaction vessels and other equipment cleaning.

Figure 5-3. Typical Release and Exposure Points During the Processing of 1,1-Dichloroethane as a Reactive Intermediate

5.3.2 Facility Estimates

Using TRI, NEI, and DMR release data, EPA identified 90 facilities that potentially process 1,1-dichloroethane as a reactive intermediate. Due to CBI claims on the annual PV of 1,1-dichloroethane, EPA does not present annual or daily site throughputs; however, almost all manufactured 1,1-dichloroethane is used for processing as a reactant (RIVM, 2007). EPA did not identify data on facility operating schedules; therefore, EPA assumes 350 days/yr of operation as discussed in Section 2.3.2.

5.3.3 Release Assessment

5.3.3.1 Environmental Release Points

EPA expects releases to occur during container and equipment cleaning and sampling waste. Environmental releases may also occur during the unloading of 1,1-dichloroethane from transport containers into intermediate storage tanks and process vessels. Equipment leaks may occur while connecting and disconnecting hoses and transfer lines. Specific release sources considered for estimating releases are shown numbered as 1 through 5 in Figure 5-3. EPA expects the following types of releases:

1. Fugitive or stack air: Release points 1, 2, 3, and 5
2. Wastewater managed in onsite treatment or discharged to a POTW: Release points 1 and 2.

3. Incineration or land: Release points 2, 3, and 4.

5.3.3.2 Environmental Release Assessment Results

EPA used 2015 to 2020 DMR, 2015 to 2020 TRI, and 2017 NEI to estimate environmental releases during the processing of 1,1-dichloroethane as a reactive intermediate, as presented in Table 5-7. According to reported data, 1,1-dichloroethane is released through the following environmental media: surface water, fugitive air, stack air, and land disposal.

Table 5-7. Summary of Environmental Releases During the Processing of 1,1-Dichloroethane as a Reactive Intermediate

Environmental Media	Estimated Yearly Release Range across Sites (kg/yr)		Number of Release Days	Daily Release (kg/site-day)		Number of Facilities	Source(s)
	Central Tendency	High-End		Central Tendency	High-End		
Surface water	3.8E−03	7.5E−02	350	1.1E–05	2.1E–04	60	TRI/DMR
Fugitive air	2.3	155		0.01	0.44	5	TRI
Fugitive air	4.1	327		1.2E–02	0.93	16	NEI
Stack air	14	610		0.04	1.7	4	TRI
Stack air	3.8	526		1.1E–02	1.5	23	NEI
Land	0.45			1.3E−02		1	TRI

5.3.3.3 Weight of Scientific Evidence for Environmental Releases

Water releases are assessed using reported releases from 2015 to 2020 TRI and DMR, which both have a medium overall data quality determination from the systematic review process. The primary strength of TRI data is that TRI compiles the best readily available release data for all reporting facilities. The water release assessment is based on 60 reporting sites. Based on other reporting databases (CDR, NEI, etc.), there are 30 additional sites that are not accounted for in this assessment.

Air releases are assessed using reported releases from 2015 to 2020 TRI, and 2014 and 2017 NEI. A strength of NEI data is that NEI captures additional sources that are not included in TRI due to reporting thresholds. Factors that decrease the overall confidence for this OES include the uncertainty in the accuracy of reported releases, and the limitations in representativeness to all sites because TRI and NEI may not capture all relevant sites.

Land releases are assessed using reported releases from 2015 to 2020 TRI. The primary limitation is that the land release assessment is based on one reporting site, and EPA did not have additional sources to estimate land releases from this OES. Based on other reporting databases (CDR, DMR, NEI, etc.), there are 89 additional sites that are not accounted for in this assessment.

Based on this information, EPA has concluded that the weight of the scientific evidence for this assessment is moderate to robust and provides a plausible estimate of releases in consideration of the strengths and limitations of reasonably available data.

5.3.4 Occupational Exposure Assessment

5.3.4.1 Worker Activities

During the processing of 1,1-dichloroethane as a reactive intermediate, workers are potentially exposed to 1,1-dichloroethane when unloading transport containers, cleaning transport containers, and cleaning reaction vessels or other equipment. These activities are all potential sources of worker exposure via inhalation of vapor or dermal contact with liquids. EPA did not find information that indicates the extent that engineering controls and worker PPE are used at facilities that processes 1,1-dichloroethane as a reactive intermediate.

ONUs include employees (*e.g.*, supervisors, managers) at the processing site that do not directly handle 1,1-dichloroethane. Therefore, the ONUs are expected to have lower inhalation exposures, lower vapor-through-skin uptake, and no expected dermal exposure.

5.3.4.2 Number of Workers and Occupational Non-users

EPA used data from the Bureau of Labor Statistics (BLS) and the U.S. Census' Statistics of US Businesses (SUSB) specific to the OES to estimate the number of workers and ONUs per site potentially exposed to 1,1-dichloroethane during the processing as a reactive intermediate (U.S. BLS, 2016; U.S. Census Bureau, 2015). This approach involved the identification of relevant Standard Occupational Classification (SOC) codes within the BLS data for the identified NAICS codes. Appendix A includes further details regarding methodology for estimating the number of workers and ONUs per site. EPA assigned the following NAICS codes for this OES:

- 325199: All Other Basic Organic Chemical Manufacturing
- 325211: Plastics Material and Resin Manufacturing
- 325110: Petrochemical Manufacturing
- 325180: Other Basic Inorganic Chemical Manufacturing

Table 5-8 summarizes the per site estimates for this OES based on the methodology described, including the potential number of sites identified in Section 5.3.2.

Table 5-8. Estimated Number of Workers Potentially Exposed to 1,1-Dichloroethane During Processing as a Reactive Intermediate

Potential Number of Sites	NAICS Code	Estimated Average Exposed Workers per Site[a]	Estimated Average Exposed Occupational Non-users per Site[a]
90	325199: All Other Basic Organic Chemical Manufacturing	94	21
	325211: Plastics Material and Resin Manufacturing		
	325110: Petrochemical Manufacturing		
	325180: Other Basic Inorganic Chemical Manufacturing		

[a] Number of workers and occupational non-users per site are calculated by dividing the exposed number of workers or occupational non-users by the number of establishments.

5.3.4.3 Occupational Inhalation Exposure Results

EPA did not identify monitoring data for the processing as a reactive intermediate OES; however, EPA assumed the exposures to be similar to manufacturing due to similar worker activities and the use of primarily closed systems during processing. Therefore, EPA incorporated the manufacturing data into the processing as a reactive intermediate exposure estimates. EPA has used this assessment approach in previous risk evaluations, including the *Risk Evaluation for Perchloroethylene (PCE)* (U.S. EPA, 2020j).

As described in Section 5.1.4.3, EPA identified 57 worker and 5 ONU full-shift PBZ samples from the Westlake Chemical LCS Site in Westlake, Louisiana, which manufactures 1,1-dichloroethane as an isolated intermediate. The samples collected were from operators/process technicians, maintenance technicians, and laboratory technicians at the site. From this monitoring data, EPA calculated the 50th and 95th percentile 8-hr TWA concentrations to represent a central tendency and high-end estimate of potential occupational inhalation exposures, respectively, for this scenario. Using these 8-hr TWA exposure concentrations, EPA calculated the AC, $ADC_{subchronic,}$ ADC, and LADC as described in Appendix B. The results of these calculations are shown in Table 5-9.

Table 5-9. Inhalation Exposures to 1,1-Dichloroethane During Processing as a Reactive Intermediate

Worker Description	8-hour TWA Exposure Concentrations		Acute Exposure Concentrations (AC)		Subchronic Average Daily Concentration ($ADC_{subchronic}$)		Average Daily Concentration (ADC)		Lifetime Average Daily Concentration (LADC)	
	High-End (ppm)	Central Tendency (ppm)	High-End (ppm)	Central Tendency (ppm)	High-End (ppm)	Central Tendency (ppm)	High-End (ppm)	Central Tendency (ppm)	High-End (ppm)	Central Tendency (ppm)
Operators/process technician	1.1	4.7E−03	0.72	3.2E−03	0.53	2.3E−03	0.49	2.2E−03	0.25	8.7E−04
Maintenance technician	0.41	7.9E−02	0.28	5.4E−02	0.21	4.0E−02	0.19	3.7E−02	9.9E−02	1.5E−02
Laboratory technician	2.4E−02	1.1E−03	1.6E−02	7.7E−04	1.0E−02	5.6E−04	1.1E−02	5.3E−04	5.6E−03	2.1E−04
ONU	2.0E−02	3.2E−03	1.4E−02	2.2E−03	1.0E−02	1.6E−03	9.4E−03	1.5E−03	4.8E−03	5.9E−04

5.3.4.4 Occupational Dermal Exposure Results

EPA estimated dermal exposures for this OES using the *Dermal Exposure to Volatile Liquid Model* and a fraction absorbed value of 0.3 percent. The maximum concentration evaluated for this dermal exposure is 100% since 1,1-dichloroethane is expected to be received at the site in pure form. Table 5-10 summarizes the APDR, ARD, SCDD, CRD (non-cancer), and CRD (cancer) for 1,1-dichloroethane during processing as a reactive intermediate. The high-ends are based on a higher loading rate of 1,1-dichloroethane (2.1 mg per cm^2 per event) and two-hand contact, and the central tendencies are based on a lower loading rate of 1,1-dichloroethane (1.4 mg per cm^2 per event) and one-hand contact. OES-specific parameters for dermal exposures are summarized below in Table 5-10.

Table 5-10. Summary of Dermal Exposure Doses to 1,1-Dichloroethane for Processing as a Reactive Intermediate

Modeled Scenario	Exposure Concentration Type	High-End	Central Tendency
Average Adult Worker[a]	Acute Potential Dose Rate (APDR) (mg/day)	6.7	2.3
	Acute Retained Dose (ARD) (mg/kg-day)	8.0E−02	3.0E−02
	Subchronic Average Daily Dose (SCDD), non-cancer (mg/kg-day)	6.0E−02	2.0E−02
	Chronic Retained Dose (CRD), non-cancer (mg/kg-day)	6.0E−02	2.0E−02
	Chronic Retained Dose (CRD), cancer (mg/kg-day)	3.0E−02	1.0E−02

[a] Conditions where no gloves are used, or for any glove / gauntlet use without permeation data and without employee training (PF = 1).

5.3.4.5 Weight of Scientific Evidence for Occupational Exposures

EPA used inhalation data to assess inhalation exposures. The primary strength of this data is the use of personal and potentially applicable data. The primary limitations of these data include the uncertainty of the representativeness of these data toward the true distribution of inhalation concentrations in this scenario since the data were surrogate from the manufacturing OES. EPA also assumed 250 exposure days per year based on 1,1-dichloroethane exposure each working day for a typical worker schedule; it is uncertain whether this captures actual worker schedules and exposures. Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is moderate and provides a plausible estimate of exposures in consideration of the strengths and limitations of reasonably available data.

EPA estimated dermal exposures using modeling methodologies, which are supported by moderate evidence. EPA used the *EPA Dermal Exposure to Volatile Liquids* to calculate the dermal retained dose. This model modifies the *EPA/OPPT 2-Hand Dermal Exposure to Liquids Model* by incorporating a "fraction absorbed (f_{abs})" parameter to account for the evaporation of volatile chemicals. These modifications improve the modeling methodology; however, the modeling approach is still limited by the low variability for different worker activities/exposure scenarios. Therefore, the weight of scientific for the modeling methodologies is moderate.

The exposure scenarios and exposure factors underlying the dermal assessment are supported by moderate to robust evidence. Dermal exposure scenarios were informed by moderate to robust process information and GS/ESD. Exposure factors for occupational dermal exposure include amount of material on the skin, surface area of skin exposed, and absorption of 1,1-dichloroethane through the skin. These exposure factors were informed by literature sources, the ChemSTEER User Guide (U.S.

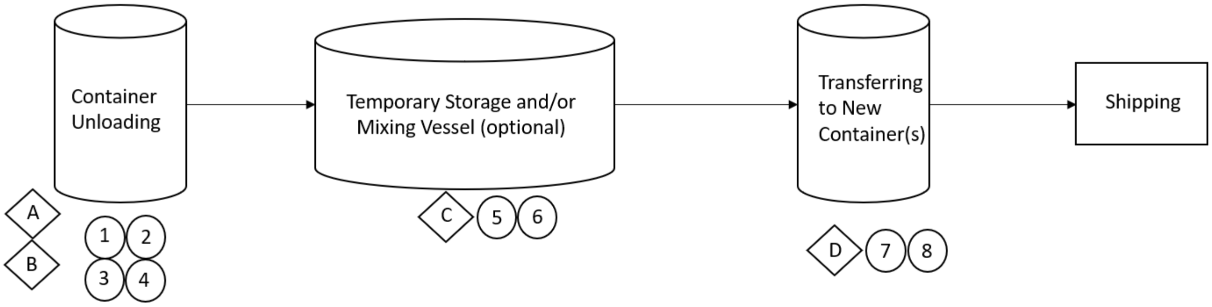
EPA, 2015) for standard exposure parameters, and a European model, with ratings from moderate to robust. Based on these strengths and limitations, EPA concluded that the weight of scientific evidence for the dermal exposure assessment is moderate to robust for all OES.

5.4 Processing—Repackaging

5.4.1 Process Description

Repackaging was not included in the original scope document; however, 1,1-dichloroethane is expected to be repackaged into smaller containers for laboratory use. Domestically manufactured commodity chemicals may be shipped within the United States in liquid cargo barges, railcars, tank trucks, tank containers, intermediate bulk containers (IBCs)/totes, and drums (U.S. EPA, 2022a). Domestically manufactured commodity chemicals may be repackaged by wholesalers for resale, for example, repackaging bulk packaging into drums or bottles. There are no known 1,1-dichloroethane imports for repackaging.

1,1-Dichloroethane may be received in its final formulation and transferred directly to smaller containers, charged to a temporary storage tank, or transferred to a mixing tank and diluted or mixed with other chemicals before repackaging (U.S. EPA, 2022a). 1,1-Dichloroethane is expected to be shipped as a neat liquid with a purity of 99.7% (NCBI, 2020; U.S. EPA, 2001). EPA assumes that the 1,1-dichloroethane is repackaged at the same concentration as it arrives. Transport containers for laboratory chemicals may range from 0.5 mL to 200 L, with an assumption of 3.79 L (1 gal) in the absence of site-specific information. In some cases, QC samples may be taken at import and repackaging sites for analyses. Figure 5-4 provides typical release and exposure points during the repackaging of 1,1-dichloroethane.



Environmental Releases:

1. Releases to air from unloading volatile chemicals from transport containers.
2. Releases to air, water, incineration, or landfill from unloading solids from transport containers.
3. Releases to water, incineration, or land from transport container residue (via container cleaning or direct disposal of empty containers).
4. Releases to air from cleaning transport containers containing volatile chemicals
5. Releases to water, incineration or land from cleaning of storage/mixing vessels and other equipment.
6. Releases to air from cleaning equipment used to process volatile chemicals.
7. Releases to air from loading volatile chemicals into transport containers.
8. Releases to air, water, incineration, or landfill from loading solids into transport containers.

Occupational Exposures:

A. Inhalation exposures to volatile liquids and dust and dermal exposure to solids and liquids from unloading transport containers.
B. Inhalation exposures to volatile liquids and dermal exposure to solids and liquids from transport container cleaning.
C. Inhalation exposures to volatile liquids and dermal exposure to solids and liquids from equipment cleaning.
D. Inhalation exposures to volatile liquids and dust and dermal exposure to solids and liquids from loading transport containers.

Figure 5-4. Typical Release and Exposure Points During the Repackaging of 1,1-Dichloroethane (U.S. EPA, 2022a).

5.4.2 Facility Estimates

For this OES, EPA identified three relevant facilities in DMR. However, the release estimates reported by these facilities were below the limit of detection, and there were no releases reported to air and land media. Due to the lack of companies reporting the import of 1,1-dichloroethane in CDR, EPA does not present annual or daily site throughputs. EPA did not identify other data on current import volumes or import sites from systematic review. Therefore, EPA assumed 1,1-dichloroethane may still be imported at volumes below the CDR reporting threshold, and the environmental releases and occupational exposures during the repackaging of 1,1-dichloroethane were modeled. As a conservative estimate, EPA assumes two repackaging sites with an annual production volume of 50,000 lb. EPA additionally assumes a shift length of 8 hours/day, 2,080 hours per year, which results in 260 days/yr of operation according to the July 2022 *Chemical Repackaging—Generic Scenario for Estimating Occupational Exposures and Environmental Releases* (U.S. EPA, 2022a).

5.4.3 Release Assessment

5.4.3.1 Environmental Release Points

EPA expects releases to occur during the emptying of drums, cleaning of emptied drums, and filling of smaller containers. EPA estimated releases from import—repackaging using a Monte Carlo simulation with 100,000 iterations and the Latin Hypercube sampling method using the models and approaches described in Appendix E. Input parameters for the models were determined using data from literature and the July 2022 *Chemical Repackaging GS* (U.S. EPA, 2022a). EPA used this method to estimate releases for individual release sources and summed the individual releases to each environmental media to estimate total annual and daily facility releases. Specific release sources considered for estimating releases are shown numbered as 1 through 8 in Figure 5-4. Because 1,1-dichloroethane is considered a hazardous chemical, water releases are not expected for this OES (U.S. EPA, 2022a). EPA expects the following types of releases:

1. Fugitive or Stack Air: Release points 1, 2, 4, 6, 7, and 8
2. Hazardous landfill/Incineration: Release points 2, 3, 5, and 8

5.4.3.2 Environmental Release Assessment Results

Appendix E includes the model equations and input parameters used in the Monte Carlo simulation for this condition of use. EPA estimated 1,1-dichloroethane releases by simulating two sites importing and processing 25,000 lb. per site. Table 5-11 summarizes the estimated release results for import—repackaging based on the scenario applied. The high-ends are the 95th percentile of the respective simulation output and the central tendencies are the 50th percentile.

Table 5-11. Summary of Modeled Environmental Releases for the Repackaging of 1,1-Dichloroethane

Modeled Scenario	Environmental Media	Annual Release (kg/site-yr)		Number of Release Days[a]		Daily Release (kg/site-day)	
		Central Tendency	High-End	Central Tendency	High-End	Central Tendency	High-End
Two sites; 25,000-lb throughput	Fugitive or Stack Air	1.1E01	1.8E01	26	129	2.4E−01	4.4E−01
	Hazardous landfill or incineration	2.8E02	3.2E02	26	129	6.0	9.4

a EPA assumes that the number of operating days is equivalent to the number of drums imported per year (i.e., one drum repackaged per day) but not to exceed 250 operating days per year. The number of release days presented in this table is based on simulation outputs for the annual release divided by the daily release (grouped by high-end or central tendency estimate), rounded to the closest integer. Annual totals may not add exactly due to rounding.

5.4.3.3 Weight of Scientific Evidence for Environmental Releases

All facility release data were below the limit of detection, therefore, EPA assessed releases to the using the assumptions and values from the *July 2022 Chemical Repackaging GS* (U.S. EPA, 2023), which the systematic review process rated medium for data quality. EPA used EPA/OPPT models combined with Monte Carlo modeling to estimate releases to the environment, with media of release assessed using assumptions from the ESD and EPA/OPPT models.

EPA believes a strength of the Monte Carlo modeling approach is that variation in model input values and a range of potential releases values is more likely than a discrete value to capture actual releases at sites. EPA lacks 1,1-dichloroethane facility production volume data and number of importing/ repackaging sites; therefore, throughput estimates are based on CDR reporting thresholds with an overall release using a hypothetical scenario of two facilities.

Based on this information, EPA has concluded that the weight of scientific evidence for this assessment is moderate to robust and provides a plausible estimate of releases in consideration of the strengths and limitations of reasonably available data.

5.4.4 Occupational Exposure Assessment

5.4.4.1 Worker Activities

During repackaging, workers are potentially exposed to 1,1-dichloroethane when transferring 1,1-dichloroethane from the import drums into smaller containers. Workers may also be exposed via inhalation of vapor or dermal contact with liquids when cleaning import drums following emptying. EPA did not find information that indicates the extent that engineering controls and worker PPE are used at facilities that repackage 1,1-dichloroethane from import drums into smaller containers.

ONUs include employees (*e.g.*, supervisors, managers) at the import site, where repackaging occurs, that do not directly handle 1,1-dichloroethane. Therefore, the ONUs are expected to have lower inhalation exposures, lower vapor-through-skin uptake, and no expected dermal exposure.

5.4.4.2 Number of Workers and Occupational Non-users

As addressed in Section 5.4.2, EPA did not identify site-specific data for the number of facilities in the Unites States repackaging 1,1-dichloroethane; therefore, EPA did not estimate the total number of workers and ONUs exposed from this OES.

5.4.4.3 Occupational Inhalation Exposure Results

For this scenario, EPA applied the EPA Mass Balance Inhalation Model to exposure points described in the July 2022 Chemical Repackaging *GS* (U.S. EPA, 2022a), particularly for the emptying of drums, filling of containers, and cleaning of drums process described in the process description. The EPA Mass Balance Inhalation Model estimates the concentration of the chemical in the breathing zone of the worker based on a vapor generation rate (G). An 8-hour TWA is then estimated and averaged over eight hours assuming no exposure occurs outside of those activities. Appendix E also describes the model equations and other input parameters used in the Monte Carlo simulation for this OES. Worker exposures were modeled for this OES; EPA did not have the approaches to separately model ONU exposures.

EPA used the vapor generation rate and exposure duration parameters from the *1991 CEB Manual* (U.S. EPA, 1991) in addition to those used in the EPA Mass Balance Inhalation Model to determine a time-weighted exposure for each exposure point. EPA estimated the time-weighted average inhalation exposure for a full work-shift (EPA assumed an 8-hour work-shift) as an output of the Monte Carlo simulation by summing the time-weighted inhalation exposures for each of the exposure points and assuming 1,1-dichloroethane exposures were zero outside these activities.

Table 5-12 summarizes the estimated 8-hour TWA exposures, AC, ADC, LADC, and $ADC_{subchronic}$ for repackaging 1,1-dichloroethane. The high-end exposures presented in Table 5-12 are the 95th percentiles of the respective simulation output, and the central tendency exposures are the 50th percentiles. Equations for calculating AC, ADC, LADC, and $ADC_{subchronic}$ are presented in Appendix B.

The estimated exposures assume that 1,1-dichloroethane is imported to the site in its pure form and repackaged into smaller containers, with no engineering controls present. Actual exposures may differ based on worker activities, 1,1-dichloroethane throughputs, and facility processes.

Table 5-12. Summary of Modeled Worker Inhalation Exposures for Processing—Repackaging of 1,1-Dichloroethane for Laboratory Chemicals

Modeled Scenario	Exposure Concentration Type	Central Tendency (mg/m^3)	High-End (mg/m^3)	Data Quality Rating of Air Concentration Data
2 sites, 22680 kg/yr production volume	8-hr TWA Exposure Concentration	3.5	13	N/A: Modeled data
	AC based on 8-hr TWA	2.4	8.8	
	ADC based on 8-hr TWA	1.8	6.4	
	LADC based on 8-hr TWA	1.7E−01	3.1	
	$ADC_{subchronic}$ based on 8-hr TWA	6.8E−02	1.6	

5.4.4.4 Occupational Dermal Exposure Results

EPA estimated dermal exposures for this OES using the *Dermal Exposure to Volatile Liquid Model* and a fraction absorbed value of 0.3 percent. The maximum concentration evaluated for this dermal exposure is 100% since 1,1-dichloroethane is expected to be received at the site in pure form. Table 5-13 summarizes the APDR, ARD, CRD (non-cancer), and CRD (cancer) for 1,1-dichloroethane during processing—repackaging. The high-ends are based on a higher loading rate of 1,1-dichloroethane (2.1 mg per cm^2 per event) and two-hand contact, and the central tendencies are based on a lower loading rate of 1,1-dichloroethane (1.4 mg per cm^2 per event) and one-hand contact. OES-specific parameters for dermal exposures are described in Appendix D.

Table 5-13. Summary of Dermal Exposure Doses to 1,1-Dichloroethane for Processing—Repackaging

Modeled Scenario	Exposure Concentration Type	High-End	Central Tendency
Average Adult Worker[a]	Acute Potential Dose Rate (APDR) (mg/day)	6.7	2.3
	Acute Retained Dose (ARD) (mg/kg-day)	8.0E−02	3.0E−02
	Short-Term/Subchronic Retained Dose, Non-cancer	6.0E−02	2.0E−02
	Chronic Retained Dose (CRD), non-cancer (mg/kg-day)	6.0E−02	2.0E−02
	Chronic Retained Dose (CRD), cancer (mg/kg-day)	3.0E−02	1.0E−02

[a] Conditions where no gloves are used, or for any glove / gauntlet use without permeation data and without employee training (PF = 1).

5.4.4.5 Weight of Scientific Evidence for Occupational Exposures

1,1-Dichloroethane monitoring data was not available for this scenario. Additionally, EPA did not identify relevant monitoring data from other scenarios or chemicals assessed in previous EPA Risk Evaluations. Therefore, EPA modeled inhalation exposures. EPA used assumptions and values from the *July 2022 Chemical Repackaging GS* (U.S. EPA, 2022a), which the systematic review process rated high for data quality, to assess inhalation exposures (OECD, 2009).

EPA used EPA/OPPT models combined with Monte Carlo modeling to estimate inhalation exposures. A strength of the Monte Carlo modeling approach is that variation in model input values and a range of potential exposure values is more likely than a discrete value to capture actual exposure at sites. The primary limitation is the uncertainty in the representativeness of values toward the true distribution of potential inhalation exposures. In addition, EPA lacks 1,1-dichloroethane facility production volume data; and therefore, throughput estimates are based on CDR reporting thresholds. Also, EPA could not estimate the number of exposure days per year associated with repackaging operations, so the exposure days per year estimates are based on an assumed site throughput of imported containers. Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is moderate and provides a plausible estimate of exposures.

EPA estimated dermal exposures using modeling methodologies, which are supported by moderate evidence. EPA used the *EPA Dermal Exposure to Volatile Liquids* to calculate the dermal retained dose. This model modifies the *EPA/OPPT 2-Hand Dermal Exposure to Liquids Model* by incorporating a “fraction absorbed (f_{abs})” parameter to account for the evaporation of volatile chemicals. These modifications improve the modeling methodology; however, the modeling approach is still limited by the low variability for different worker activities/exposure scenarios. Therefore, the weight of scientific for the modeling methodologies is moderate.

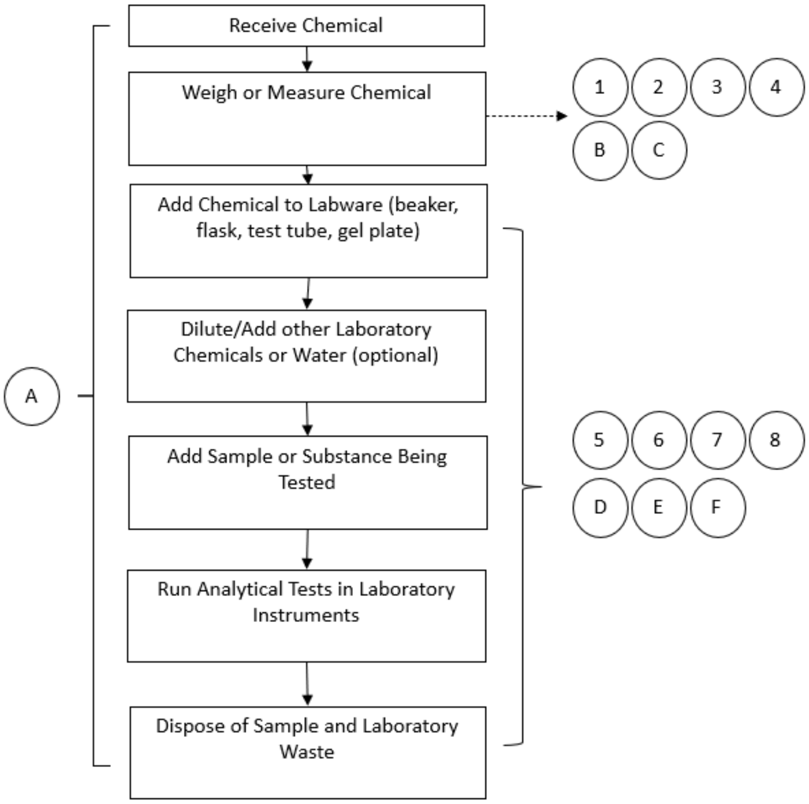
The exposure scenarios and exposure factors underlying the dermal assessment are supported by moderate to robust evidence. Dermal exposure scenarios were informed by moderate to robust process information and GS/ESD. Exposure factors for occupational dermal exposure include amount of material on the skin, surface area of skin exposed, and absorption of 1,1-dichloroethane through the skin. These exposure factors were informed by literature sources, the ChemSTEER User Guide (U.S. EPA, 2015) for standard exposure parameters, and a European model, with ratings from moderate to robust. Based on this information, EPA has concluded that the weight of scientific evidence for this assessment is moderate and provides a plausible estimate of exposures in consideration of the strengths and limitations of reasonably available data.

5.5 Commercial Use as a Laboratory Chemical

5.5.1 Process Description

Laboratory use was included in the *Final Scope of the Risk Evaluation for 1,1-Dichloroethane CASRN; 75-3-9* (U.S. EPA, 2020c) 1,1-Dichloroethane is used as a laboratory reference standard domestically for instrument calibration and analytical method validation (Sigma-Aldrich, 2020). 1,1-Dichloroethane may be received in transport containers ranging from 0.5 mL to 200 L (U.S. EPA, 2023). After receiving the chemical, it is typically weighed or measured using a balance, then added to labware such as a beaker, flask, test tube, or glass plate. If necessary, 1,1-dichloroethane may be diluted with water or mixed with another laboratory chemical to form a solution. Analytical tests may be performed such as extraction, distillation, chromatography, titration, filtration, or spectroscopy (U.S. EPA, 2023).

1,1-Dichloroethane is used for analytical standards, research, and equipment calibration and sample preparation applications. A critical use of 1,1-dichloroethane is a reference sample for analysis of terrestrial and extraterrestrial material samples (EPA-HQ-OPPT-2018-0426-0026). Multiple safety data sheets obtained by EPA described the concentration of 1,1-dichloroethane in gaseous and liquid laboratory products. The concentrations of 1,1-dichloroethane in laboratory chemicals range from 0.01 to <=100 percent (Sigma-Aldrich, 2020; Restek Corporation, 2019; Spex Certiprep, 2019; PerkinElmer Inc, 2018; Phenova, 2018; Airgas USA LLC, 2017, 2015; Chem Service, 2015; TCI America, 2014). Figure 5-5 below highlights typical release and exposure points during the use of laboratory chemicals.



Environmental Releases:

1. Release to air from transferring volatile chemicals from transport containers.
2. Release to air, water, incineration, or landfill from transferring solid powders.
3. Release to water, incineration, or land from cleaning or disposal of transport containers.
4. Release to air from cleaning containers used for volatile chemicals.
5. Labware equipment cleaning residuals released to water, incineration, or landfill.
6. Release to air during labware equipment cleaning for volatile chemicals.
7. Release to air from laboratory analyses for volatile chemicals.
8. Release to water, incineration, or landfill from laboratory waste disposal.

Occupational Exposures:

A. Full-shift inhalation and dermal exposure from all activities.
B. Inhalation and dermal exposure from unloading chemicals from transport containers (if full-shift estimates are not used).
C. Inhalation and dermal exposure during container cleaning throughout sample preparation and testing activities (if full-shift estimates are not used).
D. Inhalation and dermal exposure during equipment cleaning (if full-shift estimates are not used).
E. Inhalation and dermal exposure during laboratory analyses (if full-shift estimates are not used).
F. Inhalation and dermal exposure during disposal of laboratory chemicals (non-quantifiable).

Figure 5-5. Typical Release and Exposure Points During the Laboratory Use of 1,1-Dichloroethane (U.S. EPA, 2023)

5.5.2 Facility Estimates

EPA identified four relevant facilities in DMR and NEI. One of the facilities reported a release estimate that was below the LOD in DMR. Due to the lack of data on the annual PV of 1,1-dichloroethane as a laboratory chemical, EPA does not present annual or daily site throughputs. Almost all manufactured 1,1-dichloroethane is used for processing as a reactant, and only a small amount is used for laboratory use (RIVM, 2007). The environmental releases and occupational exposures during the laboratory use of 1,1-dichloroethane were modeled. As a conservative estimate, EPA assumes an annual 1,1-

dichloroethane production volume of 50,000 lb and a distribution of 43 to 138 sites. EPA additionally assumes between 174 and 260 (default) days of operation according to the Use of Laboratory Chemicals GS (U.S. EPA, 2023).

5.5.3 Release Assessment

5.5.3.1 Environmental Release Points

EPA expects releases to occur during the use of 1,1-dichloroethane as a laboratory chemical. EPA estimated releases using a Monte Carlo simulation with 100,000 iterations and the Latin Hypercube sampling method using the models and approaches described in Appendix E. Input parameters and release points for the models were determined using data from literature and the Use of Laboratory Chemicals—Generic Scenario for Estimating Occupational Exposures and Environmental Releases (U.S. EPA, 2023). Specific release sources considered for estimating releases are shown numbered as 1 through 8 in Figure 5-5. Per the GS, EPA expects fugitive or stack air releases from unloading containers, cleaning containers, cleaning laboratory equipment, and performing laboratory analyses. Additionally, EPA expects releases to incineration or landfill.

5.5.3.2 Environmental Release Assessment Results

EPA estimated releases using a Monte Carlo simulation with 100,000 iterations and the Latin Hypercube sampling method using the models and approaches described in Appendix E for this OES. Input parameters for the models were determined using data from literature and the Use of Laboratory Chemicals—Generic Scenario for Estimating Occupational Exposures and Environmental Releases (U.S. EPA, 2023). EPA estimated 1,1-dichloroethane releases by simulating a scenario of an annual production volume of 1,1-dichloroethane of 50,000 lb across all laboratories. Table 5-14 summarizes the estimated release results for 1,1-dichloroethane use in laboratory chemicals based on the scenario applied. The high-ends are the 95th percentile of the respective simulation output and the central tendencies are the 50th percentile.

Table 5-14. Summary of Modeled Environmental Releases for the Commercial Use of 1,1-Dichloroethane as a Laboratory Chemical

Modeled Scenario	Environmental Media	Annual Release (kg/site-yr)		Number of Release Days[a]		Daily Release (kg/site-day)	
		Central Tendency	High-End	Central Tendency	High-End	Central Tendency	High-End
50,000 lb. production volume	Fugitive or Stack Air	1.7E01	3.0E01	235	258	7.4E−02	1.3E−01
	Hazardous landfill or incineration	5.0E02	8.8E02	235	258	2.2	3.7

[a] The number of release days presented in this table is based on simulation outputs for the annual release divided by the daily release (grouped by high-end or central tendency estimate), rounded to the closest integer. Annual totals may not add exactly due to rounding.

5.5.3.3 Weight of Scientific Evidence for Environmental Releases

EPA identified two facilities reporting water and air releases of 1,1-dichloroethane, However, EPA determined this data is not sufficient to capture the entirety of environmental releases for this scenario. Therefore, releases to the environment are assessed using the Draft GS on the Use of Laboratory Chemicals, which has a high data quality rating from the systematic review process (U.S. EPA, 2023). EPA used EPA/OPPT models combined with Monte Carlo modeling to estimate releases to the environment, with media of release assessed using assumptions from the ESD and EPA/OPPT models.

EPA assumed that the media of release for disposal of laboratory waste is to hazardous waste landfill or incineration.

EPA believes a strength of the Monte Carlo modeling approach is that variation in model input values and a range of potential releases values is more likely than a discrete value to capture actual releases at sites. EPA believes the primary limitation to be the uncertainty in the representativeness of values toward the true distribution of potential releases. In addition, EPA lacks 1,1-dichloroethane laboratory chemical throughput data and number of laboratories; therefore, number of laboratories and throughput estimates are based on stock solution throughputs from the Draft GS on the Use of Laboratory Chemicals and on CDR reporting thresholds.

Based on this information, EPA has concluded that the weight of scientific evidence for this assessment is moderate and provides a plausible estimate of releases in consideration of the strengths and limitations of reasonably available data.

5.5.4 Occupational Exposure Assessment

5.5.4.1 Worker Activities

During the use of 1,1-dichloroethane as a laboratory chemical, workers are potentially exposed to 1,1-dichloroethane during the following activities: transferring 1,1-dichloroethane from transport containers to labware, laboratory sampling/analyses, and laboratory container/equipment cleaning. During these activities workers may be exposed via inhalation of vapor or dermal contact with 1,1-dichloroethane. According to the Vinyl Institute Test Order Report, workers in laboratory areas wear the following standard PPE: fire-resistant clothing, lab coat, safety glasses, chemical splash goggles, nitrile gloves, and steel toed boots. The report also listed the following task-specific PPE: half-face dust respirator (when adding dry standards), half face respirator with organic vapor cartridges (when standards are weighed on benchtop), chemical splash goggles, face shield, and nitrile gloves (Stantec ChemRisk, 2023).

ONUs include employees (*e.g.*, supervisors, managers) present at the laboratory site that do not directly handle 1,1-dichloroethane. Therefore, the ONUs are expected to have lower inhalation exposures, lower vapor-through-skin uptake, and no expected dermal exposure.

5.5.4.2 Number of Workers and Occupational Non-users

EPA used data from the Bureau of Labor Statistics (BLS) and the U.S. Census' Statistics of US Businesses (SUSB) specific to the OES to estimate the number of workers and ONUs per site potentially exposed to 1,1-dichloroethane during its use as a laboratory chemical (U.S. BLS, 2016; U.S. Census Bureau, 2015). This approach involved the identification of relevant Standard Occupational Classification (SOC) codes within the BLS data for the identified NAICS codes. Appendix A includes further details regarding methodology for estimating the number of workers and ONUs per site. EPA assigned the following NAICS codes for this OES:

- 541380: Testing Laboratories
- 541713: Research and Development in Nanotechnology
- 541714: Research and Development in Biotechnology (except Nanobiotechnology)
- 541713: Research and Development in the Physical, Engineering, and Life Sciences (Except Nanotechnology and Biotechnology)

Table 5-15 summarizes the per site estimates for this OES based on the methodology described, including the potential number of sites identified in Section 5.5.2.

Table 5-15. Estimated Number of Workers Potentially Exposed to 1,1-Dichloroethane During the Commercial Use as a Laboratory Chemical

Potential Number of Sites	NAICS Code	Estimated Average Exposed Workers per Site[a]	Estimated Average Exposed Occupational Non-users per Site[a]
43-138	541380: Testing Laboratories	2	16
	541713– Research and Development in Nanotechnology		
	541714– Research and Development in Biotechnology (except Nanobiotechnology)		
	541713– Research and Development in the Physical, Engineering, and Life Sciences (Except Nanotechnology and Biotechnology)		

[a] Number of workers and occupational non-users per site are calculated by dividing the exposed number of workers or occupational non-users by the number of establishments.

5.5.4.3 Occupational Inhalation Exposure Results

Occupational inhalation data for 1,1-dichloroethane during the manufacturing process were provided via a test order submission from the Vinyl Institute, which includes manufacturers and processors of 1,1-dichloroethane. During the manufacturing process, EPA identified nine worker full-shift samples for laboratory technicians. While there may be some difference between the activities between laboratory technicians during the manufacturing process and the commercial laboratory use OES, EPA assumes the laboratory exposures to be similar.

From this monitoring data, EPA calculated the 50th and 95th percentile 8-hr TWA concentrations to represent a central tendency and high-end estimate of potential occupational inhalation exposures, respectively, for this scenario. Using these 8-hr TWA exposure concentrations, EPA calculated the AC, $ADC_{subchronic}$, ADC, and LADC as described in Appendix B. The results of these calculations are shown in Table 5-16.

Table 5-16. Inhalation Exposures to 1,1-Dichloroethane During Commercial Use of Laboratory Chemicals

Exposure Type	Worker Inhalation Estimates (ppm)		ONU Inhalation Estimates (ppm)	
	High-End	Central Tendency	High-End	Central Tendency
8-hour TWA Exposure Concentrations	2.4E−02	1.1E−03	1.1E−03	1.1E−03
Acute Exposure Concentrations (AC)	1.6E−02	7.7E−04	7.7E−04	7.7E−04

Exposure Type	Worker Inhalation Estimates (ppm)		ONU Inhalation Estimates (ppm)	
	High-End	Central Tendency	High-End	Central Tendency
Subchronic Average Daily Concentration ($ADC_{subchronic}$)	1.0E−02	5.7E−04	5.7E−04	5.7E-04
Average Daily Concentration (ADC)	1.1E−02	3.7E−04	5.3E−04	3.7E−04
Lifetime Average Daily Concentration (LADC)	5.6E−03	1.5E−04	2.7E−04	1.5E−04

For comparison, EPA referenced the *2022 Draft GS on the Use of Laboratory Chemicals* (U.S. EPA, 2023), which listed surrogate data from 1,4-dioxane, methylene chloride, NMP, and PCE.

The GS presents the following two options:

1. Compare the molecular weight and vapor pressure for the chemical of interest to the available surrogate data listed in Table 5-4 of the GS for 1,4-dioxane, methylene chloride, NMP, and PCE.
2. If the chemical of interest is not comparable in molecular weight and vapor pressure to the chemicals in Table 5-4, EPA recommends assessing an exposure concentration of 0.87 ppm (central tendency) to 8.18 ppm (high-end) for workers based on all available data in that table.

1,4-Dioxane and methylene chloride are the closest in molecular weight and vapor pressure to 1,1-dichloroethane, although, they are not a direct match. Therefore, EPA used the highest values between option one (1,4-dioxane and methylene chloride data) and option two to determine the exposure estimates presented in Table 5-17 (U.S. EPA, 2020f, h).

Table 5-17. Inhalation Exposures to 1,1-Dichloroethane During Commercial Use of Laboratory Chemicals Using Surrogate Data

Exposure Type	Worker Inhalation Estimates (ppm)		ONU Inhalation Estimates (ppm)	
	High-End	Central Tendency	High-End	Central Tendency
8-hour TWA Exposure Concentrations	15	0.90	0.90	

The surrogate data resulted in high-end inhalation estimates of 15 ppm, which is several orders of magnitude higher than the estimate of 2.4×10^{-2} ppm.

5.5.4.4 Occupational Dermal Exposure Results

EPA estimated dermal exposures for this OES using the *Dermal Exposure to Volatile Liquid Model* and a fraction absorbed value of 0.3 percent. The maximum concentration evaluated for this dermal exposure is 100% since 1,1-dichloroethane is expected to be received at the site in pure form. Table 5-18 summarizes the APDR, ARD, SCDD, CRD (non-cancer), and CRD (cancer) for 1,1-dichloroethane during commercial use as a laboratory chemical. The high-ends are based on a higher loading rate of 1,1-dichloroethane (2.1 mg per cm^2 per event) and two-hand contact, and the central tendencies are based on a lower loading rate of 1,1-dichloroethane (1.4 mg per cm^2 per event) and one-hand contact. OES-specific parameters for dermal exposures are described in Appendix D.

Table 5-18. Summary of Dermal Exposure Doses to 1,1-Dichloroethane for Commercial Use as a Laboratory Chemical

Modeled Scenario	Exposure Concentration Type	High-End	Central Tendency
Average Adult Worker[a]	Acute Potential Dose Rate (APDR) (mg/day)	6.7	2.3
	Acute Retained Dose (ARD) (mg/kg-day)	8.0E−02	3.0E−02
	Subchronic Average Daily Dose (SCDD), non-cancer (mg/kg-day)	6.0E−02	2.0E−02
	Chronic Retained Dose (CRD), non-cancer (mg/kg-day)	6.0E−02	2.0E−02
	Chronic Retained Dose (CRD), cancer (mg/kg-day)	3.0E−02	1.0E−02

[a] Conditions where no gloves are used, or for any glove / gauntlet use without permeation data and without employee training (PF = 1).

5.5.4.5 Weight of Scientific Evidence for Occupational Exposures

EPA considered the assessment approach, the quality of the data, and uncertainties in assessment results to determine a weight of scientific evidence conclusion for the 8-hr TWA inhalation exposure estimates. EPA used inhalation data to assess inhalation exposures. The primary strength of these data is the use of personal and potentially applicable data. The primary limitation is the number of samples available for workers. Data was not available for ONUs. Additionally, there is uncertainty in the representativeness of these data toward the true distribution of inhalation concentrations in this scenario since the laboratory use occurred in a manufacturing setting. EPA assumed 250 exposure days per year based on 1,1-dichloroethane exposure each working day for a typical worker schedule; it is uncertain whether this captures actual worker schedules and exposures.

Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is moderate and provides a plausible estimate of exposures in consideration of the strengths and limitations of reasonably available data.

EPA estimated dermal exposures using modeling methodologies, which are supported by moderate evidence. EPA used the EPA Dermal Exposure to Volatile Liquids to calculate the dermal retained dose. This model modifies the EPA/OPPT 2-Hand Dermal Exposure to Liquids Model by incorporating a "fraction absorbed (f_{abs})" parameter to account for the evaporation of volatile chemicals. These modifications improve the modeling methodology; however, the modeling approach is still limited by the low variability for different worker activities/exposure scenarios. Therefore, the weight of scientific for the modeling methodologies is moderate.

The exposure scenarios and exposure factors underlying the dermal assessment are supported by moderate to robust evidence. Dermal exposure scenarios were informed by moderate to robust process information and GS/ESD. Exposure factors for occupational dermal exposure include amount of material on the skin, surface area of skin exposed, and absorption of 1,1-dichloroethane through the skin. These exposure factors were informed by literature sources, the ChemSTEER User Guide (U.S. EPA, 2015) for standard exposure parameters, and a European model, with ratings from moderate to robust. Based on these strengths and limitations, EPA concluded that the weight of scientific evidence for the dermal exposure assessment is moderate to robust for all OES.

5.6 Waste Handling, Treatment, and Disposal

5.6.1 Process Description

Each of the conditions of use of 1,1-dichloroethane may generate waste streams of the chemical that are collected and transported to third-party sites for disposal or treatment, and these cases are assessed under this condition of use. Industrial sites that treat or dispose onsite wastes that they themselves generate are assessed within that relevant condition of use assessment. Similarly, point source discharges of 1,1-dichloroethane to surface water are assessed within that relevant condition of use in Sections 5.1 through 5.6 (point source discharges are exempt as solid wastes under RCRA). Remediation is also included in this condition of use, which involves the containment and mitigation of contaminations following environmental incidents. Remediation sites that release 1,1-dichloroethane were identified based on 2015 to 2020 DMR data. Some of these sites were listed on the EPA RCRA Corrective Action (CA) sites list. Wastes of 1,1-dichloroethane that are generated during a condition of use and sent to a third-party site for treatment, disposal, or recycling may include the following:

- Wastewater: 1,1-Dichloroethane may be contained in wastewater discharged to POTW or other, non-public treatment works for treatment. Industrial wastewater containing 1,1-dichloroethane discharged to a POTW may be subject to EPA or authorized NPDES state pretreatment programs. The assessment of wastewater discharges to POTWs and non-public treatment works of 1,1-dichloroethane is included in each of the condition of use assessments in Sections 5.1 through 5.6.

- Solid Wastes: Solid wastes are defined under RCRA as any material that is discarded by being abandoned, inherently waste-like, a discarded military munition, or recycled in certain ways (certain instances of the generation and legitimate reclamation of secondary materials are exempted as solid wastes under RCRA). Solid wastes may subsequently meet RCRA’s definition of hazardous waste by either being listed as a waste at 40 CFR 261.30 to 261.35 or by meeting waste-like characteristics as defined at 40 CFR 261.20 to 261.24. Solid wastes that are hazardous wastes are regulated under the more stringent requirements of Subtitle C of RCRA, whereas non-hazardous solid wastes are regulated under the less stringent requirements of Subtitle D of RCRA.

- 1,1-Dichloroethane is a U-listed hazardous waste under code U076 under RCRA: therefore, discarded, unused pure and commercial grades of 1,1-dichloroethane are regulated as a hazardous waste under RCRA (40 CFR 261.33(f)).

- Wastes Exempted as Solid Wastes under RCRA: Certain conditions of use of 1,1-dichloroethane may generate wastes of 1,1-dichloroethane that are exempted as solid wastes under 40 CFR 261.4(a). For example, the generation and legitimate reclamation of hazardous secondary materials of 1,1-dichloroethane may be exempt as a solid waste.

2020 TRI data lists off-site transfers of 1,1-dichloroethane to land disposal, wastewater treatment, incineration, and recycling facilities. About 57% of off-site transfers were sent to wastewater treatment, 38% were recycled off-site, 4% were incinerated, and less than 1% is sent to land disposal (U.S. EPA, 2017b). Since almost all manufactured 1,1-dichloroethane is reacted in the production of other chemicals, waste containing 1,1-dichloroethane will primarily be received from laboratory use sites (RIVM, 2007).

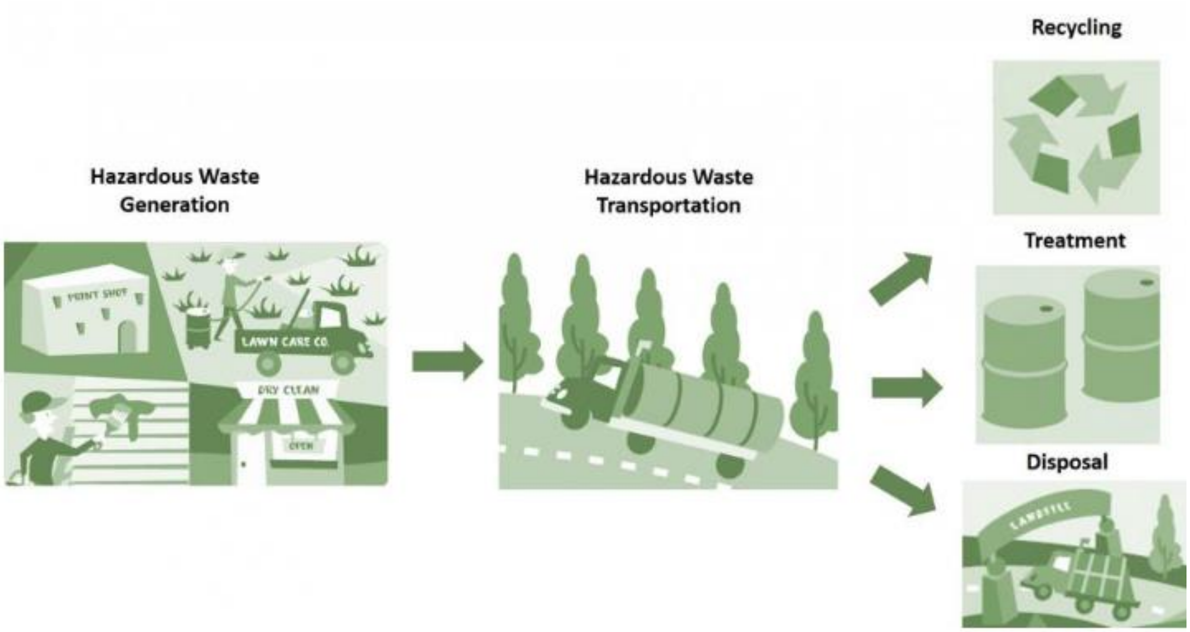


Figure 5-6. Typical Waste Disposal Process (U.S. EPA, 2017a)

Municipal Waste Incineration

Municipal waste combustors (MWCs) that recover energy are generally located at large facilities comprising an enclosed tipping floor and a deep waste storage pit. Typical large MWCs may range in capacity from 250 to over 1,000 tons per day. At facilities of this scale, waste materials are not generally handled directly by workers. Trucks may dump the waste directly into the pit, or waste may be tipped to the floor and later pushed into the pit by a worker operating a front-end loader. A large grapple from an overhead crane is used to grab waste from the pit and drop it into a hopper, where hydraulic rams feed the material continuously into the combustion unit at a controlled rate. The crane operator also uses the grapple to mix the waste within the pit, in order to provide a fuel consistent in composition and heating value, and to pick out hazardous or problematic waste.

Facilities burning refuse-derived fuel (RDF) conduct on-site sorting, shredding, and inspection of the waste prior to incineration to recover recyclables and remove hazardous waste or other unwanted materials. Sorting is usually an automated process that uses mechanical separation methods, such as trommel screens, disk screens, and magnetic separators. Once processed, the waste material may be transferred to a storage pit, or it may be conveyed directly to the hopper for combustion.

Tipping floor operations may generate dust. Air from the enclosed tipping floor, however, is continuously drawn into the combustion unit via one or more forced air fans to serve as the primary combustion air and minimize odors. Dust and lint present in the air is typically captured in filters or other cleaning devices in order to prevent the clogging of steam coils, which are used to heat the combustion air and help dry higher-moisture inputs (Kitto and Stultz, 1992).

Hazardous Waste Incineration

Commercial scale hazardous waste incinerators are generally two-chamber units, a rotary kiln followed by an afterburner, that accept both solid and liquid waste. Liquid wastes are pumped through pipes and are fed to the unit through nozzles that atomize the liquid for optimal combustion (Figure 5-7). Solids may be fed to the kiln as loose solids gravity fed to a hopper, or in drums or containers using a conveyor (ETC Hazardous Waste Resources Center, 2018); (Heritage, 2018).

Incoming hazardous waste is usually received by truck or rail, and an inspection is required for all waste received. Receiving areas for liquid waste generally consist of a docking area, pumphouse, and some kind of storage facilities. For solids, conveyor devices are typically used to transport incoming waste (Kitto and Stultz, 1992); (ETC Hazardous Waste Resources Center, 2018)

Smaller scale units that burn municipal solid waste or hazardous waste (such as infectious and hazardous waste incinerators at hospitals) may require more direct handling of the materials by facility personnel. Units that are batch-loaded require the waste to be placed on the grate prior to operation and may involve manually dumping waste from a container or shoveling waste from a container onto the grate.

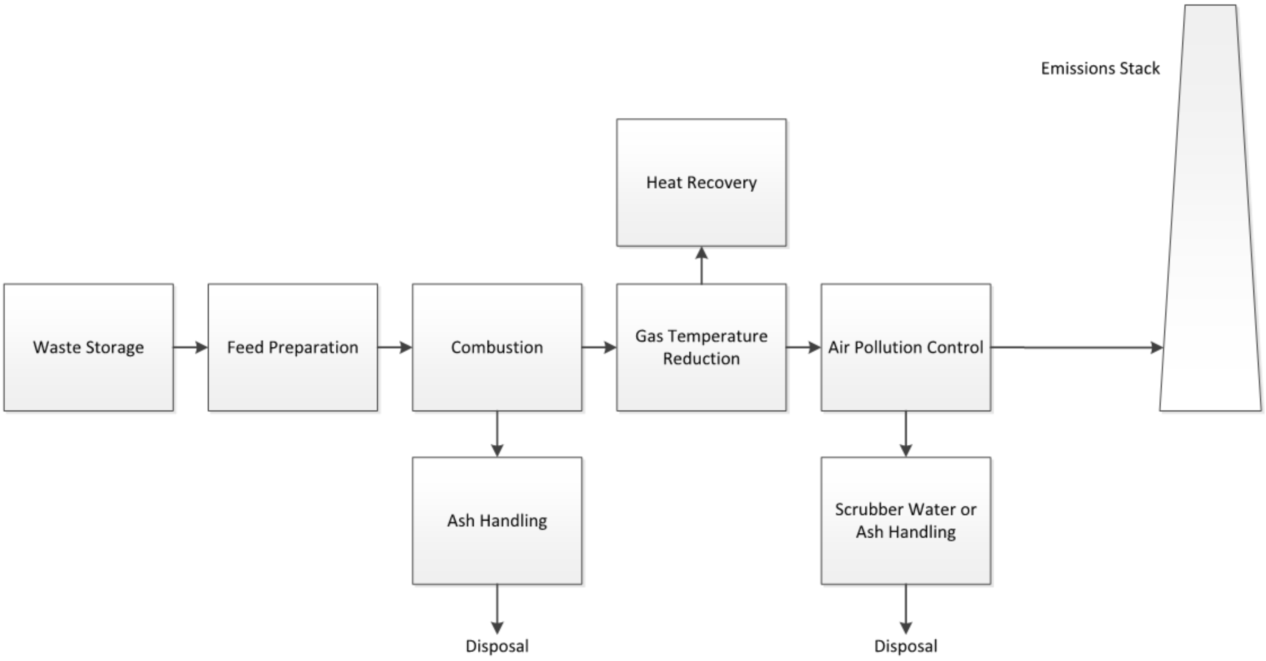


Figure 5-7. Typical Industrial Incineration Process

Municipal Waste Landfill

Municipal solid waste landfills are discrete areas of land or excavated sites that receive household wastes and other types of non-hazardous wastes (*e.g.*, industrial and commercial solid wastes). Standards and requirements for municipal waste landfills include location restrictions, composite liner requirements, leachate collection and removal system, operating practices, groundwater monitoring requirements, closure-and post-closure care requirements, corrective action provisions, and financial assurance. Non-hazardous solid wastes are regulated under RCRA Subtitle D, but states may impose more stringent requirements.

Municipal solid wastes may be first unloaded at waste transfer stations for temporary storage, prior to being transported to the landfill or other treatment or disposal facilities.

Hazardous Waste Landfill

Hazardous waste landfills are excavated or engineered sites specifically designed for the final disposal of non-liquid hazardous wastes. Design standards for these landfills require double liner, double leachate collection and removal systems, leak detection system, run on, runoff and wind dispersal controls, and construction quality assurance program (U.S. EPA, 2018b). There are also requirements for closure and post-closure, such as the addition of a final cover over the landfill and continued monitoring and maintenance. These standards and requirements prevent potential contamination of groundwater and nearby surface water resources. Hazardous waste landfills are regulated under Part 264/265, Subpart N.

5.6.2 Facility Estimates

Using release data, EPA identified 672 non-POTW (general) and 125 POTW facilities under this OES. Additionally, EPA identified 42 remediation sites that release 1,1-dichloroethane based on DMR data. Due to the lack of data on the annual PV of 1,1-dichloroethane for waste handling, treatment, and disposal, EPA does not present annual or daily site throughputs. EPA did not identify data on facility operating schedules; therefore, EPA assumes 250 days/yr of operation as discussed in Section 2.3.2.

5.6.3 Release Assessment

5.6.3.1 Environmental Release Points

Sources of potential environmental release include the unloading of solid or liquid waste containers. Releases may occur while connecting and disconnecting of transfer lines and hoses, and during the treatment of waste. EPA expects releases to air of volatile 1,1-dichloroethane during waste handling, treatment, and disposal. Additionally, EPA expects releases of solid or liquid waste to land.

5.6.3.2 Environmental Release Assessment Results

EPA used 2015 to 2020 DMR, 2015 to 2020 TRI, and 2017 NEI to estimate environmental releases during general waste handling, treatment, and disposal, as presented in Table 5-19. For non-POTW, 1,1-dichloroethane is released through the following environmental media: surface water, fugitive air, and stack air.

Table 5-19. Summary of Environmental Releases During General Waste Handling, Treatment, and Disposal

Environmental Media	Estimated Yearly Release Range across Sites (kg/yr)		Number of Release Days	Daily Release (kg/site-day)		Number of Facilities	Source(s)
	Central Tendency	High-End		Central Tendency	High-End		
Surface water	9.3E–04	6.0E–03	250	3.7E–06	2.4E–05	22	TRI/DMR
Fugitive air	0.63	7.3		2.5E–03	2.9E–02	7	TRI
Fugitive air	34	202		0.14	0.81	575	NEI
Stack air	1.8E–02	0.82		7.3E–05	3.3E–03	8	TRI
Stack air	2.5	134		1.0E–02	0.54	153	NEI

EPA used 2015 to 2020 DMR to estimate environmental releases during Waste handling, treatment, and disposal (POTW), as presented in Table 5-20.

Table 5-20. Summary of Environmental Releases During Waste Handling, Treatment, and Disposal (POTW)

Environmental Media	Estimated Yearly Release Range across Sites (kg/yr)		Number of Release Days	Daily Release (kg/site-day)		Number of Facilities	Source(s)
	Central Tendency	High-End		Central Tendency	High-End		
Surface water	5.1E−03	8.9E−02	365	1.4E–05	2.4E–04	126	DMR

EPA used 2015 to 2020 DMR to estimate environmental releases during waste handling, treatment, and disposal (remediation), as presented in Table 5-21. For remediation, 1,1-dichloroethane is released through the surface water.

Table 5-21. Summary of Environmental Releases During Waste Handling, Treatment, and Disposal (Remediation)

Environmental Media	Estimated Yearly Release Range across Sites (kg/yr)		Number of Release Days	Daily Release (kg/site-day)		Number of Facilities	Source(s)
	Central Tendency	High-End		Central Tendency	High-End		
Surface water	2.9E–04	8.5E−03	250	8.0E−07	2.3E−05	42	DMR

5.6.3.3 Weight of Scientific Evidence for Environmental Releases

General Waste Handling, Treatment, and Disposal

Water releases for non-POTW sites are assessed using reported releases from 2015 to 2020 TRI and DMR. The primary strength of TRI data is that TRI compiles the best readily available release data for all reporting facilities. For non-POTW sites, the primary limitation is that the water release assessment is based on 22 reporting sites, and EPA did not have additional sources to estimate water releases from this OES. Based on other reporting databases such as NEI, there are additional sites that are not accounted for in this assessment.

Air releases for non-POTW sites are assessed using reported releases from 2015 to 2020 TRI, and 2014 and 2017 NEI. A strength of NEI data is that NEI captures additional sources that are not included in TRI due to reporting thresholds. Factors that decrease the confidence for this OES include the uncertainty in the accuracy of reported releases, and the limitations in representativeness to all sites because TRI and NEI may not capture all relevant sites. The air release assessment is based on 650 reporting sites. Based on other reporting databases (CDR and DMR), there are 22 additional non-POTW sites that are not accounted for in this assessment. Additionally, EPA made assumptions on the number of operating days to estimate daily releases. EPA found that major sources of air emissions of 1,1-dichloroethane in landfills come from sources other than 1,1-dichloroethane COUs of Manufacture, Processing, and Commercial Use, specifically, the decomposition of 1,1,1-trichloroethane. However, it is unclear how much 1,1,1-trichloroethane is disposed to landfills and how much 1,1-dichloroethane is generated.

Based on this information, EPA has concluded that the weight of scientific evidence for this assessment is moderate to robust and provides a plausible estimate of releases in consideration of the strengths and limitations of reasonably available data.

Waste Handling, Treatment, and Disposal (POTW and Remediation)

Water releases for POTW and remediation sites are assessed using reported releases from 2015 to 2020 DMR, which has a medium overall data quality determination from the systematic review process. However, the Variability and Uncertainty data quality metric was determined to be low. A strength of using DMR data and the Pollutant Loading Tool is that the tool calculates an annual pollutant load by integrating monitoring period release reports provided to the EPA and extrapolating over the course of the year. However, this approach assumes average quantities, concentrations, and hydrologic flows for a given period are representative of other times of the year. Based on this information, for POTW releases, EPA has concluded that the weight of the scientific evidence for this assessment is moderate to robust and provides a plausible estimate of releases in consideration of the strengths and limitations of reasonably available data.

5.6.4 Occupational Exposure Assessment

5.6.4.1 Worker Activities

Workers are potentially exposed to 1,1-dichloroethane during waste handling, treatment and disposal during the unloading and cleaning of transport containers. Workers may experience inhalation of vapor or dermal contact with liquids during the unloading process. EPA did not find information that indicates the extent that engineering controls and worker PPE are used at facilities that handle, treat, and dispose of waste containing 1,1-dichloroethane in the United States.

ONUs include employees that work at the sites where waste containing 1,1-dichlrooethane is treated, but they do not directly handle the chemical and are therefore expected to have lower inhalation exposures and are not expected to have dermal exposures through contact with liquids or solids. ONUs for this scenario include supervisors, managers, and other employees that may be in the waste handling or treatment area but do not perform tasks that result in the same level of exposure as those workers that engage in tasks related to the handling or treatment of waste containing 1,1-dichlroethane.

5.6.4.2 Number of Workers and Occupational Non-users

EPA used data from the Bureau of Labor Statistics (BLS) and the U.S. Census' Statistics of US Businesses (SUSB) specific to the OES to estimate the number of workers and ONUs per site potentially exposed to 1,1-dichloroethane during waste handling, treatment, and disposal (U.S. BLS, 2016; U.S. Census Bureau, 2015). This approach involved the identification of relevant Standard Occupational Classification (SOC) codes within the BLS data for the identified NAICS codes. Appendix Aincludes further details regarding methodology for estimating the number of workers and ONUs per site. EPA assigned the following NAICS codes for this OES:

- 562211: Hazardous Waste Treatment and Disposal
- 562213: Solid Waste Combustors and Incinerators
- 325211: Plastics Material and Resin Manufacturing
- 327310: Cement Manufacturing
- 327992: Ground Treated Mineral and Earth Manufacturing
- 221320: Sewage Treatment Facilities

Table 5-22 summarizes the per site estimates for this OES based on the methodology described, including the potential number of sites identified in Section 5.6.2.

Table 5-22. Estimated Number of Workers Potentially Exposed to 1,1-Dichloroethane During Waste Handling, Disposal, and Treatment

Potential Number of Sites	NAICS Code	Estimated Average Exposed Workers per Site[a]	Estimated Average Exposed Occupational Non-users per Site[a]
672	562211: Hazardous Waste Treatment and Disposal	49	15
	562213: Solid Waste Combustors and Incinerators		
	325211: Plastics Material and Resin Manufacturing		
	327310: Cement Manufacturing		
	327992: Ground Treated Mineral and Earth Manufacturing		
125	221320: Sewage Treatment Facilities	24	12

[a] Number of workers and occupational non-users per site are calculated by dividing the exposed number of workers or occupational non-users by the number of establishments.

5.6.4.3 Occupational Inhalation Exposure Results

No monitoring data were found for workers or ONUs during waste handling, treatment, and disposal of 1,1-dichloroethane. Therefore, EPA used surrogate data from 1,2-dichloroethane, as well as other volatile liquids assessed in previous EPA Risk Evaluations to use as surrogate monitoring data for the same OES (U.S. EPA, 2024).

For general waste handling, treatment and disposal OES, EPA identified 22 full-shift worker samples from methylene chloride. For the waste handling, treatment, and disposal (POTW) OES, EPA identified three full-shift worker samples from 1,2-dichloroethane. In both cases, the OES are directly analogous; therefore, EPA expects the process and associated exposure points to be the same or similar. EPA applied a vapor correction factor when determining the exposure estimates for these OES. EPA did not assess occupational exposures during remediation of 1,1-dichloroethane.

From this monitoring data, EPA calculated the 50th and 95th percentile 8-hr TWA concentrations to represent a central tendency and high-end estimate of potential occupational inhalation exposures, respectively, for this scenario. Using these 8-hr TWA exposure concentrations, EPA calculated the AC, $ADC_{subchronic}$, ADC, and LADC as described in Appendix B. The results of these calculations are shown in Table 5-23 and Table 5-24.

Table 5-23. Inhalation Exposures of Workers to 1,1-Dichloroethane During General Waste Handling, Treatment, and Disposal

Exposure Type	Worker Inhalation Estimates (ppm)		ONU Inhalation Estimates (ppm)	
	High-End	Central Tendency	High-End	Central Tendency
8-hour TWA Exposure Concentrations	10	0.30	0.30	0.30
Acute Exposure Concentrations (AC)	7.1	0.20	0.20	0.20
Subchronic Average Daily Concentration ($ADC_{subchronic}$)	5.2	0.15	0.15	0.15
Average Daily Concentration (ADC)	4.9	0.14	0.14	0.14
Lifetime Average Daily Concentration (LADC)	2.5	5.5E−02	7.1E−02	5.5E−02

Table 5-24. Inhalation Exposures of Workers to 1,1-Dichloroethane During Waste Handling, Treatment, and Disposal (POTW)

Exposure Type	Worker Inhalation Estimates (ppm)		ONU Inhalation Estimates (ppm)	
	High-End	Central Tendency	High-End	Central Tendency
8-hour TWA Exposure Concentrations	0.68	0.25	0.25	0.25
Acute Exposure Concentrations (AC)	0.46	0.17	0.17	0.17
Subchronic Average Daily Concentration ($ADC_{subchronic}$)	0.34	0.13	0.13	0.13
Average Daily Concentration (ADC)	0.32	0.12	0.12	0.12
Lifetime Average Daily Concentration (LADC)	0.16	4.7E−02	6.1E−02	4.7E−02

5.6.4.4 Occupational Dermal Exposure Results

EPA estimated dermal exposures for this OES using the *Dermal Exposure to Volatile Liquid Model* and a fraction absorbed value of 0.3 percent. The maximum concentration evaluated for this dermal exposure is 100% since 1,1-dichloroethane is expected to be received at the site in pure form. Table 5-25 and Table 5-26 summarize the APDR, ARD, SCDD, CRD (non-cancer), and CRD (cancer) for 1,1-dichloroethane during waste handling, treatment, and disposal (general and POTW). The high-ends are based on a higher loading rate of 1,1-dichloroethane (2.1 mg per cm^2 per event) and two-hand contact, and the central tendencies are based on a lower loading rate of 1,1-dichloroethane (1.4 mg per cm^2 per event) and one-hand contact. OES-specific parameters for dermal exposures are described in Appendix D.

Table 5-25. Summary of Dermal Exposure Doses to 1,1-Dichloroethane for General Waste Handling, Treatment, and Disposal

Modeled Scenario	Exposure Concentration Type	High-End	Central Tendency
Average Adult Worker[a]	Acute Potential Dose Rate (APDR) (mg/day)	6.7	2.3
	Acute Retained Dose (ARD) (mg/kg-day)	8.0E−02	3.0E−02
	Subchronic Average Daily Dose (SCDD), non-cancer (mg/kg-day)	6.0E−02	2.0E−02
	Chronic Retained Dose (CRD), non-cancer (mg/kg-day)	6.0E−02	2.0E−02
	Chronic Retained Dose (CRD), cancer (mg/kg-day)	3.0E−02	1.0E−02

[a] Conditions where no gloves are used, or for any glove/gauntlet use without permeation data and without employee training (PF = 1).

Table 5-26. Summary of Dermal Exposure Doses to 1,1-Dichloroethane for Waste Handling, Treatment, and Disposal (POTW)

Modeled Scenario	Exposure Concentration Type	High-End	Central Tendency
Average Adult Worker[a]	Acute Potential Dose Rate (APDR) (mg/day)	6.7	2.3
	Acute Retained Dose (ARD) (mg/kg-day)	8.0E−02	3.0E−02
	Subchronic Average Daily Dose (SCDD), non-cancer (mg/kg-day)	6.0E−02	2.0E−02
	Chronic Retained Dose (CRD), non-cancer (mg/kg-day)	6.0E−02	2.0E−02
	Chronic Retained Dose (CRD), cancer (mg/kg-day)	3.0E−02	1.0E−02

[a] Conditions where no gloves are used, or for any glove / gauntlet use without permeation data and without employee training (PF = 1).

5.6.4.5 Weight of Scientific Evidence for Occupational Exposures

General Waste Handling, Treatment, and Disposal

1,1-dichloroethane monitoring data was not available for this scenario. Additionally, EPA did not identify 1,1-dichloroethane monitoring data from other scenarios. Therefore, EPA used surrogate inhalation data from methylene chloride to assess inhalation exposures. The primary limitations of these data include the uncertainty of the representativeness of these data toward the true distribution of inhalation concentrations in this scenario since the data were surrogate from methylene chloride, which results in a moderate confidence rating. EPA also assumed 250 exposure days per year based on 1,1-dichloroethane exposure each working day for a typical worker schedule; it is uncertain whether this captures actual worker schedules and exposures.

Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is moderate and provides a plausible estimate of exposures in consideration of the strengths and limitations of reasonably available data.

Waste Handling, Treatment, and Disposal (POTW)

EPA used inhalation data to assess inhalation exposures. The primary limitations of these data include the uncertainty of the representativeness of these data toward the true distribution of inhalation concentrations in this scenario since the data were surrogate from 1,2-dichloroethane, which results in a low confidence rating. In addition, the available surrogate data only provided three worker inhalation monitoring data samples for wastewater treatment. EPA also assumed 250 exposure days per year based on 1,1-dichloroethane exposure each working day for a typical worker schedule; it is uncertain whether this captures actual worker schedules and exposures.

Based on these strengths and limitations, EPA has concluded that the weight of scientific evidence for this assessment is moderate and provides a plausible estimate of exposures in consideration of the strengths and limitations of reasonably available data.

5.7 Detailed Strengths, Limitations, Assumptions, and Key Sources of Uncertainties

5.7.1 Environmental Release Assessment

EPA estimated air, water, and land releases of 1,1-dichloroethane using various methods and information sources, including TRI, DMR, and NEI data, and GSs modeling with Monte Carlo. TRI and DMR were determined to have overall data quality ratings of medium through EPA's systematic review process, and NEI was determined to have a high-quality rating. EPA determined that the various GS had overall data quality ratings of high or medium, depending on the GS.

Strengths

TRI, DMR, and NEI provided a comprehensive amount of release data for 1,1-dichloroethane. A strength of using TRI is that it compiles the best readily available release data for all facilities that reported to EPA. NEI data captures additional sources that are not included in TRI due to reporting thresholds. Additionally, point sources in NEI report at the emission-unit level. A strength of using DMR data and the Pollutant Loading Tool is that the tool calculates an annual pollutant load by integrating monitoring period release reports provided to the EPA and extrapolating over the course of the year. However, this approach assumes average quantities, concentrations, and hydrologic flows for a given period are representative of other times of the year.

Although 1,1-dichloroethane monitoring data are preferred to modeled data, EPA strengthened modeled estimates by using Monte Carlo modeling to allow for variation in environmental release calculation input parameters according to the GS and other literature sources.

Limitations

When using TRI data to analyze chemical releases, it is important to acknowledge that TRI reporting does not include all releases of the chemical and therefore, the number of sites for a given OES may be underestimated. For each OES that had TRI, DMR, or NEI data, the analysis of releases for those OES was limited to the facilities that reported releases to TRI, DMR, or NEI. Therefore, it is uncertain the extent to which sites not captured in these databases have air, water, or land releases of 1,1-dichloroethane.

EPA was unable to map certain facilities in DMR and NEI to an OES due to the lack of information regarding the activity of 1,1-dichloroethane at the site. Therefore, some facilities are mapped to an "Unknown" OES.

Assumptions

To assess daily air and water discharges, EPA assumed that the number of facility operating days was equal to the number of release days. EPA has developed generic estimates of operating days for a particular OES, as described in Section 2.3.2. For the Commercial use of laboratory chemicals OES, EPA assumed the number of operating days based on the Draft GS on Use of Laboratory Chemicals.

There is uncertainty that all sites for a given OES operate for the assumed duration; therefore, the average daily releases may be higher if sites have fewer release days or lower if they have greater release days. Furthermore, 1,1-dichloroethane concentrations in air emissions and wastewater release to receiving waterbodies at each facility may vary from day-to-day such that on any given day the actual daily releases may be higher or lower than the estimated average daily discharge. Thus, this approach minimizes variations in emissions and discharges from day to day. EPA did not estimate daily land releases due to the high level of uncertainty in the number of release days associated with land releases. The Agency expects that sites may not send waste to landfills every day and are more likely to accumulate waste for periodic shipments to landfills. However, sites that release to municipal landfills may have more frequent release days based on the frequency of shipments.

Uncertainties

Uncertainties for using TRI, DMR, and NEI data include underestimation of the number of sites for a given OES due to reporting thresholds in TRI, the accuracy of EPA's mapping of sites reporting to TRI, DMR, and NEI to a specific OES, and quality of the data reported to TRI, DMR, and NEI.

Some uncertainties of using DMR data include the accuracy of EPA's mapping of sites reporting to DMR to a specific OES, and quality of the data reported to DMR. Also, an uncertainty of using the ECHO Pollutant Loading Tool Advanced Search option is that average measurements may be reported as a quantity (kg/day) or a concentration (mg/L). Calculating annual loads from concentrations requires adding wastewater flow to the equation, which increases the uncertainty of the calculated annual load. In addition, for facilities that reported having zero pollutant loads to DMR, the EZ Search Load Module uses a combination of setting non-detects equal to zero and as one-half the detection limit to calculate the annual pollutant loadings. This method could cause overestimation or underestimation of annual and daily pollutant loads.

Some uncertainties of using NEI data include the accuracy of EPA's mapping of sites reporting to NEI to a specific OES. For point sources, there may be multiple OES at a single facility. Area/non-point sources are aggregated on a county level. Additionally, there is uncertainty due to the voluntary reporting of HAP data. As a result, EPA augments SLT-provided HAP data with other information to better estimate point, nonpoint, and mobile source HAP emissions. NEI does not require stack testing or continuous emissions monitoring, and reporting agencies may use a number of different emission estimation methods with varying degrees of reliability. These methodologies include continuous emissions monitoring, stack testing, site- and vendor-specific emission factors, SLT and/or other emission factors, and engineering judgement.

One uncertainty for using various GS is the lack of specific 1,1-dichloroethane data. Because GS are generic, assessed parameter values may not always be representative of applications specific to 1,1-dichloroethane use in each OES. Another uncertainty is lack of consideration for release controls. The GS assume that all activities occur without any release controls, and in an open-system environment where vapor freely escape (U.S. EPA, 2023, 2022a). Actual releases may be less than estimated if facilities utilize pollution control methods.

In some cases, the number of facilities for a given OES was estimated using data from the U.S. Census. In such cases, the average daily release calculated from sites reporting to TRI, NEI or DMR was applied to the total number of sites reported in (U.S. Census Bureau, 2015). It is uncertain how accurate this average release is to actual releases at these sites; therefore, releases may be higher or lower than the calculated amount.

5.7.2 Occupational Exposure Assessment

5.7.2.1 Number of Workers

There are several uncertainties surrounding the estimated number of workers potentially exposed to 1,1-dichloroethane, as outlined below. Most are unlikely to result in a systematic underestimate or overestimate but could result in an inaccurate estimate.

CDR data are used to estimate the number of workers associated with manufacturing. There are inherent limitations to the use of CDR data as they are reported by manufacturers and importers of 1,1-dichloroethane. Manufacturers and importers are only required to report if they manufactured or imported 1,1-dichloroethane in excess of 25,000 lb at a single site during any calendar year; as such, CDR may not capture all sites and workers associated with any given chemical.

There are also uncertainties with BLS data, which are used to estimate the number of workers for the remaining conditions of use. First, BLS' OES employment data for each industry/occupation combination are only available at the 3-, 4-, or 5-digit NAICS level, rather than the full 6-digit NAICS level. This lack of granularity could result in an overestimate of the number of exposed workers if some 6-digit NAICS are included in the less granular BLS estimates but are not likely to use 1,1-dichloroethane for the assessed applications. EPA addressed this issue by refining the OES estimates using total employment data from the U.S. Census' SUSB. However, this approach assumes that the distribution of occupation types (SOC codes) in each 6-digit NAICS is equal to the distribution of occupation types at the parent 5-digit NAICS level. If the distribution of workers in occupations with 1,1-dichloroethane exposure differs from the overall distribution of workers in each NAICS, then this approach will result in inaccuracy.

Second, EPA's judgments about which industries (represented by NAICS codes) and occupations (represented by SOC codes) are associated with the uses assessed in this report are based on EPA's understanding of how 1,1-dichloroethane is used in each industry. Designations of which industries and occupations have potential exposures is nevertheless subjective, and some industries/occupations with few exposures might erroneously be included, or some industries/occupations with exposures might erroneously be excluded. This would result in inaccuracy but would be unlikely to systematically either overestimate or underestimate the number of exposed workers.

5.7.2.2 Analysis of Exposure Monitoring Data

For several of the OES, 1,1-dichloroethane test order monitoring data was used to estimate inhalation exposures. The primary strength of these data is the use of personal and directly applicable data, and the number of samples available for workers and ONUs. The primary limitation is that EPA assumed 250 exposure days per year based on 1,1-dichloroethane exposure each working day for a typical worker schedule; it is uncertain whether this captures actual worker schedules and exposures.

For the remaining OES, monitoring data from other volatile chemicals previously assessed in EPA Risk Evaluations were used as surrogate. The principal limitation of the monitoring data is the uncertainty in the representativeness of the data. Where few data are available, the assessed exposure levels are unlikely to be representative of worker exposure across the entire job category or industry. This may particularly be the case when monitoring data were available for only one site. Differences in work practices and engineering controls across sites can introduce variability and limit the representativeness of monitoring data. Age of the monitoring data can also introduce uncertainty due to differences in workplace practices and equipment used at the time the monitoring data were collected compared those currently in use. Therefore, older data may overestimate or underestimate exposures, depending on these differences. The effects of these uncertainties on the occupational exposure assessment are unknown, as the uncertainties may result in either overestimation or underestimation of exposures depending on the actual distribution of 1,1-dichloroethane air concentrations and the variability of work practices among different sites.

This report uses existing worker exposure monitoring data to assess exposure to 1,1-dichloroethane during several conditions of use. To analyze the exposure data, EPA categorized each data point as either “worker” or “occupational non-user.” The categorizations are based on descriptions of worker job activity as provided in literature and EPA’s judgment. In general, samples for employees that are expected to have the highest exposure from direct handling of 1,1-dichloroethane are categorized as “worker” and samples for employees that are expected to have the lower exposure and do not directly handle 1,1-dichloroethane are categorized as “occupational non-user.”

5.8 Summary of Weight of Scientific Evidence for Environmental Releases and Occupational Exposures

Table 5-27 summarizes the weight of scientific evidence ratings for each media of release for each OES. Table 5-28 summarizes the weight of scientific evidence ratings for the occupational exposures for each OES. EPA’s general approach for weight of scientific evidence ratings is explained in Section 2.6 and the specific basis for each rating is discussed for each OES in the relevant subsection of Section 5.

2606 **Table 5-27. Summary of the Weight of Scientific Evidence Ratings for Environmental Releases**

OES	Release Media	Reported Data[a]	Data Quality Ratings for Reported Data	Modeling	Data Quality Ratings for Modeling[b]	Weight of Scientific Evidence Conclusion
Manufacturing	Surface water	✓	M	×	N/A	Moderate to Robust
	Fugitive air	✓	M	×	N/A	
	Fugitive air	✓	H	×	N/A	
	Stack air	✓	M	×	N/A	
	Stack air	✓	H	×	N/A	
	Land	✓	M	×	N/A	
Processing as a reactive intermediate	Surface water	✓	M	×	N/A	Moderate to Robust
	Fugitive air	✓	M	×	N/A	
	Fugitive air	✓	H	×	N/A	
	Stack air	✓	M	×	N/A	
	Stack air	✓	H	×	N/A	
	Land	✓	M	×	N/A	
Processing—Repackaging—repackaging	Fugitive or stack air	×	N/A	✓	M	Moderate to Robust
	Hazardous landfill or incineration	×	N/A	✓	M	
Commercial use as a laboratory chemical	Fugitive or stack air	×	N/A	✓	M	Moderate
	Hazardous landfill or incineration	×	N/A	✓	M	
	Surface water	✓	M	×	N/A	Moderate to Robust
	Fugitive air	✓	M	×	N/A	

OES	Release Media	Reported Data[a]	Data Quality Ratings for Reported Data	Modeling	Data Quality Ratings for Modeling[b]	Weight of Scientific Evidence Conclusion
General waste handling, treatment, and disposal	Fugitive air	✓	H	×	N/A	
	Stack air	✓	M	×	N/A	
	Stack air	✓	H	×	N/A	
Waste handling, treatment, and disposal (POTW)	POTW	✓	M	×	N/A	Moderate to Robust
Waste handling, treatment, and disposal (remediation)	Surface water	✓	M	×	N/A	Moderate to Robust

[a] Reported data includes data obtained from EPA databases (*i.e.*, TRI, DMR, NEI) and facility release data from literature sources.

[b] Data quality ratings for models include ratings of underlying literature sources used to select model approaches and input values/distributions such as a GS/ESD used in tandem with Monte Carlo modeling.

Table 5-28. Summary of the Weight of Scientific Evidence Ratings for Occupational Exposures

OES	Inhalation Exposure												Dermal Exposure		
	1,1-Dichloroethane Monitoring					Surrogate Monitoring					Modeling		Monitoring		Modeling
	Worker	# Data Points	ONU	# Data Points	Data Quality Ratings	Worker	# Data Points	ONU	# Data Points	Data Quality Ratings	Worker	ONU	Worker	Data Quality Rating	Worker
Manufacturing	✓	57	✓	5	H	✓	451	×	N/A	H	×	×	×	N/A	✓
Processing as a reactive intermediate	✓	57	✓	5	H	✓	46	×	N/A	M	×	×	×	N/A	✓
Processing—Repackaging—repackaging	×	N/A	×	N/A	N/A	×	N/A	×	N/A	N/A	✓	×	×	N/A	✓
Commercial use as a laboratory chemical	✓	9	×	N/A	H	✓	76	×	N/A	H	×	×	×	N/A	✓
Recycling	✓	57	✓	5	H	×	N/A	×	N/A	N/A	×	×	×	N/A	✓
Distribution in commerce	Not Estimated														
Waste handling, treatment, and disposal (POTW)	×	N/A	×	N/A	N/A	✓	3	×	N/A	M	×	×	×	N/A	✓
General waste handling, treatment, and disposal	×	N/A	×	N/A	N/A	✓	22	×	N/A	M	×	×	×	N/A	✓

Where EPA was not able to estimate ONU inhalation exposure from monitoring data or models, this was assumed equivalent to the central tendency experienced by workers for the corresponding OES; dermal exposure for ONUs was not evaluated because they are not expected to be in direct contact with 1,1-dichloroethane.
ONU: Occupational Non-user
× No data available
✓ Data available

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Appendix A EXAMPLE OF ESTIMATING NUMBER OF WORKERS AND OCCUPATIONAL NON-USERS

This appendix summarizes the methods that EPA/OPPT used to estimate the number of workers who are potentially exposed to 1,1-dichloroethane in each of its conditions of use. The method consists of the following steps:

1. Check relevant emission scenario documents (ESDs) and Generic Scenarios (GSs) for estimates on the number of workers potentially exposed.
2. Identify the NAICS codes for the industry sectors associated with each condition of use.
3. Estimate total employment by industry/occupation combination using the Bureau of Labor Statistics' Occupational Employment Statistics (OES) data (U.S. BLS, 2016).
4. Refine the OES estimates where they are not sufficiently granular by using the U.S. Census' (U.S. Census Bureau, 2015) Statistics of U.S. Businesses (SUSB) data on total employment by 6-digit NAICS.
5. Estimate the percentage of employees likely to be using 1,1-dichloroethane instead of other chemicals (*i.e.*, the market penetration of 1,1-dichloroethane in the condition of use).
6. Estimate the number of sites and number of potentially exposed employees per site.
7. Estimate the number of potentially exposed employees within the condition of use.

Step 1: Identifying Affected NAICS Codes

As a first step, EPA/OPPT identified NAICS industry codes associated with each condition of use. EPA/OPPT generally identified NAICS industry codes for a condition of use by the following:

- Querying the U.S. Census Bureau's *NAICS Search* tool using keywords associated with each condition of use to identify NAICS codes with descriptions that match the condition of use.
- Referencing EPA/OPPT Generic Scenarios (GS's) and Organisation for Economic Co-operation and Development (OECD) Emission Scenario Documents (ESDs) for a condition of use to identify NAICS codes cited by the GS or ESD.
- Reviewing CDR data for the chemical, identifying the industrial sector codes reported for downstream industrial uses, and matching those industrial sector codes to NAICS codes using Table D-2 provided in the CDR reporting instructions (U.S. EPA, 2016).

Each condition of use section in the main body of this report identifies the NAICS codes EPA/OPPT identified for the respective condition of use.

Step 2: Estimating Total Employment by Industry and Occupation

BLS's OES data provide employment data for workers in specific industries and occupations (U.S. BLS, 2016). The industries are classified by NAICS codes (identified previously), and occupations are classified by Standard Occupational Classification (SOC) codes.

Among the relevant NAICS codes (identified previously), EPA/OPPT reviewed the occupation description and identified those occupations (SOC codes) where workers are potentially exposed to 1,1-dichloroethane. Table_Apx A-1 shows the SOC codes EPA/OPPT classified as occupations potentially exposed to 1,1-dichloroethane. These occupations are classified as workers (W) and occupational non-users (O). All other SOC codes are assumed to represent occupations where exposure is unlikely.

Table_Apx A-1. SOCs with Worker and ONU Designations for All Conditions of Use Except Dry Cleaning

SOC	Occupation	Designation
11-9020	Construction Managers	O
17-2000	Engineers	O
17-3000	Drafters, Engineering Technicians, and Mapping Technicians	O
19-2031	Chemists	O
19-4000	Life, Physical, and Social Science Technicians	O
47-1000	Supervisors of Construction and Extraction Workers	O
47-2000	Construction Trades Workers	W
49-1000	Supervisors of Installation, Maintenance, and Repair Workers	O
49-2000	Electrical and Electronic Equipment Mechanics, Installers, and Repairers	W
49-3000	Vehicle and Mobile Equipment Mechanics, Installers, and Repairers	W
49-9010	Control and Valve Installers and Repairers	W
49-9020	Heating, Air Conditioning, and Refrigeration Mechanics and Installers	W
49-9040	Industrial Machinery Installation, Repair, and Maintenance Workers	W
49-9060	Precision Instrument and Equipment Repairers	W
49-9070	Maintenance and Repair Workers, General	W
49-9090	Miscellaneous Installation, Maintenance, and Repair Workers	W
51-1000	Supervisors of Production Workers	O
51-2000	Assemblers and Fabricators	W
51-4020	Forming Machine Setters, Operators, and Tenders, Metal and Plastic	W
51-6010	Laundry and Dry-Cleaning Workers	W
51-6020	Pressers, Textile, Garment, and Related Materials	W
51-6030	Sewing Machine Operators	O
51-6040	Shoe and Leather Workers	O
51-6050	Tailors, Dressmakers, and Sewers	O
51-6090	Miscellaneous Textile, Apparel, and Furnishings Workers	O
51-8020	Stationary Engineers and Boiler Operators	W
51-8090	Miscellaneous Plant and System Operators	W
51-9000	Other Production Occupations	W
W = worker designation; O = ONU designation		

For dry cleaning facilities, due to the unique nature of work expected at these facilities and that different workers may be expected to share among activities with higher exposure potential (*e.g.*, unloading the dry-cleaning machine, pressing/finishing a dry-cleaned load), EPA/OPPT made different SOC code worker and ONU assignments for this condition of use. Table_Apx A-2 summarizes the SOC codes with worker and ONU designations used for dry cleaning facilities.

Table_Apx A-2. SOCs with Worker and ONU Designations for Dry Cleaning Facilities

SOC	Occupation	Designation
41-2000	Retail Sales Workers	O
49-9040	Industrial Machinery Installation, Repair, and Maintenance Workers	W
49-9070	Maintenance and Repair Workers, General	W
49-9090	Miscellaneous Installation, Maintenance, and Repair Workers	W
51-6010	Laundry and Dry-Cleaning Workers	W
51-6020	Pressers, Textile, Garment, and Related Materials	W

SOC	Occupation	Designation
51-6030	Sewing Machine Operators	O
51-6040	Shoe and Leather Workers	O
51-6050	Tailors, Dressmakers, and Sewers	O
51-6090	Miscellaneous Textile, Apparel, and Furnishings Workers	O
W = worker designation; O = ONU designation		

After identifying relevant NAICS and SOC codes, EPA/OPPT used BLS data to determine total employment by industry and by occupation based on the NAICS and SOC combinations. For example, there are 110,640 employees associated with 4-digit NAICS 8123 (*Drycleaning and Laundry Services*) and SOC 51-6010 (*Laundry and Dry-Cleaning Workers*).

Using a combination of NAICS and SOC codes to estimate total employment provides more accurate estimates for the number of workers than using NAICS codes alone. Using only NAICS codes to estimate number of workers typically result in an overestimate, because not all workers employed in that industry sector will be exposed. However, in some cases, BLS only provide employment data at the 4-digit or 5-digit NAICS level; therefore, further refinement of this approach may be needed (see next step).

Step 3: Refining Employment Estimates to Account for lack of NAICS Granularity

The third step in EPA/OPPT's methodology was to further refine the employment estimates by using total employment data in the U.S. Census Bureau's SUSB (U.S. Census Bureau, 2015). In some cases, BLS OES's occupation-specific data are only available at the 4-digit or 5-digit NAICS level, whereas the SUSB data are available at the 6-digit level (but are not occupation-specific). Identifying specific 6-digit NAICS will ensure that only industries with potential 1,1-dichloroethane exposure are included. As an example, OES data are available for the 4-digit NAICS 8123 *Drycleaning and Laundry Services*, which includes the following 6-digit NAICS:

- NAICS 812310 Coin-Operated Laundries and Drycleaners;
- NAICS 812320 Drycleaning and Laundry Services (except Coin-Operated);
- NAICS 812331 Linen Supply; and
- NAICS 812332 Industrial Launderers.

In this example, only NAICS 812320 is of interest. The Census data allow EPA/OPPT to calculate employment in the specific 6-digit NAICS of interest as a percentage of employment in the BLS 4-digit NAICS.

The 6-digit NAICS 812320 comprises 46 percent of total employment under the 4-digit NAICS 8123. This percentage can be multiplied by the occupation-specific employment estimates given in the BLS OES data to further refine our estimates of the number of employees with potential exposure. Table_Apx A-3 illustrates this granularity adjustment for NAICS 812320.

Table_Apx A-3. Estimated Number of Potentially Exposed Workers and ONUs under NAICS 812320

NAICS	SOC CODE	SOC Description	Occupation Designation	Employment by SOC at 4-Digit NAICS Level	% of Total Employment	Estimated Employment by SOC at 6-Digit NAICS Level
8123	41-2000	Retail Sales Workers	O	44,500	46.0%	20,459
8123	49-9040	Industrial Machinery Installation, Repair, and Maintenance Workers	W	1,790	46.0%	823
8123	49-9070	Maintenance and Repair Workers, General	W	3,260	46.0%	1,499
8123	49-9090	Miscellaneous Installation, Maintenance, and Repair Workers	W	1,080	46.0%	497
8123	51-6010	Laundry and Dry-Cleaning Workers	W	110,640	46.0%	50,867
8123	51-6020	Pressers, Textile, Garment, and Related Materials	W	40,250	46.0%	18,505
8123	51-6030	Sewing Machine Operators	O	1,660	46.0%	763
8123	51-6040	Shoe and Leather Workers	O	Not Reported for this NAICS Code		
8123	51-6050	Tailors, Dressmakers, and Sewers	O	2,890	46.0%	1,329
8123	51-6090	Miscellaneous Textile, Apparel, and Furnishings Workers	O	0	46.0%	0
Total Potentially Exposed Employees				**206,070**		**94,740**
Total Workers						**72,190**
Total Occupational Non-users						**22,551**

Note: numbers may not sum exactly due to rounding.
W = worker; O = occupational non-user
Source: US Census, 2015 (U.S. Census Bureau, 2015); BLS, 2016 (U.S. BLS, 2016).

Step 4: Estimating the Percentage of Workers Using 1,1-Dichloroethane Instead of Other Chemicals

In the final step, EPA/OPPT accounted for the market share by applying a factor to the number of workers determined in Step 3. This accounts for the fact that 1,1-dichloroethane may be only one of multiple chemicals used for the applications of interest. EPA/OPPT did not identify market penetration data for any conditions of use. In the absence of market penetration data for a given condition of use, EPA/OPPT assumed 1,1-dichloroethane may be used at up to all sites and by up to all workers calculated in this method as a bounding estimate. This assumes a market penetration of 100%.

Step 5: Estimating the Number of Workers per Site

EPA/OPPT calculated the number of workers and occupational non-users in each industry/occupation combination using the formula below (granularity adjustment is only applicable where SOC data are not available at the 6-digit NAICS level):

Number of Workers or ONUs in NAICS/SOC (Step 2) × *Granularity Adjustment Percentage (Step 3) = Number of Workers or ONUs in the Industry/Occupation Combination*

EPA/OPPT then estimated the total number of establishments by obtaining the number of establishments reported in the U.S. Census Bureau's SUSB (U.S. BLS, 2016) data at the 6-digit NAICS level.

EPA/OPPT then summed the number of workers and occupational non-users over all occupations within a NAICS code and divided these sums by the number of establishments in the NAICS code to calculate the average number of workers and occupational non-users per site.

Step 6: Estimating the Number of Workers and Sites for a Condition of Use

EPA/OPPT estimated the number of workers and occupational non-users potentially exposed to 1,1-dichloroethane and the number of sites that use 1,1-dichloroethane in a given condition of use through the following steps:

6.A. Obtaining the total number of establishments by:
   i. Obtaining the number of establishments from SUSB at the 6-digit NAICS level (Step 5) for each NAICS code in the condition of use and summing these values; or
   ii. Obtaining the number of establishments from the TRI, DMR, NEI, or literature for the condition of use.

6.B. Estimating the number of establishments that use 1,1-dichloroethane by taking the total number of establishments from Step 6.A and multiplying it by the market penetration factor from Step 4.

6.C. Estimating the number of workers and occupational non-users potentially exposed to 1,1-dichloroethane by taking the number of establishments calculated in Step 6.B and multiplying it by the average number of workers and occupational non-users per site from Step 5.

Appendix B EQUATIONS FOR CALCULATING ACUTE, SUBCHRONIC, AND CHRONIC (NON-CANCER AND CANCER) INHALATION AND DERMAL EXPOSURES

This report assesses 1,1-dichloroethane inhalation exposures to workers in occupational settings, presented as 8-hr (*i.e.*, full-shift) time weighted average (TWA). The full-shift TWA exposures are then used to calculate acute exposure concentrations (AC), subchronic average daily concentrations (SADC), average daily concentrations (ADC) for chronic, non-cancer risks, lifetime average daily concentrations (LADC) for chronic, cancer risks.

This report also assesses 1,1-dichloroethane dermal exposures to workers in occupational settings, presented as a dermal acute potential dose rate (APDR). The APDRs are then used to calculate acute retained doses (AD), subchronic average daily doses (SCDD), average daily doses (ADD) for chronic non-cancer risks, and lifetime average daily doses (LADD) for chronic cancer risks.

This appendix presents the equations and input parameter values used to estimate each exposure metric.

B.1 Equations for Calculating Acute, Subchronic, and Chronic (Non-cancer and Cancer) Inhalation Exposures

AC is used to estimate workplace inhalation exposures for acute risks (*i.e.*, risks occurring as a result of exposure for less than one day), per Equation_Apx B-1.

Equation_Apx B-1

$$AC = \frac{C \times ED \times BR}{AT_{acute}}$$

Where:

AC = Acute exposure concentration
C = Contaminant concentration in air (TWA)
ED = Exposure duration (hr/day)
BR = Breathing rate ratio (unitless)
AT_{acute} = Acute averaging time (hr)

SADC is used to estimate workplace exposures for subchronic risks and is estimated as follows:

Equation_Apx B-2

$$SADC = \frac{C \times ED \times EF_{sc} \times BR}{AT_{sc}}$$

Equation_Apx B-3

$$AT_{SC} = SCD \times 24 \frac{hr}{day}$$

Where:

$SADC$ = Subchronic average daily concentration
EF_{SC} = Subchronic exposure frequency
AT_{SC} = Averaging time (hr) for subchronic exposure
SCD = Days for subchronic duration (day)

ADC and LADC are used to estimate workplace exposures for non-cancer and cancer risks, respectively. These exposures are estimated as follows:

Equation_Apx B-4

$$ADC\ or\ LADC = \frac{C \times ED \times EF \times WY \times BR}{AT\ or\ AT_c}$$

Equation_Apx B-5

$$AT = WY \times 365\frac{day}{yr} \times 24\frac{hr}{day}$$

Equation_Apx B-6

$$AT_C = LT \times 365\frac{day}{yr} \times 24\frac{hr}{day}$$

Where:

ADC = Average daily concentration used for chronic non-cancer risk calculations
$LADC$ = Lifetime average daily concentration used for chronic cancer risk calculations
ED = Exposure duration (hr/day)
EF = Exposure frequency (day/yr)
WY = Working years per lifetime (yr)
AT = Averaging time (hr) for chronic, non-cancer risk
AT_C = Averaging time (hr) for cancer risk
LT = Lifetime years (yr) for cancer risk

B.2 Equations for Calculating Acute, Subchronic, and Chronic (Non-cancer and Cancer) Dermal Exposures

AD is used to estimate workplace dermal exposures for acute risks and are calculated using Equation_Apx B-7.

Equation_Apx B-7

$$AD = \frac{APDR}{BW}$$

Where:

AD = Acute retained dose (mg/kg-day)
$APDR$ = Acute potential dose rate (mg/day)
BW = Body weight (kg)

SCDDs is used to estimate workplace dermal exposures for subchronic risks. and is estimated using Equation_Apx B-8.

Equation_Apx B-8

$$SCDD = \frac{APDR \times EF_{sc}}{BW \times SCD}$$

Where:

$SCDD$ = Subchronic average daily dose (mg/kg-day)

ADD and LADD are used to estimate workplace dermal exposures for non-cancer and cancer risks and are calculated using Equation_Apx B-9.

Equation_Apx B-9

$$ADD\ or\ LADD = \frac{APDR \times EF \times WY}{BW \times 365\frac{days}{yr} \times (WY\ or\ LT)}$$

Where WY and LT are used in the denominator for ADD and LADD, respectively.

B.3 Acute, Subchronic, and Chronic (Non-cancer and Cancer) Equation Inputs

The input parameter values in Table_Apx B-1 are used to calculate each of the above acute, subchronic, and chronic exposure estimates. Where exposure is calculated using probabilistic modeling, the calculations are integrated into the Monte Carlo simulation. Where multiple values are provided for ED, it indicates that EPA may have used different values for different conditions of use. The EF and EF_{SC} used for each OES can differ and the values used are described in the appropriate sections of this report. The maximum values used in the equations as well as a general summary for these differences are described below in this section.

Table_Apx B-1. Parameter Values for Calculating Inhalation Exposure Estimates

Parameter Name	Symbol	Value	Unit
Exposure duration	ED	8	hr/day
Breathing rate ratio	BR	2.04	unitless
Exposure frequency	EF	125 to 350[a]	days/yr
Exposure frequency, subchronic	EF_{sc}	22	days
Days for subchronic duration	SCD	30	days
Working years	WY	31 (50th percentile) 40 (95th percentile)	years
Lifetime years, cancer	LT	78	years
Averaging time, subchronic	AT_{sc}	720	hr
Averaging time, non-cancer	AT	271,560 (central tendency)[b] 350,400 (high-end)[c]	hr
Averaging rime, cancer	AT_c	683,280	hr
Body weight	BW	80 (average adult worker) 72.4 (female of reproductive age)	kg

Parameter Name	Symbol	Value	Unit

[a] Depending on OES
[b] Calculated using the 50th percentile value for working years (WY)
[c] Calculated using the 95th percentile value for working years (WY)

B.3.1 Exposure Duration (ED)

EPA generally uses an exposure duration of eight hours per day for averaging full-shift exposures.

B.3.2 Breathing Rate Ratio

EPA uses a breathing rate ratio, which is the ratio between the worker breathing rate and resting breathing rate, to account for the amount of air a worker breathes during exposure. The typical worker breathes about 10 m^3 of air in 8 hours, or 1.25 m^3/hr (U.S. EPA, 1991) while the resting breathing rate is 0.6125 m^3/hr (U.S. EPA, 1991). The ratio of these two values is equivalent to 2.04.

B.3.3 Exposure Frequency (EF)

EPA generally uses a maximum exposure frequency of 250 days per year. However, for the Processing—Repackaging OES, EPA used probabilistic modeling to estimate exposures and the associated exposure frequencies, resulting in exposure frequencies below 250 days per year. The estimation of the exposure frequency and associated distributions for each OES are described in the relevant section of this report.

EF is expressed as the number of days per year a worker is exposed to the chemical being assessed. In some cases, it may be reasonable to assume a worker is exposed to the chemical on each working day. In other cases, it may be more appropriate to estimate a worker's exposure to the chemical occurs during a subset of the worker's annual working days. The relationship between exposure frequency and annual working days can be described mathematically as follows:

Equation_Apx B-10

$$EF = f \times AWD$$

Where:

EF = Exposure frequency, the number of days per year a worker is exposed to the chemical (day/yr)
f = Fractional number of annual working days during which a worker is exposed to the chemical (unitless)
AWD = Annual working days, the number of days per year a worker works (day/yr)

BLS (U.S. BLS, 2016) provides data on the total number of hours worked and total number of employees by each industry NAICS code. These data are available from the 3- to 6-digit NAICS level (where 3-digit NAICS are less granular and 6-digit NAICS are the most granular). Dividing the total, annual hours worked by the number of employees yields the average number of hours worked per employee per year for each NAICS.

EPA has identified approximately 140 NAICS codes applicable to the multiple conditions of use for the ten chemicals undergoing risk evaluation. For each NAICS code of interest, EPA looked up the average hours worked per employee per year at the most granular NAICS level available (*i.e.*, 4-digit, 5-digit, or 6-digit). EPA converted the working hours per employee to working days per year per employee assuming employees work an average of eight hours per day. The average number of days per year worked, or AWD, ranges from 169 to 282 days per year, with a 50th percentile value of 250 days per year. EPA repeated this analysis for all NAICS codes at the 4-digit level. The average AWD for all 4-digit NAICS codes ranges from 111 to 282 days per year, with a 50th percentile value of 228 days per year. 250 days per year is approximately the 75th percentile. In the absence of industry- and 1,1-dichloroethane-specific data, EPA assumes the parameter *f* is equal to one for all conditions of use except Processing—Repackaging. Repackaging used a discrete value of 0.962 for *f*. The 0.962 value was derived from the ratio of the number of operating days (260 days/yr) and the assumption that workers are only potentially exposed up to 250 days/yr. Therefore, the default for *f* is 0.962 day of exposure/day of operation for this OES.

B.3.4 Subchronic Exposure Frequency (EF$_{SC}$)

For 1,1-dichloroethane, the SCD was set at 30 days. EPA estimated the maximum number of working days within the SCD, using the following equation and assuming 5 working days/wk:

Equation_Apx B-11

$$EF_{SC}(max) = 5\frac{working\ days}{wk} \times \frac{30\ total\ days}{7\frac{total\ days}{wk}} = 21.4\ days, rounded\ up\ to\ 22\ days$$

B.3.5 Subchronic Duration (SCD)

EPA assessed a subchronic duration of 30 days based on the available health data.

B.3.6 Working Years (WY)

EPA has developed a triangular distribution for working years. EPA has defined the parameters of the triangular distribution as follows:

- Minimum value: BLS CPS tenure data with current employer as a low-end estimate of the number of lifetime working years: 10.4 years;
- Mode value: The 50th percentile tenure data with all employers from SIPP as a mode value for the number of lifetime working years: 36 years; and
- Maximum value: The maximum average tenure data with all employers from SIPP as a high-end estimate on the number of lifetime working years: 44 years.

This triangular distribution has a 50th percentile value of 31 years and a 95th percentile value of 40 years. EPA uses these values for central tendency and high-end ADC and LADC calculations, respectively.

The BLS (U.S. BLS, 2014) provides information on employee tenure with *current employer* obtained from the Current Population Survey (CPS). CPS is a monthly sample survey of about 60,000 households that provides information on the labor force status of the civilian non-institutional population age 16 and over; CPS data are released every 2 years. The data are available by demographics and by generic industry sectors but are not available by NAICS codes.

The U.S. Census’ (U.S. Census Bureau, 2019a) Survey of Income and Program Participation (SIPP) provides information on *lifetime tenure with all employers*. SIPP is a household survey that collects data on income, labor force participation, social program participation and eligibility, and general demographic characteristics through a continuous series of national panel surveys of between 14,000 and 52,000 households (U.S. Census Bureau, 2019a). EPA analyzed the 2008 SIPP Panel Wave 1, a panel that began in 2008 and covers the interview months of September 2008 through December 2008

(U.S. Census Bureau, 2019a, b). For this panel, lifetime tenure data are available by Census Industry Codes, which can be cross-walked with NAICS codes.

SIPP data include fields for the industry in which each surveyed, employed individual works (TJBIND1), worker age (TAGE), and years of work experience *with all employers* over the surveyed individual's lifetime.[9] Census household surveys use different industry codes than the NAICS codes used in its firm surveys, so these were converted to NAICS using a published crosswalk. EPA calculated the average tenure for the following age groups: (1) workers age 50 and older; (2) workers age 60 and older; and (3) workers of all ages employed at time of survey. EPA used tenure data for age group "50 and older" to determine the high-end lifetime working years, because the sample size in this age group is often substantially higher than the sample size for age group "60 and older". For some industries, the number of workers surveyed, or the *sample size*, was too small to provide a reliable representation of the worker tenure in that industry. Therefore, EPA excluded data where the sample size is less than five from our analysis.

Table_Apx B-2 summarizes the average tenure for workers age 50 and older from SIPP data. Although the tenure may differ for any given industry sector, there is no significant variability between the 50th and 95th percentile values of average tenure across manufacturing and non-manufacturing sectors.

Table_Apx B-2. Overview of Average Worker Tenure from U.S. Census SIPP (Age Group 50+)

Industry Sectors	Working Years			
	Average	50th Percentile	95th Percentile	Maximum
All industry sectors relevant to the 10 chemicals undergoing risk evaluation	35.9	36	39	44
Manufacturing sectors (NAICS 31–33)	35.7	36	39	40
Non-manufacturing sectors (NAICS 42–81)	36.1	36	39	44

Source: (U.S. Census Bureau, 2019a).
Note: Industries where sample size is less than five are excluded from this analysis.

BLS CPS data provides the median years of tenure that wage and salary workers had been with their current employer. Table_Apx B-3 presents CPS data for all demographics (men and women) by age group from 2008 to 2012. To estimate the low-end value on number of working years, EPA uses the most recent (2014) CPS data for workers aged 55 to 64 years, which indicates a median tenure of 10.4 years with their current employer. The use of this low-end value represents a scenario where workers are only exposed to the chemical of interest for a portion of their lifetime working years, as they may change jobs or move from one industry to another throughout their career.

Table_Apx B-3. Median Years of Tenure with Current Employer by Age Group

Age	January 2008	January 2010	January 2012	January 2014
16 years and over	4.1	4.4	4.6	4.6

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[9] To calculate the number of years of work experience EPA took the difference between the year first worked (TMAKMNYR) and the current data year (*i.e.*, 2008). EPA then subtracted any intervening months when not working (ETIMEOFF).

Age	January 2008	January 2010	January 2012	January 2014
16 to 17 years	0.7	0.7	0.7	0.7
18 to 19 years	0.8	1.0	0.8	0.8
20 to 24 years	1.3	1.5	1.3	1.3
25 years and over	5.1	5.2	5.4	5.5
25 to 34 years	2.7	3.1	3.2	3.0
35 to 44 years	4.9	5.1	5.3	5.2
45 to 54 years	7.6	7.8	7.8	7.9
55 to 64 years	9.9	10.0	10.3	10.4
65 years and over	10.2	9.9	10.3	10.3
Source: BLS, 2014b.				

B.3.7 Lifetime Years (LT)

EPA assumes a lifetime of 78 years for all worker demographics.

B.3.8 Body Weight (BW)

EPA assumes a body weight of 80 kg for average adult workers. EPA assumed a body weight of 72.4 kg for females of reproductive age, per Chapter 8 of the *Exposure Factors Handbook* (U.S. EPA, 2011).

Appendix C SAMPLE CALCULATIONS FOR CALCULATING ACUTE AND CHRONIC (NON-CANCER AND CANCER) INHALATION EXPOSURES

Sample calculations for high-end and central tendency acute and chronic (non-cancer and cancer) exposure concentrations for one condition of use, Manufacturing, are demonstrated below. The explanation of the equations and parameters used is provided in Appendix A.

C.1 Example High-End AC, ADC, LADC, and SADC Calculations

Calculate AC_{HE}:

$$AC_{HE} = \frac{C_{HE} \times ED \times BR}{AT_{acute}}$$

$$AC_{HE} = \frac{1.1\ ppm \times 8\ hr/day \times 2.04}{24\ hr/day} = \ 0.72\ ppm$$

Calculate $SADC_{HE}$:

$$SADC = \frac{C_{HE} \times ED \times EF_{SC} \times BR}{AT_{sc}}$$

$$SADC_{HE} = \frac{1.1\ ppm \times 8\frac{hr}{day} \times 22\frac{days}{year} \times 2.04}{24\frac{hr}{day} \times 30\frac{days}{year}} = 0.53\ ppm$$

Calculate ADC_{HE}:

$$ADC_{HE} = \frac{C_{HE} \times ED \times EF \times WY \times BR}{AT}$$

$$ADC_{HE} = \frac{1.1\ ppm \times 8\frac{hr}{day} \times 350\frac{days}{year} \times 40\ years \times 2.04}{40\ years \times 365\frac{days}{yr} \times 24\frac{hr}{day}} = 0.49\ ppm$$

Calculate $LADC_{HE}$:

$$LADC_{HE} = \frac{C_{HE} \times ED \times EF \times WY \times BR}{AT_c}$$

$$LADC_{HE} = \frac{1.1\ ppm \times 8\frac{hr}{day} \times 350\frac{days}{year} \times 40\ years \times 2.04}{78\ years \times 365\frac{days}{year} \times 24\ hr/day} = 0.25\ ppm$$

C.2 Example Central Tendency AC, ADC, LADC, and SADC Calculations

Calculate AC$_{CT}$:

$$AC_{CT} = \frac{C_{CT} \times ED \times BR}{AT_{acute}}$$

$$AC_{CT} = \frac{4.7 \times 10^{-3}\ ppm \times 8\ hr/day \times 2.04}{24\ hr/day} = 3.2 \times 10^{-3}\ ppm$$

Calculate SADC$_{CT}$:

$$SADC_{CT} = \frac{C_{CT} \times ED \times EF_{SC} \times BR}{AT_{sc}}$$

$$SADC_{CT} = \frac{4.7 \times 10^{-3}\ ppm \times 8\frac{hr}{day} \times 22\frac{days}{year} \times 2.04}{24\frac{hr}{day} \times 30\frac{days}{year}} = 2.3 \times 10^{-3}\ ppm$$

Calculate ADC$_{CT}$:

$$ADC_{CT} = \frac{C_{CT} \times ED \times EF \times WY \times BR}{AT}$$

$$ADC_{CT} = \frac{4.7 \times 10^{-3}\ ppm \times 8\frac{hr}{day} \times 350\frac{days}{year} \times 31\ years \times 2.04}{31\ years \times 365\frac{days}{yr} \times 24\frac{hr}{day}} = 3.1 \times 10^{-3}\ ppm$$

Calculate LADC$_{CT}$:

$$LADC_{CT} = \frac{C_{CT} \times ED \times EF \times WY \times BR}{AT_c}$$

$$LADC_{CT} = \frac{4.7 \times 10^{-3}\ ppm \times 8\frac{hr}{day} \times 350\frac{days}{year} \times 31\ years \times 2.04}{78\ years \times 365\frac{days}{year} \times 24\ hr/day} = 1.2 \times 10^{-3}\ ppm$$

Appendix D DERMAL EXPOSURE ASSESSMENT METHOD

This appendix presents the modeling approach and equations to estimate occupational dermal exposures. This method was developed through review of relevant literature and consideration of existing exposure models, such as EPA/OPPT models and the ECETOC TRA.

D.1 Dermal Dose Equation

EPA used the following equation to estimate the acute potential dose rate (APDR) from occupational dermal exposures:

Equation_Apx D-1

$$APDR = S \times Q_u \times f_{abs} \times Y_{derm} \times FT$$

Where:

S = Surface area of skin in contact with the chemical formulation (cm^2);
Q_u = Dermal load (*i.e.*, the quantity of the chemical formulation on the skin after the dermal contact event, mg/cm^2-event);
f_{abs} = Fractional absorption of the chemical formulation into the stratum corneum, accounting for evaporation of the chemical from the dermal load, Q_u (unitless, $0 \leq f_{abs} \leq 1$);
Y_{derm} = Weight fraction of the chemical of interest in the liquid (unitless, $0 \leq Y_{derm} \leq 1$);
FT = Frequency of events (integer number per day).

The inputs to the dermal dose equation are described in Appendix B.2.

D.2 Model Input Parameters

Table_Apx D-1 summarizes the model parameters and their values for estimating dermal exposures. Additional explanations of EPA's selection of the inputs for each parameter are provided in the subsections after this table.

Table_Apx D-1. Summary of Model Input Values

Input Parameter	Symbol	Value	Unit	Rationale
Surface Area	S	535 (central tendency) 1,070 (high-end)	cm^2	See Appendix D.2.1
Dermal Load	Q_u	1.4 (central tendency) 2.1 (high-end)	mg/cm^2-event	See Appendix D.2.2
Fractional Absorption	f_{abs}	0.003	unitless	See Appendix D.2.3
Weight Fraction of Chemical	Y_{derm}	1	unitless	See Appendix D.2.4
Frequency of Events	FT	1	events/day	See Appendix D.2.5

D.2.1 Surface Area

EPA used a high-end exposed skin surface area (S) for workers of 1,070 cm^2 based on the mean two-hand surface area for adult males ages 21 or older from Chapter 7 of EPA's *Exposure Factors Handbook* (U.S. EPA, 2011). For central tendency estimates, EPA assumed the exposure surface area was equivalent to only a single hand (or one side of two hands) and used half the mean values for two-hand surface areas (*i.e.*, 535 cm^2 for workers).

It should be noted that while the surface area of exposed skin is derived from data for hand surface area, EPA did not assume that only the workers hands may be exposed to the chemical. Nor did EPA assume that the entirety of the hands is exposed for all activities. Rather, EPA assumed that dermal exposures occur to some portion of the hands plus some portion of other body parts (*e.g.,* arms) such that the total exposed surface area is approximately equal to the surface area of one or two hands for the central tendency and high-end exposure scenario, respectively.

D.2.2 Dermal Load

The dermal load (Q_u) is the quantity of chemical on the skin after the dermal contact event. This value represents the quantity remaining after the bulk chemical formulation has fallen from the hand that cannot be removed by wiping the skin (*e.g.,* the film that remains on the skin). To estimate the dermal load from each activity, EPA used data from references cited by EPA's September 2013 engineering policy memorandum: *Updating CEB's Method for Screening-Level Assessments of Dermal Exposure* (U.S. EPA, 2013). This memorandum provides for the following dermal exposure scenarios:

- Routine and incidental contact with liquids (*e.g.,* maintenance activities, manual cleaning of equipment, filling drums, connecting transfer lines, sampling, and bench-scale liquid transfers);
- Routine immersion in liquids (*e.g.,* handling of wet surfaces and spray painting);
- Routine contact with container surfaces (*e.g.,* handling closed or empty bags of solid materials); and
- Routine, direct handling of solids (*e.g.,* filling/dumping containers of powders/flakes/granules, weighing powder/scooping/mixing, handling wet or dried material in a filtration and drying process).

For liquids, the memorandum uses values of 0.7 to 2.1 mg/cm^2-event for routine or incidental contact with liquids and 1.3 to 10.3 mg/cm^2-event for routine immersion in liquids (U.S. EPA, 2013). EPA used the maximum from each range to estimate high-end dermal loads. The memorandum does not provide recommended values for a central tendency dermal loading estimate. Therefore, EPA analyzed data from EPA's technical report *A Laboratory Method to Determine the Retention of Liquids on the Surface of the Hands* (U.S. EPA, 1992b) that served as the basis for the liquid dermal loads provided in the 2013 memorandum. To estimate central tendency liquid dermal loading values, EPA used the 50th percentile of the dermal loading results from the study for each type of activity (*i.e.*, routine/incidental contact and immersion). The 50th percentile was 1.7 mg/cm^2-event for routine/incidental contact with liquids and 3.8 mg/cm^2-event for routine immersion in liquids.

For 1,1-dichloroethane, EPA used high-end and central tendency dermal loading values of 1.4 and 2.1 mg/cm^2-event, respectively, for each OES.

D.2.3 Fractional Absorption

EPA assumes a fractional absorption (f_{abs}) of 0.003 for neat solutions. Since 1,1-dichloroethane is expected to be received at all OES sites in pure form, EPA used a single fractional absorption of 0.003 across all OESs.

D.2.4 Weight Fraction of Chemical

The weight fraction of 1,1-dichloroethane, Y_{derm}, refers to the concentration of 1,1-dichloroethane in the liquid formulation the worker's skin is exposed to. EPA generally assumes that this concentration will be equal to the weight fraction of 1,1-dichloroethane in the chemical products being handled within the OES. EPA assumes that 1,1-dichloroethane will be handled as a neat liquid with a weight fraction of 1 across all OES .

D.2.5 Frequency of Events

The frequency of events, FT, refers to the number of dermal exposure events per day. Depending on the OES, workers may perform multiple activities throughout their shift that could potentially result in dermal exposures. Equation_Apx D-1Equation_Apx D-1 shows a linear relationship between FT and APDR; however, this fails to account for time between contact events. Since the chemical simultaneously evaporates from and absorbs into the skin, dermal exposure is a function of both the number of contact events per day and the time between contact events. Subsequent dermal exposure events may only meaningfully increase the dermal dose if there is sufficient time between the contact events to allow for significant evaporation/absorption of the previous exposure event. EPA did not identify information on how many contact events may occur and the time between contact events. Therefore, EPA assumes a single contact event per day for estimating dermal exposures for all OESs.

Appendix E MODEL APPROACHES AND PARAMETERS

This appendix section presents the modeling approach and model equations used in estimating environmental releases and occupational exposures for each of the applicable OESs. The models were developed through review of the literature and consideration of existing EPA/OPPT models, ESDs, and/or GSs. An individual model input parameter could either have a discrete value or a distribution of values. EPA assigned statistical distributions based on reasonably available literature data. A Monte Carlo simulation (a type of stochastic simulation) was conducted to capture variability in the model input parameters. The simulation was conducted using the Latin hypercube sampling method in @Risk Industrial Edition, Version 7.0.0. The Latin hypercube sampling method generates a sample of possible values from a multi-dimensional distribution and is considered a stratified method, meaning the generated samples are representative of the probability density function (variability) defined in the model. EPA performed the model at 100,000 iterations to capture a broad range of possible input values, including values with low probability of occurrence.

EPA used the 95th and 50th percentile Monte Carlo simulation model result values for assessment. The 95th percentile value represents the high-end release amount or exposure level, whereas the 50th percentile value represents the typical release amount or exposure level. The following subsections detail the model design equations and parameters for each of the OESs.

E.1 EPA/OPPT Standard Models

This appendix section discusses the standard models used by EPA to estimate environmental releases of chemicals and occupational inhalation exposures. All the models presented in this section are models that were previously developed by EPA and are not the result of any new model development work for this risk evaluation. Therefore, this appendix does not provide the details of the derivation of the model equations which have been provided in other documents such as the *ChemSTEER User Guide* (U.S. EPA, 2015), *Chemical Engineering Branch Manual for the Preparation of Engineering Assessments, Volume 1* (U.S. EPA, 1991), *Evaporation of pure liquids from open surfaces* (Arnold and Engel, 2001), *Evaluation of the Mass Balance Model Used by the References Environmental Protection Agency for Estimating Inhalation Exposure to New Chemical Substances* (Fehrenbacher and Hummel, 1996), and *Releases During Cleaning of Equipment* (PEI Associates, 1988) The models include loss fraction models as well as models for estimating chemical vapor generation rates used in subsequent model equations to estimate the volatile releases to air and occupational inhalation exposure concentrations. The parameters in the equations of this appendix section are specific to calculating environmental releases of 1,1-dichloroethane.

The *EPA/OPPT Penetration Model* estimates releases to air from evaporation of a chemical from an open, exposed liquid surface. This model is appropriate for determining volatile releases from activities that are performed indoors or when air velocities are expected to be less than or equal to 100 feet per minute. The *EPA/OPPT Penetration Model* calculates the average vapor generation rate of the chemical from the exposed liquid surface using the following equation:

Equation_Apx E-1

$$G_{activity} = \frac{(8.24 \times 10^{-8}) * \left(MW_{1,1-DCA}^{0.835}\right) * F_{correction\_factor} * VP * \sqrt{Rate_{air\_speed}} * \left(0.25\pi D_{opening}^{2}\right)\sqrt[4]{\frac{1}{29} + \frac{1}{MW_{1,1-DCA}}}}{T^{0.05} * \sqrt{D_{opening}} * \sqrt{P}}$$

Where:

$G_{activity}$ = Vapor generation rate for activity [g/s]
MW_{TCEP} = 1,1-dichloroethane molecular weight [g/mol]

$F_{correction\_factor}$ = Vapor pressure correction factor [unitless]
VP = 1,1-dichloroethane vapor pressure [torr]
$Rate_{air\_speed}$ = Air speed [cm/s]
$D_{opening}$ = Diameter of opening [cm]
T = Temperature [K]
P = Pressure [torr]

The EPA/OPPT Mass Transfer Coefficient Model estimates releases to air from the evaporation of a chemical from an open, exposed liquid surface. This model is appropriate for determining this type of volatile release from activities that are performed outdoors or when air velocities are expected to be greater than 100 feet per minute. The EPA/OPPT Mass Transfer Coefficient Model calculates the average vapor generation rate of the chemical from the exposed liquid surface using the following equation:

Equation_Apx E-2

$$G_{activity} = \frac{(1.93 \times 10^{-7}) * \left({MW_{1,1-DCA}}^{0.78}\right) * F_{correction\_factor} * VP * Rate_{air\_speed}^{0.78} * (0.25\pi D_{opening}^{2})^{3}\sqrt{\frac{1}{29} + \frac{1}{MW_{1,1-DCA}}}}{T^{0.4} D_{opening}^{0.11} (\sqrt{T} - 5.87)^{2/3}}$$

Where:

$G_{activity}$ = Vapor generation rate for activity [g/s]
MW_{TCEP} = 1,1-dichloroethane molecular weight [g/mol]
$F_{correction\_factor}$ = Vapor pressure correction factor [unitless]
VP = 1,1-dichloroethane vapor pressure [torr]
$Rate_{air\_speed}$ = Air speed [cm/s]
$D_{opening}$ = Diameter of opening [cm]
T = Temperature [K]

The EPA's *Office of Air Quality Planning and Standards (OAQPS) AP-42 Loading Model* estimates releases to air from the displacement of air containing chemical vapor as a container/vessel is filled with a liquid. This model assumes that the rate of evaporation is negligible compared to the vapor loss from the displacement and is used as the default for estimating volatile air releases during both loading activities and unloading activities. This model is used for unloading activities because it is assumed while one vessel is being unloaded another is assumed to be loaded. The *EPA/OAQPS AP-42 Loading Model* calculates the average vapor generation rate from loading or unloading using the following equation:

Equation_Apx E-3

$$G_{activity} = \frac{F_{saturation\_factor} * MW_{1,1-DCA} * V_{container} * 3785.4\frac{cm^3}{gal} * F_{correction\_factor} * VP * \frac{RATE_{fill}}{3600\frac{s}{hr}}}{R * T}$$

Where:

$G_{activity}$ = Vapor generation rate for activity [g/s]
$F_{saturation\_factor}$ = Saturation factor [unitless]
MW_{TCEP} = 1,1-dichloroethane molecular weight [g/mol]
$V_{container}$ = Volume of container [gal/container]
$F_{correction\_factor}$ = Vapor pressure correction factor [unitless]

VP = 1,1-dichloroethane vapor pressure [torr]
$RATE_{fill}$ = Fill rate of container [containers/hr]
R = Universal gas constant [L*torr/mol-K]
T = Temperature [K]

For each of the vapor generation rate models, the vapor pressure correction factor ($F_{correction\_factor}$) can be estimated using Raoult's Law and the mole fraction of 1,1-dichloroethane in the liquid of interest.

If calculating an environmental release, the vapor generation rate calculated from one of the above models (Equation_Apx E-1, Equation_Apx E-2, and Equation_Apx E-3) is then used along with an operating time to calculate the release amount:

Equation_Apx E-4

$$Release\_Year_{activity} = Time_{activity} * G_{activity} * 3600 \frac{s}{hr} * 0.001 \frac{kg}{g}$$

Where:

$Release\_Year_{activity}$ = 1,1-dichloroethane released for activity per site-year [kg/site-yr]
$Time_{activity}$ = Operating time for activity [hr/site-yr]
$G_{activity}$ = Vapor generation rate for activity [g/s]

In addition to the vapor generation rate models, EPA uses various loss fraction models to calculate environmental releases, including the following:

- EPA/OPPT Small Container Residual Model
- EPA/OPPT Drum Residual Model
- EPA/OPPT Multiple Process Vessel Residual Model
- EPA/OPPT Single Process Vessel Residual Model

The loss fraction models apply a given loss fraction to the overall throughput of 1,1-dichloroethane for the given process. The loss fraction value or distribution of values differs for each model; however, the models each follow the same general equation:

Equation_Apx E-5

$$Release\_Year_{activity} = PV * F_{activity\_loss}$$

Where:

$Release\_Year_{activity}$ = 1,1-dichloroethane released for activity per site-year [kg/site-yr]
PV = Production volume throughput of 1,1-dichloroethane [kg/site-yr]
$F_{activity\_loss}$ = Loss fraction for activity [unitless]

The EPA/OPPT Mass Balance Inhalation Model estimates a worker inhalation exposure to an estimated concentration of chemical vapors within the worker's breathing zone using a one box model. The model estimates the amount of chemical inhaled by a worker during an activity in which the chemical has volatilized and the airborne concentration of the chemical vapor is estimated as a function of the source vapor generation rate or the saturation level of the chemical in air. First, the applicable vapor generation rate model (Equation_Apx E-1, Equation_Apx E-2, and Equation_Apx E-3) is used to calculate the vapor generation rate for the given activity. With this vapor generation rate, the *EPA/OPPT Mass Balance Inhalation Model* calculates the volumetric concentration of using the following equation:

Equation_Apx E-6

$$Cv_{activity} = Minimum: \begin{cases} \left[\dfrac{170{,}000 * T * G_{activity}}{MW_{1,1-DCA} * Q * k}\right] \\ \left[\dfrac{1{,}000{,}000ppm * F_{correction\_factor} * VP}{P}\right] \end{cases}$$

Where:

$Cv_{activity}$ = Exposure activity volumetric concentration [ppm]
$G_{activity}$ = Exposure activity vapor generation rate [g/s]
MW_{TCEP} = 1,1-dichloroethane molecular weight [g/mol]
Q = Ventilation rate [ft^3/min]
k = Mixing factor [unitless]
T = Temperature [K]
$F_{correction\_factor}$ = Vapor pressure correction factor [unitless]
VP = 1,1-dichloroethane vapor pressure [torr]
P = Pressure [torr]

Mass concentration can be estimated by multiplying the volumetric concentration by the molecular weight of 1,1-dichloroethane and dividing by molar volume at standard temperature and pressure.

EPA uses the above equations in the 1,1-dichloroethane environmental release and occupational exposure models, and EPA references the model equations by model name and/or equation number within Appendix E.

E.2 Processing—Repackaging Model Approaches and Parameters

This appendix presents the modeling approach and equations used to estimate environmental releases and occupational exposures for 1,1-dichloroethane during the Processing—repackaging OES. This approach utilizes the *ESD for Transport and Storage of Chemicals* (OECD, 2009) combined with Monte Carlo simulation (a type of stochastic simulation).

Based on the ESD, EPA identified the following release sources from repackaging operations:

- Release source 1: Transfer Operation Losses to Air from Emptying Drum.
- Release source 2: Releases during Storage (not assessed).
- Release source 3: Transfer Operation Losses to Air from Filling Small Containers.
- Release source 4: Open Surface Losses to Air during Drum Cleaning.
- Release source 5: Drum Cleaning Releases to Landfill or Incineration.

Based on the ESD, EPA also identified the following inhalation exposure points:

- Exposure point A: Transfer Operation Exposures from Emptying Drum.
- Exposure point B: Transfer Operation Exposure from Filling Small Containers.
- Exposure point C: Exposures during Drum Cleaning.

Environmental releases and occupational exposures for 1,1-dichloroethane during repackaging are a function of 1,1-dichloroethane's physical properties, container size, mass fractions, and other model parameters. While physical properties are fixed, some model parameters are expected to vary. EPA used a Monte Carlo simulation to capture variability in the following model input parameters: ventilation rate, mixing factor, air speed, saturation factor, loss factor, container sizes, working years, and drum fill rates. EPA used the outputs from a Monte Carlo simulation with 100,000 iterations and the Latin Hypercube sampling method in @Risk to calculate release amounts and exposure concentrations for this OES.

E.2.1 Model Equations

Table_Apx E-1 provides the models and associated variables used to calculate environmental releases for each release source within each iteration of the Monte Carlo simulation. EPA used these environmental releases to develop a distribution of release outputs for the repackaging OES. The variables used to calculate each of the following values include deterministic or variable input parameters, known constants, physical properties, conversion factors, and other parameters. The values for these variables are provided in Appendix E.2.2. The Monte Carlo simulation calculated the total 1,1-dichloroethane release (by environmental media) across all release sources during each iteration of the simulation. EPA then selected 50th percentile and 95th percentile values to estimate the central tendency and high-end releases, respectively.

Table_Apx E-1. Models and Variables Applied for Release Sources in the Processing—Repackaging OES

Release Source	Model(s) Applied	Variables Used
Release source 1: Transfer Operation Losses to Air from Emptying Drum.	*EPA/OAQPS AP-42 Loading Model* (Equation_Apx E-3)	Vapor Generation Rate: $F_{1,1-DCA}$; VP; $F_{saturation\_unloading}$; $MW_{1,1-DCA}$; V_{import_cont}; R; T; $RATE_{fill\_drum}$ Operating Time: $RATE_{fill\_drum}$
Release source 2: Releases during Storage (not assessed).	Not assessed; release is not expected to lead to significant losses to the environment unless there is an accident.	Not applicable
Release source 3: Transfer Operation Losses to Air from Filling Small Containers.	*EPA/OAQPS AP-42 Loading Model* (Equation_Apx E-3)	Vapor Generation Rate: $F_{1,1-DCA}$; VP; $F_{saturation\_loading}$; $MW_{1,1-DCA}$; V_{fill_cont}; R; T; $RATE_{fill\_smallcont}$ Operating Time: $RATE_{fill\_smallcont}$
Release source 4: Open Surface Losses to Air During Drum Cleaning.	*EPA/OPPT Penetration Model* or *EPA/OPPT Mass Transfer Coefficient Model*, based on air speed (Equation_Apx E-1, Equation_Apx E-2)	Vapor Generation Rate: $F_{1,1-DCA}$; $MW_{1,1-DCA}$; VP; $RATE_{air\_speed}$; $D_{opening\_cont-cleaning}$; T; P Operating Time: $RATE_{fill\_drum}$
Release source 5: Drum Cleaning Releases to Incineration or Landfill.	*EPA/OPPT Drum Residual Model* (Equation_Apx E-5)	PV; F_{loss_cont}

Appendix E.2.6 provides equations and discussion for release source operating times used to calculate releases to air as included in Equation_Apx E-4.

Table_Apx E-2 provides the models and associated variables used to calculate occupational exposures for each exposure point within each iteration of the Monte Carlo simulation. EPA used these occupational exposures to develop a distribution of exposure outputs for the repackaging OES. EPA assumed that the same worker performed each exposure activity resulting in a total exposure duration of up to 8 hours per day. The variables used to calculate each of the following exposure concentrations and durations include deterministic or variable input parameters, known constants, physical properties, conversion factors, and other parameters.

The values for these variables are provided in Appendix E.2.2 and Appendix E.2.3. The Monte Carlo simulation calculated an 8-hr TWA exposure concentration for each iteration using the exposure concentration and duration associated with each activity and assuming exposures outside the exposure activities were zero. EPA then selected 50th percentile and 95th percentile values to estimate the central tendency and high-end exposure concentrations, respectively.

Table_Apx E-2. Models and Variables Applied for Exposure Points in the Processing—Repackaging OES

Exposure Point	Model(s) Applied	Variables Used
Exposure point A: Transfer Operation Exposures from Emptying Drum	*EPA/OPPT Mass Balance Inhalation Model* with vapor generation rate from *EPA/OAQPS AP-42 Loading Model* (Equation_Apx E-6)	Vapor Generation Rate: $F_{1,1-DCA}$; VP; $F_{saturation\_unloading}$; $MW_{1,1-DCA}$; V_{import_cont}; R; T; $RATE_{fill\_drum}$; Q; k; Vm Exposure Duration: $RATE_{fill\_drum}$
Exposure point B: Transfer Operation Exposure from Filling Small Containers	*EPA/OPPT Mass Balance Inhalation Model* with vapor generation rate from *EPA/OAQPS AP-42 Loading Model* (Equation_Apx E-6)	Vapor Generation Rate: $F_{1,1-DCA}$; VP; $F_{saturation\_loading}$; $MW_{1,1-DCA}$; V_{small_cont}; R; T; $RATE_{fill\_smallcont}$; Q; k; Vm Exposure Duration: V_{import_cont}; V_{fill_cont}; $RATE_{fill\_drum}$
Exposure point C: Exposures during Drum Cleaning	*EPA/OPPT Mass Balance Inhalation Model* with vapor generation rate from *EPA/OPPT Penetration Model* or *EPA/OPPT Mass Transfer Coefficient Model*, based on air speed (Equation_Apx E-6)	Vapor Generation Rate: $F_{1,1-DCA}$; $MW_{1,1-DCA}$; VP; $RATE_{air\_speed}$; $D_{opening\_cont-cleaning}$; T; P; Q; k; Vm Exposure Duration: $RATE_{fill\_drum}$

Appendix E.2.6 provides equations and discussion for exposure durations used for each exposure activity. Note that the number of exposure days is set equal to the number of operating days per year up to a maximum of 250 days per year. If the number of operating days is greater than 250 days per year, EPA assumed that a single worker would not work more than 250 days per year such that the maximum exposure days per year was still 250.

E.2.2 Model Input Parameters

Table_Apx E-3 summarizes the model parameters and their values for the Processing—repackaging Monte Carlo simulation. Additional explanations of EPA's selection of the distributions for each parameter are provided after this table.

3525 **Table_Apx E-3. Summary of Parameter Values and Distributions Used in the Processing—Repackaging Models**

Input Parameter	Symbol	Unit	Deterministic Values	Uncertainty Analysis Distribution Parameters				Rationale / Basis
			Value	Lower Bound	Upper Bound	Mode	Distribution Type	
Air Speed	$RATE_{air\_speed}$	cm/s	10	1.3	202.2	–	Lognormal	See Section E.2.7
Container Loss Fraction	F_{loss_cont}	kg/kg	0.025	0.017	0.03	0.025	Triangular	See Section E.2.8
Saturation Factor Unloading	$F_{saturation\_unloading}$	unitless	0.5	0.5	1.45	0.5	Triangular	See Section E.2.10
Saturation Factor Loading	$F_{saturation\_loading}$	unitless	0.5	0.5	1.45	0.5	Triangular	See Section E.2.10
Import Container Volume	V_{import_cont}	gal/container	55	20	100	55	Triangular	See Section E.2.11
Small Container Volume	V_{prod_cont}	gal/container	5	5	20	5	Triangular	See Section E.2.11
Number of Sites	Ns	sites	2	–	–	–	–	“What-if” scenario input
Production Volume Assessed	PV_lb	lb/year	50,000	–	–	–	–	“What-if” scenario input
Production Volume	PV	kg/year	22,680	–	–	–	–	PV input converted to kilograms
Import Concentration	$F_{1,1\text{-}DCA\_import}$	kg/kg	1.0	–	–	–	–	Assumed pure 1,1-dichloroethane repackaged
Temperature	T	Kelvin	298	–	–	–	–	Process parameter
Pressure	P	torr	760	–	–	–	–	Process parameter
Gas Constant	R	L*torr/(mol*K)	62.36367	–	–	–	–	Universal constant
1,1-dichloroethane Vapor Pressure	VP	torr	227	–	–	–	–	Physical property

Input Parameter	Symbol	Unit	Deterministic Values	Uncertainty Analysis Distribution Parameters				Rationale / Basis
			Value	Lower Bound	Upper Bound	Mode	Distribution Type	
1,1-dichloroethane Density	$\rho_{1,1\text{-}DCA}$	kg/m^3	1,168	–	–	–	–	Physical property
1,1-dichloroethane Molecular Weight	$MW_{1,1\text{-}DCA}$	g/mol	98.95	–	–	–	–	Physical property
Fill Rate of Drum	$RATE_{fill\_drum}$	containers/hr	20	–	–	–	–	See Section E.2.12
Fill Rate of Small Container	$RATE_{fill\_small}$	containers/hr	60	–	–	–	–	See Section E.2.12
Diameter of Opening for Container Cleaning	$D_{opening\_cont\text{-}cleaning}$	cm	5.08	–	–	–	–	See Section E.2.9
Ventilation Rate	Q	ft^3/min	3,000	500	10,000	3,000	Triangular	See Section E.2.13
Mixing Factor	k	unitless	0.5	0.1	1	0.5	Triangular	See Section E.2.14

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E.2.3 Throughput Parameters

The facility production rate is calculated as an input value to be used in the model equations during each iteration. The facility production rate is calculated using the following equation:

Equation_Apx E-7.

$$PV_{site} = \frac{PV}{N_s}$$

Where:

PV = Production volume [kg/year]
N_s = Number of sites [sites]
PV_{site} = Facility production rate [kg/site-year]

EPA assumed the number of release days in a single year is also equivalent to the number of import containers unloaded for repackaging in a single year. This is a result of the production volume of 1,1-dichloroethane selected only allows for the number of containers received in a single year to be between 26 to 129 containers per year. The equation to calculate the number of import containers is in Appendix E.2.4.

E.2.4 Number of Containers per Year

EPA assumed that facilities unloaded one imported drum in a single day for repackaging. EPA assumes 1,1-dichloroethane is imported in its pure form at 100% concentration. Based on the two production volumes and import container sizes shown in Table_Apx E-3, this only allows for the number of containers received in a single year to be between four to 40 containers per year. By assuming only one imported drum is unloaded and repackaged in a single day, the number of containers unloaded per year is equivalent to the number of release days per year. The number of import containers of 1,1-dichloroethane used by a site per year is calculated using the following equation:

Equation_Apx E-8

$$N_{cont\_yr} = \frac{PV}{N_s * \rho_{1,1-DCA} * \left(0.00378541\ \frac{m^3}{gal}\right) * V_{import\_cont}}$$

Where:

PV = Production volume [kg/year]
ρ_{TCEP} = 1,1-dichloroethane density [kg/m^3]
V_{import_cont} = Import container volume [gal/container]
N_s = Number of sites [sites]
N_{cont_yr} = Annual number of import containers [container/site-year]

E.2.5 Release Days per Year

EPA calculated the number of release days in a single year using the following equation:

Equation_Apx E-9

$$RD = \frac{PV_{site}}{\rho_{1,1-DCA} * \left(0.00378541\ \frac{m^3}{gal}\right) * V_{import\_cont}}$$

Where:

RD = Release days or Number of import containers [days/site-yr or containers/site-yr]

ρ_{TCEP} = 1,1-Dichloroethane density [kg/m^3]

V_{import_cont} = Import container volume [gal/container]

As described in Appendix E.2.4, EPA assumed that the number of import containers unloaded in a single operating day was one. Therefore, the number of release days is equivalent to the number of import containers, with a range of 26 to 129 release days.

E.2.6 Operating Hours and Exposure Durations

EPA estimated operating hours and exposure durations using calculations and parameters provided by the *ESD on Transport and Storage of Chemicals* (OECD, 2009) and *ChemSTEER User Guide* (U.S. EPA, 2015). The operating time for release and exposure activities associated with unloading (release source 1 and 4; exposure points A and C) are calculated using the following equation:

Equation_Apx E-10

$$Time_{RP1/RP4} = \frac{1}{RATE_{fill\_drum}}$$

Where:

$Time_{RP1/RP4}$ = Operating time for release sources 1 and 4 [hrs/container]

$RATE_{fill\_drum}$ = Fill rate of drum [containers/hr]

For the emptying of drums, the *ChemSTEER User Guide* (U.S. EPA, 2015) indicates a drum fill rate of 20 drums per hour based on the *Chemical Engineering Branch Manual for the Preparation of Engineering Assessments, Volume 1* [CEB Manual] (U.S. EPA, 1991). EPA assumed that one drum is imported and repackaged in a single operating day therefore equating the number of import containers received in a single year to the number of release days per year. For the cleaning of drums, the *ChemSTEER User Guide* (U.S. EPA, 2015) uses the same drum fill rate as emptying drums to estimate an exposure duration. EPA did not identify any other information on drum fill rates; therefore, EPA used a single deterministic value for fill rate.

The operating hours for both release source 3 and exposure point B is calculated using the following equation:

Equation_Apx E-11

$$Time_{RP3} = \frac{V_{import\_cont}}{V_{fill\_cont} * Rate_{fill_{smallcont}} * RD}$$

Where:

$Time_{RP3}$ = Operating time for release source 3 [hrs/site-day]

V_{import_cont} = Import container volume [gal/container]

V_{fill_cont} = Small container volume [gal/container]

$RATE_{fill\_smallcont}$ = Fill rate of small container [containers/hr]

RD = Release days or Number of import containers [days/site-yr or containers/site-yr]

For filling small containers, see Appendix E.2.11 for details on the distribution of small container volume and Appendix E.2.12 for details on the small container fill rate. Generally, EPA calculated the duration of filling small containers using the container volume and fill rate from the *ChemSTEER User Guide* (U.S. EPA, 2015). The calculated small container fill duration was used for both the release source (operating hours rate for release source 3) and exposure point (exposure duration for exposure point B).

E.2.7 Air Speed

Baldwin and Maynard measured indoor air speeds across a variety of occupational settings in the United Kingdom (Baldwin and Maynard, 1998), specifically, 55 work areas were surveyed. EPA analyzed the air speed data from Baldwin and Maynard and categorized the air speed surveys into settings representative of industrial facilities and representative of commercial facilities. EPA fit separate distributions for these industrial and commercial settings and used the industrial distribution for this OES.

EPA fit a lognormal distribution for the data set as consistent with the authors' observations that the air speed measurements within a surveyed location were lognormally distributed and the population of the mean air speeds among all surveys were lognormally distributed (Baldwin and Maynard, 1998). Since lognormal distributions are bound by zero and positive infinity, EPA truncated the distribution at the largest observed value among all of the survey mean air speeds.

EPA fit the air speed surveys representative of industrial facilities to a lognormal distribution with the following parameter values: mean of 22.414 cm/s and standard deviation of 19.958 cm/s. In the model, the lognormal distribution is truncated at a minimum allowed value of 1.3 cm/s and a maximum allowed value of 202.2 cm/s (largest surveyed mean air speed observed in Baldwin and Maynard) to prevent the model from sampling values that approach infinity or are otherwise unrealistically small or large (Baldwin and Maynard, 1998).

Baldwin and Maynard only presented the mean air speed of each survey. The authors did not present the individual measurements within each survey. Therefore, these distributions represent a distribution of mean air speeds and not a distribution of spatially variable air speeds within a single workplace setting. However, a mean air speed (averaged over a work area) is the required input for the model. EPA converted the units to ft/min prior to use within the model equations.

E.2.8 Container Residue Loss Fraction

EPA previously contracted PEI Associates, Inc. (PEI) to conduct a study for providing estimates of potential chemical releases during cleaning of process equipment and shipping containers (PEI Associates, 1988). The study used both a literature review (analyzing cleaning practices and release data) and a pilot-scale experiment to determine the amount of residual material left in vessels. The data from literature and pilot-scale experiments addressed different conditions for the emptying of containers and tanks, including various bulk liquid materials, different container constructions (*e.g.*, lined steel drums or plastic drums), and either a pump or pour/gravity-drain method for emptying. EPA reviewed the pilot-scale data from PEI and determined a range and average percentage of residual material remaining in vessels following emptying from drums by either pumping or pouring as well as tanks by gravity-drain (PEI Associates, 1988).

EPA previously used the study results to generate default central tendency and high-end loss fraction values for the residual models (*e.g.*, *EPA/OPPT Small Container Residual Model*, *EPA/OPPT Drum Residual Model*) provided in the *ChemSTEER User Guide* (U.S. EPA, 2015). Previously, EPA adjusted the default loss fraction values based on rounding the PEI study results or due to policy decisions. EPA used a combination of the PEI study results and *ChemSTEER User Guide* default loss fraction values to develop probability distributions for various container sizes.

Specifically, EPA paired the data from the PEI study such that the residuals data for emptying drums by pouring was aligned with the default central tendency and high-end values from the *EPA/OPPT Small Container Residual Model*, and the residuals data for emptying drums by pumping was aligned with the default central tendency and high-end values from the *EPA/OPPT Drum Residual Model*. EPA applied the *EPA/OPPT Small Container Residual Model* to containers with capacities less than 20 gallons, and the *EPA/OPPT Drum Residual Model* to containers with capacities between 20 and 100 gallons (U.S. EPA, 2015).

For unloading drums via pouring, the PEI study experiments showed average container residuals in the range of 0.03 percent to 0.79 percent with a total average of 0.32 percent (PEI Associates, 1988). The *EPA/OPPT Small Container Residual Model* recommends a default central tendency loss fraction of 0.3 percent and a high-end loss fraction of 0.6 percent (U.S. EPA, 2015). For unloading drums by pumping, the PEI study experiments showed average container residuals in the range of 1.7 percent to 4.7 percent with a total average of 2.6 percent (PEI Associates, 1988).

The *EPA/OPPT Drum Residual Model* from the *ChemSTEER User Guide* recommends a default central tendency loss fraction of 2.5 percent and a high-end loss fraction of 3.0 percent (U.S. EPA, 2015). The underlying distribution of the loss fraction parameter for small containers or drums is not known; therefore, EPA assigned a triangular distribution defined by the estimated lower bound, upper bound, and mode of the parameter values. EPA assigned the mode and upper bound values for the loss fraction triangular distributions using the central tendency and high-end values from the respective *ChemSTEER User Guide* model (U.S. EPA, 2015). EPA assigned the lower bound values for the triangular distributions using the minimum average percent residual measured in the PEI study for the respective drum emptying technique (pouring or pumping) (PEI Associates, 1988).

E.2.9 Diameters of Opening

The *ChemSTEER User Guide* indicates diameters for the openings for various vessels that may hold liquids in order to calculate vapor generation rates during different activities (U.S. EPA, 2015). In the simulation developed for the processing—repackaging OES based on the *ESD for Transport and Storage of Chemicals* (OECD, 2009), EPA used the default diameters of vessels from the ChemSTEER User Guide for container cleaning.

For container cleaning activities, the *ChemSTEER User Guide* indicates a single default value of 5.08 cm (U.S. EPA, 2015). Therefore, EPA could not develop a distribution of values for this parameter and used the single value 5.08 cm from the *ChemSTEER User Guide*.

E.2.10 Saturation Factor

The *Chemical Engineering Branch Manual for the Preparation of Engineering Assessments, Volume 1* [CEB Manual] indicates that during splash filling, the saturation concentration was reached or exceeded by misting with a maximum saturation factor of 1.45 (U.S. EPA, 1991). The CEB Manual indicates that saturation concentration for bottom filling was expected to be about 0.5 (U.S. EPA, 1991). The underlying distribution of this parameter is not known; therefore, EPA assigned a triangular distribution based on the lower bound, upper bound, and mode of the parameter. Because a mode was not provided for this parameter, EPA assigned a mode value of 0.5 for bottom filling as bottom filling minimizes volatilization (U.S. EPA, 1991). This value also corresponds to the typical value provided in the *ChemSTEER User Guide* for the *EPA/OAQPS AP-42 Loading Model* (U.S. EPA, 2015).

E.2.11 Container Size

The *ChemSTEER User Guide* (U.S. EPA, 2015) indicates a range of 20 to less than 100 gallons for the volume capacity of drums modeled in container-related activities, and the *ESD for Transport and Storage of Chemicals* (OECD, 2009) suggests nearly 80% of all steel drums in the United States have a capacity of 55 gallons. The underlying distribution import drum sizes is not known; therefore, EPA assigned a lower bound of 20 gallons, an upper bound of 100 gallons, and a mode of 55 gallons for the import container volume distribution.

The *ChemSTEER User Guide* (U.S. EPA, 2015) indicates a range of 5 to less than 20 gallons for the volume capacity of small containers modeled in container-related activities with 5 gallons as the default volume size. Therefore, EPA assigned a lower bound of 5 gallons, an upper bound of 20 gallons, and a mode of 5 gallons for the small container volume distribution.

E.2.12 Container Fill Rates

The *ChemSTEER User Guide* (U.S. EPA, 2015) provides a typical fill rate of 20 containers per hour for containers with 20 to 100 gallons of liquid and a typical fill rate of 60 containers per hour for containers with less than 20 gallons of liquid.

E.2.13 Ventilation Rate

The CEB Manual (U.S. EPA, 1991) indicates general ventilation rates in industry range from 500 to 10,000 ft^3/min, with a typical value of 3,000 ft^3/min. The underlying distribution of this parameter is not known; therefore, EPA assigned a triangular distribution based on an estimated lower bound, upper bound, and mode of the parameter. EPA assumed the lower and upper bound using the industry range of 500 to 10,000 ft^3/min and the mode using the 3,000 ft^3/min typical value (U.S. EPA, 1991).

E.2.14 Mixing Factor

The CEB Manual (U.S. EPA, 1991) indicates mixing factors may range from 0.1 to 1, with 1 representing ideal mixing. The CEB Manual references the *1988 ACGIH Ventilation Handbook*, which suggests the following factors and descriptions: 0.67 to 1 for best mixing; 0.5 to 0.67 for good mixing; 0.2 to 0.5 for fair mixing; and 0.1 to 0.2 for poor mixing (U.S. EPA, 1991). The underlying distribution of this parameter is not known; therefore, EPA assigned a triangular distribution based on the defined lower and upper bound and estimated mode of the parameter. The mode for this distribution was not provided; therefore, EPA assigned a mode value of 0.5 based on the typical value provided in the *ChemSTEER User Guide* for the *EPA/OPPT Mass Balance Inhalation Model* (U.S. EPA, 2015).

E.3 Commercial Use as a Laboratory Chemical Model Approach and Parameters

This appendix presents the modeling approach and equations used to estimate environmental releases for 1,1-dichloroethane during the Commercial Use as a Laboratory Chemical OES. This approach utilized the *Use of Laboratory Chemicals—Generic Scenario for Estimating Occupational Exposures and Environmental Releases* (U.S. EPA, 2023) combined with Monte Carlo simulations (a type of stochastic simulation).

Based on the GS, EPA identified the following release sources from laboratory operations:

- Release source 1: Release during unloading of liquids
- Release source 2: Release during unloading of solids (not assessed)
- Release source 3: Release from cleaning transport container

- Release source 4: Open surface losses to air during container cleaning
- Release source 5: Labware equipment cleaning
- Release source 6: Open surface losses during equipment cleaning
- Release source 7: Releases to air during laboratory analyses
- Release source 8: Release from disposal of laboratory waste

Environmental releases for 1,1-dichloroethane during use as a laboratory chemical are a function of 1,1-dichloroethane's physical properties, container size, mass fractions, and other model parameters. While some parameters are fixed, others are expected to vary. EPA used a Monte Carlo simulation to capture variability in the following model input parameters: ventilation rate, mixing factor, air speed, saturation factor, loss factor, container sizes, working years, and drum fill rates. EPA used the outputs from a Monte Carlo simulation with 100,000 iterations and the Latin Hypercube sampling method in @Risk to calculate release amounts and exposure concentrations for this OES.

E.3.1 Model Equations

Table_Apx E-4 provides the models and associated variables used to calculate environmental releases for each release source within each iteration of the Monte Carlo simulation. EPA used these environmental releases to develop a distribution of release outputs for the Commercial Use as a Laboratory Chemical OES. The variables used to calculate each of the following values include deterministic or variable input parameters. The values for these variables are provided in Appendix E.3.2. The Monte Carlo simulation calculated the total 1,1-dichloroethane release (by environmental media) across all release sources during each iteration of the simulation. EPA then selected 50th percentile and 95th percentile values to estimate the central tendency and high-end releases, respectively.

Table_Apx E-4. Models and Variables Applied for Release Sources in the Commercial Use as a Laboratory Chemical OES

Release Source	Model(s) Applied	Variables Used
Release source 1: Release during unloading of liquid	*EPA/OAQPS AP-42 Loading Model* (Equation_Apx E-3)	Vapor Generation Rate: $F_{1,1-DCA}$; VP; $F_{saturation\_unloading}$; $MW_{1,1-DCA}$; Q_{cont}; R; T; $RATE_{fill\ smallcont}$ Operating Time: $RATE_{fill\_smallcont}$; $N_{cont\ unload\ yr}$; OP_{days}
Release source 2: Release during unloading of solids	Not assessed; release is not expected since 1,1-dichloroethane is assumed to be managed as a liquid	Not applicable
Release source 3: Release from cleaning transport container	*EPA/OPPT Small Container Residual Model* (Equation_Apx E-5)	$Q_{chem\ site\ day\ (recalc)}$; $F_{loss\_smallcont}$; OP_{days}
Release source 4: Open surface losses to air during container cleaning	*EPA/OPPT Penetration Model* or *EPA/OPPT Mass Transfer Coefficient Model*, based on air speed (Equation_Apx E-1 and Equation_Apx E-2)	Vapor Generation Rate: F_{TCEP}; $MW_{1,1-DCA}$; VP; $RATE_{air\_speed}$; $D_{container}$; T; P Operating Time: $RATE_{fill\_smallcont}$; $N_{cont\ unload\ yr}$; OP_{days}

Release Source	Model(s) Applied	Variables Used
Release source 5: Labware equipment cleaning	*EPA/OPPT Multiple Process Residual Model (*Equation_Apx E-5*)*	$Q_{chem\ site\ day\ (recalc)}$; F_{loss_equip}; OP_{days}
Release source 6: Open surface losses during equipment cleaning	*EPA/OPPT Penetration Model* or *EPA/OPPT Mass Transfer Coefficient Model*, based on air speed (Equation_Apx E-1 and Equation_Apx E-2)	Vapor Generation Rate: F_{TCEP}; $MW_{1,1-DCA}$; VP; $RATE_{air\_speed}$; $D_{container}$; T; P Operating Time: OH_{equip}
Release source 7: Releases to air during laboratory analyses	*EPA/OPPT Penetration Model* or *EPA/OPPT Mass Transfer Coefficient Model*, based on air speed (Equation_Apx E-1 and Equation_Apx E-2)	Vapor Generation Rate: $F_{1,1-DCA}$; $MW_{1,1-DCA}$; VP; $RATE_{air\_speed}$; $D_{container\ lab\ analysis}$; T; P Operating Time: $OH_{sampling}$
Release source 8: Release from disposal	No model applicable; all chemicals used in the laboratory are expected to be disposed at the end of each working day. Remaining chemical not released from the previous release sources is released here	Not applicable

E.3.2 Model Input Parameters

Table_Apx E-5 summarizes the model parameters and their values for the Commercial Use as a Laboratory Chemical Monte Carlo simulation. Additional explanations of EPA's selection of the distributions for each parameter are provided after this table.

Table_Apx E-5. Summary of Parameter Values and Distributions Used in the Commercial Use as a Laboratory Chemical Model

Input Parameter	Symbol	Unit	Deterministic Values	Uncertainty Analysis Distribution Parameters				Rationale / Basis
			Value	Lower Bound	Upper Bound	Mode	Distribution Type	
Air Speed	$RATE_{air\_speed}$	cm/s	10	1.3	202.2	—	Lognormal	See Section E.3.8
Loss Fraction for Small Containers	$F_{loss\_smallcont}$	kg/kg	0.003	0.0003	0.006	0.003	Triangular	See Section E.3.9
Saturation Factor Unloading	$F_{saturation\_unloading}$	unitless	0.5	0.5	1.45	0.5	Triangular	See Section E.3.11
Daily Throughput of Stock Solutions	$Q_{stock\_site\_day}$	mL/site-day	2,000	0.5	4,000	2,000	Triangular	See Section E.3.4
Diameter of Laboratory Analysis Containers	$D_{container\_lab\_analysis}$	cm	2.5	2.5	10	2.5	Triangular	See Section E.3.14
Operating Days	$TIME_{operating\_days}$	days/yr	260	173	261	260	Triangular	See Section E.3.6
Production Volume Assessed	PV_lb	lb/yr	50,000	–	–	–	–	"What-if" scenario input
Production Volume	PV	kg/yr	22,680	–	–	–	–	PV input converted to kilograms
Temperature	T	K	298	–	–	–	–	Process parameter
Pressure (torr)	P_torr	torr	760	–	–	–	–	Process parameter
Pressure (atm)	P_atm	Atm	1	–	–	–	–	Process parameter
Gas Constant	R	L*torr/mol-K	62.36367	–	–	–	–	Universal constant
1,1-dichloroethane Vapor Pressure	VP	torr	227	–	–	–	–	Physical property
1,1-dichloroethane Molecular Weight	$MW_{1,1\text{-}DCA}$	g/mol	98.95	–	–	–	–	Physical property
Molar Volume	$Vm_{1,1\text{-}DCA}$	L/mol	24.45	–	–	–	–	Physical property
Fill Rate of Small Container	$RATE_{fill\_smallcont}$	containers/hr	60	–	–	–	–	See Section E.3.12
Container Volume	Q_{cont}	gal/container	1	–	–	–	–	See Section E.3.10
Loss Fraction for Equipment Cleaning	F_{loss_equip}	kg/kg	0.02	–	–	–	–	See Section E.3.13
Hours per Equipment Cleaning	OH_{equip_clean}	hrs	4	–	–	–	–	See Section E.3.6

Input Parameter	Symbol	Unit	Deterministic Values	Uncertainty Analysis Distribution Parameters				Rationale / Basis
			Value	Lower Bound	Upper Bound	Mode	Distribution Type	
Hours per Analysis Sampling	$OH_{sampling}$	hrs	1	–	–	–	–	See Section E.3.6
Diameter of Opening for Container	$D_{container}$	cm	5.08	–	–	–	–	See Section E.3.14
Product density	$\rho_{product}$	kg/m^3	–	Multiple distributions depending on product data			Uniform	See Section E.3.15
Product Concentration	$F_{1,1\text{-}DCA\_prod}$	kg/kg	–	Multiple distributions depending on product data			Uniform	See Section E.3.15
Ventilation Rate	Q	ft^3/min	–	500	10,000	3,000	Triangular	See Section E.3.16
Mixing Factor	k	unitless	–	0.1	1	0.5	Triangular	See Section E.3.17

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E.3.3 Number of Sites

The *Use of Laboratory Chemicals—Generic Scenario for Estimating Occupational Exposures and Environmental Releases* (U.S. EPA, 2023) provides a method of determining the number of laboratory sites based on the total annual production volume and annual throughput per site of the chemical of interest. The total annual production volume is 50,000 lb/yr (see Section 5.5.3). The annual throughput per site of 1,1-dichloroethane is determined according to Section E.3.4.

Equation_Apx E-12

$$N_{sites} = \frac{PV}{Q_{chem\ site\ yr}}$$

Where:

N_{sites} = Number of sites [site]
PV = Annual production volume [kg/yr]
$Q_{chem\ site\ yr}$ = Annual Throughput of 1,1-dichloroethane [kg/site-yr]

E.3.4 Throughput Parameters

The *Use of Laboratory Chemicals—Generic Scenario for Estimating Occupational Exposures and Environmental Releases* (U.S. EPA, 2023) provides daily throughput of 1,1-dichloroethane required for laboratory stock solutions. According to the GS, laboratory liquid use rate ranges from 0.5 mL up to 4 liters per day. Laboratory stock solutions are used for multiple analyses and eventually need to be replaced, The expiration or replacement times range from daily to 6 months (U.S. EPA, 2023). For this scenario, EPA assumes stock solutions are prepared daily. Therefore, EPA assigned a triangular distribution for the daily throughput of laboratory stock solutions with upper and lower bounds corresponding to the high and low throughputs, 4,000 and 0.5 mL respectively, with a mode of 2,000 mL. The daily throughput of 1,1-dichloroethane is calculated using the following equation:

Equation_Apx E-13

$$Q_{chem\ site\ day} = \frac{Q_{stock\ site\ day}}{\rho_{product} * F_{1,1-DCA\ prod} * 1000\frac{L}{m^3} * 1000\frac{mL}{L}}$$

Where:

$Q_{chem\ site\ day}$ = Daily Throughput of 1,1-dichloroethane [kg/site-day]
$Q_{stock\ site\ day}$ = Daily Throughput of Stock Solutions [kg/site-day]
$\rho_{product}$ = Product density [kg/m^3]
F_{TCEP_prod} = Weight fraction of 1,1-dichloroethane in product [unitless]

The annual throughput of 1,1-dichloroethane is calculated using Equation_Apx E-14 by multiplying the daily throughput by the number of operating days. The number of operating days is determined according to Section E.3.6.

Equation_Apx E-14

$$Q_{chem\ site\ yr} = Q_{chem\ site\ day} * TIME_{operating\ days}$$

Where:

$TIME_{operating\ days}$ = Operating days [days/yr]

The annual throughput of 1,1-dichloroethane cannot exceed the production volume limit of 50,000 lb/yr. Therefore, in the event an iteration of the simulation does calculate an annual throughput greater than the production volume limit, EPA set the number of sites equal to one, and the annual throughput equal to the total annual production volume. The model then recalculated the number of operating days using Equation_Apx E-15 below.

Equation_Apx E-15

$$TIME_{operating\ days\ (recalc)} = \frac{PV}{N_{sites} * Q_{chem\ site\ day}}$$

Where:

$TIME_{operating\ days\ (recalc)}$ = Recalculated number of operating days [days/yr]

E.3.5 Number of Containers Unloaded Annually per Site

EPA estimated the number of containers unloaded annually per site using the *Use of Laboratory Chemicals—Generic Scenario for Estimating Occupational Exposures and Environmental Releases* (U.S. EPA, 2023), as well as other parameters. The total number of containers unloaded annually per site is calculated based on the annual throughput (See Section E.3.4), product concentration (See Section E.3.15), and container volume (See Section E.3.10). The total number of containers unloaded annually per site is calculated using Equation_Apx E-16 below.

Equation_Apx E-16

$$N_{cont\ unload\ yr} = \frac{Q_{chem\ site\ yr}}{F_{1,1-DCA\ prod} * Q_{cont}}$$

Where:

$N_{cont\ unload\ yr}$ = Number of Containers Unloaded Annually per site [container/site-yr]
Q_{cont} = Container volume [gal/container]

E.3.6 Operating Days

The *Use of Laboratory Chemicals—Generic Scenario for Estimating Occupational Exposures and Environmental Releases* (U.S. EPA, 2023), estimates the number of operating days from employment data obtained through the U.S. Bureau of Labor Statistics (BLS) Occupational Employment Statistics. The U.S. BLS assumes the operating duration per NAICS code or a ‘year-round, full-time’ hours figure, to be 2,080 hours (U.S. EPA, 2023). Using this annual duration and an assumed daily shift lengths of 8-,10-, and 12-hours/day, EPA calculated 260, 208, and 174 operating days/year, respectively.

E.3.7 Operating Hours

EPA estimated operating hours using the *Use of Laboratory Chemicals—Generic Scenario for Estimating Occupational Exposures and Environmental Releases* (U.S. EPA, 2023), as well as other parameters and equations. The operating hours for release sources 1 and 4 are calculated using the number of product containers used at the site, the container fill rate, and operating days (see Section E.3.6). The following equations provide the calculation.

Equation_Apx E-17

$$Time_{RP1/4} = \frac{N_{cont\ unload\ yr}}{TIME_{operating\ days\ (recalc)} * RATE_{fill\_smallcont}}$$

Where:

$Time_{RP1/4}$ = Operating times for release sources 1 and 4 [hrs/site-day]
$RATE_{fill\_smallcont}$ = Fill rate of small container [containers/hr]

For equipment cleaning, the *Use of Laboratory Chemicals—Generic Scenario for Estimating Occupational Exposures and Environmental Releases* (U.S. EPA, 2023) uses the multiple vessel model with a default release duration of 4 hours per day. Therefore, EPA assumes 4 hours per day as the release for release source 6.

For laboratory analyses, the *Use of Laboratory Chemicals—Generic Scenario for Estimating Occupational Exposures and Environmental Releases* (U.S. EPA, 2023) provides a default release estimate of 1 hour per day based on the default for sampling. EPA assumes 1 hour per day for release source 7.

E.3.8 Air Speed

Baldwin and Maynard measured indoor air speeds across a variety of occupational settings in the United Kingdom (Baldwin and Maynard, 1998). Fifty-five work areas were surveyed across a variety of workplaces. EPA analyzed the air speed data from Baldwin and Maynard and categorized the air speed surveys into settings representative of industrial facilities and representative of commercial facilities. EPA fit separate distributions for these industrial and commercial settings and used the industrial distribution for this OES.

EPA fit a lognormal distribution for the data set as consistent with the authors' observations that the air speed measurements within a surveyed location were lognormally distributed and the population of the mean air speeds among all surveys were lognormally distributed (Baldwin and Maynard, 1998). Since lognormal distributions are bound by zero and positive infinity, EPA truncated the distribution at the largest observed value among all of the survey mean air speeds.

EPA fit the air speed surveys representative of industrial facilities to a lognormal distribution with the following parameter values: mean of 22.414 cm/s and standard deviation of 19.958 cm/s. In the model, the lognormal distribution is truncated at a minimum allowed value of 1.3 cm/s and a maximum allowed value of 202.2 cm/s (largest surveyed mean air speed observed in Baldwin and Maynard) to prevent the model from sampling values that approach infinity or are otherwise unrealistically small or large (Baldwin and Maynard, 1998).

Baldwin and Maynard only presented the mean air speed of each survey. The authors did not present the individual measurements within each survey. Therefore, these distributions represent a distribution of mean air speeds and not a distribution of spatially variable air speeds within a single workplace setting. However, a mean air speed (averaged over a work area) is the required input for the model. EPA converted the units to ft/min prior to use within the model equations.

E.3.9 Container Residue Loss Fraction

EPA previously contracted PEI Associates, Inc (PEI) to conduct a study for providing estimates of potential chemical releases during cleaning of process equipment and shipping containers (PEI Associates, 1988). The study used both a literature review of cleaning practices and release data as well as a pilot-scale experiment to determine the amount of residual material left in vessels. The data from literature and pilot-scale experiments addressed different conditions for the emptying of containers and tanks, including various bulk liquid materials, different container constructions (*e.g.*, lined steel drums or plastic drums), and either a pump or pour/gravity-drain method for emptying. EPA reviewed the pilot-scale data from PEI and determined a range and average percentage of residual material remaining in vessels following emptying from drums by either pumping or pouring as well as tanks by gravity-drain (PEI Associates, 1988).

EPA previously used the study results to generate default central tendency and high-end loss fraction values for the residual models (*e.g.*, *EPA/OPPT Small Container Residual Model*, *EPA/OPPT Drum Residual Model*) provided in the *ChemSTEER User Guide* (U.S. EPA, 2015). Previously, EPA adjusted the default loss fraction values based on rounding the PEI study results or due to policy decisions. EPA used a combination of the PEI study results and *ChemSTEER User Guide* default loss fraction values to develop probability distributions for various container sizes.

Specifically, EPA paired the data from the PEI study such that the residuals data for emptying drums by pouring was aligned with the default central tendency and high-end values from the *EPA/OPPT Small Container Residual Model*, and the residuals data for emptying drums by pumping was aligned with the default central tendency and high-end values from the *EPA/OPPT Drum Residual Model*. EPA applied the *EPA/OPPT Small Container Residual Model* to containers with capacities less than 20 gallons, and the *EPA/OPPT Drum Residual Model* to containers with capacities between 20 and 100 gallons (U.S. EPA, 2015). For unloading drums by pouring, the PEI study experiments showed average container residuals in the range of 0.03 percent to 0.79 percent with a total average of 0.32 percent (PEI Associates, 1988). The *EPA/OPPT Small Container Residual Model* recommends a default central tendency loss fraction of 0.3 percent and a high-end loss fraction of 0.6 percent (U.S. EPA, 2015). For unloading drums by pumping, the PEI study experiments showed average container residuals in the range of 1.7 percent to 4.7 percent with a total average of 2.6 percent (PEI Associates, 1988). The *EPA/OPPT Drum Residual Model* from the *ChemSTEER User Guide* recommends a default central tendency loss fraction of 2.5 percent and a high-end loss fraction of 3.0 percent (U.S. EPA, 2015). The underlying distribution of the loss fraction parameter for small containers or drums is not known; therefore, EPA assigned a triangular distribution defined by the estimated lower bound, upper bound, and mode of the parameter values. EPA assigned the mode and upper bound values for the loss fraction triangular distributions using the central tendency and high-end values from the respective *ChemSTEER User Guide* model (U.S. EPA, 2015). EPA assigned the lower bound values for the triangular distributions using the minimum average percent residual measured in the PEI study for the respective drum emptying technique (pouring or pumping) (PEI Associates, 1988).

E.3.10 Product Container Volume

EPA did not identify container sizes for 1,1-dichloroethane use in laboratories from available literature. Therefore, EPA assumes that 1,1-dichloroethane is transported in 1 L containers to small vials for use per the *Use of Laboratory Chemicals—Generic Scenario for Estimating Occupational Exposures and Environmental Releases* (U.S. EPA, 2023).

E.3.11 Saturation Factor

The CEB Manual indicates that during splash filling, the saturation concentration was reached or exceeded by misting with a maximum saturation factor of 1.45 (U.S. EPA, 1991). The CEB Manual indicates that saturation concentration for bottom filling was expected to be about 0.5 (U.S. EPA, 1991). The underlying distribution of this parameter is not known; therefore, EPA assigned a triangular distribution based on the lower bound, upper bound, and mode of the parameter. Because a mode was not provided for this parameter, EPA assigned a mode value of 0.5 for bottom filling as bottom filling minimizes volatilization (U.S. EPA, 1991). This value also corresponds to the typical value provided in the *ChemSTEER User Guide* for the *EPA/OAQPS AP-42 Loading Model* (U.S. EPA, 2015).

E.3.12 Container Fill Rates

The *ChemSTEER User Guide* (U.S. EPA, 2015) provides a typical fill rate of 60 containers per hour for containers with less than 20 gallons of liquid.

E.3.13 Equipment Cleaning Loss Fraction

The *Use of Laboratory Chemicals—Generic Scenario for Estimating Occupational Exposures and Environmental Releases* (U.S. EPA, 2023) recommends using the *EPA/OPPT Multiple Process Residual Model* to estimate the releases from equipment cleaning. The *EPA/OPPT Multiple Process Residual Model*, as detailed in the *ChemSTEER User Guide* (U.S. EPA, 2015) provides an overall loss fraction of 2 percent from equipment cleaning.

E.3.14 Diameters of Opening

The *ChemSTEER User Guide* indicates diameters for the openings for various vessels that may hold liquids in order to calculate vapor generation rates during different activities (U.S. EPA, 2015). In the simulation developed for the Use in Laboratory Chemicals OES based on the *Use of Laboratory Chemicals—Generic Scenario for Estimating Occupational Exposures and Environmental Releases* (U.S. EPA, 2023), EPA used default diameters of vessels from the *ChemSTEER User Guide* for container and equipment cleaning, and laboratory analyses. For container and equipment cleaning, EPA assessed a single value of 5.08 cm (U.S. EPA, 2015). For laboratory analyses, EPA applied the *EPA/OPPT Penetration Model* and assumed two container sizes for sampling liquid product. For a typical release estimate, the model assumes sampling occurs from a 2.5 cm diameter bottle opening; and for a worst-case release estimate, the model assumes sampling occurs from a 10 cm diameter beaker opening. The underlying distribution for laboratory container sizes is not known, therefore, EPA assigned this parameter a triangular distribution with lower bound of 2.5 cm, upper bound or 10 cm, and mode of 2.5 cm.

E.3.15 Product Data (Concentration and Density)

EPA compiled 1,1-dichloroethane concentration and product density information from laboratory products containing 1,1-dichloroethane to develop distributions for concentration and density in the simulation. SDSs for 1,1-dichloroethane laboratory products provided a single value for the 1,1-dichloroethane concentration and product density in each product. Therefore, EPA used the values from the SDSs as discrete input parameters. EPA did not have information on the prevalence or market share of different laboratory products in commerce; therefore, EPA assumed a uniform distribution of laboratory products. The model first selects a laboratory product for the iteration and then based on the product selected, selects a concentration and density associated with that product. Table_Apx E-6 provides the 1,1-dichloroethane-containing laboratory products used in the model along with product-specific concentration and density values used.

Table_Apx E-6. 1,1-Dichloroethane Concentrations and Densities for Commercial Use as a Laboratory Chemical OES

Product	1,1-Dichloroethane Concentration (Mass Fraction)	Concentration Distribution	Density (kg/m^3)	Source Reference(s)
1,1-Dichloroethane 48512	≤1.00	Discrete (single value)	1,168 (density listed as 1.17 g/cm^3)	(MilliporeSigma, 2023)

Product	1,1-Dichloroethane Concentration (Mass Fraction)	Concentration Distribution	Density (kg/m^3)	Source Reference(s)
1,1-Dichloroethane 36967	≤1.00	Discrete (single value)	1,168 (density listed as 1.17 g/cm^3)	(Sigma-Aldrich, 2016)
1,1-Dichloroethane (stabilized with Nitromethane) D0363	>0.95	Discrete (single value)	1,168 (relative density listed as 1.18 g/cm^3)	(TCI America, 2014)

E.3.16 Ventilation Rate

The CEB Manual (U.S. EPA, 1991) indicates general ventilation rates in industry range from 500 to 10,000 ft^3/min, with a typical value of 3,000 ft^3/min. The underlying distribution of this parameter is not known; therefore, EPA assigned a triangular distribution based on an estimated lower bound, upper bound, and mode of the parameter. EPA assumed the lower and upper bound using the industry range of 500 to 10,000 ft^3/min and the mode using the 3,000 ft^3/min typical value (U.S. EPA, 1991).

E.3.17 Mixing Factor

The CEB Manual (U.S. EPA, 1991) indicates mixing factors may range from 0.1 to 1, with 1 representing ideal mixing. The CEB Manual references the *1988 ACGIH Ventilation Handbook*, which suggests the following factors and descriptions: 0.67 to 1 for best mixing; 0.5 to 0.67 for good mixing; 0.2 to 0.5 for fair mixing; and 0.1 to 0.2 for poor mixing (U.S. EPA, 1991). The underlying distribution of this parameter is not known; therefore, EPA assigned a triangular distribution based on the defined lower and upper bound and estimated mode of the parameter. The mode for this distribution was not provided; therefore, EPA assigned a mode value of 0.5 based on the typical value provided in the *ChemSTEER User Guide* for the *EPA/OPPT Mass Balance Inhalation Model* (U.S. EPA, 2015).

Appendix F CONSIDERATION OF ENGINEERING CONTROLS AND PERSONAL PROTECTIVE EQUIPMENT

OSHA and NIOSH recommend employers utilize the hierarchy of controls to address hazardous exposures in the workplace. The hierarchy of controls strategy outlines, in descending order of priority, the use of elimination, substitution, engineering controls, administrative controls, and lastly personal protective equipment (PPE). The hierarchy of controls prioritizes the most effective measures first which is to eliminate or substitute the harmful chemical (*e.g.*, use a different process, substitute with a less hazardous material), thereby preventing or reducing exposure potential. Following elimination and substitution, the hierarchy recommends engineering controls to isolate employees from the hazard (*e.g.*, source enclosure, local exhaust ventilation systems), followed by administrative controls (*e.g.*, do not open machine doors when running), or changes in work practices (*e.g.*, maintenance plan to check equipment to ensure no leaks) to reduce exposure potential. Administrative controls are policies and procedures instituted and overseen by the employer to limit worker exposures. Under §1910.1000, OSHA requires the use of engineering or administrative controls to bring exposures to the levels permitted under the air contaminants standard. The respirators do not replace engineering controls and they are implemented in addition to feasible engineering controls (29 CFR 1910.134(a)(1). The PPE (*e.g.*, respirators, gloves) could be used as the last means of control, when the other control measures cannot reduce workplace exposure to an acceptable level.

The remainder of this section discusses respiratory protection and glove protection, including protection factors for various respirators and dermal protection strategies. EPA's estimates of occupational exposure presented in this document do not assume the use of engineering controls or PPE; however, the effect of respiratory and dermal protection factors on EPA's occupational exposure estimates can be explored in *Risk Evaluation for 1,1-Dichloroethane, Supplemental Information Risk Calculator for Occupational Exposures.*

F.1 Respiratory Protection

OSHA's Respiratory Protection Standard (29 CFR 1910.134) requires employers in certain industries to address workplace hazards by implementing engineering control measures and, if these are not feasible, provide respirators that are applicable and suitable for the purpose intended. Engineering and administrative controls must be implemented whenever employees are exposed above the PEL. If engineering and administrative controls do not reduce exposures to below the PEL, respirators must be worn. Respirator selection provisions are provided in part 1910.134(d) and require that appropriate respirators are selected based on the respiratory hazard(s) to which the worker will be exposed and workplace and user factors that affect respirator performance and reliability. Assigned protection factors (APFs) are provided in Table 1 under part 1910.134(d)(3)(i)(A) (see below in Table_Apx F-1) and refer to the level of respiratory protection that a respirator or class of respirators could provide to employees when the employer implements a continuing, effective respiratory protection program. Implementation of a full respiratory protection program requires employers to provide training, appropriate selection, fit testing, cleaning, and change-out schedules in order to have confidence in the efficacy of the respiratory protection.

If respirators are necessary in atmospheres that are not immediately dangerous to life or health, workers must use NIOSH-certified air-purifying respirators or NIOSH-approved supplied-air respirators with the appropriate APF. Respirators that meet these criteria may include air-purifying respirators with organic vapor cartridges. Respirators must meet or exceed the required level of protection listed in Table_Apx F-1. Based on the APF, inhalation exposures may be reduced by a factor of 5 to 10,000 if respirators are properly worn and fitted.

For atmospheres that are immediately dangerous to life and health, workers must use a full facepiece pressure demand self-contained breathing apparatus (SCBA) certified by NIOSH for a minimum service life of 30 minutes or a combination full facepiece pressure demand supplied-air respirator (SAR) with auxiliary self-contained air supply. Respirators that are provided only for escape from an atmosphere that is immediately dangerous to life and health must be NIOSH-certified for escape from the atmosphere in which they will be used.

Table_Apx F-1. Assigned Protection Factors for Respirators in OSHA Standard 29 CFR 1910.134

Type of Respirator	Quarter Mask	Half Mask	Full Facepiece	Helmet/ Hood	Loose-Fitting Facepiece
1. Air-Purifying Respirator	5	10	50		
2. Power Air-Purifying Respirator (PAPR)		50	1,000	25/1,000	25
3. Supplied-Air Respirator (SAR) or Airline Respirator					
• Demand mode		10	50		
• Continuous flow mode		50	1,000	25/1,000	25
• Pressure-demand or other positive-pressure mode		50	1,000		
4. Self-Contained Breathing Apparatus (SCBA)					
• Demand mode		10	50	50	
• Pressure-demand or other positive-pressure mode (*e.g.*, open/closed circuit)			10,000	10,000	
Source: 29 CFR 1910.134(d)(3)(i)(A)					

The National Institute for Occupational Safety and Health (NIOSH) and the U.S. Department of Labor's Bureau of Labor Statistics (BLS) conducted a voluntary survey of U.S. employers regarding the use of respiratory protective devices between August 2001 and January 2002. The survey was sent to a sample of 40,002 establishments designed to represent all private sector establishments. The survey had a 75.5% response rate (NIOSH, 2003). A voluntary survey may not be representative of all private industry respirator use patterns as some establishments with low or no respirator use may choose to not respond to the survey. Therefore, results of the survey may potentially be biased towards higher respirator use.

NIOSH and BLS estimated about 619,400 establishments used respirators for voluntary or required purposes (including emergency and non-emergency uses). About 281,800 establishments (45%) were estimated to have had respirator use for required purposes in the 12 months prior to the survey. The 281,800 establishments estimated to have had respirator use for required purposes were estimated to be approximately 4.5% of all private industry establishments in the U.S. at the time (NIOSH, 2003).

The survey found that the establishments that required respirator use had the following respirator program characteristics (NIOSH, 2003):

- 59% provided training to workers on respirator use.
- 34% had a written respiratory protection program.
- 47% performed an assessment of the employees' medical fitness to wear respirators.

- 24% included air sampling to determine respirator selection.

The survey report does not provide a result for respirator fit testing or identify if fit testing was included in one of the other program characteristics.

Of the establishments that had respirator use for a required purpose within the 12 months prior to the survey, NIOSH and BLS found (NIOSH, 2003):

- Non-powered air purifying respirators are most common, 94% overall and varying from 89% to 100% across industry sectors.
- Powered air-purifying respirators represent a minority of respirator use, 15% overall and varying from 7% to 22% across industry sectors.
- Supplied air respirators represent a minority of respirator use, 17% overall and varying from 4% to 37% across industry sectors.

Of the establishments that used non-powered air-purifying respirators for a required purpose within the 12 months prior to the survey, NIOSH and BLS found (NIOSH, 2003):

- A high majority use dust masks, 76% overall and varying from 56% to 88% across industry sectors.
- A varying fraction use half-mask respirators, 52% overall and varying from 26% to 66% across industry sectors.
- A varying fraction use full-facepiece respirators, 23% overall and varying from 4% to 33% across industry sectors.

Table_Apx F-2 summarizes the number and percent of all private industry establishments and employees that used respirators for a required purpose within the 12 months prior to the survey and includes a breakdown by industry sector (NIOSH, 2003).

Table_Apx F-2. Number and Percent of Establishments and Employees Using Respirators within 12 Months Prior to Survey

Industry	Establishments		Employees	
	Number	Percent of All Establishments	Number	Percent of All Employees
Total Private Industry	281,776	4.5	3,303,414	3.1
Agriculture, forestry, and fishing	13,186	9.4	101,778	5.8
Mining	3,493	11.7	53,984	9.9
Construction	64,172	9.6	590,987	8.9
Manufacturing	48,556	12.8	882,475	4.8
Transportation and public utilities	10,351	3.7	189,867	2.8
Wholesale Trade	31,238	5.2	182,922	2.6
Retail Trade	16,948	1.3	118,200	0.5
Finance, Insurance, and Real Estate	4,202	0.7	22,911	0.3
Services	89,629	4.0	1,160,289	3.2

F.2 Glove Protection

OSHA's hand protection standard (29 CFR 1910.138) requires employers select and require employees to use appropriate hand protection when expected to be exposed to hazards such as those from skin absorption of harmful substances; severe cuts or lacerations; severe abrasions; punctures; chemical burns; thermal burns; and harmful temperature extremes. Dermal protection selection provisions are provided in part 1910.138(b) and require that appropriate hand protection is selected based on the performance characteristics of the hand protection relative to the task(s) to be performed, conditions present, duration of use, and the hazards to which employees will be exposed.

Unlike respiratory protection, OSHA standards do not provide protection factors (PFs) associated with various hand protection PPE, such as gloves, and data about the frequency of effective glove use—that is, the proper use of effective gloves—is very limited in industrial settings. Initial literature review suggests that there is unlikely to be sufficient data to justify a specific probability distribution for effective glove use for a chemical or industry. Instead, the impact of effective glove use is explored by considering different percentages of effectiveness.

Gloves only offer barrier protection until the chemical breaks through the glove material. Using a conceptual model, Cherrie (Cherrie et al., 2004) proposed a glove workplace protection factor: the ratio of estimated uptake through the hands without gloves to the estimated uptake though the hands while wearing gloves: this protection factor is driven by flux, and thus varies with time. The European Centre for Ecotoxicology and Toxicology of Chemicals Targeted Risk Assessment (ECETOC TRA) model represents the protection factor of gloves as a fixed, assigned protection factor equal to 5, 10, or 20 (Marquart et al., 2017) where, similar to the APF for respiratory protection, the inverse of the protection factor is the fraction of the chemical that penetrates the glove. It should be noted that the described PFs are not based on experimental values or field investigations of PPE effectiveness, but rather professional judgements used in the development of the ECETOC TRA model. EPA did not identify reasonably available information on PPE usage to corroborate the PFs used in this model.

As indicated in Table_Apx F-3, use of protection factors above 1 is recommended only for glove materials that have been tested for permeation against the 1,1-dichloroethane-containing liquids associated with the condition of use. EPA has not found information that would indicate specific activity training (*e.g.*, procedure for glove removal and disposal) for tasks where dermal exposure can be expected to occur in a majority of sites in industrial only OESs, so the PF of 20 would usually not be expected to be achieved.

Table_Apx F-3. Glove Protection Factors for Different Dermal Protection Strategies from ECETOC TRA v3

Dermal Protection Characteristics	Affected User Group	Indicated Efficiency (%)	Protection Factor, PF
a. Any glove / gauntlet without permeation data and without employee training	Both industrial and professional users	0	1
b. Gloves with available permeation data indicating that the material of construction offers good protection for the substance		80	5
c. Chemically resistant gloves (*i.e.*, as *b* above) with "basic" employee training		90	10
d. Chemically resistant gloves in combination with specific activity training (*e.g.*, procedure for glove removal and disposal) for tasks where dermal exposure can be expected to occur	Industrial users only	95	20

Appendix G PROCEDURES FOR MAPPING FACILITIES FROM STANDARD ENGINEERING SOURCES TO OESs SCENARIOS AND COUs

G.1 Conditions of Use and Occupational Exposure Scenarios

Condition of Use (COU)
TSCA section3(4) defines COUs as “the circumstances, as determined by the Administrator, under which a chemical substance is intended, known, or reasonably foreseen to be manufactured, processed, distributed in commerce, used, or disposed of”. COUs included in the scope of EPA’s risk evaluations are typically tabulated in scope documents and risk evaluation documents as summaries of life cycle stages, categories, and subcategories of use, as shown in Table_Apx G-1. Therefore, a COU is defined as a combination of life cycle stage, category, and subcategory. EPA identifies COUs for chemicals during the scoping phase; this process is not discussed in this document.

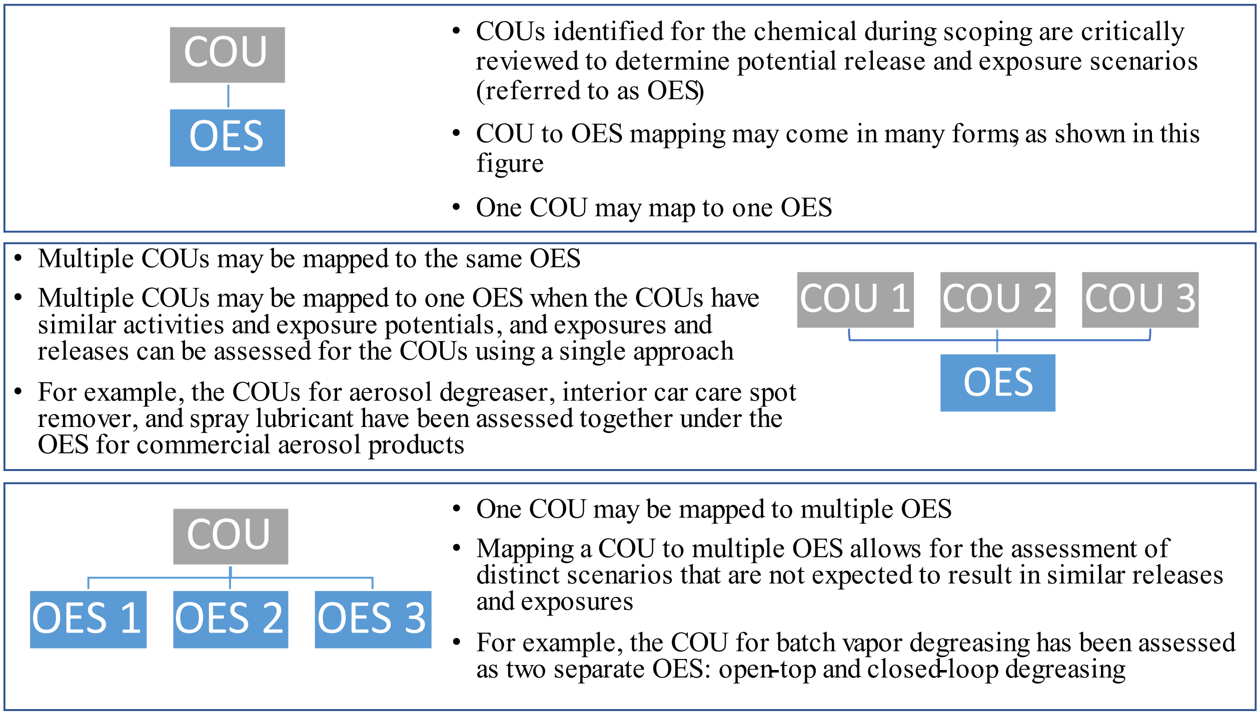
Occupational Exposure Scenario (OES)
Thus far, EPA has not adopted a standardized definition for OES. The purpose of an OES is to group or segment COUs for assessment of releases and exposures based on similarity of the operations and data availability for each COU. For example, EPA may assess a group of multiple COUs together as one OES due to similarities in release and exposure potential (*e.g.*, the COUs for formulation of paints, formulation of cleaning solutions, and formulation of other products may be assessed together as a single OES). Alternatively, EPA may assess multiple OES for one COU because there are different release and exposure potentials for a given COU (*e.g.*, the COU for batch vapor degreasing may be assessed as separate OES for open-top vapor degreasing and closed-loop vapor degreasing). OES determinations are also largely driven by the availability of data and modeling approaches to assess occupational releases and exposures. For example, even if there are similarities between multiple COUs, if there is sufficient data to separately assess releases and exposures for each COU, EPA would not group them into the same OES. This is depicted in Figure_Apx G-1.

For chemicals undergoing risk evaluation, ERG/EPA maps each industrial and commercial COU to one or more OES based on reasonably available data and information (*e.g.*, CDR, use reports, process information, public and stakeholder comments), assumptions, and inferences that describe how release and exposure take place within a COU. ERG/EPA identify OES for COUs, not vice-versa (*i.e.*, COUs are not altered during OES mapping). The mapping of COUs to OES is separate from and occurs after the identification of COUs. Both the identification of COUs and subsequent mapping of COUs to OES occur early in the risk evaluation process and are not in scope of this document. This section is intended to just provide background context on COUs and OES.

Table_Apx G-1. Example Condition of Use Table with Mapped Occupational Exposure Scenarios

Condition of Use (COU)			Occupational Exposure Scenario (OES)
Life Cycle Stage	**Category[a]**	**Subcategory**	
Manufacturing	Domestic Manufacturing	Domestic Manufacturing	Manufacturing
	Import	Import	Repackaging
Processing	As a reactant	Intermediate in all other basic organic chemical manufacturing	Processing as a Reactant
	Processing—Incorporation into formulation, mixture, or reaction product	Solvents (for cleaning or degreasing)	Formulation
		Adhesives and sealant chemicals	
	Repackaging	Solvents (for cleaning or degreasing)	Repackaging
	Etc.		

[a] Categories reflect CDR codes and broadly represent the industrial and/or commercial settings of the COU.
[b] The subcategories reflect more specific COUs.



- COUs identified for the chemical during scoping are critically reviewed to determine potential release and exposure scenarios (referred to as OES)
- COU to OES mapping may come in many forms, as shown in this figure
- One COU may map to one OES

- Multiple COUs may be mapped to the same OES
- Multiple COUs may be mapped to one OES when the COUs have similar activities and exposure potentials, and exposures and releases can be assessed for the COUs using a single approach
- For example, the COUs for aerosol degreaser, interior car care spot remover, and spray lubricant have been assessed together under the OES for commercial aerosol products

- One COU may be mapped to multiple OES
- Mapping a COU to multiple OES allows for the assessment of distinct scenarios that are not expected to result in similar releases and exposures
- For example, the COU for batch vapor degreasing has been assessed as two separate OES: open-top and closed-loop degreasing

Figure_Apx G-1. Condition of Use to Occupational Exposure Scenario Mapping Options

G.2 Standard Sources Requiring Facility Mapping

EPA utilizes release data from EPA programmatic databases and exposure data from standard sources to complete occupational exposure and environmental release assessments, which are described below:

- Chemical Data Reporting (CDR), to which import and manufacturing sites producing the chemical at or above a specified threshold must report. EPA uses CDR to identify COUs, OES, sites that import or manufacture the chemical, and for information on physical form and concentration of the chemical. In addition, EPA is currently developing the Tiered Data Reporting (TDR) rule, which will establish reporting requirements, including changes to CDR, to collect information that better meets data needs for the TSCA existing chemical program. The rule will have reporting requirements tiered to specific stages of existing chemical assessments (*e.g.*, prioritization, risk evaluation) and harmonized to the Organization for Economic Co-operation and Development (OECD) risk assessment framework, which will help to better inform uses of chemicals and improve upon the OES mapping procedures in this document.

- Toxics Release Inventory (TRI), to which facilities handling a chemical covered by the TRI program at or above a specified threshold must report. EPA uses TRI data to quantify air, water, and land releases of the chemical undergoing risk evaluation.

- National Emissions Inventory (NEI), a compilation of air emissions of criteria pollutants, criteria precursors and hazardous air pollutants from point and non-point source air emissions. EPA uses NEI data to quantify air emissions of the chemical undergoing risk evaluation.

- Discharge Monitoring Report (DMR), a periodic report required of National Pollutant Discharge Elimination System (NPDES) permitted facilities discharging to surface waters. EPA uses NEI data to quantify surface water discharges of the chemical undergoing risk evaluation.

- Occupational Safety and Health Administration (OSHA): Chemical Exposure Health Data (CEHD), a compilation of industrial hygiene samples taken when OSHA monitors worker exposures to chemical hazards. EPA uses OSHA CEHD to quantify occupational inhalation exposures to the chemical undergoing risk evaluation.

- National Institute of Occupational Safety and Health (NIOSH): Health Hazard Evaluations (HHEs), a compilation of voluntary employee, union, or employer requested evaluations of health hazards present at given workplace. EPA uses NIOSH HHE data to quantify occupational inhalation exposures to the chemical undergoing risk evaluation.

To utilize the data from these sources, the facilities that report to each must first be mapped to an OES. There may be other sources of data for specific facilities that require mapping the facilities to an OES; however, this document covers the most common data sources. Additionally, EPA often uses data from sources such as public and stakeholder comments, generic scenarios, and process data that are usually not specific to an individual site; therefore, unlike the above sources, they do not involve the mapping of specific sites to an OES. Therefore, they are not discussed further in this document.

Mapping procedures for the above sources are discussed in detail in the subsequent sections; however, Table_Apx G-2 includes a summary of the type of information reported by companies in each database that helps to inform OES and COU mapping. This includes industrial classification codes such as those associated with the North American Industry Classification System (NAICS) and Standard Industrial Classification (SIC) system. Note that the U.S. government replaced SIC codes with NAICS codes in

1997; however, SIC codes are still used in DMR and are applicable for data from all listed sources for years prior to 1997. Additionally, some of the sources in Table_Apx G-2 have specific reporting requirements that include flags for the type of processes that occur at the site.

Assessors should be sure that a facility that reports to multiple databases/sources is consistently mapped to the same OES, as applicable. This is not applicable if the facility reports separately for different areas/processes of their facility (*e.g.*, a large chemical plant may report one block of unit operations separate from another such that they have different OES).

Table_Apx G-2. EPA Programmatic Database Information that Aids OES/COU Mapping

Source	Reported Information Useful for Mapping OES/COU	Reporting Frequency	Notes
CDR	- Indication if the chemical is imported or domestically manufactured - Indication if the chemical is imported but never at the site, used on-site, or exported	- Facilities must report to CDR every four years - New data sets take years to become publicly available - Latest reporting year with available data: 2020	- While CDR also includes information on downstream processing and use, it does not include site identities for these operations; thus, it does not inform reporting site OES/COU mapping. - Claims of confidential business information (CBI) can limit data utility in risk evaluations.
TRI	- NAICS codes - Flags for uses and subuses of the chemical - Release media information	- Facilities must report to TRI annually - New data sets become publicly available in October for the previous year - Latest reporting year with available data: 2021	- Reporters must select from specific uses (*e.g.*, manufacture, import, processing) and subuses (*e.g.*, formulation additive, degreaser, lubricant). - Subuse information is only available in data sets starting in 2018. - Facilities may report with a Form A under certain circumstances; [a] Form A's do not require use/subuse reporting.
NEI	- Source Classification Codes (SCCs), which classify different types of activities that generate air emissions - Emissions Inventory System (EIS) Sectors, which classify industry sectors - NAICS codes - Process description free-text field (used for additional information about the process related to the emission unit)	- Facilities must report to TRI every three years - New data sets take years to become publicly available. - Latest reporting year with available date: 2020	- NEI contains specific SCC codes and industry sectors from which reporters select. - Free-text fields are not mandatory for the reporter to fill out.

	- Emission unit description free-text field		
DMR	- SIC codes - National Pollutant Discharge Elimination System (NPDES) permit numbers	- Facilities must report to DMR at the frequency specified in their NPDES permit, which is typically monthly - Data typically flows through the State DMR reporting platform to EPA's Enforcement and Compliance History Online (ECHO) database continuously	- Sites that only report non-detection of the chemical for the year are generally excluded from mapping. - NPDES permit numbers can sometimes indicate the type of general permit, which can inform mapping (*e.g.*, remediation general permit).
OSHA	- NAICS or SIC codes	- OSHA conducts monitoring as-needed for site investigations - Monitoring data is available in CEHD when the investigation and any subsequent litigation cases are closed - Latest year in CEHD with data: 2021	- CEHD includes data from 1984 and forward.
NIOSH HHE	- Facility process information - Worker activities	- NIOSH conducts HHEs upon request - HHEs are published online when NIOSH is completed with the evaluation - Latest year with a published HHE: 2023	- NIOSH HHEs generally include narrative descriptions of facility processes and worker activities, with specific information on how the chemical being monitored for is used.
[a] Facilities may report using a Form A if the annual reportable release amount of the chemical did not exceed 500 pounds for the reporting year, and the amounts manufactured, or processed, or otherwise used did not exceed 1 million pounds for that year.			

G.3 OES Mapping Procedures

This section contains procedures for mapping facilities to OES for each source discussed in Section G.2.

G.3.1 Chemical Data Reporting (CDR)

The only facilities required to report to CDR are those that manufacture or import specific chemicals at or above a specified threshold.[10] Therefore, sites that report for the chemical of interest in CDR will generally be mapped to either the manufacturing or import/repackaging OES. These sites must also report the processing and uses of the chemical; however, these procedures are specific to mapping of the reporting site and not downstream processing or use sites.

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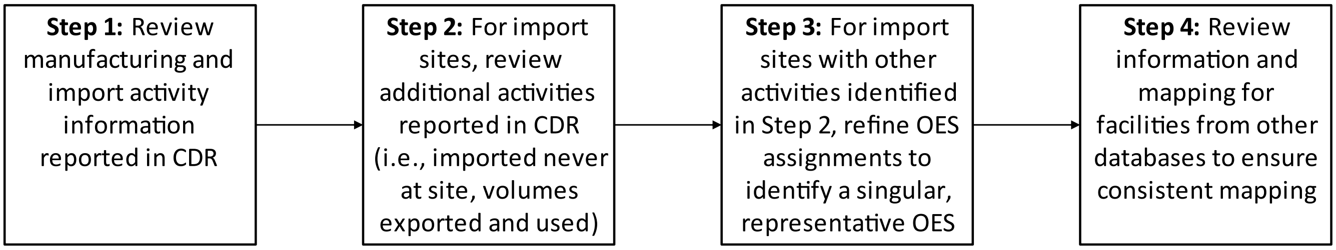
[10] The 2020 CDR reporting instructions, including descriptions on the information required to be reported, can be found at: https://www.epa.gov/chemical-data-reporting/instructions-reporting-2020-tsca-chemical-data-reporting.

CDR, under TSCA, requires manufacturers (including importers) to provide EPA with information on the production and use of chemicals in commerce. These facilities must report to CDR every four years. For risk evaluations conducted under the amended TSCA, EPA has primarily used 2016 and 2020 CDR. The procedures in this document are appliable to both 2016 and 2020 CDR data; however, there are some data elements that are only applicable to 2020 CDR, which are called out in the procedures where appliable. These procedures should be applicable to future CDR, depending on changes to reporting requirements. When the TDR rule is implemented, these procedures will be updated accordingly.

Chemical data reported under CDR is classified using Industrial Function Category (IFC) codes and/or commercial/consumer use product categories (PCs). CDR IFC codes describe the “intended physical or chemical characteristics for which a chemical substance or mixture is consumed as a reactant; incorporated into a formulation, mixture, reaction product, or article, repackaged; or used.” Alternatively, PCs describe the consumer and commercial products in which each reportable chemical is used. EPA typically uses these CDR codes to identify the COUs for the chemical in the published scope documents.

Figure_Apx G-2 depicts the steps that should be followed to map CDR reporting sites to OES. Each step is explained in the text below the figure. Additionally, Section G.5.1 shows step-by-step examples for using the mapping procedures to determine the OES for three example CDR reporting facilities.



Figure_Apx G-2. OES Mapping Procedures for CDR

To map sites reporting to CDR, the following procedures should be used with the non-CBI CDR:

1. Review Manufacturing and Import Activity Information: The first step in the process is to review the reported activity information to identify if the facility imports or manufactures the chemical.
    a. If the facility reports domestic manufacturing, the manufacturing OES should be assigned, even if the facility also reports importation or the facility may conduct other operations with the chemical. This is because manufacturing of the chemical is expected to be the primary operation, with any other processing or uses being ancillary operations.
    b. If the chemical is being manufactured as a byproduct (this is a voluntary reporting element starting in 2020 CDR), this may need to be considered separately from non-byproduct manufacturing depending on assessment needs for the chemical.
    c. If the facility does not manufacture the chemical and only imports the chemical, check if additional processes occur at the site as described in the subsequent steps.
2. For Importation Sites, Review Fields for “Imported Never at Site”, “Volume Exported”, and “Volume Used”: The next step is to review these additional fields to determine if the reporting facility conducts more than just importation activities.
    a. If the facility imports the chemical, they must report if it is imported but never physically at the reporting site. If the facility indicates the chemical is imported and never at site, the

facility does not handle the chemical and the only applicable OES is importation. In such cases, the assessor should proceed to Step 4. If the facility does not indicate the chemical is imported and never at site, proceed to Step 2b.

   b. If the facility reports a quantity for "volume exported" and this quantity is the same as that imported, no additional OES occurs at the site beyond importation. In such cases, the assessor should proceed to Step 4. If the exported quantity is not equal to volume imported, assessors should check if any of the chemical is used at the reporting site per Step 2c.

   c. If the facility reports a quantity for "volume used", additional OES may be applicable to the facility beyond manufacturing or importation. Proceed to Step 3 to identify and refine additional OES.

3. <u>Refine OES Assignments</u>: If multiple OES were identified from the previous steps, a single primary OES must be selected using additional facility information. OES determinations should be made with the following considerations:

   a. 6-digit NAICS code reported by the facility in CDR. Note that this is only a requirement starting in 2020 CDR (*e.g.*, for a facility that reported NAICS code was 325520, Adhesive Manufacturing, the incorporation into a formulation, mixture, or reaction product OES may be appropriate; for a facility reporting a NAICS code starting in 424690, Other Chemical and Allied Products Merchant Wholesalers, only the repackaging OES is likely applicable).

   b. Downstream processing and use information reported in CDR. The reporting site must provide information on downstream processing and use of the chemical for all sites, meaning it cannot be distinguished which processing and use information includes the reporting site operations vs. downstream site operations. However, this information may still help inform the operations at the reporting site and should be reviewed. Specifically, for a given processing/use activity, if the submitter reports "Fewer than 10 sites" for the "number of sites" field (which is the lowest number of sites that can be reported), there is a likelihood that the facility's operations may be included in this processing/use activity. In such cases, review the corresponding fields for "type of processing or use operation", "industrial sector", and "function category" to help identify the OES. The greater number of sites that are reported, the more likely that the associated processing and use information includes information from downstream sites and the less reliable the information is for mapping OES to the reporting site.

   c. Internet research of the types of products made at the facility (*e.g.*, if a facility's website indicates the facility manufactures plastic products, the chemical may be used as a processing aid or component in the plastic products, depending on the known uses of the chemical within the plastics industry).

   d. Information from other reporting databases as described in Step 3.

   e. An evaluation of the OES that is most likely to result in a release (*e.g.*, for facilities that reported importation and may also conduct formulation per the reported NAICS code, the formulation OES may be assigned, because, in most cases, importation would have a lower likelihood of a release).

   f. Grouped OES for similar uses (*e.g.*, multiple facilities that may conduct formulation operations based on the reported NAICS code may be assigned a grouped formulation OES that covers all types of formulation [*e.g.*, adhesives, paints, cleaning products]).

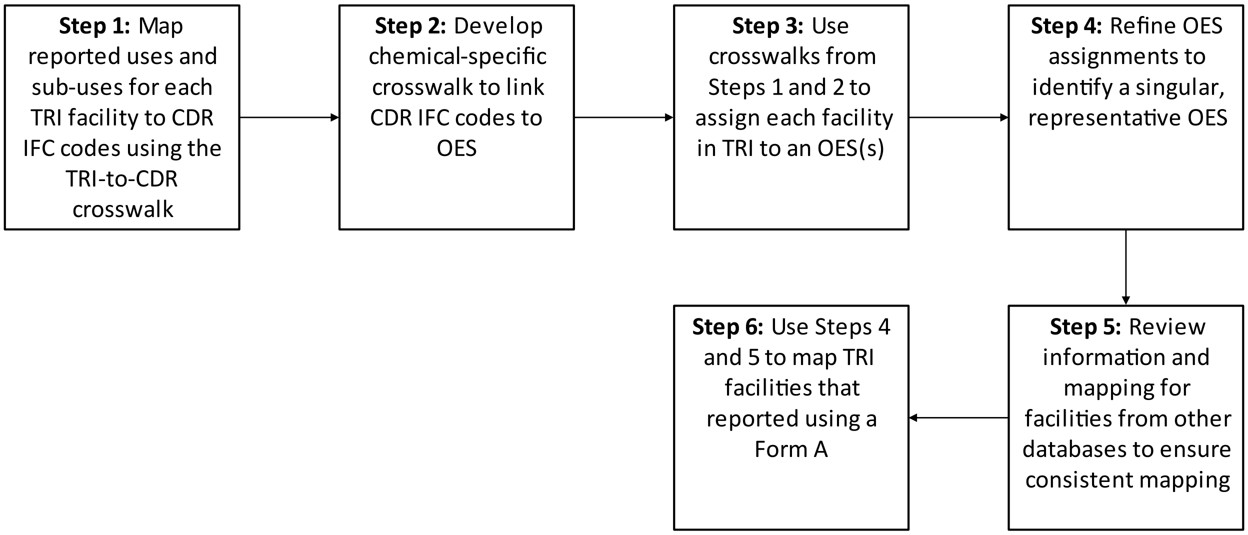
4. Review Information from Other Databases: Other databases/sources (such as TRI, NEI, and DMR) should be checked to see if the facility has reported to these. If so, the OES determined from the mapping procedures for those databases (discussed in other sections of this document) should also be used. It is important that the same facility is mapped consistently across multiple databases/sources. The facility's TRI identification number (TRFID) and Facility Registry Services identification number (FRS ID) can be used to identify sites that report to TRI, DMR, and NEI. If the facility does not report to these databases, but additional OES are possible per Step 2, the assessor should search available facility information on the internet.

Given the information available in CDR, ERG/EPA expects that, for most chemicals, 100% of the sites reporting to CDR can feasibly be mapped to an OES.

G.3.2 Toxics Release Inventory (TRI)

TRI reporting is required for facilities that manufacture (including import), process, or otherwise use any TRI-listed chemical in quantities greater than the established threshold in the calendar year AND have 10 or more full-time employee equivalents (*i.e.*, a total of 20,000 hours or greater) and are included in a covered NAICS code. Therefore, unlike CDR reporters that are primarily manufacturers and importers, TRI reporters can be mapped to a variety of different OES.

Figure_Apx G-3 depicts the steps that should be followed to map TRI reporting sites to OES. Each step is explained in the text below the figure. Additionally, Section G.5.2 shows step-by-step examples for using the mapping procedures to determine the OES for three example TRI reporting facilities.



Figure_Apx G-3. OES Mapping Procedures for TRI

To map sites reporting to TRI, the following procedures should be used:

1. Assign Chemical Data Reporting Codes using TRI-to-CDR Crosswalk: The first step in the TRI mapping process is to map the uses and sub-uses reported by each facility to one or more 2016 CDR IFC codes. To do this, first compile all TRI uses/sub-uses for the reporting facility into a single column, then map them to CDR IFC codes using the TRI-to-CDR Use Mapping crosswalk (see Appendix B). This is a universal crosswalk that applies to all chemicals.
2. Develop Chemical-Specific Crosswalk to Link CDR Codes to OES: The next step is to develop a separate CDR IFC code-to-OES crosswalk that links CDR IFC codes to OES for the chemical.

To create this crosswalk, match the COU categories and subcategories from the COU table in the published scope documents (like the example provided in Table 1-1) to the list of 2016 CDR IFC codes in the CDR reporting instructions.[11] The categories and subcategories of COUs typically match the IFC code category. Recent examples of already completed CDR IFC code-to-OES crosswalk can be found for the fenceline chemicals (1-bromopropane, methylene chloride, n-Methylpyrrolidone, carbon tetrachloride, perchloroethylene, trichloroethylene, and 1,4-dioxane).

3. Assign OES: Each TRI facility is then mapped to one or more OES using the CDR IFC codes assigned to each facility in Step 1 and the CDR IFC code-to-OES crosswalk developed in Step 2.
4. Refine OES Assignments: If a facility maps to more than one OES in Step 3, a single primary OES must be selected using additional facility information. OES determinations should be made with the following considerations:
    a. 6-digit NAICS codes reported by the facility in TRI (*e.g.*, for a facility that reported TRI uses for both formulation and use as cleaner, EPA assigned the formulation OES if the NAICS code was 325199, All Other Basic Organic Chemical Manufacturing; another example is NAICS codes 562211, Hazardous Waste Treatment and Disposal, and 327310, Cement Manufacturing, almost always correspond to the disposal OES, regardless of the reported TRI uses and sub-uses).
    b. Internet research of the types of products made at the facility (*e.g.*, if a facility's website indicates the facility manufactures metal parts, the facility is likely to use chemicals for degreasing or in a metalworking fluid) and information from sources cited in the COU table and scoping document, such as public and stakeholder comments (*i.e.*, EPA/ERG will review sources cited in the COU table and scoping document to see if there is any information specific to the reporting site that can be used to inform the mapping).
    c. Information from other reporting databases as described in Step 5.
    d. An evaluation of the OES that is most likely to result in a release (*e.g.*, facilities that reported both importation and formulation may be assigned a formulation OES, because, in most cases, importation would have a lower likelihood of a release).
    e. Grouped OES for similar uses/sub-uses (*e.g.*, facilities that reported cleaner and degreaser sub-uses may be assigned a grouped OES that covers both cleaning and degreasing because the specific cleaning/degreasing operation cannot be determined from the TRI data).
5. Review Information from Other Databases: Other databases/sources (including CDR, NEI, and DMR) should be checked to see if the facility has reported to these. If so, the OES determined from the mapping procedures for those databases (discussed in other sections of this document) should also be used. It is important that the same facility is mapped consistently across multiple databases/sources. The facility's TRFID and FRS ID can be used to identify sites that report to TRI, DMR, and NEI.
6. Note that facilities that submit using a TRI Form A do not report TRI uses/sub-uses. To determine the OES for these facilities, EPA will use information from Steps 4 and 5.

Given the information available in TRI, ERG/EPA expects that, for most chemicals, 100% of the sites reporting to TRI can feasibly be mapped to an OES.

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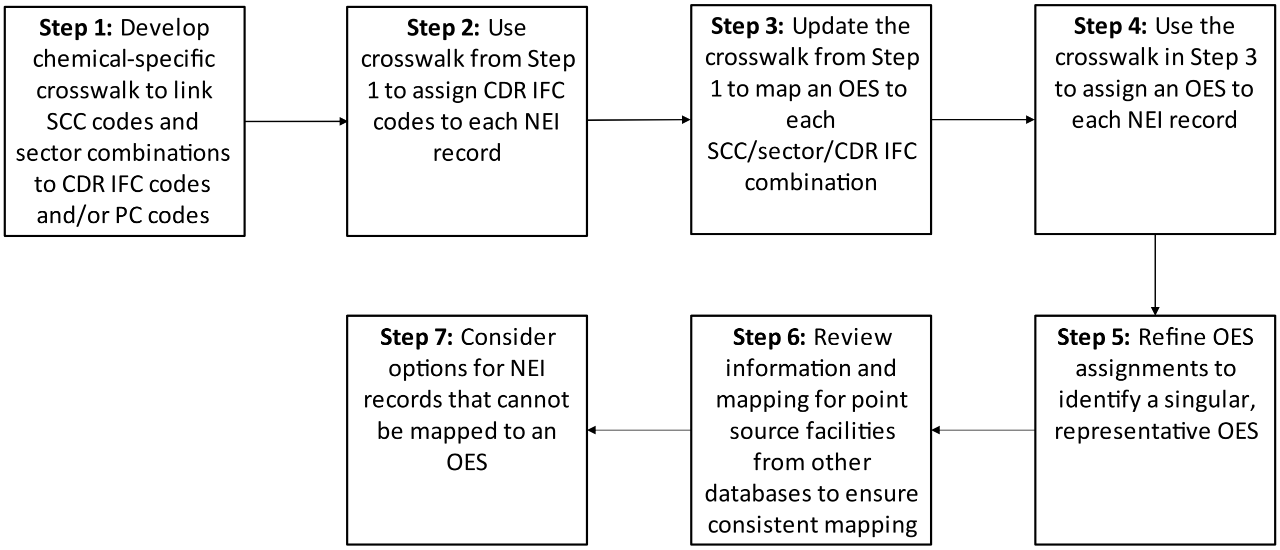
[11] IFC codes and their definitions can be found in Table 4-11 of the CDR reporting instructions: https://www.epa.gov/chemical-data-reporting/instructions-reporting-2016-tsca-chemical-data-reporting

G.3.3 National Emissions Inventory (NEI)

The NEI is a compilation of air emissions of criteria pollutants, criteria precursors, and hazardous air pollutants from point and non-point source air emissions. Air emissions data for the NEI are collected at the state, local, and tribal (SLT) level. The Air Emissions Reporting Requirement rule requires SLT air agencies to collect, compile, and submit criteria pollutant air emissions data to EPA. Many SLT air agencies also voluntarily submit data for pollutants on EPA's list of hazardous air pollutants. Major sources are required to report point source emissions data to their SLT air agency. Each SLT entity must, in turn, report point source emissions data to EPA every one to three years, depending upon the size of the source. Nonpoint estimates are typically developed by state personnel.

Figure_Apx G-4 depicts the steps that should be followed to map NEI reporting sites/records to OES. Each step is explained in the text below the figure. Additionally, Section G.5.3 shows step-by-step examples for using the mapping procedures to determine the OES for one point source example and one nonpoint source example.



Figure_Apx G-4. OES Mapping Procedures for NEI

To map sites reporting point source emissions and nonpoint emissions records for the chemical of interest to NEI, the following procedures should be used:

1. Develop Crosswalks to Link NEI-Reported SCC and Sector Combinations to Chemical Data Reporting Codes: The first step in mapping NEI data to potentially relevant OES is to develop a crosswalk to map each unique combination of NEI-reported Source Classification Code (SCC) (levels 1-4) and industry sectors to one or more CDR codes. This crosswalk is developed on a chemical-by-chemical basis rather than an overall crosswalk for all chemicals because SCCs correspond to emission sources rather than chemical uses such that the crosswalk to CDR codes may differ from chemical to chemical. In some cases, it may not be possible to assign all SCC sector combinations to CDR codes, in which case information from Step 5 can be used to help make OES assignments. Separate crosswalks are needed for point and nonpoint source records, as discussed below.
    a. For the point source NEI data, the crosswalk should map each unique combination of NEI-reported SCC and industry sectors to one or more CDR IFC codes.

   b. For nonpoint source NEI data, the crosswalk should link the SCC codes and sectors to both CDR IFC codes and/or commercial/consumer use PCs. This is because the nonpoint source data may include commercial operations, for which CDR PCs may be more appropriate.

2. Use CDR Crosswalks to Assign CDR Codes: Next, the chemical-specific CDR crosswalk developed in Step 1 should be used to assign CDR IFC codes to each point source NEI record and CDR IFC codes and/or commercial/consumer use PCs to each nonpoint source NEI record.

3. Update CDR Crosswalks to Link CDR Codes to OES: The chemical-specific crosswalk developed in Step 1 is then used to link the SCCs, sectors, and CDR codes in the crosswalk to an OES. The OES will be assigned based on the chemical specific COU categories and subcategories and the OES mapped to them as discussed in Section G.1.

4. Use CDR Crosswalks to Assign OES: The chemical-specific CDR crosswalks developed in Steps 1-3 are then used to assign OES to each point source and nonpoint source NEI data record (*i.e.*, each combination of facility-SCC-sector). Note that the individual facilities in the point source data set may have multiple emission sources, described by different SCC and sector combinations within NEI, such that multiple OES map to these NEI records. In such cases, a single, representative OES must be selected for each NEI record using the additional information described in Step 5. Similarly, the sectors reported by nonpoint sources may map to multiple CDR IFC or PC codes, such that multiple OES are applicable and must be refined to a single OES for each NEI record.

5. Refine OES Assignments: The initial OES assignments may need to be confirmed and/or refined to identify a single primary OES using the following information described below for point source and nonpoint source records.
   a. For point source records in NEI, use the following information to refine OES assignments:
      - Additional information available in NEI:
         - Facility name.
         - Primary NAICS code and description, populated from the EIS lookup tables.
         - Facility site description, which, when populated, is intended to describe the type of industry the facility operates (similar to a NAICS description).
         - Process description, which is a free-text field where reporters can provide additional information about the process related to their emission unit.
         - Emission unit description, which is a free-text field where reporters can provide additional information about their emission units.
      - Internet research of the types of products made at the facility (*e.g.*, if a facility's website indicates the facility manufactures metal parts, the facility is likely to use chemicals for degreasing or in a metalworking fluid) and information from sources cited in the COU table and scoping document, such as public and stakeholder comments (*i.e.*, EPA/ERG will review sources cited in the COU table and scoping document to see if there is any information specific to the reporting site that can be used to inform the mapping).
      - Information from other reporting databases as described in Step b.

        - An evaluation of the OES that is most likely to result in a release (*e.g.*, facilities that map to both lubricant use and vapor degreasing may be assigned a vapor degreasing OES, because, in most cases, vapor degreasing results in higher air emissions).
        - Grouped OES for similar uses/sub-uses (*e.g.*, facilities that map to both general cleaning and vapor degreasing may be assigned a grouped OES that covers both cleaning and degreasing because the specific cleaning/degreasing operation cannot be determined from the NEI data).

    b. For nonpoint source records in NEI, use the following information to refine OES assignments (there is no additional data reported to NEI by nonpoint sources that can help refine the OES mapping):
        - General knowledge about the use of the chemical in the reported sector, such as from scope documents, public or stakeholder comments, process descriptions, professional judgement, or already-identified sources from systematic review.
        - Internet research of the uses of the chemical in the reported sector, if insufficient information is not already available per the previous bullet.
        - An evaluation of the OES that is most likely to result in a release (*e.g.*, sectors that map to both lubricant use and vapor degreasing may be assigned a vapor degreasing OES, because, in most cases, vapor degreasing results in higher air emissions).
        - Grouped OES for similar uses/sub-uses (*e.g.*, sectors that map to both general cleaning and vapor degreasing may be assigned a grouped OES that covers both cleaning and degreasing because the specific cleaning/degreasing operation cannot be determined from the NEI data).

6. Review Information from Other Databases for Point Source Facilities: Other databases/sources (including CDR, TRI, and DMR) should be checked to see if the point source facilities have reported to these. If so, the OES determined from the mapping procedures for those databases (discussed in other sections of this document) should also be used. It is important that the same facility is mapped consistently across multiple databases/sources. The facility's TRFID and FRS ID can be used to identify sites that report to TRI, DMR, and NEI.

7. Consider Options for NEI Records that Cannot be Mapped to an OES: Given the number of records in NEI and the information available, it may not always be feasible to achieve mapping of 100% of the sites reporting to NEI to an OES. For example, there may be NEI records for restaurants or the commercial cooking sector, which do not map to an in-scope COU or OES. Additionally, NEI records may include emissions from combustion byproducts for the chemical, which does not correspond to a COU or OES. In such cases, multiple options may be appropriate depending on assessment needs, such as:

    a. Assigning the sites as having an unknown OES with 250 release days/year. This allows for subsequent exposure modeling and the assessment of risk. For sites with identified risk, the OES can then be mapped using the below resources.

    b. Contacting the facility for clarification on the use of the chemical. ICR requirements also apply when contacting 10 or more facilities. Note that information requests such as these may require an Information Collection Request (ICR) if 10 or more entities are contacted.[12]

G.3.4 Discharge Monitoring Report (DMR)

Facilities must submit DMRs for chemicals when the following two conditions are met: (1) the facility has an NPDES permit for direct discharges to surface water, and (2) the NPDES permit contains monitoring requirements for the chemical of interest. Indirect discharges (*e.g.*, those sent to an off-site wastewater treatment plant or publicly owned treatment works) are not covered under the NPDES program.

If a facility has discharge monitoring requirements for the chemical of interest, these requirements are either technology-based or water-quality based. Typically, a facility has NPDES monitoring requirements for a chemical because the facility somehow manufactures, processes, or uses the chemical. However, it is possible for a facility to have monitoring requirements for a chemical they do not handle if the facility falls within a guideline containing requirements for that chemical, as described below.

- Technology-based guidelines: If the facility falls within a certain industrial sector, it may be covered by a national effluent guideline. Effluent guidelines are industry-specific and contain treatment technology-based guidelines for discharges of specified pollutants (chemicals) commonly found within that industry.[13] A common effluent guideline containing requirements for chemicals that have or are currently undergoing risk evaluation is the Organic Chemicals, Plastics & Synthetic Fibers (OCPSF) effluent guideline. Alternatively, if there is no applicable effluent guideline for the facility, the permitting authority may establish technology-based guidelines using best professional judgment. If a facility falls within an existing effluent guideline, the permitting authority will generally include monitoring requirements in the facility's NPDES permit that are consistent with the effluent guideline, even if the facility does not handle all the chemicals for which there are monitoring requirements. Therefore, under this reasoning, it is possible that a facility reporting for the chemical of interest in DMRs does not actually handle the chemical.[14]
- Water quality-based guidelines: The receiving water for the facility's discharges is impaired such that the permitting authority sets general water-quality based effluent limits and monitoring requirements for chemicals that may further impair the water quality. It is possible that the permitting authority uses these same general water-quality based requirements for all facilities that discharge to the water body. Therefore, under this reasoning, it is possible that a facility reporting for the chemical of interest in DMRs does not actually handle the chemical.[5]

Figure_Apx G-5 depicts the steps that should be followed to map DMR reporting sites to OES. Each step is explained in the text below the figure. Additionally, Section G.5.4 shows step-by-step examples for using the mapping procedures to determine the OES for two example DMR reporting facilities.

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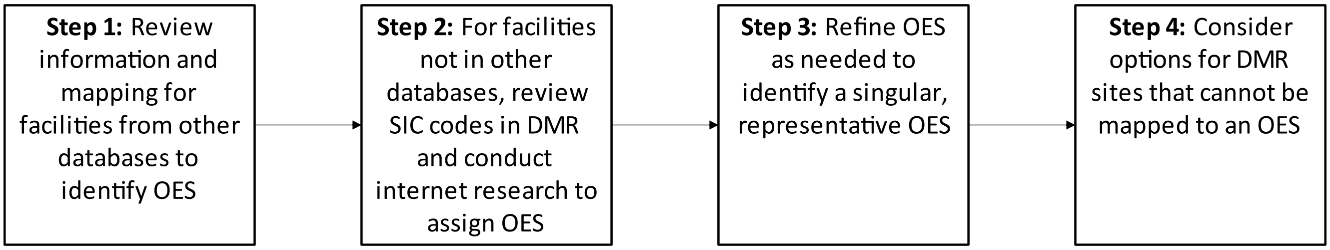
[12] More on Information Collection Requests can be found at: https://www.epa.gov/icr/icr-basics

[13] A list of the industries for which EPA has promulgated effluent guidelines is available at: https://www.epa.gov/eg/industrial-effluent-guidelines#existing

[14] Note that a facility may request to have monitoring requirements reduced or removed from the permit where historical sampling demonstrates that these chemicals are consistently measured below the effluent limits. Thus, it is possible for a facility to cease monitoring for the chemical of interest upon approval by the permitting authority.



Figure_Apx G-5. OES Mapping Procedures for DMR

To map sites reporting to DMR, the following procedures should be used:

1. <u>Review Information from Other Databases</u>: Given the limited facility information reported in DMRs, the first step for mapping facilities reporting to DMR should be to check other databases/sources (including CDR, TRI, and NEI). If so, the OES determined from the mapping procedures for those databases (discussed in other sections of this document) should be used. It is important that the same facility is mapped consistently across multiple databases/sources. The facility's TRFID and FRS ID can be used to identify sites that report to TRI, DMR, and NEI.
2. <u>Assign OES</u>: If the facility does not report to other databases, the following information should be used to assign an OES.
    a. 4-digit SIC codes reported by the facility in DMR (*e.g.*, a facility that reported SIC code 2891, Adhesives and Sealants, likely formulates these products; a facility that reported SIC code 4952, Sewerage Systems, likely treats wastewater). Note that SIC codes can be crosswalked to NAICS codes, which are often more useful for mapping OES because they are more descriptive than SIC codes.
    b. Internet research of the types of products made at the facility (*e.g.*, if a facility's website indicates the facility manufactures metal parts, the facility is likely to use chemicals for degreasing or in a metalworking fluid) and information from sources cited in the COU table and scoping document, such as public and stakeholder comments (*i.e.*, EPA/ERG will review sources cited in the COU table and scoping document to see if there is any information specific to the reporting site that can be used to inform the mapping).
3. <u>Refine OES</u>: If the specific OES still cannot be determined using the information in Step 2, the following should be considered.
    a. NPDES permit numbers reported in DMR. The permit number generally indicates if the permit is an individual permit or a general permit.[15] If the permit is a general permit, the permit number can often indicate the type of general permit, which can provide information on the operations at the facility.
        - Individual NPDES permits are numbered in the format of the state abbreviation followed by a seven-digit number (*e.g.*, VA0123456). General permits are usually numbered in the format of state abbreviation followed by one letter then a six-digit number (*e.g.*, VAG112345 or MAG912345).
        - Since each state is slightly different in their general permit numbering, the general permit number should be searched on the internet to determine the type of general

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[15] Information on individual and general NPDES permits can be found at: https://www.epa.gov/npdes/npdes-permit-basics

permit. For the general permit number examples provided above, a permit number beginning in “VAG11” signifies Virginia’s general permit for concrete products facilities and a permit number beginning with “MAG91” signifies Massachusetts’ general permit for groundwater remediation. Other common general permit types include those for construction sites, mining operations, sites that only discharge non-contact cooling water, and vehicle washes.

   b. Searching for the permit online. If the specific NPDES permit for the facility can be found online, it may contain some general process information for the facility that can help inform the OES mapping. However, NPDES permits may be difficult to find online and do not generally contain much information on process operations.
   c. An evaluation of the OES that is most likely to result in a water release (*e.g.*, for facilities that report an SIC code for the production of metal products, both vapor degreasing and metalworking fluid OES are applicable; in such cases, the metalworking fluid OES may be assigned because it is more likely to result in water releases than vapor degreasing).
   d. Grouped OES for similar uses (*e.g.*, multiple facilities that may conduct formulation operations based on the reported SIC code may be assigned a grouped formulation OES that covers all types of formulation [*e.g.*, adhesives, paints, cleaning products]).

4. <u>Consider Options for DMR Sites that Cannot be Mapped to an OES:</u> Given the limited information available in DMR, it may not always be feasible to achieve mapping of 100% of the sites reporting to DMR to an OES. In such cases, multiple options may be appropriate depending on assessment needs, such as:
   a. Assigning the sites as having an unknown OES with 250 release days/year. This allows for subsequent exposure modeling and the assessment of risk. For sites with identified risk, the OES can then be mapped using the below resources.
   b. Contacting the state government for the NPDES permit, permit applications, past inspection reports, and any available information on facility operations. Note that information requests such as these may require an ICR if 10 or more entities are contacted.
   c. Contacting the facility for clarification on the use of the chemical. ICR requirements also apply when contacting 10 or more facilities.

G.3.5 Occupational Safety and Health Administration (OSHA) Chemical and Exposure Data (CEHD)

OSHA CEHD is a compilation of industrial hygiene samples (*i.e.*, occupational exposure data) taken when OSHA monitors worker exposures to chemical hazards. OSHA will conduct monitoring at facilities that fall within targeted industries based on national and regional emphasis programs.[16] OSHA conducts monitoring to compare against occupational health standards. Therefore, unlike CDR, TRI, NEI, and DMR, facilities are not required to report data to OSHA CEHD. Also, OSHA only visits selected facilities, so the amount of OSHA data available for each OES is often limited.

Figure_Apx G-6 depicts the steps that should be followed to map OSHA CEHD sites to OES. Each step is explained in the text below the figure. Additionally, Section G.5.5 shows step-by-step examples for using the mapping procedures to determine the OES for two example OSHA CEHD facilities.

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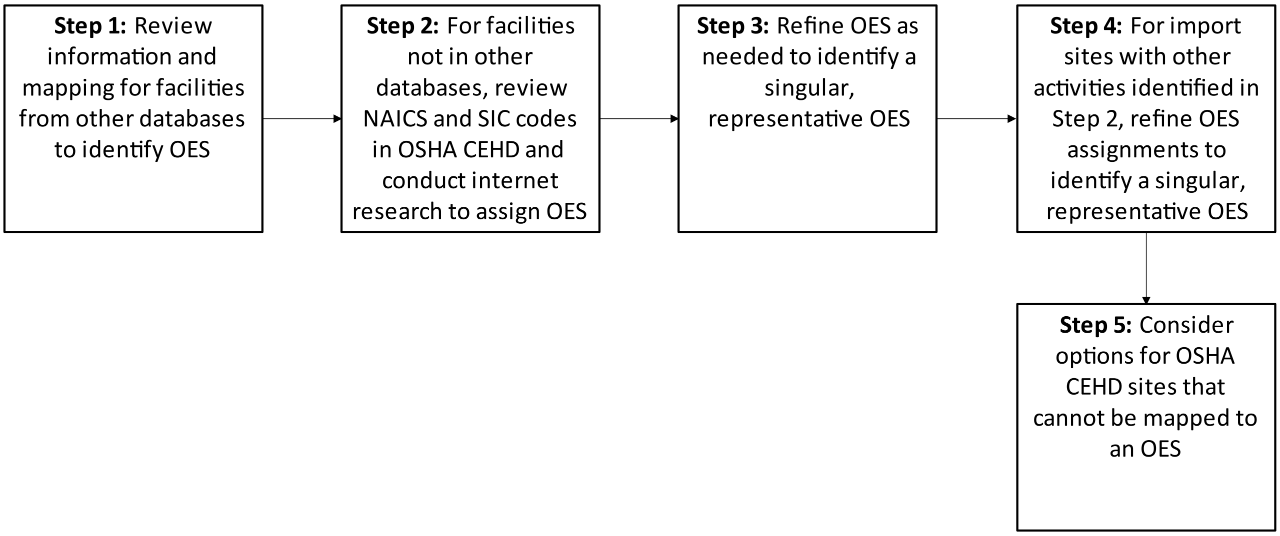
[16] More information on OSHA CEHD can be found at: https://www.osha.gov/opengov/health-samples



Figure_Apx G-6. OES Mapping Procedures for OSHA CEHD

Within the OSHA CEHD data, there may be sites for which all air sampling data are non-detect (below the limit of detection) for the chemical. In these cases, if there is also no bulk sampling data indicating the presence of the chemical, there is no evidence that the chemical is present at the site. OSHA may have sampled for the chemical based on a suspicion or pre-determined sampling plan, and not because the chemical was actually present at the site. Therefore, these sites do not need to be mapped to OES. To map sites for which there is OSHA CEHD data that are not all non-detect for the chemical, the following procedures should be used:

1. <u>Review Information from Other Databases</u>: Given the limited facility information reported in OSHA CEHD, the first step for mapping facilities should be to check other databases/sources (including CDR, TRI, NEI, and TRI). If so, the OES determined from the mapping procedures for those databases (discussed in other sections of this document) should be used. It is important that the same facility is mapped consistently across multiple databases/sources. Because facility identifiers such as TRFID and FRS ID are not available in the CEHD, the name of the facility in the CEHD will need to be compared to the facility names in other databases to identify if the facility is present in multiple databases/sources.
2. <u>Assign OES</u>: If the facility does not report to other databases, the following information should be used to assign an OES.
    a. 4-digit SIC and 6-digit NAICS codes reported in the CEHD (*e.g.*, a facility that reported SIC code 2891, Adhesives and Sealants, likely formulates these products; a facility that reported NAICS code 313320, Fabric Coating Mills, likely uses the chemical in fabric coating).
    b. Internet research of the types of products made at the facility (*e.g.*, if a facility's website indicates the facility manufactures metal parts, the facility is likely to use chemicals for degreasing or in a metalworking fluid) and information from sources cited in the COU table and scoping document, such as public and stakeholder comments (*i.e.*, EPA/ERG will review sources cited in the COU table and scoping document to see if there is any information specific to the reporting site that can be used to inform the mapping).

3. Refine OES: If the specific OES still cannot be determined using the information in Step 2, the following should be considered.
    a. An evaluation of the OES that is most likely to result in occupational exposures (*e.g.*, for facilities that report an SIC code for janitorial services, multiple OES may be applicable, such as cleaning, painting (*e.g.*, touch-ups), other maintenance activities; in such cases, the cleaning OES may be assigned for volatile chemicals because it has the highest exposure potential).
    b. Grouped OES for similar uses (*e.g.*, multiple facilities that may conduct formulation operations based on the reported NAICS or SIC code may be assigned a grouped formulation OES that covers all types of formulation [*e.g.*, adhesives, paints, cleaning products]).
4. Consider Options for OSHA CEHD Sites that Cannot be Mapped to an OES: Given the limited information available in OSHA CEHD, it may not always be feasible to achieve mapping of 100% of the sites in the database to an OES. In such cases, multiple options may be appropriate depending on assessment needs, such as:
    a. Assigning the sites as having an unknown OES with 250 exposure days/year. This allows for subsequent health modeling and the assessment of risk. For workers with identified risk, the OES can then be mapped using the below resources.
    b. Contacting OSHA for additional information on the facility from the OSHA inspection/monitoring.
    c. Contacting the facility for clarification on the use of the chemical. Note that information requests such as these may require an ICR if 10 or more entities are contacted.
    d. As discussed previously, sites for which all air monitoring data is non-detect for the chemical and for which there is no bulk data indicating the presence of the chemical do not need to be mapped to an OES. This is because the data do not provide evidence that the chemical is present at the site.

G.3.6 National Institute of Occupational Safety and Health (NIOSH) Health Hazard Evaluation (HHE)

NIOSH conducts HHEs at facilities to evaluate current workplace conditions and to make recommendations to reduce or eliminate the identified hazards.[17] NIOSH conducts HHEs at the request of employers, unions, or employees in workplaces where employee health and wellbeing is affected by the workplace. Therefore, unlike CDR, TRI, NEI, and DMR, facilities are not required to report data to NIOSH under the HHE program. Also, NIOSH only visits selected facilities where an HHE was requested, so the number of NIOSH HHEs available for each OES is often limited.

To map a facility that is the subject of a NIOSH HHE, the information in the HHE report should be used. Specifically, the HHE report typically includes general process information for the facility, information on how the chemical is used, worker activities, and the facility's SIC code. This information should be sufficient to map the facility to a single representative OES. Additionally, given the extent of information available about the subject facilities in NIOSH HHE reports, 100% of these facilities can be mapped to an OES. Additionally, Section G.5.6 shows two examples of how to map NIOSH HHE facilities to OES.

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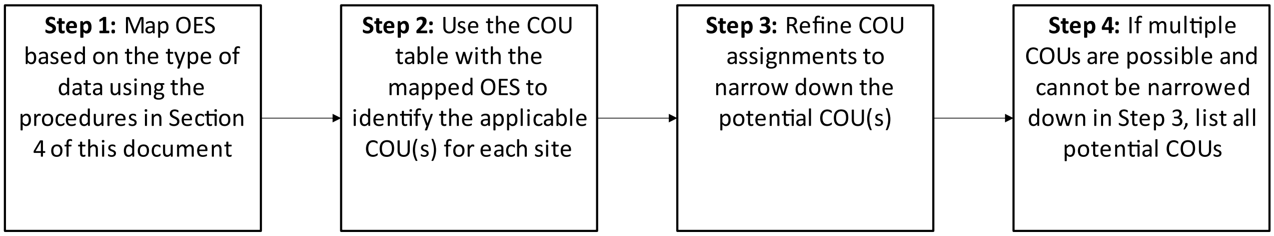
[17] More information about NIOSH HHEs is available at: https://www.cdc.gov/niosh/hhe/about.html

G.4 COU Mapping Procedures

As discussed in Section G.1, there is not always a one-to-one mapping between COUs and OES.

Figure_Apx G-7 depicts the steps that should be followed to map sites from the standard sources discussed in this document to COUs, using the OES mapping completed in Section G.3. Each step is explained in the text below the figure. Additionally, Section G.5.7 shows step-by-step examples for using the mapping procedures to determine the COU for three example facilities.



Figure_Apx G-7. COU Mapping Procedures for Standard Sources Already Mapped to OES

To map facilities from standard sources (*i.e.,* CDR, TRI, NEI, DMR, OSHA CEHD, NIOSH HHE) to COUs, the following procedures should be used:

1. Map the Facility to an OES: To map a facility from a standard source to a COU, the facility should first be mapped to an OES following the procedures for the specific source of data (discussed in Section G.3).
2. Use the COU Table with Mapped OES to Assign COUs: At the point of the risk evaluation process where EPA/ERG are mapping data from standard sources to OES and COU, EPA/ERG have already mapped OES to each of the COUs from the scope document, as shown in Table 1-1. Crosswalk of Subcategories of Use Listed in the Final Scope Document to Occupational Exposure Scenarios Assessed in the Risk Evaluation. This crosswalk between COUs and OES should be used to identify the COU(s) for the facility using the OES mapped per Section G.3.
3. Refine the COU Assignment: In some instances, more than one COU may map to the facility. In such cases, the following information should be used to try to narrow down the list of potentially applicable COUs:
    a. Information from the standard sources (*e.g.*, if ERG/EPA assigned a grouped OES like “Industrial Processing Aid” and the facility’s NAICS code in TRI or NEI is related to battery manufacturing, the COU can be identified as the “Processing Aid” category and Process solvent used in battery manufacture” subcategory).
    b. Internet research of the types of products made at the facility (*e.g.*, if a facility’s website indicates the facility makes adhesives, the COU category of “Processing—Incorporation into formulation, mixture or reaction product” and subcategory of “Adhesives and sealant chemicals” can be assigned and the remaining subcategories [*e.g.*, solvents for cleaning or degreasing, solvents which become part of the product formulation or mixture] are not applicable) and information from sources cited in the COU table and scoping document, such as public and stakeholder comments (*i.e.,* EPA/ERG will review sources cited in the COU table and scoping document to see if there is any information specific to the reporting site that can be used to inform the mapping).

4. List all Potential COUs: Where the above information does not narrow down the list of potentially applicable COUs, EPA/ERG will list all the potential COUs and will not attempt to select just one from the list where there is insufficient information to do so.

G.5 Example Case Studies

This section contains step-by-step examples of how to implement the OES and COU mapping procedures listed in Sections G.3 and G.4 to determine OES for facilities that report to standard engineering sources.

G.5.1 CDR Mapping Examples

This section includes examples of how to implement the OES mapping procedures for sites reporting to CDR, as listed in Section G.3.1. Specifically, this section includes examples for three example sites that reported to 2020 CDR for the round 2 chemical Di-isononyl phthalate (DINP). These example sites are referred to as Facility A, Facility B, and Facility C.

To map Facilities A, B, and C to an OES, the following procedures are used with the non-CBI 2020 CDR database.

1. Review Manufacturing and Import Activity Information: The first step in the process is to review the reported activity information to identify if the facility imports or manufactures the chemical. Table_Apx G-3 summarizes the information gathered from 2020 CDR for the three example sites for this step.

Table_Apx G-3. Step 1 for CDR Mapping Facilities

Facility Name	Step 1a: Reported Activity	Step 1b: Byproduct Information	Step 1c: Check Other Activities?	OES Determination
Facility A	Domestically Manufactured/Imported	Not known or reasonably ascertainable	Not needed.	Per Step 1a, this site maps to the Manufacturing OES.
Facility B	Imported	CBI	Yes	Cannot be determined in Step 1—Proceed with Step 2.
Facility C	Imported	Not known or reasonably ascertainable	Yes	Cannot be determined in Step 1—Proceed with Step 2.

1. For Importation Sites, Review Fields for “Imported Never at Site”, “Volume Exported”, and “Volume Used”: The next step is to review these additional fields to determine if the reporting facility conducts more than just importation activities. Table_Apx G-4 summarizes the information gathered from 2020 CDR for the three example sites for this step.

Table_Apx G-4. Step 2 for CDR Mapping Example Facilities

Facility Name	Step 2a: Imported Never at Site	Step 2b: Volume Exported	Step 2c: Volume Used	OES Determination
Facility A	n/a: OES determined in Step 1			
Facility B	CBI	CBI	CBI	Cannot be determined in Step 2: Proceed with Step 3.
Facility C	Yes	0	0	Since the facility only imports and does not use DINP, this site maps to the Import/Repackaging OES.

2. Refine OES Assignments: If multiple OES were identified from the previous steps, a single primary OES must be selected using additional facility information as discussed in Steps 3a to 3f. Table_Apx G-5 summarizes the information gathered from 2020 CDR for the three example sites for this step.

Table_Apx G-5. Step 3 for CDR Mapping Example Facilities

Facility Name	Step 3a: NAICS	Step3b: Processing/Use Information	Step 3c: Internet Research	Step 3d–e: Other Databases and OES Grouping	OES Determination
Facility A	n/a: OES determined in Step 1				
Facility B	325110, Petrochemical Manufacturing	CBI	Research indicates the facility is a petrochemical plant and does not indicate how DINP is used.	Check other databases per Step 4.	Cannot be determined in Step 2: Proceed with Step 4.
Facility C	n/a: OES determined in Step 2				

3. Review Information from Other Databases: Lastly, other databases/sources (such as TRI, NEI, and DMR) should be checked to see if the facility has reported to these. If the facility does not report to these databases, but additional OES are possible per Step 2, search available facility information on the internet. Table_Apx G-6 summarizes the information gathered from 2020 CDR for the three example sites for this step.

Table_Apx G-6. Step 4 for CDR Mapping Example Facilities

Facility Name	Step 4: Other Databases	OES Determination
Facility A	n/a: OES determined in Step 1	
Facility B	Using the FRS ID reported in CDR, this facility does not report to TRI, NEI, or DMR. EPA searched the facility in EPA's ECHO database and found that the facility does not have any listed NAICS codes, SIC codes, or permits, and appears to be a warehouse from aerial imagery. Therefore, this facility is likely just an importer.	Using the information from Step 4, this site maps to the Import/Repackaging OES.
Facility C	n/a: OES determined in Step 2	

G.5.2 TRI Mapping Examples

This appendix includes examples of how to implement the OES mapping procedures for sites reporting to TRI, as listed in Section G.3.2. Specifically, this appendix includes examples for three example sites that reported to TRI for the round 2 chemical 1,2-dichloroethane (1,2-dichloroethane). These example sites are referred to as Facility D, Facility E, and Facility F.

To map Facilities D, E, and F to an OES, the following procedures are used with information from TRI.

1. Assign Chemical Data Reporting Codes using TRI-to-CDR Crosswalk: The first step in the TRI mapping process is to map the uses and sub-uses reported by each facility to one or more 2016 CDR IFC codes. The uses and sub-uses reported to TRI by each example site are compiled in Table_Apx G-7, along with the 2016 CDR IFC codes mapped using Appendix A.

Table_Apx G-7. Step 1 for TRI Mapping Example Facilities

Facility Name	TRI Form Type	TRI Uses (Sub-uses)	2016 CDR IFC Codes
Facility D	R	Manufacture: produce, import, for onsite use/processing, for sale/distribution, as a byproduct Processing: as a reactant, as a formulation component (P299 Other) Otherwise Used: ancillary or other use (Z399 Other)	PK, U001, U003, U016, U013, U014, U018, U019, U020, U023, U027, U028, or U999
Facility E	R	Otherwise Used: ancillary or other use (Z399 Other)	U001, U013, U014, U018, U020, or U023
Facility F	A	None—not reported in Form A submissions	

2. Develop Chemical-Specific Crosswalk to Link CDR Codes to OES: The next step is to develop a separate CDR IFC code-to-OES crosswalk that links CDR IFC codes to OES for the chemical. To create this crosswalk, match the COU and OES from the COU table in the published scope documents to the list of 2016 CDR IFC codes in Appendix. The categories and subcategories of COUs typically match the IFC code category. See Table_Apx G-8 for the completed crosswalk for 1,2-dichloroethane.

Table_Apx G-8. Step 2 for TRI Mapping Example Facilities

COU and OES from Published Scope Document				Mapping		
Life Cycle Stage	Category	Subcategory	Occupational Exposure Scenario	2016 CDR IFC Code	2016 CDR IFC Code Name	Rationale
Manufacturing	Domestic Manufacturing	Domestic Manufacturing	Manufacturing	None	None	Per Section G.5.1, there is no corresponding CDR code for this COU/OES.
Repackaging	Repackaging	Repackaging	Repackaging	PK	Processing-repackaging	Category matches CDR code
Processing	Processing—As a Reactant	Intermediate in Petrochemical manufacturing	Processing as a reactant	U015; U016; U019; U024	Processing as a reactant	Category matches CDR code
		Plastic material and resin manufacturing				
		All other basic organic chemical manufacturing				
Processing	Processing—Incorporation into formulation, mixture, or reaction product	Fuels and fuel additives: All other petroleum and coal products manufacturing	Incorporated into formulation, mixture, or reaction product	U012	Fuel and fuel additives	Category matches CDR code
		Formulation of Adhesives and Sealants		U002	Adhesives and sealant chemicals	Category matches CDR code
		Processing aids: specific to petroleum production		U025	Processing aids: specific to petroleum production	Category matches CDR code
Distribution in Commerce	Distribution in Commerce	Distribution in Commerce	Distribution in commerce	None	None	Per Section G.5.1, there is no corresponding CDR

COU and OES from Published Scope Document				Mapping		
						code for this COU/OES.
Industrial Use	Adhesives and Sealants	Adhesives and Sealants	Adhesives and sealants	U002	Adhesives and sealant chemicals	Category matches CDR code
	Functional Fluids (Closed Systems)	Engine Coolant Additive	Functional fluids (closed systems)	U013	Functional Fluids (closed systems)	Category matches CDR code
	Lubricants and Greases	Paste lubricants and greases	Lubricants and greases	U017	Lubricants and Lubricant additives	Category matches CDR code
	Oxidizing/Reducing Agents	Oxidation inhibitor in controlled oxidative chemical reactions	Oxidizing/reducing agents	U019	Oxidizing/reducing agents	Category matches CDR code
	Cleaning and Degreasing	Industrial and commercial non-aerosol cleaning/degreasing	Solvents (for cleaning and degreasing)	U029	Solvents (for cleaning or degreasing)	Category matches CDR code
		Vapor Degreasing (TBD)				
Commercial Use	Cleaning and Degreasing	Commercial aerosol products (Aerosol degreasing, aerosol lubricants, automotive care products)				
	Plastic and Rubber Products	Products such as: plastic and rubber products	Plastics and rubber products	None	None	Per Section G.5.1, there is no corresponding CDR code for this COU/OES.
	Fuels and Related Products	Fuels and related products	Fuels and Related Products	U012	Fuels and Fuel Additives	Category matches CDR code

COU and OES from Published Scope Document				Mapping		
	Other use	Laboratory Chemical	Other use	None	Use-non-incorporative activities	This use does not match any other CDR codes and is non-incorporative
		Embalming agent				
Waste Handling, Disposal, Treatment, and Recycling	Waste Handling, Disposal, Treatment, and Recycling	Waste Handling, Disposal, Treatment, and Recycling	Waste Handling, Disposal, Treatment, and Recycling	None	None	Per Section G.5.1, there is no corresponding CDR code for this COU/OES.

3. Assign OES: Each TRI facility is then mapped to one or more OES using the CDR IFC codes assigned to each facility in Step 1 and the CDR IFC code-to-OES crosswalk developed in Step 2. Table_Apx G-9 includes the potential OES for each example facility per this step.

Table_Apx G-9. Step 3 for TRI Mapping Example Facilities

Facility Name	TRI Form Type	2016 CDR IFC Codes	Crosswalked OES	OES Determination
Facility D	R	PK, U001, U003, U016, U013, U014, U018, U019, U020, U023, U027, U028, or U999	Repackaging, Processing as a Reactant, Functional Fluids (Closed Systems), or Oxidizing/ Reducing Agents	Cannot be determined in Step 3: proceed to Step 4.
Facility E	R	U001, U013, U014, U018, U020, or U023	Functional Fluids (Closed Systems)	Since the facility maps to only one OES, the OES is Functional Fluids (Closed Systems).
Facility F	A	None; not reported in Form A submissions		Cannot be determined in Step 3: proceed to Step 4.

4. Refine OES Assignments: If a facility maps to more than one OES in Step 3, a single primary OES must be selected using additional facility information per Steps 4a-e. Table_Apx G-10 summarizes the information gathered for the three example sites for this step.

Table_Apx G-10. Step 4 for TRI Mapping Example Facilities

Facility Name	Step 4a: NAICS Code	Step 4b: Internet Research	Step 4c: Other Databases	Step 4d-e: Most Likely OES or OES Grouping	OES Determination
Facility D	486990, All Other Pipeline Transportation	The facility is a large chemical manufacturing plant.	Check databases per Step 5.	Based on the type of facility, the Processing as a Reactant OES seems the most likely OES from Step 3.	Most likely Processing as a Reactant OES. Check other databases in Step 5 to verify.
Facility E		n/a; OES determined in Step 3			

Facility Name	Step 4a: NAICS Code	Step 4b: Internet Research	Step 4c: Other Databases	Step 4d-e: Most Likely OES or OES Grouping	OES Determination
Facility F	325199, All Other Basic Organic Chemical Manufacturing	The facility is a chemical supplier that does not appear to produce chemicals.	Check databases per Step 5.	Based on the NAICS code and type of facility, the Repackaging OES seems the most likely.	Most likely Repackaging OES. Check other databases in Step 5 to verify.

5. Review Information from Other Databases: Other databases/sources (including CDR, NEI, and DMR) should be checked to see if the facility has reported to these. If so, the OES determined from the mapping procedures for those databases (discussed in other sections of this document) should also be used. It is important that the same facility is mapped consistently across multiple databases/sources. The facility's TRFID and FRS ID can be used to identify sites that report to TRI, DMR, and NEI. Table_Apx G-11 summarizes the information gathered from other databases for the three example sites for this step.

Table_Apx G-11. Step 5 for TRI Mapping Example Facilities

Facility Name	Step 4: Other Databases	OES Determination
Facility D	The facility did not report to 2016 or 2020 CDR. The facility reported to 2020 NEI, reporting emissions of 1,2-dichloroethane from storage tanks and process equipment from chemical manufacturing processes and storage/transfer operations. The facility reported DMRs for the past few years but reported no releases of 1,2-dichloroethane to DMR.	The NEI information corroborates the most likely OES determined in Step 4d. Therefore, this site maps to the Processing as a Reactant OES.
Facility E	n/a; OES determined in Step 3	
Facility F	The facility did not report to 2016 or 2020 CDR, 2020 NEI, or the past few years of DMR.	Since no additional information was determined in Step 5, the site maps to the Repackaging OES per Step 4d.

G.5.3 NEI Mapping Examples

This section includes examples of how to implement the OES mapping procedures for sites reporting to NEI, as listed in Section G.3.3. Specifically, this section includes two examples for 1,2-dichloroethane from 2017 NEI: (1) Facility G, which is an industrial site that reported point source emissions under multiple NEI records, and (2) Example H, which is a county that reported non-point source emissions under multiple NEI records.

To map Facility G (point source) and Example H (non-point source) NEI records to OES, the following procedures should be used:

1. Develop Crosswalks to Link NEI-Reported SCC and Sector Combinations to Chemical Data Reporting Codes: The first step in mapping NEI data to potentially relevant OES is to develop a crosswalk to map each unique combination of NEI-reported Source Classification Code (SCC) (levels 1-4) and industry sectors to one or more CDR codes. This crosswalk is developed on a chemical-by-chemical basis rather than an overall crosswalk for all chemicals because SCCs correspond to emission sources rather than chemical uses such that the crosswalk to CDR codes may differ from chemical to chemical. In some cases, it may not be possible to assign all SCC sector combinations to CDR codes, in which case information from Step 5 can be used to help make OES assignments. Separate crosswalks are needed for point and nonpoint source records, as shown in Table_Apx G-12 and Table_Apx G-13. Note that theses tables only present the crosswalk for the SCC and sector codes relevant to Facility G (point source) and Example H (non-point source) examples; there are many more SCC and sector codes reported for 1,2-dichloroethane in 2017 NEI.

Table_Apx G-12. Step 1a for NEI Mapping Example Facilities

SCC Level One	SCC Level Two	SCC Level Three	SCC Level Four	Sector	Assigned CDR Code	Rationale
Chemical Evaporation	Organic Solvent Evaporation	Air Stripping Tower	Solvent	Solvent—Industrial Surface Coating & Solvent Use	U029: Solvents (for Cleaning and Degreasing)	Based on sector.
Chemical Evaporation	Organic Solvent Evaporation	Cold Solvent Cleaning/Stripping	Other Not Classified	Solvent—Degreasing	U029: Solvents (for Cleaning and Degreasing)	Based on sector.
Chemical Evaporation	Organic Solvent Evaporation	Dry Cleaning	Other Not Classified	Solvent—Dry Cleaning	U029: Solvents (for Cleaning and Degreasing)	Based on sector.
Chemical Evaporation	Organic Solvent Evaporation	Fugitive Emissions	General	Solvent—Degreasing	U029: Solvents (for Cleaning and Degreasing)	Based on sector.

SCC Level One	SCC Level Two	SCC Level Three	SCC Level Four	Sector	Assigned CDR Code	Rationale
Chemical Evaporation	Organic Solvent Evaporation	Miscellaneous Volatile Organic Compound Evaporation	Miscellaneous	Solvent—Industrial Surface Coating & Solvent Use	U029: Solvents (for Cleaning and Degreasing)	Based on sector.
Chemical Evaporation	Organic Solvent Evaporation	Solvent Storage	General Processes: Drum Storage—Pure Organic Chemicals	Industrial Processes—Storage and Transfer	n/a: no matching CDR IFC, likely Distribution in Commerce	Matched SCC and Sector code.
Chemical Evaporation	Organic Solvent Evaporation	Solvent Storage	General Processes: Spent Solvent Storage	Industrial Processes—Storage and Transfer	n/a: no matching CDR IFC, likely Distribution in Commerce	Matched SCC and Sector code.
Chemical Evaporation	Organic Solvent Evaporation	Waste Solvent Recovery Operations	Other Not Classified	Solvent—Industrial Surface Coating & Solvent Use	n/a: no matching CDR IFC, likely Waste Handling, Disposal and Treatment	Matched to SCC level 3 code.
Chemical Evaporation	Organic Solvent Evaporation	Waste Solvent Recovery Operations	Solvent Loading	Industrial Processes—Storage and Transfer	n/a: no matching CDR IFC, likely Waste Handling, Disposal and Treatment	Matched to SCC level 3 code.
Industrial Processes	Photo Equip/Health Care/Labs/Air Condit/SwimPools	Health Care—Crematoriums	Cremation—Animal	Industrial Processes—NEC	U999: Other	Does not fit other CDR code.
Industrial Processes	Photo Equip/Health	Health Care—Crematoriums	Cremation—Human	Industrial Processes—NEC	U999: Other	Does not fit other CDR code.

SCC Level One	SCC Level Two	SCC Level Three	SCC Level Four	Sector	Assigned CDR Code	Rationale
	Care/Labs/Air Condit/SwimPools					
Industrial Processes	Photo Equip/Health Care/Labs/Air Condit/SwimPools	Health Care—Crematoriums	Crematory Stack—Human and Animal Crematories	Industrial Processes—NEC	U999: Other	Does not fit other CDR code.
Industrial Processes	Photo Equip/Health Care/Labs/Air Condit/SwimPools	Health Care	Miscellaneous Fugitive Emissions	Industrial Processes—NEC	U999: Other	Assume use as a laboratory chemical in the healthcare industry.
Industrial Processes	Photo Equip/Health Care/Labs/Air Condit/SwimPools	Laboratories	Bench Scale Reagents: Research	Industrial Processes—NEC	U999: Other	SCC for laboratories.
Industrial Processes	Photo Equip/Health Care/Labs/Air Condit/SwimPools	Laboratories	Bench Scale Reagents: Testing	Industrial Processes—NEC	U999: Other	SCC for laboratories.

Table_Apx G-13. Step 1b for NEI Mapping Example Facilities

Sector	Assigned CDR Code	Rationale
Commercial Cooking	n/a; no matching CDR IFC	Unknown
Fuel Comb—Comm/Institutional—Biomass	U012: Fuels and fuel additives	Consistent with sector code
Fuel Comb—Comm/Institutional—Coal	U012: Fuels and fuel additives	Consistent with sector code
Fuel Comb—Industrial Boilers, ICEs—Biomass	U012: Fuels and fuel additives	Consistent with sector code
Fuel Comb—Industrial Boilers, ICEs—Coal	U012: Fuels and fuel additives	Consistent with sector code
Fuel Comb—Residential—Other	U012: Fuels and fuel additives	Consistent with sector code
Gas Stations	U012: Fuels and fuel additives	Consistent with sector code
Solvent—Consumer & Commercial Solvent Use	U029: Solvents (for cleaning or degreasing)	Consistent with sector code
Waste Disposal	n/a: no matching CDR IFC, likely Waste Handling, Disposal and Treatment	Consistent with sector code

2. <u>Use CDR Crosswalks to Assign CDR Codes</u>: Next, the chemical-specific CDR crosswalk developed in Step 1 should be used to assign CDR IFC codes to each point source NEI record and CDR IFC codes and/or commercial/consumer use PCs to each nonpoint source NEI record. This is shown in Table_Apx G-14 for Facility G (point source) and Example H (non-point source).

Table_Apx G-14. Step 2 for NEI Mapping Example Facilities

Facility Name	SCC Level One	SCC Level Two	SCC Level Three	SCC Level Four	Sector	Assigned CDR IFC Code
Facility G	Chemical Evaporation	Organic Solvent Evaporation	Air Stripping Tower	Solvent	Solvent—Industrial Surface Coating & Solvent Use	U029: Solvents (for Cleaning and Degreasing)
	Industrial Processes	Photo Equip/Health Care/Labs/Air Condit/SwimPools	Laboratories	Bench Scale Reagents: Testing	Industrial Processes—NEC	U999: Other
Example H	n/a: not applicable to nonpoint source				Commercial Cooking	n/a: no matching CDR IFC
	n/a: not applicable to nonpoint source				Fuel Comb—Residential—Other	U012: Fuels and fuel additives
	n/a: not applicable to nonpoint source				Gas Stations	U012: Fuels and fuel additives

3. Update CDR Crosswalks to Link CDR Codes to OES: The chemical-specific crosswalk developed in Step 1 is then used to link the SCCs, sectors, and CDR codes in the crosswalk to an OES. The OES will be assigned based on the chemical specific COU categories and subcategories and the OES mapped to them. The same crosswalk developed in Table_Apx G-8 (TRI Step 2) links CDR codes to COUs and OES and is used in this example.

4. Use CDR Crosswalks to Assign OES: The chemical-specific CDR crosswalks developed in Steps 1-3 are then used to assign OES to each point source and nonpoint source NEI data record (*i.e.*, each combination of facility-SCC-sector). Note that the individual facilities in the point source data set may have multiple emission sources, described by different SCC and sector combinations within NEI, such that multiple OES map to each NEI record. In such cases, a single, representative OES must be selected for each NEI record using the additional information described in Step 5. Similarly, the sectors reported by nonpoint sources may map to multiple CDR IFC or PC codes, such that multiple OES are applicable and must be refined to a single OES. See Table_Apx G-15 for completed Step 4 for the example facilities.

Table_Apx G-15. Step 4 for NEI Mapping Example Facilities

Facility Name	SCC Level One	SCC Level Two	SCC Level Three	SCC Level Four	Sector	Assigned CDR IFC Code	Mapped OES	OES Determination
Facility G	Chemical Evaporation	Organic Solvent Evaporation	Air Stripping Tower	Solvent	Solvent—Industrial Surface Coating & Solvent Use	U029: Solvents (for Cleaning and Degreasing)	Solvents (for cleaning and degreasing)	Since only one OES maps to this NEI record, the OES is Solvents (for cleaning and degreasing)
	Industrial Processes	Photo Equip/Health Care/Labs/Air Condit/SwimPools	Laboratories	Bench Scale Reagents: Testing	Industrial Processes—NEC	U999: Other	Laboratory Chemical Embalming Agent	Cannot be determined in Step 4: Proceed with Step 5.
Example H	n/a: not applicable to nonpoint source				Commercial Cooking	n/a: no matching CDR IFC	None	Cannot be determined in Step 4: Proceed with Step 5.
	n/a: not applicable to nonpoint source				Fuel Comb—Residential—Other	U012: Fuels and fuel additives	Incorporated into Formulation, Mixture, or Reaction Product Fuels and Related Products	Cannot be determined in Step 4: Proceed with Step 5.
	n/a: not applicable to nonpoint source				Gas Stations	U012: Fuels and fuel additives	Incorporated into Formulation, Mixture, or Reaction Product Fuels and Related Products	Cannot be determined in Step 4: Proceed with Step 5.

5. Refine OES Assignments: The initial OES assignments may need to be confirmed and/or refined to identify a single primary OES using the following information described in Steps 5a-b. See Table_Apx G-16 for Facility G (point source) and Example H (non-point source).

Table_Apx G-16. Step 5 for NEI Mapping Example Facilities

Facility Name	Sector	Step 5a: Additional Point Source Information	Step 5b: Additional Non-Point Source Information	OES Determination
Facility G	Solvent—Industrial Surface Coating & Solvent Use	n/a: mapped to OES in Step 4		
	Industrial Processes—NEC	NAICS is 336415, Guided Missile and Space Vehicle Propulsion Unit and Propulsion Unit Parts Manufacturing. Emitting process is analytical lab operations.	n/a	Information from Step 4 and 5a affirm the OES is Laboratory Chemical.
Example H	Commercial Cooking	n/a	No knowledge is available on the use of 1,2-dichloroethane in commercial cooking	Cannot be determined in Step 5: Proceed to Step 7.
	Fuel Comb—Residential—Other	n/a	1,2-dichloroethane may be used in fuel additives.	Information from Step 4 and 5a affirm the OES is Fuels and Related Products.
	Gas Stations	n/a	1,2-dichloroethane may be used in fuel additives.	Information from Step 4 and 5a affirm the OES is Fuels and Related Products.

6. Review Information from Other Databases for Point Source Facilities: Other databases/sources (including CDR, TRI, and DMR) should be checked to see if the point source facilities have reported to these. Facility G does not report to other databases. This step is not applicable to non-point source Example H.

7. Consider Options for NEI Records that Cannot be Mapped to an OES: Given the number of records in NEI and the information available, it may not always be feasible to achieve mapping of 100% of the sites reporting to NEI to an OES. This is the case for the NEI record Example H—Commercial Cooking. In this case, the OES will be assessed, per Step 7a, as “unknown OES” with 250 release days/year. This allows for subsequent exposure modeling and the assessment of risk.

G.5.4 DMR Mapping Examples

This section includes examples of how to implement the OES mapping procedures for sites reporting to DMR, as listed in Section G.3.4. Specifically, this appendix includes examples for two example sites that reported to DMR for 1,2-dichloroethane. These example sites are referred to as Facility I and J.

To map Facilities I and J to an OES, the following procedures are used with information from DMR:

1. Review Information from Other Databases: Given the limited facility information reported in DMRs, the first step for mapping facilities reporting to DMR should be to check other databases/sources (including CDR, TRI, and NEI). For these examples, neither Facility I nor J reported to other databases.
2. Assign OES: If the facility does not report to other databases, the reported SIC code from DMR and internet research should be used to map the facility to an OES, per Steps 2a and 2b. See Table_Apx G-17 for completed Step 2 for the example facilities.

Table_Apx G-17. Step 2 for DMR Mapping Example Facilities

Facility Name	Step 2a: SIC Code	Step 2b: Internet Research	OES Determination
Facility I	4613, Refined Petroleum Pipeline	Internet research indicates that the facility is a fuel terminal.	Cannot be determined in Step 2: Proceed with Step 3.
Facility J	2821, Plastics Materials and Resins	Internet research indicates the facility makes poly vinyl chloride. 1,2-dichloroethane is known to be used as a reactant in this process.	This facility maps to the Processing as a Reactant OES, based on the SIC code (which matches the subcategory of use in the COU table, Table_Apx G-8) and internet research.

3. Refine OES: If the specific OES still cannot be determined using the information in Step 2, information in Steps 3a-d should be considered. This includes searching for the facility NPDES permit and trying to determine which OES (or group of OES) is the most likely. See Table_Apx G-18 for completed Step 3 for the example facilities.

Table_Apx G-18. Step 3 for DMR Mapping Example Facilities

Facility Name	Step 3a: NPDES Permit Number	Step 3b: Finding the NPDES Permit	Step 3c-d: Most Likely OES or Grouped OED	OES Determination
Facility I	VAG83#### → A search of VA NPDES permits indicates that permit numbers	The facility's NPDES permit could not be found online.	None of COUs or OES for 1,2-dichloroethane in Table_Apx G-8 cover remediation.	Since the facility's permit is for remediation, the facility most likely does not use 1,2-dichloroethane but the chemical is present as a contaminant at the site. This

Facility Name	Step 3a: NPDES Permit Number	Step 3b: Finding the NPDES Permit	Step 3c-d: Most Likely OES or Grouped OED	OES Determination
	starting in "VAG0083" are remediation general permits.			does not correspond to an in-scope OES. However, the OES should be designated as "Remediation" for EPA to determine how/if to present the release data.
Facility J	n/a: This facility was mapped to an OES in Step 2.			

G.5.5 OSHA CEHD Mapping Examples

This section includes examples of how to implement the OES mapping procedures for sites in the OSHA CEHD data set, as listed in Section G.3.5. Specifically, this section includes examples for two example sites in the OSHA CEHD data set for 1,4-dioxane. These example sites are referred to as Facility K and L.

To map Facilities K and L to an OES, the following procedures are used with information from OSHA CEHD:

1. Review Information from Other Databases: Given the limited facility information reported in OSHA CEHD, the first step for mapping facilities should be to check other databases/sources (including CDR, TRI, NEI, and TRI). For these examples, neither Facility K nor L reported to other databases.
2. Assign OES: If the facility does not report to other databases, the reported SIC code from OSHA CEHD and internet research should be used to map the facility to an OES, per Steps 2a and 2b. See Table_Apx G-19 for completed Step 2 for the example facilities.

Table_Apx G-19. Step 2 for OSHA CEHD Mapping Example Facilities

Facility Name	Step 2a: SIC or NAICS Code	Step 2b: Internet Research	OES Determination
Facility K	339112, Surgical and Medical Instrument Manufacturing	Internet research indicates that the facility produces medical equipment for cardiovascular procedures.	Based on the OES in Table_Apx G-8, the most applicable OES are likely Processing as a Reactant (for the production of plastics used in equipment), Solvents (for Cleaning or Degreasing), Plastics and Rubber Products, or Other Use. The specific OES cannot be determined in Step 2: Proceed with Step 3.
Facility L	5169, Chemicals and Allied Products, Not	Internet research indicates the facility is a waste management company.	This facility maps to the Waste Handling, Disposal, Treatment, and Recycling, based on information from

Facility Name	Step 2a: SIC or NAICS Code	Step 2b: Internet Research	OES Determination
	Elsewhere Classified		internet research.

3. Refine OES: If the specific OES still cannot be determined using the information in Step 2, an evaluation of the OES that is most likely or a group of OES should be considered per Steps 3a and 3b. See Table_Apx G-20 for completed Step 3 for the example facilities.

Table_Apx G-20. Step 3 for OSHA CEHD Mapping Example Facilities

Facility Name	Step 3a: Mostly Likely OES	Step 3b: Grouped OED	OES Determination
Facility K	The scope document for 1,2-dichloroethane indicates that the chemical is used to make polyvinyl chloride that is then used in medical devices. The use of 1,2-dichloroethane to produce polyvinyl chloride falls under the Processing as a Reactant OES (as an intermediate for plastics).	Not needed: the OES was determined as Processing as a Reactant in Step 3a.	Per Step 3a, this facility maps to the Processing as a Reactant OES. To further support this determination, EPA may contact OSHA for additional information on the visit to this facility, per Step 4b.
Facility L	n/a: This facility was mapped to an OES in Step 2.		

G.5.6 NIOSH HHE Mapping Examples

This section includes examples of how to implement the OES mapping procedures listed in Section G.3.6 for two example NIOSH HHEs for 1,2-dichloroethane. To map facilities that are the subject of a NIOSH HHE, the process information and other narrative descriptions in the NIOSH HHE should be used.

1. The first example is for the following NIOSH HHE: https://www.cdc.gov/niosh/hhe/reports/pdfs/80-186-1149.pdf. The following information is found in the NIOSH HHE:
    a. The facility produces plastic products, primarily plastic tubes for packaging.
    b. 1,2-dichloroethane was used as a bonding agent for sealing packaging.

   OES determination: Based on the OES for 1,2-dichloroethane (listed in Table_Apx G-8. Step 2 for TRI Mapping Example Facilities), the use of 1,2-dichloroethane for sealants falls under the Adhesives and Sealants OES.

2. The second example is for the following NIOSH HHE: https://www.cdc.gov/niosh/hhe/reports/pdfs/77-73-610.pdf. The following information is found in the NIOSH HHE:
    a. The facility is a chemical manufacturer.
    b. The facility uses 1,2-dichloroethane as a solvent in a reaction to produce another chemical.

   OES determination: Based on the OES for 1,2-dichloroethane (listed in Table_Apx G-8. Step 2 for TRI Mapping Example Facilities), the use of 1,2-dichloroethane as a reactant falls under the Processing as a Reactant OES.

As discussed in Section G.3.6, NIOSH HHEs typically contain detailed process information and description of how the chemical is used at the facility. Therefore, the mapping of NIOSH HHE facilities to OES is straightforward.

G.5.7 COU Mapping Examples

This appendix includes examples of how to implement the COU mapping procedures for sites from standard sources (*i.e.*, CDR, TRI, NEI, DMR, OSHA CEHD, NIOSH HHE, as listed in Section G.4. Specifically, this appendix uses the same example facilities (Facility D, Facility E, and Facility F) for the TRI examples in Section G.5.2.

To map Facilities D, E, and F to an COUs, the following procedures should be used:

1. Map the Facility to an OES: To map a facility from a standard source to a COU, the facility should first be mapped to an OES following the procedures for the specific source of data (discussed in Section G.3). This mapping was completed in completed in Section G.5.2 and is summarized in Table_Apx G-21.

Table_Apx G-21. Step 1 for COU Mapping Example Facilities

Facility Name	Step 1: OES Determination from Appendix A.2
Facility D	Processing as a Reactant
Facility E	Functional Fluids (Closed Systems)
Facility F	Repackaging

2. Use the COU Table with Mapped OES to Assign COUs: At the point of the risk evaluation process where EPA/ERG are mapping data from standard sources to OES and COU, EPA/ERG have already mapped OES to each of the COUs from the scope document. This crosswalk between COUs and OES, which is in Table_Apx G-8, for the example facilities should be used to identify the COU(s). See Table_Apx G-22 for completed Step 2 for the example facilities.

Table_Apx G-22. Step 2 for COU Mapping Example Facilities

<table>
<tr><th>Facility Name</th><th>OES Determination from Appendix A.2</th><th>Step 2: Mapped COUs</th></tr>
<tr><td>Facility D</td><td>Processing as a Reactant</td><td>Using the COU to OES crosswalk previously developed (Table_Apx G-8), the COUs that map to this OES are:
<table>
<tr><th>Life Cycle Stage</th><th>Category</th><th>Subcategory</th></tr>
<tr><td>Processing</td><td>Processing—As a Reactant</td><td>Intermediate in Petrochemical manufacturing</td></tr>
<tr><td></td><td></td><td>Plastic material and resin manufacturing</td></tr>
<tr><td></td><td></td><td>All other basic organic chemical manufacturing</td></tr>
</table></td></tr>
<tr><td>Facility E</td><td>Functional Fluids (Closed Systems)</td><td>Using the COU to OES crosswalk previously developed (Table_Apx G-8), only one COU maps to this OES:
<table>
<tr><th>Life Cycle Stage</th><th>Category</th><th>Subcategory</th></tr>
<tr><td>Industrial use</td><td>Functional Fluids (Closed Systems)</td><td>Engine Coolant Additive</td></tr>
</table></td></tr>
<tr><td>Facility F</td><td>Repackaging</td><td>Using the COU to OES crosswalk previously developed (Table_Apx G-8), only one COU maps to this OES:</td></tr>
</table>

Facility Name	OES Determination from Appendix A.2	Step 2: Mapped COUs		
		Life Cycle Stage	Category	Subcategory
		Repackaging	Repackaging	Repackaging

3. Refine the COU Assignment: In some instances, more than one COU may map to the facility. In such cases, the reported NAICS code and internet research should be used to try to narrow down the list of potentially applicable COUs, per Steps 3a-b. See Table_Apx G-23 for completed Step 3 for the example facilities.

Table_Apx G-23. Step 3 for COU Mapping Example Facilities

Facility Name	Step 3a: NAICS Code	Step 3b: Internet Research	COU Determination
Facility D	486990, All Other Pipeline Transportation	The facility is a large chemical manufacturing plant.	The COU subcategory for "Plastic material and resin manufacturing" can be eliminated. However, the COU cannot be narrowed down between the remaining two subcategories of use. Proceed to Step 4.
Facility E	n/a: COU determined in Step 2		
Facility F	n/a: COU determined in Step 2		

4. List all Potential COUs: Where the above information does not narrow down the list of potentially applicable COUs, EPA/ERG will list all the potential COUs and will not attempt to select just one from the list where there is insufficient information to do so. Since a singular OES was identified for Facility D and F, this step is not applicable to those facilities. For Facility F, there are two possible COUs that are listed in Table_Apx G-24. Since a COU consists of a life cycle stage, category, and subcategory, all three should be presented in this step.

Table_Apx G-24. Step 4 for COU Mapping Example Facilities

Facility Name	Step 4: All Potential COUs		
Facility D	All potential COUs for this facility are as follows:		
	Life Cycle Stage	Category	Subcategory
	Processing	Processing—As a Reactant	Intermediate in Petrochemical manufacturing
			All other basic organic chemical manufacturing

G.6 TRI to CDR Use Mapping Crosswalk

Table_Apx G-25 presents the TRI-CDR Crosswalk used to map facilities to the OES for each chemical. “N/A” in the 2016 CDR code column indicates there is no corresponding CDR code that matches the TRI code. 2020 CDR introduced new codes for chemicals designated as high priority for risk evaluation; however, reporters may still use the same 2016 CDR codes listed in Table_Apx G-25 for all other chemicals. For 2020 CDR reporting facilities using the new codes, the crosswalk between 2016 CDR codes and 2020 CDR codes in Table 4-15 of the 2020 CDR reporting instructions should be used with Table_Apx G-25.

Table_Apx G-25. TRI-CDR Use Code Crosswalk

TRI Section	TRI Description	TRI Sub-use Code	TRI Sub-use Code Name	2016 CDR Code	2016 CDR Code Name	2016 CDR Functional Use Definition
3.1.a	Manufacture: Produce	N/A	N/A	N/A	N/A	N/A
3.1.b	Manufacture: Import	N/A	N/A	N/A	N/A	N/A
3.1.c	Manufacture: For on-site use/processing	N/A	N/A	N/A	N/A	N/A
3.1.d	Manufacture: For sale/distribution	N/A	N/A	N/A	N/A	N/A
3.1.e	Manufacture: As a byproduct	N/A	N/A	N/A	N/A	N/A
3.1.f	Manufacture: As an impurity	N/A	N/A	N/A	N/A	N/A
3.2.a	Processing: As a reactant	N/A	N/A	PC	Processing as a reactant	Chemical substance is used in chemical reactions for the manufacturing of another chemical substance or product.
3.2.a	Processing: As a reactant	P101	Feedstocks	N/A	N/A	N/A
3.2.a	Processing: As a reactant	P102	Raw Materials	N/A	N/A	N/A
3.2.a	Processing: As a reactant	P103	Intermediates	U015	Intermediates	Chemical substances consumed in a reaction to produce other chemical substances for commercial advantage. A residual of the intermediate chemical substance which has no separate function may remain in the reaction product.

TRI Section	TRI Description	TRI Sub-use Code	TRI Sub-use Code Name	2016 CDR Code	2016 CDR Code Name	2016 CDR Functional Use Definition
3.2.a	Processing: As a reactant	P104	Initiators	U024	Process regulators	Chemical substances used to change the rate of a chemical reaction, start or stop the reaction, or otherwise influence the course of the reaction. Process regulators may be consumed or become part of the reaction product.
3.2.a	Processing: As a reactant	P199	Other	U016	Ion exchange agents	Chemical substances, usually in the form of a solid matrix, are used to selectively remove targeted ions from a solution. Examples generally consist of an inert hydrophobic matrix such as styrene divinylbenzene or phenol-formaldehyde, cross-linking polymer such as divinylbenzene, and ionic functional groups including sulfonic, carboxylic or phosphonic acids. This code also includes aluminosilicate zeolites.
3.2.a	Processing: As a reactant	P199	Other	U019	Oxidizing/ reducing agent	Chemical substances used to alter the valence state of another substance by donating or accepting electrons or by the addition or removal of hydrogen to a substance. Examples of oxidizing agents include nitric acid, perchlorates, hexavalent chromium compounds, and peroxydisulfuric acid salts. Examples of reducing agents include hydrazine, sodium thiosulfate, and coke produced from coal.
3.2.a	Processing: As a reactant	P199	Other	U999	Other (specify)	Chemical substances used in a way other than those described by other codes.
3.2.b	Processing: As a formulation component	N/A	N/A	PF	Processing-incorporation into formulation, mixture, or reaction product	Chemical substance is added to a product (or product mixture) prior to further distribution of the product.
3.2.b	Processing: As a formulation component	P201	Additives	U007	Corrosion inhibitors and antiscaling agents	Chemical substances used to prevent or retard corrosion or the formation of scale. Examples include phenylenediamine, chromates, nitrates, phosphates, and hydrazine.
3.2.b	Processing: As a	P201	Additives	U009	Fillers	Chemical substances used to provide bulk, increase strength, increase hardness, or improve resistance to

TRI Section	TRI Description	TRI Sub-use Code	TRI Sub-use Code Name	2016 CDR Code	2016 CDR Code Name	2016 CDR Functional Use Definition
	formulation component					impact. Fillers incorporated in a matrix reduce production costs by minimizing the amount of more expensive substances used in the production of articles. Examples include calcium carbonate, barium sulfate, silicates, clays, zinc oxide and aluminum oxide.
3.2.b	Processing: As a formulation component	P201	Additives	U010	Finishing agents	Chemical substances used to impart such functions as softening, static proofing, wrinkle resistance, and water repellence. Substances may be applied to textiles, paper, and leather. Examples include quaternary ammonium compounds, ethoxylated amines, and silicone compounds.
3.2.b	Processing: As a formulation component	P201	Additives	U017	Lubricants and lubricant additives	Chemical substances used to reduce friction, heat, or wear between moving parts or adjacent solid surfaces, or that enhance the lubricity of other substances. Examples of lubricants include mineral oils, silicate and phosphate esters, silicone oil, greases, and solid film lubricants such as graphite and PTFE. Examples of lubricant additives include molybdenum disulphide and tungsten disulphide.
3.2.b	Processing: As a formulation component	P201	Additives	U034	Paint additives and coating additives not described by other codes	Chemical substances used in a paint or coating formulation to enhance properties such as water repellence, increased gloss, improved fade resistance, ease of application, foam prevention, etc. Examples of paint additives and coating additives include polyols, amines, vinyl acetate ethylene emulsions, and aliphatic polyisocyanates.
3.2.b	Processing: As a formulation component	P202	Dyes	U008	Dyes	Chemical substances used to impart color to other materials or mixtures (*i.e.*, substrates) by penetrating the surface of the substrate. Example types include azo, anthraquinone, amino azo, aniline, eosin, stilbene, acid, basic or cationic, reactive, dispersive, and natural dyes.
3.2.b	Processing: As a	P202	Dyes	U021	Pigments	Chemical substances used to impart color to other materials or mixtures

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	formulation component					(*i.e.*, substrates) by attaching themselves to the surface of the substrate through binding or adhesion. This code includes fluorescent agents, luminescent agents, whitening agents, pearlizing agents, and opacifiers. Examples include metallic oxides of iron, titanium, zinc, cobalt, and chromium; metal powder suspensions; lead chromates; vegetable and animal products; and synthetic organic pigments.
3.2.b	Processing: As a formulation component	P203	Reaction Diluents	U030	Solvents (which become part of product formulation or mixture)	Chemical substances used to dissolve another substance (solute) to form a uniformly dispersed mixture (solution) at the molecular level. Examples include diluents used to reduce the concentration of an active material to achieve a specified effect and low gravity materials added to reduce cost.
3.2.b	Processing: As a formulation component	P203	Reaction Diluents	U032	Viscosity adjustors	Chemical substances used to alter the viscosity of another substance. Examples include viscosity index (VI) improvers, pour point depressants, and thickeners.
3.2.b	Processing: As a formulation component	P204	Initiators	U024	Process regulators	Chemical substances used to change the rate of a chemical reaction, start, or stop the reaction, or otherwise influence the course of the reaction. Process regulators may be consumed or become part of the reaction product.
3.2.b	Processing: As a formulation component	P205	Solvents	U030	Solvents (which become part of product formulation or mixture)	Chemical substances used to dissolve another substance (solute) to form a uniformly dispersed mixture (solution) at the molecular level. Examples include diluents used to reduce the concentration of an active material to achieve a specified effect and low gravity materials added to reduce cost.
3.2.b	Processing: As a formulation component	P206	Inhibitors	U024	Process regulators	Chemical substances used to change the rate of a chemical reaction, start, or stop the reaction, or otherwise influence the course of the reaction. Process regulators may be consumed or become part of the reaction product.
3.2.b	Processing: As a	P207	Emulsifiers	U003	Adsorbents and absorbents	Chemical substances used to retain other substances by accumulation on

TRI Section	TRI Description	TRI Sub-use Code	TRI Sub-use Code Name	2016 CDR Code	2016 CDR Code Name	2016 CDR Functional Use Definition
	formulation component					their surface or by assimilation. Examples of adsorbents include silica gel, activated alumina, and activated carbon. Examples of absorbents include straw oil, alkaline solutions, and kerosene.
3.2.b	Processing: As a formulation component	P208	Surfactants	U002	Adhesives and sealant chemicals	Chemical substances used to promote bonding between other substances, promote adhesion of surfaces, or prevent seepage of moisture or air. Examples include epoxides, isocyanates, acrylamides, phenol, urea, melamine, and formaldehyde.
3.2.b	Processing: As a formulation component	P208	Surfactants	U023	Plating agents and surface treating agents	Chemical substances applied to metal, plastic, or other surfaces to alter physical or chemical properties of the surface. Examples include metal surface treating agents, strippers, etchants, rust and tarnish removers, and descaling agents.
3.2.b	Processing: As a formulation component	P208	Surfactants	U031	Surface active agents	Chemical substances used to modify surface tension when dissolved in water or water solutions or reduce interfacial tension between two liquids or between a liquid and a solid or between liquid and air. Examples include carboxylates, sulfonates, phosphates, carboxylic acid, esters, and quaternary ammonium salts.
3.2.b	Processing: As a formulation component	P209	Lubricants	U017	Lubricants and lubricant additives	Chemical substances used to reduce friction, heat, or wear between moving parts or adjacent solid surfaces, or that enhance the lubricity of other substances. Examples of lubricants include mineral oils, silicate and phosphate esters, silicone oil, greases, and solid film lubricants such as graphite and PTFE. Examples of lubricant additives include molybdenum disulphide and tungsten disulphide.
3.2.b	Processing: As a formulation component	P210	Flame Retardants	U011	Flame retardants	Chemical substances used on the surface of or incorporated into combustible materials to reduce or eliminate their tendency to ignite when exposed to heat or a flame for a short period of time. Examples include inorganic salts, chlorinated, or

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						brominated organic compounds, and organic phosphates/phosphonates.
3.2.b	Processing: As a formulation component	P211	Rheological Modifiers	U022	Plasticizers	Chemical substances used in plastics, cement, concrete, wallboard, clay bodies, or other materials to increase their plasticity or fluidity. Examples include phthalates, trimellitates, adipates, maleates, and lignosulphonates.
3.2.b	Processing: As a formulation component	P211	Rheological Modifiers	U032	Viscosity adjustors	Chemical substances used to alter the viscosity of another substance. Examples include VI improvers, pour point depressants, and thickeners.
3.2.b	Processing: As a formulation component	P299	Other	U003	Adsorbents and absorbents	Chemical substances used to retain other substances by accumulation on their surface or by assimilation. Examples of adsorbents include silica gel, activated alumina, and activated carbon. Examples of absorbents include straw oil, alkaline solutions, and kerosene.
3.2.b	Processing: As a formulation component	P299	Other	U016	Ion exchange agents	Chemical substances, usually in the form of a solid matrix, are used to selectively remove targeted ions from a solution. Examples generally consist of an inert hydrophobic matrix such as styrene divinylbenzene or phenol-formaldehyde, cross-linking polymer such as divinylbenzene, and ionic functional groups including sulfonic, carboxylic or phosphonic acids. This code also includes aluminosilicate zeolites.
3.2.b	Processing: As a formulation component	P299	Other	U018	Odor agents	Chemical substances used to control odors, remove odors, mask odors, or impart odors. Examples include benzenoids, terpenes and terpenoids, musk chemicals, aliphatic aldehydes, aliphatic cyanides, and mercaptans.
3.2.b	Processing: As a formulation component	P299	Other	U019	Oxidizing/ reducing agent	Chemical substances used to alter the valence state of another substance by donating or accepting electrons or by the addition or removal of hydrogen to a substance. Examples of oxidizing agents include nitric acid, perchlorates, hexavalent chromium compounds, and peroxydisulfuric acid

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						salts. Examples of reducing agents include hydrazine, sodium thiosulfate, and coke produced from coal.
3.2.b	Processing: As a formulation component	P299	Other	U020	Photosensitive chemicals	Chemical substances used for their ability to alter their physical or chemical structure through absorption of light, resulting in the emission of light, dissociation, discoloration, or other chemical reactions. Examples include sensitizers, fluorescents, photovoltaic agents, ultraviolet absorbers, and ultraviolet stabilizers.
3.2.b	Processing: As a formulation component	P299	Other	U027	Propellants and blowing agents	Chemical substances used to dissolve or suspend other substances and either to expel those substances from a container in the form of an aerosol or to impart a cellular structure to plastics, rubber, or 177hermos set resins. Examples include compressed gasses and liquids and substances which release ammonia, carbon dioxide, or nitrogen.
3.2.b	Processing: As a formulation component	P299	Other	U028	Solid separation agents	Chemical substances used to promote the separation of suspended solids from a liquid. Examples include flotation aids, flocculants, coagulants, dewatering aids, and drainage aids.
3.2.b	Processing: As a formulation component	P299	Other	U999	Other (specify)	Chemical substances used in a way other than those described by other codes.
3.2.c	Processing: As an article component	N/A	N/A	PA	Processing-incorporation into article	Chemical substance becomes an integral component of an article distributed for industrial, trade, or consumer use.
3.2.c	Processing: As an article component	N/A	N/A	U008	Dyes	Chemical substances used to impart color to other materials or mixtures (*i.e.*, substrates) by penetrating the surface of the substrate. Example types include azo, anthraquinone, amino azo, aniline, eosin, stilbene, acid, basic or cationic, reactive, dispersive, and natural dyes.
3.2.c	Processing: As an article component	N/A	N/A	U009	Fillers	Chemical substances used to provide bulk, increase strength, increase hardness, or improve resistance to impact. Fillers incorporated in a

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						matrix reduce production costs by minimizing the amount of more expensive substances used in the production of articles. Examples include calcium carbonate, barium sulfate, silicates, clays, zinc oxide and aluminum oxide.
3.2.c	Processing: As an article component	N/A	N/A	U021	Pigments	Chemical substances used to impart color to other materials or mixtures (*i.e.*, substrates) by attaching themselves to the surface of the substrate through binding or adhesion. This code includes fluorescent agents, luminescent agents, whitening agents, pearlizing agents, and opacifiers. Examples include metallic oxides of iron, titanium, zinc, cobalt, and chromium; metal powder suspensions; lead chromates; vegetable and animal products; and synthetic organic pigments.
3.2.c	Processing: As an article component	N/A	N/A	U034	Paint additives and coating additives not described by other codes	Chemical substances used in a paint or coating formulation to enhance properties such as water repellence, increased gloss, improved fade resistance, ease of application, foam prevention, etc. Examples of paint additives and coating additives include polyols, amines, vinyl acetate ethylene emulsions, and aliphatic polyisocyanates.
3.2.c	Processing: As an article component	N/A	N/A	U999	Other (specify)	Chemical substances used in a way other than those described by other codes.
3.2.d	Processing: Repackaging	N/A	N/A	PK	Processing-repackaging	Preparation of a chemical substance for distribution in commerce in a different form, state, or quantity. This includes transferring the chemical substance from a bulk container into smaller containers. This definition does not apply to sites that only relabel or redistribute the reportable chemical substance without removing the chemical substance from the container in which it is received or purchased.

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3.2.e	Processing: As an impurity	N/A	N/A	N/A	N/A	N/A
3.2.f	Processing: Recycling	N/A	N/A	N/A	N/A	N/A
3.3.a	Otherwise Use: As a chemical processing aid	N/A	N/A	U	Use-non incorporative Activities	Chemical substance is otherwise used (*e.g.*, as a chemical processing or manufacturing aid).
3.3.a	Otherwise Use: As a chemical processing aid	Z101	Process Solvents	U029	Solvents (for cleaning or degreasing)	Chemical substances used to dissolve oils, greases, and similar materials from textiles, glassware, metal surfaces, and other articles. Examples include trichloroethylene, perchloroethylene, methylene chloride, liquid carbon dioxide, and n-propyl bromide.
3.3.a	Otherwise Use: As a chemical processing aid	Z102	Catalysts	U020	Photosensitive chemicals	Chemical substances used for their ability to alter their physical or chemical structure through absorption of light, resulting in the emission of light, dissociation, discoloration, or other chemical reactions. Examples include sensitizers, fluorescents, photovoltaic agents, ultraviolet absorbers, and ultraviolet stabilizers.
3.3.a	Otherwise Use: As a chemical processing aid	Z102	Catalysts	U025	Processing aids, specific to petroleum production	Chemical substances added to water-, oil-, or synthetic drilling muds or other petroleum production fluids to control viscosity, foaming, corrosion, alkalinity and pH, microbiological growth, hydrate formation, etc., during the production of oil, gas, and other products from beneath the earth's surface.
3.3.a	Otherwise Use: As a chemical processing aid	Z102	Catalysts	U026	Processing aids, not otherwise listed	Chemical substances used to improve the processing characteristics or the operation of process equipment or to alter or buffer the pH of the substance or mixture, when added to a process or to a substance or mixture to be processed. Processing agents do not become a part of the reaction product and are not intended to affect the function of a substance or article created. Examples include buffers,

TRI Section	TRI Description	TRI Sub-use Code	TRI Sub-use Code Name	2016 CDR Code	2016 CDR Code Name	2016 CDR Functional Use Definition
						dehumidifiers, dehydrating agents, sequestering agents, and chelators.
3.3.a	Otherwise Use: As a chemical processing aid	Z103	Inhibitors	U024	Process regulators	Chemical substances used to change the rate of a chemical reaction, start or stop the reaction, or otherwise influence the course of the reaction. Process regulators may be consumed or become part of the reaction product.
3.3.a	Otherwise Use: As a chemical processing aid	Z103	Inhibitors	U025	Processing aids, specific to petroleum production	Chemical substances added to water-, oil-, or synthetic drilling muds or other petroleum production fluids to control viscosity, foaming, corrosion, alkalinity and pH, microbiological growth, hydrate formation, etc., during the production of oil, gas, and other products from beneath the earth's surface.
3.3.a	Otherwise Use: As a chemical processing aid	Z103	Inhibitors	U026	Processing aids, not otherwise listed	Chemical substances used to improve the processing characteristics or the operation of process equipment or to alter or buffer the pH of the substance or mixture, when added to a process or to a substance or mixture to be processed. Processing agents do not become a part of the reaction product and are not intended to affect the function of a substance or article created. Examples include buffers, dehumidifiers, dehydrating agents, sequestering agents, and chelators.
3.3.a	Otherwise Use: As a chemical processing aid	Z104	Initiators	U024	Process regulators	Chemical substances used to change the rate of a chemical reaction, start, or stop the reaction, or otherwise influence the course of the reaction. Process regulators may be consumed or become part of the reaction product.
3.3.a	Otherwise Use: As a chemical processing aid	Z104	Initiators	U025	Processing aids, specific to petroleum production	Chemical substances added to water-, oil-, or synthetic drilling muds or other petroleum production fluids to control viscosity, foaming, corrosion, alkalinity and pH, microbiological growth, hydrate formation, etc., during the production of oil, gas, and other products from beneath the earth's surface.
3.3.a	Otherwise Use: As a	Z104	Initiators	U026	Processing aids, not	Chemical substances used to improve the processing characteristics or the

TRI Section	TRI Description	TRI Sub-use Code	TRI Sub-use Code Name	2016 CDR Code	2016 CDR Code Name	2016 CDR Functional Use Definition
	chemical processing aid				otherwise listed	operation of process equipment or to alter or buffer the pH of the substance or mixture, when added to a process or to a substance or mixture to be processed. Processing agents do not become a part of the reaction product and are not intended to affect the function of a substance or article created. Examples include buffers, dehumidifiers, dehydrating agents, sequestering agents, and chelators.
3.3.a	Otherwise Use: As a chemical processing aid	Z105	Reaction Terminators	U024	Process regulators	Chemical substances used to change the rate of a chemical reaction, start, or stop the reaction, or otherwise influence the course of the reaction. Process regulators may be consumed or become part of the reaction product.
3.3.a	Otherwise Use: As a chemical processing aid	Z105	Reaction Terminators	U025	Processing aids, specific to petroleum production	Chemical substances added to water-, oil-, or synthetic drilling muds or other petroleum production fluids to control viscosity, foaming, corrosion, alkalinity and pH, microbiological growth, hydrate formation, etc., during the production of oil, gas, and other products from beneath the earth's surface.
3.3.a	Otherwise Use: As a chemical processing aid	Z105	Reaction Terminators	U026	Processing aids, not otherwise listed	Chemical substances used to improve the processing characteristics or the operation of process equipment or to alter or buffer the pH of the substance or mixture, when added to a process or to a substance or mixture to be processed. Processing agents do not become a part of the reaction product and are not intended to affect the function of a substance or article created. Examples include buffers, dehumidifiers, dehydrating agents, sequestering agents, and chelators.
3.3.a	Otherwise Use: As a chemical processing aid	Z106	Solution Buffers	U026	Processing aids, not otherwise listed	Chemical substances used to improve the processing characteristics or the operation of process equipment or to alter or buffer the pH of the substance or mixture, when added to a process or to a substance or mixture to be processed. Processing agents do not become a part of the reaction product and are not intended to affect the

TRI Section	TRI Description	TRI Sub-use Code	TRI Sub-use Code Name	2016 CDR Code	2016 CDR Code Name	2016 CDR Functional Use Definition
						function of a substance or article created. Examples include buffers, dehumidifiers, dehydrating agents, sequestering agents, and chelators.
3.3.a	Otherwise Use: As a chemical processing aid	Z199	Other	U002	Adhesives and sealant chemicals	Chemical substances used to promote bonding between other substances, promote adhesion of surfaces, or prevent seepage of moisture or air. Examples include epoxides, isocyanates, acrylamides, phenol, urea, melamine, and formaldehyde.
3.3.a	Otherwise Use: As a chemical processing aid	Z199	Other	U006	Bleaching agents	Chemical substances used to lighten or whiten a substrate through chemical reaction, usually an oxidative process which degrades the color system. Examples generally fall into one of two groups: chlorine containing bleaching agents (*e.g.*, chlorine, hypochlorite, N-chloro compounds and chlorine dioxide); and, peroxygen bleaching agents (*e.g.*, hydrogen peroxide, potassium permanganate, and sodium perborate).
3.3.a	Otherwise Use: As a chemical processing aid	Z199	Other	U018	Odor agents	Chemical substances used to control odors, remove odors, mask odors, or impart odors. Examples include benzenoids, terpenes and terpenoids, musk chemicals, aliphatic aldehydes, aliphatic cyanides, and mercaptans.
3.3.a	Otherwise Use: As a chemical processing aid	Z199	Other	U023	Plating agents and surface treating agents	Chemical substances applied to metal, plastic, or other surfaces to alter physical or chemical properties of the surface. Examples include metal surface treating agents, strippers, etchants, rust and tarnish removers, and descaling agents.
3.3.a	Otherwise Use: As a chemical processing aid	Z199	Other	U025	Processing aids, specific to petroleum production	Chemical substances added to water-, oil-, or synthetic drilling muds or other petroleum production fluids to control viscosity, foaming, corrosion, alkalinity and pH, microbiological growth, hydrate formation, etc., during the production of oil, gas, and other products from beneath the earth’s surface.
3.3.a	Otherwise Use: As a	Z199	Other	U026	Processing aids, not	Chemical substances used to improve the processing characteristics or the

TRI Section	TRI Description	TRI Sub-use Code	TRI Sub-use Code Name	2016 CDR Code	2016 CDR Code Name	2016 CDR Functional Use Definition
	chemical processing aid				otherwise listed	operation of process equipment or to alter or buffer the pH of the substance or mixture, when added to a process or to a substance or mixture to be processed. Processing agents do not become a part of the reaction product and are not intended to affect the function of a substance or article created. Examples include buffers, dehumidifiers, dehydrating agents, sequestering agents, and chelators.
3.3.a	Otherwise Use: As a chemical processing aid	Z199	Other	U028	Solid separation agents	Chemical substances used to promote the separation of suspended solids from a liquid. Examples include flotation aids, flocculants, coagulants, dewatering aids, and drainage aids.
3.3.b	Otherwise Use: As a manufacturing aid	N/A	N/A	U	Use−non incorporative Activities	Chemical substance is otherwise used (*e.g.*, as a chemical processing or manufacturing aid).
3.3.b	Otherwise Use: As a manufacturing aid	Z201	Process Lubricants	U017	Lubricants and lubricant additives	Chemical substances used to reduce friction, heat, or wear between moving parts or adjacent solid surfaces, or that enhance the lubricity of other substances. Examples of lubricants include mineral oils, silicate and phosphate esters, silicone oil, greases, and solid film lubricants such as graphite and PTFE. Examples of lubricant additives include molybdenum disulphide and tungsten disulphide.
3.3.b	Otherwise Use: As a manufacturing aid	Z202	Metalworking Fluids	U007	Corrosion inhibitors and antiscaling agents	Chemical substances used to prevent or retard corrosion or the formation of scale. Examples include phenylenediamine, chromates, nitrates, phosphates, and hydrazine.
3.3.b	Otherwise Use: As a manufacturing aid	Z202	Metalworking Fluids	U014	Functional fluids (open systems)	Liquid or gaseous chemical substances used for one or more operational properties in an open system. Examples include antifreezes and de−icing fluids such as ethylene and propylene glycol, sodium formate, potassium acetate, and sodium acetate. This code also includes substances incorporated into metal working fluids.

TRI Section	TRI Description	TRI Sub-use Code	TRI Sub-use Code Name	2016 CDR Code	2016 CDR Code Name	2016 CDR Functional Use Definition
3.3.b	Otherwise Use: As a manufacturing aid	Z203	Coolants	U013	Functional fluids (closed systems)	Liquid or gaseous chemical substances used for one or more operational properties in a closed system. Examples include heat transfer agents (*e.g.*, coolants and refrigerants) such as polyalkylene glycols, silicone oils, liquified propane, and carbon dioxide; hydraulic/transmission fluids such as mineral oils, organophosphate esters, silicone, and propylene glycol; and dielectric fluids such as mineral insulating oil and high flash point kerosene. This code does not include fluids used as lubricants.
3.3.b	Otherwise Use: As a manufacturing aid	Z204	Refrigerants	U013	Functional fluids (closed systems)	Liquid or gaseous chemical substances used for one or more operational properties in a closed system. Examples include heat transfer agents (*e.g.*, coolants and refrigerants) such as polyalkylene glycols, silicone oils, liquified propane, and carbon dioxide; hydraulic/transmission fluids such as mineral oils, organophosphate esters, silicone, and propylene glycol; and dielectric fluids such as mineral insulating oil and high flash point kerosene. This code does not include fluids used as lubricants.
3.3.b	Otherwise Use: As a manufacturing aid	Z205	Hydraulic Fluids	U013	Functional fluids (closed systems)	Liquid or gaseous chemical substances used for one or more operational properties in a closed system. Examples include heat transfer agents (*e.g.*, coolants and refrigerants) such as polyalkylene glycols, silicone oils, liquified propane, and carbon dioxide; hydraulic/transmission fluids such as mineral oils, organophosphate esters, silicone, and propylene glycol; and dielectric fluids such as mineral insulating oil and high flash point kerosene. This code does not include fluids used as lubricants.
3.3.b	Otherwise Use: As a manufacturing aid	Z299	Other	U013	Functional fluids (closed systems)	Liquid or gaseous chemical substances used for one or more operational properties in a closed system. Examples include heat transfer agents (*e.g.*, coolants and refrigerants) such as polyalkylene glycols, silicone oils,

TRI Section	TRI Description	TRI Sub-use Code	TRI Sub-use Code Name	2016 CDR Code	2016 CDR Code Name	2016 CDR Functional Use Definition
						liquified propane, and carbon dioxide; hydraulic/transmission fluids such as mineral oils, organophosphate esters, silicone, and propylene glycol; and dielectric fluids such as mineral insulating oil and high flash point kerosene. This code does not include fluids used as lubricants.
3.3.b	Otherwise Use: As a manufacturing aid	Z299	Other	U023	Plating agents and surface treating agents	Chemical substances applied to metal, plastic, or other surfaces to alter physical or chemical properties of the surface. Examples include metal surface treating agents, strippers, etchants, rust and tarnish removers, and descaling agents.
3.3.c	Otherwise Use: Ancillary or other use	N/A	N/A	U	Use−non incorporative Activities	Chemical substance is otherwise used (*e.g.*, as a chemical processing or manufacturing aid).
3.3.c	Otherwise Use: Ancillary or other use	Z301	Cleaner	U007	Corrosion inhibitors and antiscaling agents	Chemical substances used to prevent or retard corrosion or the formation of scale. Examples include phenylenediamine, chromates, nitrates, phosphates, and hydrazine.
3.3.c	Otherwise Use: Ancillary or other use	Z301	Cleaner	U029	Solvents (for cleaning or degreasing)	Chemical substances used to dissolve oils, greases, and similar materials from textiles, glassware, metal surfaces, and other articles. Examples include trichloroethylene, perchloroethylene, methylene chloride, liquid carbon dioxide, and n-propyl bromide.
3.3.c	Otherwise Use: Ancillary or other use	Z302	Degreaser	U003	Adsorbents and Absorbents	Chemical substances used to retain other substances by accumulation on their surface or by assimilation. Examples of adsorbents include silica gel, activated alumina, and activated carbon. Examples of absorbents include straw oil, alkaline solutions, and kerosene.
3.3.c	Otherwise Use: Ancillary or other use	Z302	Degreaser	U029	Solvents (for cleaning or degreasing)	Chemical substances used to dissolve oils, greases, and similar materials from textiles, glassware, metal surfaces, and other articles. Examples include trichloroethylene, perchloroethylene, methylene

TRI Section	TRI Description	TRI Sub-use Code	TRI Sub-use Code Name	2016 CDR Code	2016 CDR Code Name	2016 CDR Functional Use Definition
						chloride, liquid carbon dioxide, and n-propyl bromide.
3.3.c	Otherwise Use: Ancillary or other use	Z303	Lubricant	U017	Lubricants and lubricant additives	Chemical substances used to reduce friction, heat, or wear between moving parts or adjacent solid surfaces, or that enhance the lubricity of other substances. Examples of lubricants include mineral oils, silicate and phosphate esters, silicone oil, greases, and solid film lubricants such as graphite and PTFE. Examples of lubricant additives include molybdenum disulphide and tungsten disulphide.
3.3.c	Otherwise Use: Ancillary or other use	Z304	Fuel	U012	Fuels and fuel additives	Chemical substances used to create mechanical or thermal energy through chemical reactions, or which are added to a fuel for the purpose of controlling the rate of reaction or limiting the production of undesirable combustion products, or which provide other benefits such as corrosion inhibition, lubrication, or detergency. Examples of fuels include coal, oil, gasoline, and various grades of diesel fuel. Examples of fuel additives include oxygenated compound such as ethers and alcohols, antioxidants such as phenylenediamines and hindered phenols, corrosion inhibitors such as carboxylic acids, amines, and amine salts, and blending agents such as ethanol.
3.3.c	Otherwise Use: Ancillary or other use	Z305	Flame Retardant	U011	Flame retardants	Chemical substances used on the surface of or incorporated into combustible materials to reduce or eliminate their tendency to ignite when exposed to heat or a flame for a short period of time. Examples include inorganic salts, chlorinated, or brominated organic compounds, and organic phosphates/phosphonates.
3.3.c	Otherwise Use: Ancillary or other use	Z306	Waste Treatment	U006	Bleaching agents	Chemical substances used to lighten or whiten a substrate through chemical reaction, usually an oxidative process which degrades the color system. Examples generally fall into one of

TRI Section	TRI Description	TRI Sub-use Code	TRI Sub-use Code Name	2016 CDR Code	2016 CDR Code Name	2016 CDR Functional Use Definition
						two groups: chlorine containing bleaching agents (*e.g.*, chlorine, hypochlorites, N-chloro compounds and chlorine dioxide); and peroxygen bleaching agents (*e.g.*, hydrogen peroxide, potassium permanganate, and sodium perborate).
3.3.c	Otherwise Use: Ancillary or other use	Z306	Waste Treatment	U018	Odor agents	Chemical substances used to control odors, remove odors, mask odors, or impart odors. Examples include benzenoids, terpenes and terpenoids, musk chemicals, aliphatic aldehydes, aliphatic cyanides, and mercaptans.
3.3.c	Otherwise Use: Ancillary or other use	Z306	Waste Treatment	U019	Oxidizing/reducing agent	Chemical substances used to alter the valence state of another substance by donating or accepting electrons or by the addition or removal of hydrogen to a substance. Examples of oxidizing agents include nitric acid, perchlorates, hexavalent chromium compounds, and peroxydisulfuric acid salts. Examples of reducing agents include hydrazine, sodium thiosulfate, and coke produced from coal.
3.3.c	Otherwise Use: Ancillary or other use	Z306	Waste Treatment	U028	Solid separation agents	Chemical substances used to promote the separation of suspended solids from a liquid. Examples include flotation aids, flocculants, coagulants, dewatering aids, and drainage aids.
3.3.c	Otherwise Use: Ancillary or other use	Z307	Water Treatment	U006	Bleaching agents	Chemical substances used to lighten or whiten a substrate through chemical reaction, usually an oxidative process which degrades the color system. Examples generally fall into one of two groups: chlorine containing bleaching agents (*e.g.*, chlorine, hypochlorites, N-chloro compounds and chlorine dioxide); and peroxygen bleaching agents (*e.g.*, hydrogen peroxide, potassium permanganate, and sodium perborate).
3.3.c	Otherwise Use: Ancillary or other use	Z307	Water Treatment	U018	Odor agents	Chemical substances used to control odors, remove odors, mask odors, or impart odors. Examples include benzenoids, terpenes and terpenoids, musk chemicals, aliphatic aldehydes, aliphatic cyanides, and mercaptans.

TRI Section	TRI Description	TRI Sub-use Code	TRI Sub-use Code Name	2016 CDR Code	2016 CDR Code Name	2016 CDR Functional Use Definition
3.3.c	Otherwise Use: Ancillary or other use	Z307	Water Treatment	U019	Oxidizing/reducing agent	Chemical substances used to alter the valence state of another substance by donating or accepting electrons or by the addition or removal of hydrogen to a substance. Examples of oxidizing agents include nitric acid, perchlorates, hexavalent chromium compounds, and peroxydisulfuric acid salts. Examples of reducing agents include hydrazine, sodium thiosulfate, and coke produced from coal.
3.3.c	Otherwise Use: Ancillary or other use	Z307	Water Treatment	U028	Solid separation agents	Chemical substances used to promote the separation of suspended solids from a liquid. Examples include flotation aids, flocculants, coagulants, dewatering aids, and drainage aids.
3.3.c	Otherwise Use: Ancillary or other use	Z308	Construction Materials	N/A	N/A	N/A
3.3.c	Otherwise Use: Ancillary or other use	Z399	Other	U001	Abrasives	Chemical substances used to wear down or polish surfaces by rubbing against the surface. Examples include sandstones, pumice, silex, quartz, silicates, aluminum oxides, and glass.
3.3.c	Otherwise Use: Ancillary or other use	Z399	Other	U013	Functional fluids (closed systems)	Liquid or gaseous chemical substances used for one or more operational properties in a closed system. Examples include heat transfer agents (*e.g.*, coolants and refrigerants) such as polyalkylene glycols, silicone oils, liquified propane, and carbon dioxide; hydraulic/transmission fluids such as mineral oils, organophosphate esters, silicone, and propylene glycol; and dielectric fluids such as mineral insulating oil and high flash point kerosene. This code does not include fluids used as lubricants.
3.3.c	Otherwise Use: Ancillary or other use	Z399	Other	U014	Functional fluids (open systems)	Liquid or gaseous chemical substances used for one or more operational properties in an open system. Examples include antifreezes and de-icing fluids such as ethylene and propylene glycol, sodium formate, potassium acetate, and sodium acetate. This code also includes substances

TRI Section	TRI Description	TRI Sub-use Code	TRI Sub-use Code Name	2016 CDR Code	2016 CDR Code Name	2016 CDR Functional Use Definition
						incorporated into metal working fluids.
3.3.c	Otherwise Use: Ancillary or other use	Z399	Other	U018	Odor agents	Chemical substances used to control odors, remove odors, mask odors, or impart odors. Examples include benzenoids, terpenes and terpenoids, musk chemicals, aliphatic aldehydes, aliphatic cyanides, and mercaptans.
3.3.c	Otherwise Use: Ancillary or other use	Z399	Other	U020	Photosensitive chemicals	Chemical substances used for their ability to alter their physical or chemical structure through absorption of light, resulting in the emission of light, dissociation, discoloration, or other chemical reactions. Examples include sensitizers, fluorescents, photovoltaic agents, ultraviolet absorbers, and ultraviolet stabilizers.
3.3.c	Otherwise Use: Ancillary or other use	Z399	Other	U023	Plating agents and surface treating agents	Chemical substances applied to metal, plastic, or other surfaces to alter physical or chemical properties of the surface. Examples include metal surface treating agents, strippers, etchants, rust and tarnish removers, and descaling agents.

Appendix H ESTIMATING DAILY WASTEWATER DISCHARGES FROM DISCHARGE MONITORING REPORTS AND TOXICS RELEASE INVENTORY DATA

This section provides steps and examples for estimating daily wastewater discharges from industrial and commercial facilities manufacturing, processing, or using chemicals undergoing risk evaluation under the Toxics Substances Control Act (TSCA). Wastewater discharges are reported either via Discharge Monitoring Reports (DMRs) under the National Pollutant Discharge Elimination System (NPDES) or the Toxics Release Inventory (TRI).

Estimation Methods are provided:

- Average Daily Wastewater Discharge Rate (kg/site-day);
- High-End Daily Wastewater Discharge Rate (kg/site-day);
- 1-Day Maximum Wastewater Discharge Rate (kg/site-day); and
- Trends over 5 years for a facility including the Minimum, Maximum and Median wastewater discharge rate that has occurred for a facility within the past 5 years.

These estimates will be used in modeling to estimate surface water concentrations in receiving waters for the assessment of risks to aquatic species and to the general population from drinking water.

H.1 Collecting and Mapping Wastewater Discharge Data to Conditions of Use and Occupational Exposure Scenarios

The first step in estimating daily releases is obtaining and mapping the relevant data to the Conditions of Use (COUs) for the chemical that were identified in the Scoping Document. Some COUs may be broad categories of use and additional steps may be taken in the Risk Evaluation to further define the COUs into more specific Occupational Exposure Scenarios (OES). A methodology for how to do this mapping step has been developed and the key steps are described below.

1. Query the Loading Tool and TRI for each of the past five years, starting with the most recent calendar year for which TRI data are available. In general, when a facility reports under both the NPDES program and TRI, EPA will perform comparisons of the data to determine if any discrepancies exist and, if so, which data are more appropriate to use in the risk evaluation. However, the two data sets are not updated concurrently. The Loading Tool automatically and continuously checks ICIS-NPDES for newly submitted DMRs. The Loading Tool processes the data weekly and calculates pollutant loading estimates; therefore, water discharge data (DMR data) are available on a continual basis. Although the Loading Tool process data weekly, each permitted discharging facility is only required to report their monitoring results for each pollutant at a frequency specified in the permit (*e.g.*, monthly, every two months, quarterly). TRI data is only reported annually for the previous calendar year and is typically released in July (*i.e.*, 2020 TRI data is released in July 2021). To ensure EPA is making an appropriate comparison between the two data sets, EPA should only use data for years where data from both data sets are available.
2. Remove the following DMR facility types from further analysis:
    a. Facilities reporting zero discharges for the chemical of interest for each of the five years queried as EPA cannot confirm if the pollutant is present at the facility.
3. Map each remaining facility to a condition of use (COU) and occupational exposure scenario (OES). The OES will inform estimates of average operating days per year for the facility.

H.2 Estimating the Number of Facility Operating Days per Year

The number of operating days per year (days/year) for each facility that reports wastewater discharges may be available but will most likely be unknow. An approach has been developed for use in Risk Evaluations for estimating the number of facility operating days before and is described below.

1. **<u>Facility-specific data</u>:** Use facility-specific data if available. If facility-specific data is not available, estimate the days/year using one of the following approaches:
    a. If facilities have known or estimated average daily use rates, calculate the days/year as: Days/year = Estimated Annual Use Rate for the Site (kg/year) / average daily use rate from sites with available data (kg/day).
    b. If sites with days/year data do not have known or estimate average daily use rates, use the average number of days/year from the sites with such data.
2. **<u>Industry-specific data</u>:** Industry-specific data may be available in the form of generic scenarios (GSs), emission scenario documents (ESDs), trade publications, or other relevant literature. In such cases, these estimates should take precedent over other approaches, unless facility-specific data are available.
3. **<u>Manufacture of large-production volume (PV) commodity chemicals</u>:** For the manufacture of the large-PV commodity chemicals, a value of 350 days/year should be used. This assumes the plant runs 7 day/week and 50 week/year (with two weeks down for turnaround) and assumes that the plant is always producing the chemical.
4. **<u>Manufacture of lower-PV specialty chemicals</u>:** For the manufacture of lower-PV specialty chemicals, it is unlikely the chemical is being manufactured continuously throughout the year. Therefore, a value of 250 days/year should be used. This assumes the plant manufactures the chemical 5 days/week and 50 weeks/year (with 2 weeks down for turnaround).
5. **<u>Processing as reactant (intermediate use) in the manufacture of commodity chemicals</u>:** Similar to #3, the manufacture of commodity chemicals is assumed to occur 350 days/year such that the use of a chemicals as a reactant to manufacture a commodity chemical will also occur 350 days/year.
6. **<u>Processing as reactant (intermediate use) in the manufacture of specialty chemicals</u>:** Similar to #4, the manufacture of specialty chemicals is not likely to occur continuously throughout the year. Therefore, a value of 250 days/year can be used.
7. **<u>Other Chemical Plant OES (*e.g.*, processing into formulation and use of industrial processing aids)</u>:** For these OES, it is reasonable to assume that the chemical of interest is not always in use at the facility, even if the facility operates 24/7. Therefore, in general, a value of 300 days/year can be used based on the "SpERC fact sheet—Formulation & (re)packing of substances and mixtures—Industrial (Solvent-borne)" which uses a default of 300 days/year for the chemical industry. However, in instances where the OES uses a low volume of the chemical of interest, 250 days/year can be used as a lower estimate for the days/year.
8. **<u>POTWs</u>:** Although POTWs are expected to operate continuously over 365 days/year, the discharge frequency of the chemical of interest from a POTW will be dependent on the discharge patterns of the chemical from the upstream facilities discharging to the POTW. The upstream discharge patterns will be addressed in a second-tier analysis. However, there can be multiple upstream facilities (possibly with different OES) discharging to the same POTW and information to determine when the discharges from each facility occur on the same day or separate days is

typically not available. Therefore, an exact number of days/year the chemical of interest is discharged from the POTW cannot be determined and a value of 365 days/year should be used.

9. **<u>All Other OES</u>:** Regardless of what the facility operating schedule is, other OES are unlikely to use the chemical of interest every day. Therefore, a value of 250 days/year should be used for these OES.

H.3 Approach for Estimating Daily Discharges

After the initial steps of selecting and mapping of the water discharge data and estimating the number of facility operating days/yr have been completed, the next steps in the analysis are to make estimates of daily wastewater discharges. This guidance presents approaches for making the following estimates:

- Average daily wastewater discharges: this approach averages out the yearly discharges into an average daily discharge rate for the entire year for the facility.
- High-end daily wastewater discharges: this approach estimates a high-end daily discharge rate that may take place for a period of time during the year for the facility.
- 1-Day maximum discharge rate: this approach estimates a discharge rate that may represent a 1-day maximum rate for the facility.

H.3.1 Average Daily Wastewater Discharges

The following steps should be used to estimate the average daily wastewater discharge for each facility for each year:

1. Obtain total annual loads calculated from the Loading Tool and reported annual surface water discharges in TRI.
2. For facilities with both TRI and DMR data, compare the annual surface water discharges reported to each to see if they agree. If not, select the data representing the highest annual discharge.
3. Divide the annual discharge over the number of estimated operating days for the OES to which the facility has been mapped. The number of operating days will differ for each OES and chemical but typically ranges from 200 to 350 days/year (see Section 2.3.2 for approach to estimating operating days/year).

This approach can be used for both direct discharges to surface water and indirect discharges to POTW or non-POTW WWT. However, special care should be given to facilities reporting transfers to POTW or non-POTW WWT plants in TRI as the subsequent discharge to surface water from these transfers may already be accounted for in the receiving facilities DMRs.

H.3.2 High-End Daily Direct Discharge for Facilities with DMR Data

The following steps should be used to estimate the high-end daily direct discharge for each facility with DMR data for each year:

1. Use the Loading Tool to obtain the reporting periods (*e.g.*, monthly, bimonthly, quarterly, biannually, annually) and required reporting statistics (*e.g.*, average monthly concentration, max daily concentration) for each external outfall at each facility. When there is one outfall reported in the Loading Tool, assume it is an external outfall. If multiple outfalls are reported in the Loading Tool, further investigation to determine the external outfall would be required, such as a review of facility's permits.
2. For each external outfall at each facility, calculate the average daily load for each reporting period by multiplying the period average concentration by the period average wastewater

flowrate. If there is one outfall reported in the Loading Tool, we will assume it is an external outfall. Further investigation is needed if multiple outfalls are reported in the Loading Tool to determine the external outfall, such as a review of the facility's permit.

3. Sum the average daily loads from each external outfall for each period.
4. Select the period with the highest average daily load across all external outfalls as an estimate of the high-end daily discharge assessed over the number of days in the period. The number of days in the reporting period does not necessarily equate to the number of operating days in the reporting period. For example, for a plant that operates 200 days/year, we use 200 rather than 365 days/year for average daily discharge. Therefore, discharges will not occur every day of the reporting period, but only for a fraction: 200/365 = 68%. The number of days of the reporting period should be multiplied by this factor to maintain consistency between operating days/year and operating days/reporting period.

H.3.3 High-End Daily Direct Consecutive Discharge for Facilities without DMRs

Some facilities may report surface water discharges to TRI but are not required to monitor or report those discharges under the NPDES. In such cases, EPA will only have the annual discharge value and not discharge values from multiple periods throughout the year. To estimate the high-end daily direct discharges for these facilities the following steps should be used:

1. Identify facilities that report under the NPDES program for the same chemical, same year, and same OES as the TRI facility and report DMRs monthly. Note: if no monthly reporters exist, reporters with less frequent reporting can be substituted provided the number of release days per year are adjusted in subsequent steps.
2. For each facility identified in #1, calculate the percentage of the total annual discharge that occurred in the highest one-month period.
3. Calculate a generic factor for the OES as the average of the percentages calculated in #2.
4. Estimate the high-end daily discharge for each facility without DMRs by multiplying the annual discharge by the generic factor from #3. For example, a facility reports 500 pounds (lb) released per year and has a generic factor of 15% for the OES from #3. The estimated high-end chronic daily discharge for the facility would be: 500 lb × 15% = 75 lb/month.
5. Use the value calculated in #4 as an estimate of the high-end daily discharge assessed over 30 days per year. For example, the high-end daily discharge assessed over 30 days per year for the facility with the estimated high-end chronic daily discharge of 75 lb/month (from #4 above) is: 75 lb/month / 30 days = 2.5 lb/day for 30 days.

This approach can also be applied to facilities that have less frequent reporting periods under the NPDES program (*e.g.*, facilities that report quarterly or biannually). Use the facility specific permit data for less frequent reporting periods. Refer to Section H.5: Example Facilities for additional details.

H.3.4 High-End Daily Indirect Discharges

In general, EPA is unlikely to have detailed information to estimate high-end daily indirect discharges to POTWs or non-POTW WWT and will only be able to calculate average daily discharges. However, in some cases, EPA may have site-specific information that allows for the estimation of a range for the release days per year (for example such information can be find in ECHO). In such instances, EPA can calculate the high-end daily discharge as the annual discharge divided by the minimum number of release days per year.

H.3.5 1-Day Discharges

Facilities required to report under the NPDES may sometimes be required to report a daily maximum discharge concentration for the period. These values can be used to estimate 1-day discharges by multiplying the maximum daily concentration by the corresponding month's maximum daily wastewater flow rate.

H.4 Trends in Wastewater Discharge Data: 5 Year Data Characterization

Wastewater discharge data may vary from year to year for a facility due to factors including the economy. A trend of the releases from each facility can be used to characterize results and develop a range of potential discharges from each site. A 5-year period will be used for this analysis. Prior to calculating the five-year statistics, it is recommended that an evaluation be done of whether the 5-year range includes any outlier years and remove them from the analysis to ensure no atypical years are being included in the statistics. The interquartile rule for outliers can be used for this analysis.

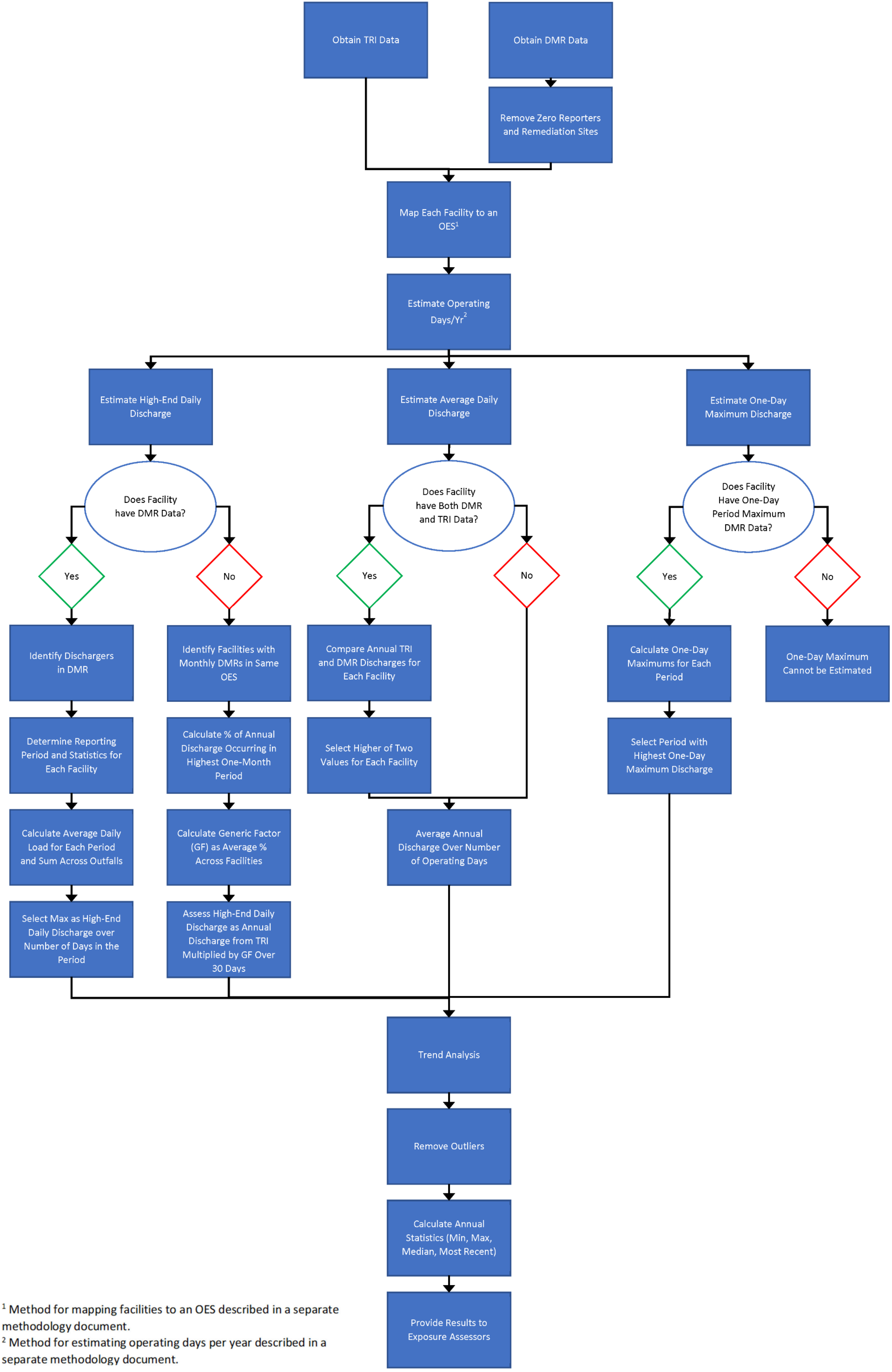
The interquartile rule for outliers states that if the distance between a data point and the first or third quartile is greater than 1.5 times the interquartile range (IQR), the data point is an outlier. The IQR is the difference between the third quartile (*i.e.*, 75th percentile) and first quartile (*i.e.*, 25th percentile) of a data set. Therefore, any values <25th percentile − 1.5IQR or values >75th percentile + 1.5IQR would be considered outliers.

After any outliers are removed, the following five-year statistics should be determined for each facility:

1. Minimum, maximum, median, and most recent (if different than the maximum) annual discharge.
2. Minimum, maximum, median, and most recent (if different than the maximum) average chronic daily discharge.
3. Minimum, maximum, median, and most recent (if different than the maximum) high-end chronic daily discharge; and
4. Minimum, maximum, median, and most recent (if different than the maximum) acute 1-day discharge.

H.4.1 Decision Tree for DMR and TRI Wastewater Discharge Estimates

A *Decision Tree for Wastewater Discharge Estimates Using TRI and/or DMR Data*, provided as Figure_Apx H-1 below, helps visualize the process for estimating daily discharges.



[1] Method for mapping facilities to an OES described in a separate methodology document.

[2] Method for estimating operating days per year described in a separate methodology document.

Figure_Apx H-1. Decision Tree for Wastewater Discharge Estimates Using TRI and DMR Data

H.5 Example Facilities

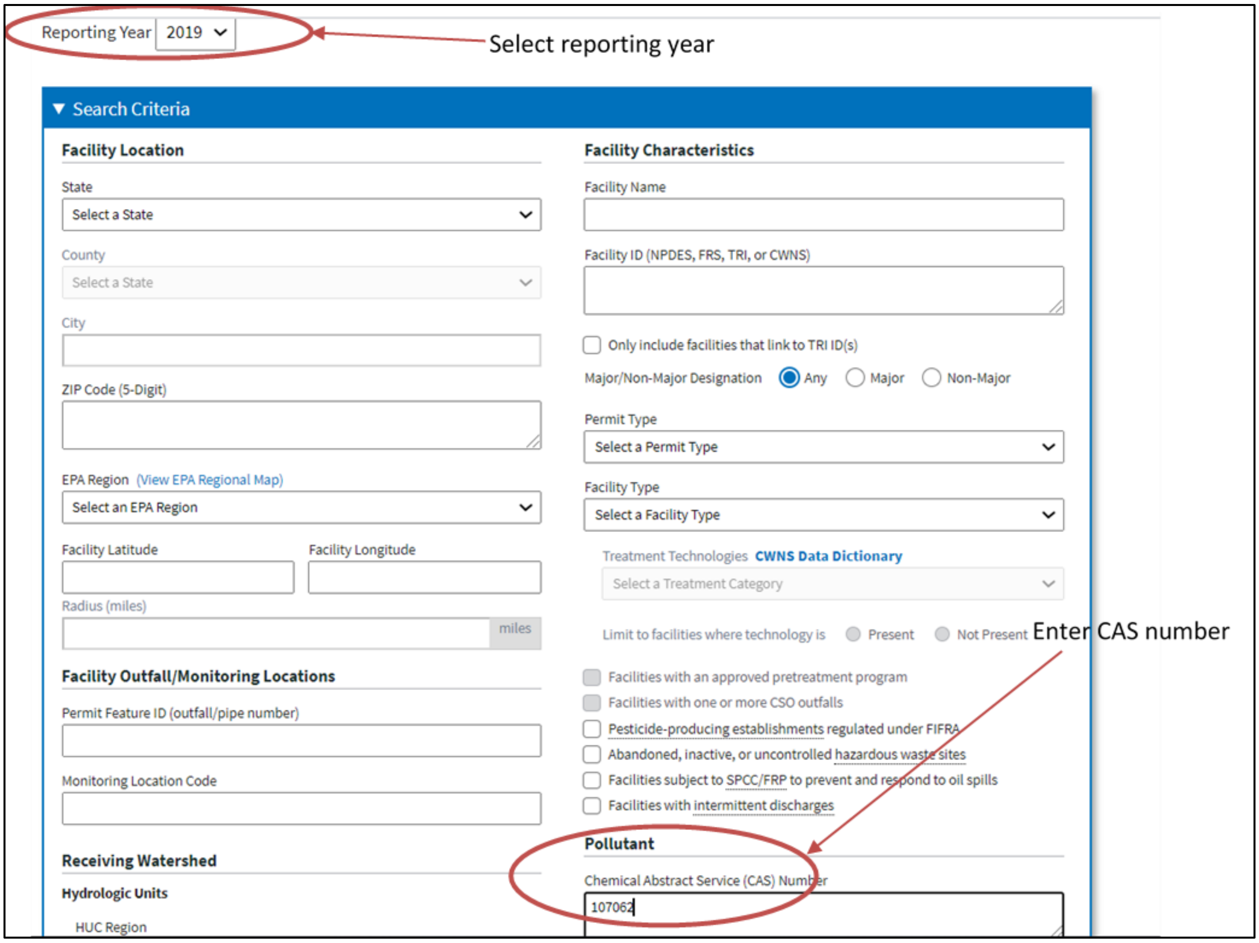
This section illustrates how to calculate both high-end and average daily discharges for situations where a facility has both TRI and DMR data and where a facility only has TRI data. It also includes calculations for 1-day daily discharges from DMR data. The examples provided are for two facilities reporting for the pollutant 1,2-dichloroethane (1,2-dichloroethane):

1. Westlake Vinyls in Calvert City, KY: reports both DMR and TRI; and
2. Axiall LLC in Plaquemine, LA: reports to TRI only.

For purposes of this example, only a single year for each database is presented.

- **Obtaining DMR Data**

DMR data can be obtained through multiple methods; however, this method focuses on a single approach for simplicity. To query the loading tool for all pollutant data, the user should go to the following webpage: https://echo.epa.gov/trends/loading-tool/get-data/custom-search, select the reporting year of interest and then enter a chemical CAS number as shown in Figure_Apx H-2.


Select reporting year

Enter CAS number

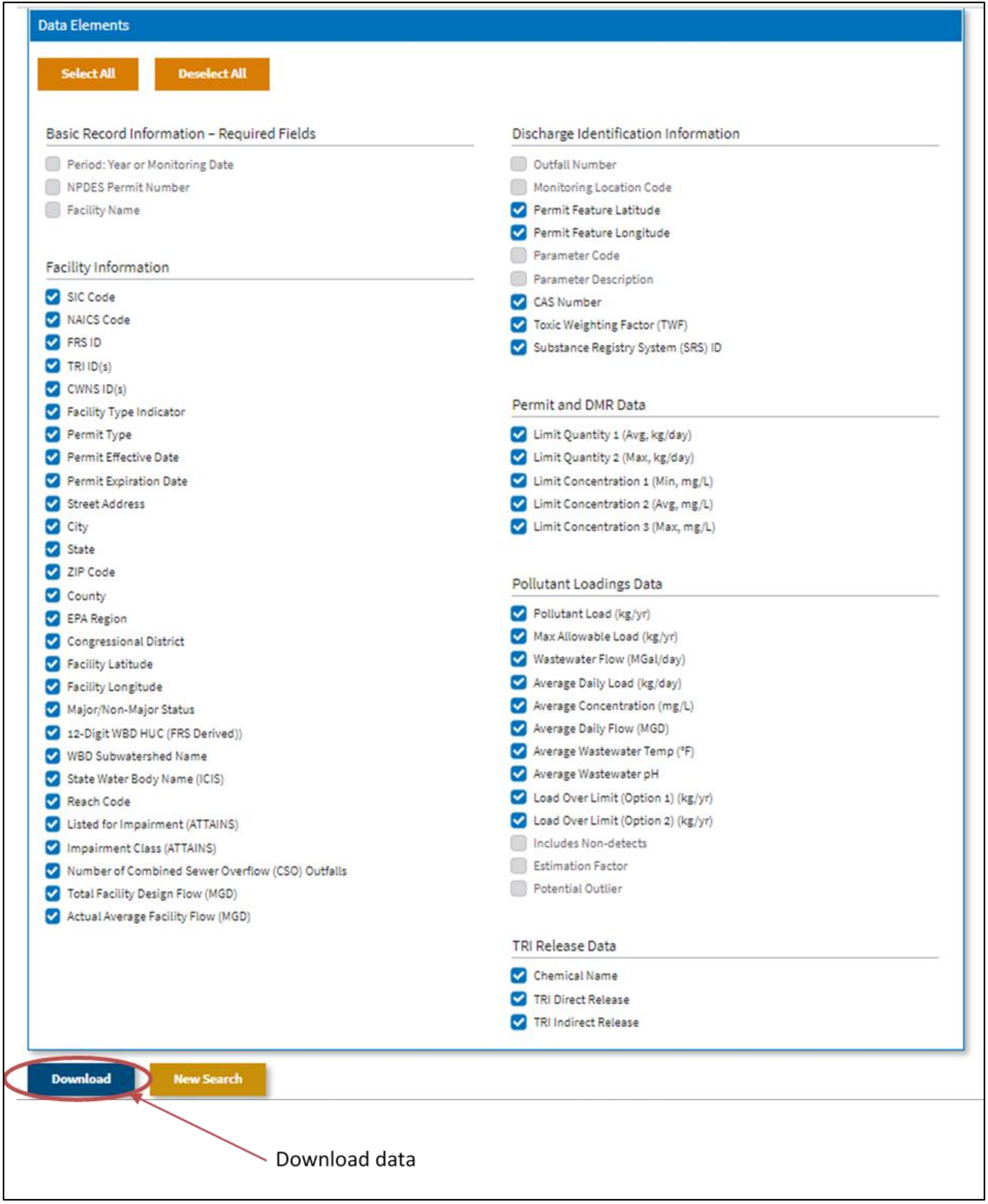
Reporting Year: 2019

Major/Non-Major Designation: ● Any ○ Major ○ Non-Major

Chemical Abstract Service (CAS) Number: 107062

Figure_Apx H-2. Loading Tool – Data Query

After clicking submit, the Loading Tool will present a list of data elements that can be selected or deselected for the query. By default, all data elements will be selected and for this methodology, it is suggested to leave that unchanged to ensure all relevant data fields are downloaded. The user should then click “download”, as shown in Figure_Apx H-3. This will provide an Excel spreadsheet with all the facilities that are required to monitor for the pollutant for the selected year and their annual discharge calculated by the Loading Tool.



Basic Record Information – Required Fields

☐ Period: Year or Monitoring Date
☐ NPDES Permit Number
☐ Facility Name

Facility Information

☑ SIC Code
☑ NAICS Code
☑ FRS ID
☑ TRI ID(s)
☑ CWNS ID(s)
☑ Facility Type Indicator
☑ Permit Type
☑ Permit Effective Date
☑ Permit Expiration Date
☑ Street Address
☑ City
☑ State
☑ ZIP Code
☑ County
☑ EPA Region
☑ Congressional District
☑ Facility Latitude
☑ Facility Longitude
☑ Major/Non-Major Status
☑ 12-Digit WBD HUC (FRS Derived))
☑ WBD Subwatershed Name
☑ State Water Body Name (ICIS)
☑ Reach Code
☑ Listed for Impairment (ATTAINS)
☑ Impairment Class (ATTAINS)
☑ Number of Combined Sewer Overflow (CSO) Outfalls
☑ Total Facility Design Flow (MGD)
☑ Actual Average Facility Flow (MGD)

Discharge Identification Information

☐ Outfall Number
☐ Monitoring Location Code
☑ Permit Feature Latitude
☑ Permit Feature Longitude
☐ Parameter Code
☐ Parameter Description
☑ CAS Number
☑ Toxic Weighting Factor (TWF)
☑ Substance Registry System (SRS) ID

Permit and DMR Data

☑ Limit Quantity 1 (Avg, kg/day)
☑ Limit Quantity 2 (Max, kg/day)
☑ Limit Concentration 1 (Min, mg/L)
☑ Limit Concentration 2 (Avg, mg/L)
☑ Limit Concentration 3 (Max, mg/L)

Pollutant Loadings Data

☑ Pollutant Load (kg/yr)
☑ Max Allowable Load (kg/yr)
☑ Wastewater Flow (MGal/day)
☑ Average Daily Load (kg/day)
☑ Average Concentration (mg/L)
☑ Average Daily Flow (MGD)
☑ Average Wastewater Temp (°F)
☑ Average Wastewater pH
☑ Load Over Limit (Option 1) (kg/yr)
☑ Load Over Limit (Option 2) (kg/yr)
☐ Includes Non-detects
☐ Estimation Factor
☐ Potential Outlier

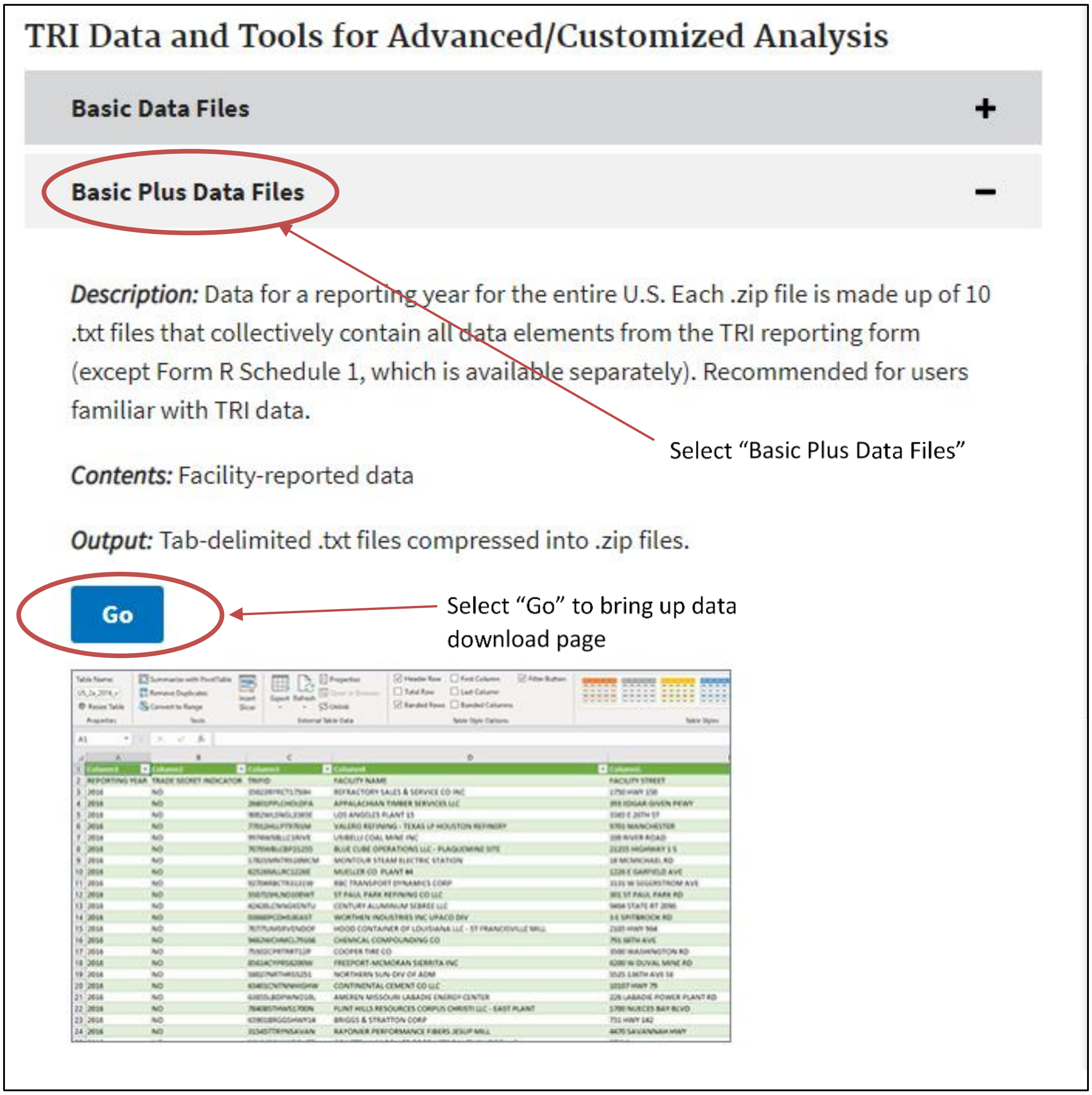
TRI Release Data

☑ Chemical Name
☑ TRI Direct Release
☑ TRI Indirect Release

Figure_Apx H-3. Loading Tool – Download Facility Discharges from Query Results

- **Obtaining TRI Data**

TRI data is available in several formats with various levels of detail depending on the type of information a user intends to use. For this analysis, the “Basic Plus Data Files” were used. This data can be obtained by going to the following website: https://www.epa.gov/toxics-release-inventory-tri-program/tri-data-and-tools, selecting “Basic Plus Data Files”, then “Go” as shown in Figure_Apx H-4.



TRI Data and Tools for Advanced/Customized Analysis

Basic Data Files +

Basic Plus Data Files −

Description: Data for a reporting year for the entire U.S. Each .zip file is made up of 10 .txt files that collectively contain all data elements from the TRI reporting form (except Form R Schedule 1, which is available separately). Recommended for users familiar with TRI data.

Contents: Facility-reported data

Output: Tab-delimited .txt files compressed into .zip files.

Go

Select “Basic Plus Data Files”

Select “Go” to bring up data download page

Figure_Apx H-4. Accessing Basic Plus Data Files[a]

[a] Guides for accessing, downloading, and importing the Basic Plus Data files can be found on [EPA’s website]().

The subsequent webpage can then be used to select the reporting year of interest and download the data files as shown in Figure_Apx H-5. This will provide a zip file containing multiple tab-delimited .txt files, which can be imported into Excel Spreadsheets and contain all the 2019 TRI data for all chemicals, including annual direct and indirect wastewater discharges. The files can then be filtered for the chemical of interest and facilities with non-zero discharges.[18] Table_Apx H-1 provides a list of key data fields and which Basic Plus data file they can be obtained from.

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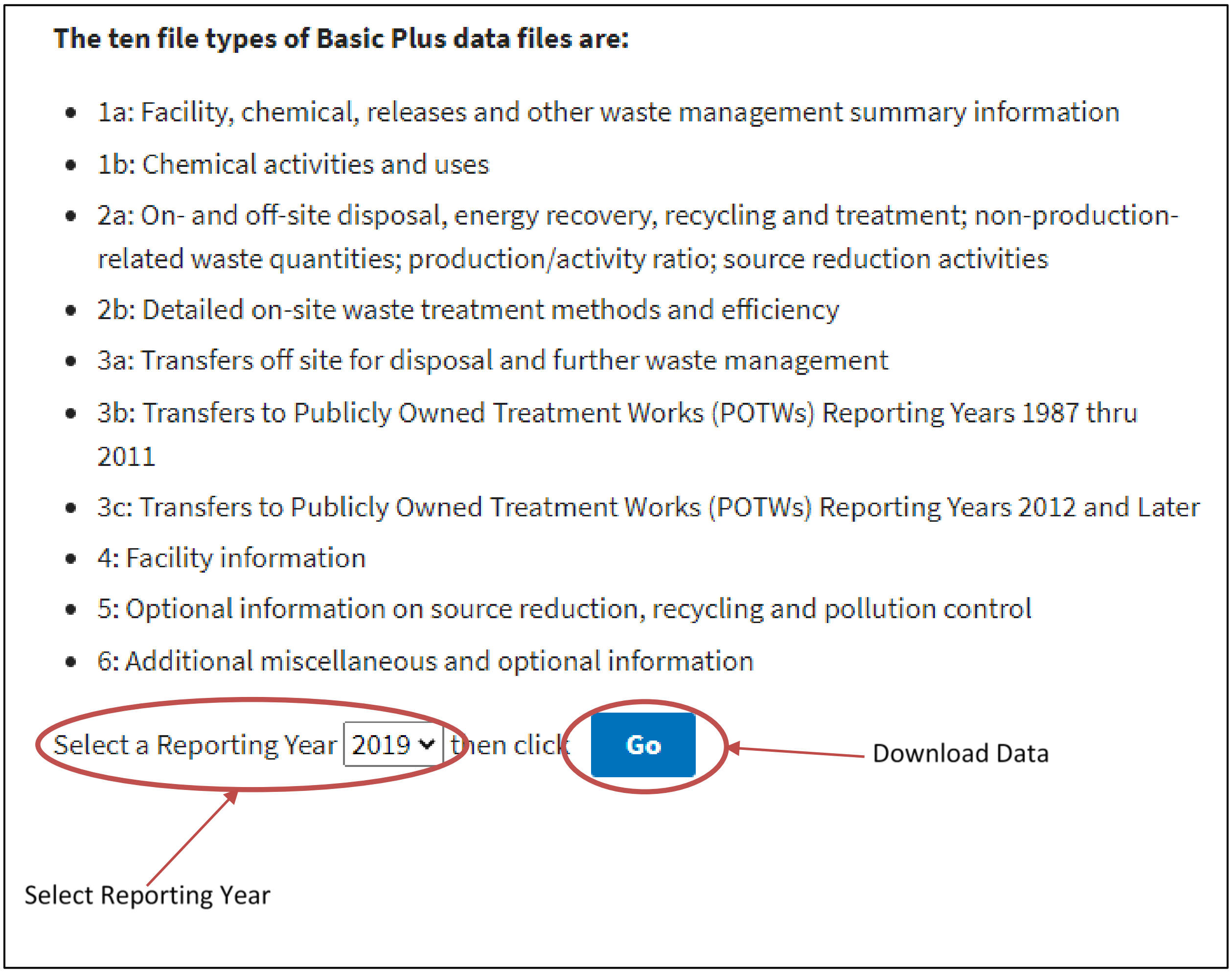
[18] Facilities using a Form A rather than a Form R to report to TRI do not report any release information; therefore, the wastewater discharges for these facilities will be shown as “0” in the TRI data files. However, these may not be true zero discharges. Discharges from these facilities may need to be estimated separately and is outside the scope of this document.



The ten file types of Basic Plus data files are:

- 1a: Facility, chemical, releases and other waste management summary information
- 1b: Chemical activities and uses
- 2a: On- and off-site disposal, energy recovery, recycling and treatment; non-production-related waste quantities; production/activity ratio; source reduction activities
- 2b: Detailed on-site waste treatment methods and efficiency
- 3a: Transfers off site for disposal and further waste management
- 3b: Transfers to Publicly Owned Treatment Works (POTWs) Reporting Years 1987 thru 2011
- 3c: Transfers to Publicly Owned Treatment Works (POTWs) Reporting Years 2012 and Later
- 4: Facility information
- 5: Optional information on source reduction, recycling and pollution control
- 6: Additional miscellaneous and optional information

Select a Reporting Year 2019 then click Go

Download Data

Select Reporting Year

Figure_Apx H-5. TRI – Downloading Basic Data Plus Files

Table_Apx H-1. List of Key Data Fields from TRI Basic Plus Data

TRI Basic Plus Data File	Field Name
US_1a_[Year]	1. FORM TYPE
US_1a_[Year]	2. REPORTING YEAR
US_1a_[Year]	9. TRIFD
US_1a_[Year]	10. FACILITY NAME
US_1a_[Year]	11. FACILITY STREET
US_1a_[Year]	12. FACILITY CITY
US_1a_[Year]	13. FACILITY COUNTY
US_1a_[Year]	14. FACILITY STATE
US_1a_[Year]	15. FACILITY ZIP CODE
US_1a_[Year]	41. PRIMARY NAICS CODE

TRI Basic Plus Data File	Field Name
US_1a_[Year]	47. LATITUDE
US_1a_[Year]	48. LONGITUDE
US_1a_[Year]	74. FRS FACILITY ID
US_1a_[Year]	76. CAS NUMBER
US_1a_[Year]	77. CHEMICAL NAME
US_1a_[Year]	81. UNIT OF MEASURE
US_1a_[Year]	112. DISCHARGES TO STREAM A—STREAM NAME
US_1a_[Year]	113. DISCHARGES TO STREAM A—RELEASE POUNDS
US_1a_[Year]	114. DISCHARGES TO STREAM A—RELEASE RANGE CODE
US_1a_[Year]	115. TOTAL DISCHARGES TO STREAM A
US_1a_[Year]	116. DISCHARGES TO STREAM A—BASIS OF ESTIMATE
US_1a_[Year]	117. DISCHARGES TO STREAM A—% FROM STORMWATER
US_1a_[Year]	118. DISCHARGES TO STREAM B—STREAM NAME
US_1a_[Year]	119. DISCHARGES TO STREAM B—RELEASE POUNDS
US_1a_[Year]	120. DISCHARGES TO STREAM B—RELEASE RANGE CODE
US_1a_[Year]	121. TOTAL DISCHARGES TO STREAM B
US_1a_[Year]	122. DISCHARGES TO STREAM B—BASIS OF ESTIMATE
US_1a_[Year]	123. DISCHARGES TO STREAM B—% FROM STORMWATER
US_1a_[Year]	124. DISCHARGES TO STREAM C—STREAM NAME
US_1a_[Year]	125. DISCHARGES TO STREAM C—RELEASE POUNDS
US_1a_[Year]	126. DISCHARGES TO STREAM C—RELEASE RANGE CODE
US_1a_[Year]	127. TOTAL DISCHARGES TO STREAM C
US_1a_[Year]	128. DISCHARGES TO STREAM C—BASIS OF ESTIMATE
US_1a_[Year]	129. DISCHARGES TO STREAM C—% FROM STORMWATER
US_1a_[Year]	130. DISCHARGES TO STREAM D—STREAM NAME
US_1a_[Year]	131. DISCHARGES TO STREAM D—RELEASE POUNDS
US_1a_[Year]	132. DISCHARGES TO STREAM D—RELEASE RANGE CODE
US_1a_[Year]	133. TOTAL DISCHARGES TO STREAM D
US_1a_[Year]	134. DISCHARGES TO STREAM D—BASIS OF ESTIMATE
US_1a_[Year]	135. DISCHARGES TO STREAM D—% FROM STORMWATER
US_1a_[Year]	136. DISCHARGES TO STREAM E—STREAM NAME

TRI Basic Plus Data File	Field Name
US_1a_[Year]	137. DISCHARGES TO STREAM E—RELEASE POUNDS
US_1a_[Year]	138. DISCHARGES TO STREAM E—RELEASE RANGE CODE
US_1a_[Year]	139. TOTAL DISCHARGES TO STREAM E
US_1a_[Year]	140. DISCHARGES TO STREAM E—BASIS OF ESTIMATE
US_1a_[Year]	141. DISCHARGES TO STREAM E—% FROM STORMWATER
US_1a_[Year]	142. DISCHARGES TO STREAM F—STREAM NAME
US_1a_[Year]	143. DISCHARGES TO STREAM F—RELEASE POUNDS
US_1a_[Year]	144. DISCHARGES TO STREAM F—RELEASE RANGE CODE
US_1a_[Year]	145 TOTAL DISCHARGES TO STREAM F
US_1a_[Year]	146 DISCHARGES TO STREAM F—BASIS FOR ESTIMATE
US_1a_[Year]	147. DISCHARGES TO STREAM F—% FROM STORMWATER
US_1a_[Year]	148. DISCHARGES TO STREAM G—STREAM NAME
US_1a_[Year]	149. DISCHARGES TO STREAM G—RELEASE POUNDS
US_1a_[Year]	150. DISCHARGES TO STREAM G—RELEASE RANGE CODE
US_1a_[Year]	151. TOTAL DISCHARGES TO STREAM G
US_1a_[Year]	152. DISCHARGES TO STREAM G—BASIS FOR ESTIMATE
US_1a_[Year]	153. DISCHARGES TO STREAM G—% FROM STORMWATER
US_1a_[Year]	154. DISCHARGES TO STREAM H—STREAM NAME
US_1a_[Year]	155. DISCHARGES TO STREAM H—RELEASE POUNDS
US_1a_[Year]	156. DISCHARGES TO STREAM H—RELEASE RANGE CODE
US_1a_[Year]	157. TOTAL DISCHARGES TO STREAM H
US_1a_[Year]	158. DISCHARGES TO STREAM H—BASIS FOR ESTIMATE
US_1a_[Year]	159. DISCHARGES TO STREAM H—% FROM STORMWATER
US_1a_[Year]	160. DISCHARGES TO STREAM I—STREAM NAME
US_1a_[Year]	161. DISCHARGES TO STREAM I—RELEASE POUNDS
US_1a_[Year]	162. DISCHARGES TO STREAM I—RELEASE RANGE CODE
US_1a_[Year]	163. TOTAL DISCHARGES TO STREAM I
US_1a_[Year]	164. DISCHARGES TO STREAM I—BASIS FOR ESTIMATE
US_1a_[Year]	165. DISCHARGES TO STREAM I—% FROM STORMWATER
US_1a_[Year]	166. TOTAL NUMBER OF RECEIVING STREAMS
US_1a_[Year]	167. TOTAL SURFACE WATER DISCHARGE

TRI Basic Plus Data File	Field Name
US_1a_[Year]	217. OFF SITE—POTW RELEASES 81C
US_1a_[Year]	218. OFF SITE—POTW RELEASES 81D
US_1a_[Year]	219. OFF SITE—POTW RELEASES
US_1a_[Year]	222. OFF-SITE—WASTEWATER TREATMENT RELEASE (EXCLUDING POTWs)—METALS AND METAL COMPOUNDS ONLY
US_1a_[Year]	224. OFF-SITE—WASTEWATER TREATMENT (EXCLUDING POTWS) METALS AND METAL COMPOUNDS ONLY
US_1a_[Year]	249. OFF-SITE—POTW TREATMENT
US_1a_[Year]	253. OFF-SITE—WASTEWATER TREATMENT (EXCLUDING POTWs)—NON-METALS ONLY
US_1a_[Year]	259. TOTAL POTW TRANSFER
US_1b_[Year]	1. FORM TYPE
US_1b_[Year]	2. REPORTING YEAR
US_1b_[Year]	3. TRADE SECRET INDICATOR
US_1b_[Year]	4. SANITIZED INDICATOR
US_1b_[Year]	5. TITLE OF CERTIFYING OFFICIAL
US_1b_[Year]	6. NAME OF CERTIFYING OFFICIAL
US_1b_[Year]	7. CERTIFYING OFFICIAL’S SIGNATURE INDICATOR
US_1b_[Year]	8. DATE SIGNED
US_1b_[Year]	9. TRIFD
US_1b_[Year]	10. FACILITY NAME
US_1b_[Year]	11. FACILITY STREET
US_1b_[Year]	12. FACILITY CITY
US_1b_[Year]	13. FACILITY COUNTY
US_1b_[Year]	14. FACILITY STATE
US_1b_[Year]	15. FACILITY ZIP CODE
US_1b_[Year]	16. BIA CODE
US_1b_[Year]	17. TRIBE NAME
US_1b_[Year]	18. MAILING NAME
US_1b_[Year]	19. MAILING STREET
US_1b_[Year]	20. MAILING CITY
US_1b_[Year]	21. MAILING STATE

TRI Basic Plus Data File	Field Name
US_1b_[Year]	22. MAILING PROVINCE
US_1b_[Year]	23. MAILING ZIP CODE
US_1b_[Year]	24. ENTIRE FACILITY IND
US_1b_[Year]	25. PARTIAL FACILITY IND
US_1b_[Year]	26. FEDERAL FACILITY IND
US_1b_[Year]	27. GOCO FACILITY IND
US_1b_[Year]	28. ASSIGNED FED FACILITY FLAG
US_1b_[Year]	29. ASSIGNED PARTIAL FACILITY FLAG
US_1b_[Year]	30. PUBLIC CONTACT NAME
US_1b_[Year]	31. PUBLIC CONTACT PHONE
US_1b_[Year]	32. PUBLIC CONTACT PHONE EXT
US_1b_[Year]	33. PUBLIC CONTACT EMAIL
US_1b_[Year]	34. PRIMARY SIC CODE
US_1b_[Year]	35. SIC CODE 2
US_1b_[Year]	36. SIC CODE 3
US_1b_[Year]	37. SIC CODE 4
US_1b_[Year]	38. SIC CODE 5
US_1b_[Year]	39. SIC CODE 6
US_1b_[Year]	40. NAICS ORIGIN
US_1b_[Year]	41. PRIMARY NAICS CODE
US_1b_[Year]	42. NAICS CODE 2
US_1b_[Year]	43. NAICS CODE 3
US_1b_[Year]	44. NAICS CODE 4
US_1b_[Year]	45. NAICS CODE 5
US_1b_[Year]	46. NAICS CODE 6
US_1b_[Year]	47. LATITUDE
US_1b_[Year]	48. LONGITUDE
US_1b_[Year]	49. D and B NR A
US_1b_[Year]	50. D and B NR B
US_1b_[Year]	51. RCRA NR A
US_1b_[Year]	52. RCRA NR B

TRI Basic Plus Data File	Field Name
US_1b_[Year]	53. RCRA NR C
US_1b_[Year]	54. RCRA NR D
US_1b_[Year]	55. RCRA NR E
US_1b_[Year]	56. RCRA NR F
US_1b_[Year]	57. RCRA NR G
US_1b_[Year]	58. RCRA NR H
US_1b_[Year]	59. RCRA NR I
US_1b_[Year]	60. RCRA NR J
US_1b_[Year]	61. NPDES NR A
US_1b_[Year]	62. NPDES NR B
US_1b_[Year]	63. NPDES NR C
US_1b_[Year]	64. NPDES NR D
US_1b_[Year]	65. NPDES NR E
US_1b_[Year]	66. NPDES NR F
US_1b_[Year]	67. NPDES NR G
US_1b_[Year]	68. NPDES NR H
US_1b_[Year]	69. NPDES NR I
US_1b_[Year]	70. NPDES NR J
US_1b_[Year]	71. PARENT COMPANY NAME
US_1b_[Year]	72. PARENT COMPANY D and B NR
US_1b_[Year]	73. STANDARDIZED PARENT COMPANY NAME
US_1b_[Year]	74. FRS FACILITY ID
US_1b_[Year]	75. DOCUMENT CONTROL NUMBER
US_1b_[Year]	76. CAS NUMBER
US_1b_[Year]	77. CHEMICAL NAME
US_1b_[Year]	78. MIXTURE NAME
US_1b_[Year]	79. ELEMENTAL METAL INCLUDED
US_1b_[Year]	80. CLASSIFICATION
US_1b_[Year]	81. UNIT OF MEASURE
US_1b_[Year]	82. METAL IND
US_1b_[Year]	83. REVISION CODE 1

TRI Basic Plus Data File	Field Name
US_1b_[Year]	84. REVISION CODE 2
US_1b_[Year]	85. PRODUCE THE CHEMICAL
US_1b_[Year]	86. IMPORT THE CHEMICAL
US_1b_[Year]	87. ON-SITE USE OF THE CHEMICAL
US_1b_[Year]	88. SALE OR DISTRIBUTION OF THE CHEMICAL
US_1b_[Year]	89. AS A BYPRODUCT
US_1b_[Year]	90. AS A MANUFACTURED IMPURITY
US_1b_[Year]	91. USED AS A REACTANT
US_1b_[Year]	92. P101 FEEDSTOCKS
US_1b_[Year]	93. P102 RAW MATERIALS
US_1b_[Year]	94. P103 INTERMEDIATES
US_1b_[Year]	95. P104 INITIATORS
US_1b_[Year]	96. P199 OTHER
US_1b_[Year]	97. ADDED AS A FORMULATION COMPONENT
US_1b_[Year]	98. P201 ADDITIVES
US_1b_[Year]	99. P202 DYES
US_1b_[Year]	100. P203 REACTION DILUENTS
US_1b_[Year]	101. P204 INITIATORS
US_1b_[Year]	102. P205 SOLVENTS
US_1b_[Year]	103. P206 INHIBITORS
US_1b_[Year]	104. P207 EMULSIFIERS
US_1b_[Year]	105. P208 SURFACTANTS
US_1b_[Year]	106. P209 LUBRICANTS
US_1b_[Year]	107. P210 FLAME RETARDANTS
US_1b_[Year]	108. P211 RHEOLOGICAL MODIFIERS
US_1b_[Year]	109. P299 OTHER
US_1b_[Year]	110. USED AS AN ARTICLE COMPONENT
US_1b_[Year]	111. REPACKAGING
US_1b_[Year]	112. AS A PROCESS IMPURITY
US_1b_[Year]	113. PROCESSED / RECYCLING
US_1b_[Year]	114. USED AS A CHEMICAL PROCESSING AID

TRI Basic Plus Data File	Field Name
US_1b_[Year]	115. Z101 PROCESS SOLVENTS
US_1b_[Year]	116. Z102 CATALYSTS
US_1b_[Year]	117. Z103 INHIBITORS
US_1b_[Year]	118. Z104 INITIATORS
US_1b_[Year]	119. Z105 REACTION TERMINATORS
US_1b_[Year]	120. Z106 SOLUTION BUFFERS
US_1b_[Year]	121. Z199 OTHER
US_1b_[Year]	122. USED AS A MANUFACTURING AID
US_1b_[Year]	123. Z201 PROCESS LUBRICANTS
US_1b_[Year]	124. Z202 METALWORKING FLUIDS
US_1b_[Year]	125. Z203 COOLANTS
US_1b_[Year]	126. Z204 REFRIGERANTS
US_1b_[Year]	127. Z205 HYDRAULIC FLUIDS
US_1b_[Year]	128. Z299 OTHER
US_1b_[Year]	129. ANCILLARY OR OTHER USE
US_1b_[Year]	130. Z301 CLEANER
US_1b_[Year]	131. Z302 DEGREASER
US_1b_[Year]	132. Z303 LUBRICANT
US_1b_[Year]	133. Z304 FUEL
US_1b_[Year]	134. Z305 FLAME RETARDANT
US_1b_[Year]	135. Z306 WASTE TREATMENT
US_1b_[Year]	136. Z307 WATER TREATMENT
US_1b_[Year]	137. Z308 CONSTRUCTION MATERIALS
US_1b_[Year]	138. Z399 OTHER
US_3c_[Year]	1. FORM TYPE
US_3c_[Year]	2. TRIFID
US_3c_[Year]	3. DOCUMENT CONTROL NUMBER
US_3c_[Year]	4. CAS NUMBER
US_3c_[Year]	5. CHEMICAL NAME
US_3c_[Year]	7. MIXTURE NAME
US_3c_[Year]	6. ELEMENTAL METAL INCLUDED

TRI Basic Plus Data File	Field Name
US_3c_[Year]	8. CLASSIFICATION
US_3c_[Year]	9. UNIT OF MEASURE
US_3c_[Year]	10. METAL INDICATOR
US_3c_[Year]	11. REVISION CODE 1
US_3c_[Year]	12. REVISION CODE 2
US_3c_[Year]	13. REPORTING YEAR
US_3c_[Year]	14. TRADE SECRET INDICATOR
US_3c_[Year]	15. FACILITY NAME
US_3c_[Year]	16. FACILITY STREET
US_3c_[Year]	17. FACILITY CITY
US_3c_[Year]	18. FACILITY COUNTY
US_3c_[Year]	19. FACILITY STATE
US_3c_[Year]	20. FACILITY ZIP CODE
US_3c_[Year]	21. ASSIGNED FED FACILITY FLAG
US_3c_[Year]	22. ASSIGNED PARTIAL FACILITY FLAG
US_3c_[Year]	23. BIA CODE
US_3c_[Year]	24. TRIBE NAME
US_3c_[Year]	25. ENTIRE FACILITY IND
US_3c_[Year]	26. PARTIAL FACILITY IND
US_3c_[Year]	27. FEDERAL FACILITY IND
US_3c_[Year]	28. GOCO FACILITY IND
US_3c_[Year]	29. PUBLIC CONTACT NAME
US_3c_[Year]	30. PUBLIC CONTACT PHONE
US_3c_[Year]	31. PUBLIC CONTACT PHONE EXT
US_3c_[Year]	32. PUBLIC CONTACT EMAIL
US_3c_[Year]	33. PRIMARY SIC CODE
US_3c_[Year]	34. SIC CODE 2
US_3c_[Year]	35. SIC CODE 3
US_3c_[Year]	36. SIC CODE 4
US_3c_[Year]	37. SIC CODE 5
US_3c_[Year]	38. SIC CODE 6

TRI Basic Plus Data File	Field Name
US_3c_[Year]	39. NAICS ORIGIN
US_3c_[Year]	40. PRIMARY NAICS CODE
US_3c_[Year]	41. NAICS CODE 2
US_3c_[Year]	42. NAICS CODE 3
US_3c_[Year]	43. NAICS CODE 4
US_3c_[Year]	44. NAICS CODE 5
US_3c_[Year]	45. NAICS CODE 6
US_3c_[Year]	46. LATITUDE
US_3c_[Year]	47. LONGITUDE
US_3c_[Year]	48. DB NR A
US_3c_[Year]	49. DB NR B
US_3c_[Year]	50. RCRA NR A
US_3c_[Year]	51. RCRA NR B
US_3c_[Year]	52. RCRA NR C
US_3c_[Year]	53. RCRA NR D
US_3c_[Year]	54. RCRA NR E
US_3c_[Year]	55. RCRA NR F
US_3c_[Year]	56. RCRA NR G
US_3c_[Year]	57. RCRA NR H
US_3c_[Year]	58. RCRA NR I
US_3c_[Year]	59. RCRA NR J
US_3c_[Year]	60. NPDES NR A
US_3c_[Year]	61. NPDES NR B
US_3c_[Year]	62. NPDES NR C
US_3c_[Year]	63. NPDES NR D
US_3c_[Year]	64. NPDES NR E
US_3c_[Year]	65. NPDES NR F
US_3c_[Year]	66. NPDES NR G
US_3c_[Year]	67. NPDES NR H
US_3c_[Year]	68. NPDES NR I
US_3c_[Year]	69. NPDES NR J

TRI Basic Plus Data File	Field Name
US_3c_[Year]	70. PARENT COMPANY NAME
US_3c_[Year]	71. PARENT COMPANY DB NR
US_3c_[Year]	72. STANDARDIZED PARENT COMPANY NAME
US_3c_[Year]	73. FRS FACILITY ID
US_3c_[Year]	74. POTW NAME
US_3c_[Year]	75. POTW ADDRESS
US_3c_[Year]	76. POTW CITY
US_3c_[Year]	77. POTW STATE
US_3c_[Year]	78. POTW COUNTY
US_3c_[Year]	79. POTW ZIP
US_3c_[Year]	80. POTW REGISTRY ID
US_3c_[Year]	81. QUANTITY TRANSFERRED
US_3c_[Year]	82. BASIS OF ESTIMATE
US_3c_[Year]	83. DISCHARGES TO WATER STREAMS
US_3c_[Year]	84. DISCHARGES TO WATER STREAMS—BASIS OF ESTIMATE
US_3c_[Year]	85. DISCHARGES TO OTHER ACTIVITIES
US_3c_[Year]	86. DISCHARGES TO OTHER ACTIVITIES—BASIS OF ESTIMATE
US_3c_[Year]	87. RELEASED TO AIR
US_3c_[Year]	88. RELEASED TO AIR—BASIS OF ESTIMATE
US_3c_[Year]	89. SLUDGE TO DISPOSAL
US_3c_[Year]	90. SLUDGE TO DISPOSAL—BASIS OF ESTIMATE
US_3c_[Year]	91. SLUDGE TO INCINERATION—METALS
US_3c_[Year]	92. SLUDGE TO INCINERATION—METALS—BASIS OF ESTIMATE
US_3c_[Year]	93. SLUDGE TO AGRICULTURAL APPLICATIONS
US_3c_[Year]	94. SLUDGE TO AGRICULTURAL APPLICATIONS—BASIS OF ESTIMATE
US_3c_[Year]	95. OTHER OR UNKNOWN DISPOSAL
US_3c_[Year]	96. OTHER OR UNKNOWN DISPOSAL—BASIS OF ESTIMATE
US_3c_[Year]	97. OFF-SITE POTW RELEASES—8.1C
US_3c_[Year]	98. OFF-SITE POTW RELEASES—8.1D
US_3c_[Year]	99. OFF-SITE—POTW RELEASES

TRI Basic Plus Data File	Field Name
US_3c_[Year]	100. OTHER OR UNKNOWN TREATMENT
US_3c_[Year]	101. OTHER OR UNKNOWN TREATMENT—BASIS OF ESTIMATE
US_3c_[Year]	102. SLUDGE TO INCINERATION—NONMETALS
US_3c_[Year]	103. SLUDGE TO INCINERATION—NONMETALS—BASIS OF ESTIMATE
US_3c_[Year]	104. EXPERIMENTTAL AND ESTIMATED TREATMENT
US_3c_[Year]	105. EXPERIMENTTAL AND ESTIMATED TREATMENT—BASIS OF ESTIMATE
US_3c_[Year]	106. TOTAL TREATED

- **Mapping Facilities to an OES and Selecting the Number of Operating Days per Year**

Both facilities used in this example reported to the 2016 Chemical Data Reporting (CDR) as domestic manufacturers of 1,2-dichloroethane. Therefore, they are mapped to the manufacturing OES. Because 1,2-dichloroethane is a commodity chemical, each facility is assumed to operate 350 days/year.

- **Annual Facility Discharges**

Annual facility discharges can be obtained directly from the Loading Tool and TRI data file downloads for each facility. The 2019 annual discharges for the two facilities in this example are provided in Table_Apx H-2.

Table_Apx H-2. Example Facilities' 2019 Annual Discharges

Facility	Annual Surface Water Discharge from Loading Tool (kg)	Annual Reported Discharge from TRI (kg)
Westlake Vinyls in Calvert City, KY	209 kg[a]	212 kg to surface water 0 kg to POTW and non-POTW WWT
Axiall LLC in Plaquemine, LA	N/A: No DMR data for this facility	10 kg to surface water 0 kg to POTW and non-POTW WWT

[a] The Loading Tool estimates this discharge a 495 lb (or 224 kg) as the sum of outfalls 001, 002, and 009. However, the NPDES permit for this facility indicates that 002 and 009 are internal outfalls that discharge into 001. Therefore, discharges from 001 includes those from 002 and 009 and the total annual discharge shown in the table is equal to the Loading Tool's estimate for outfall 001 only (461 lb or 209 kg). Review of NPDES permits is generally outside the scope of this methodology document; however, permit information for Westlake Vinyls can be found here: https://dep.gateway.ky.gov/eSearch/AgencyInterest.

- **Average Daily Discharges**

To calculate average daily discharges at each facility, the annual discharge is averaged over the number of operating as shown in the calculations below:

$$ADR = \frac{YR}{OD}$$

Where:

ADR = Average daily discharge (kg/day)
YR = Annual discharge (kg/year)
OD = Operating days (days/year)

For Westlake Vinyls the annual discharge of 209 kg/year is averaged over 350 days/year (operating days for manufacturers) to calculate the daily discharge using DMR as:

$$ADR = \frac{YR}{OD} = \frac{209\ kg/yr}{350\ days/yr} = 0.6\ kg/day$$

Similarly, for Westlake Vinyls the average daily discharge using TRI is calculated as the 212 kg/year annual discharge over 350 days/year, as shown below:

$$ADR = \frac{YR}{OD} = \frac{212\ kg/yr}{350\ days/yr} = 0.6\ kg/day$$

For Axiall LLC, the average daily discharge is calculated as the annual discharge of 10 kg/year over 350 days/year:

$$ADR = \frac{YR}{OD} = \frac{10\ kg/yr}{350\ days/yr} = 0.03\ kg/day$$

- **High-End Daily Discharges for Facilities with DMRs**

To estimate high-end daily discharge for sites with DMRs, the reporting frequency and pollutant load for each reporting period throughout the year must be determined. This information can be obtained from the Loading Tool by going to the “Top Facility Discharges” table in the query results and clicking on the desired facility name as shown in Figure_Apx H-6.[19] This will open the details of the facility’s DMR.

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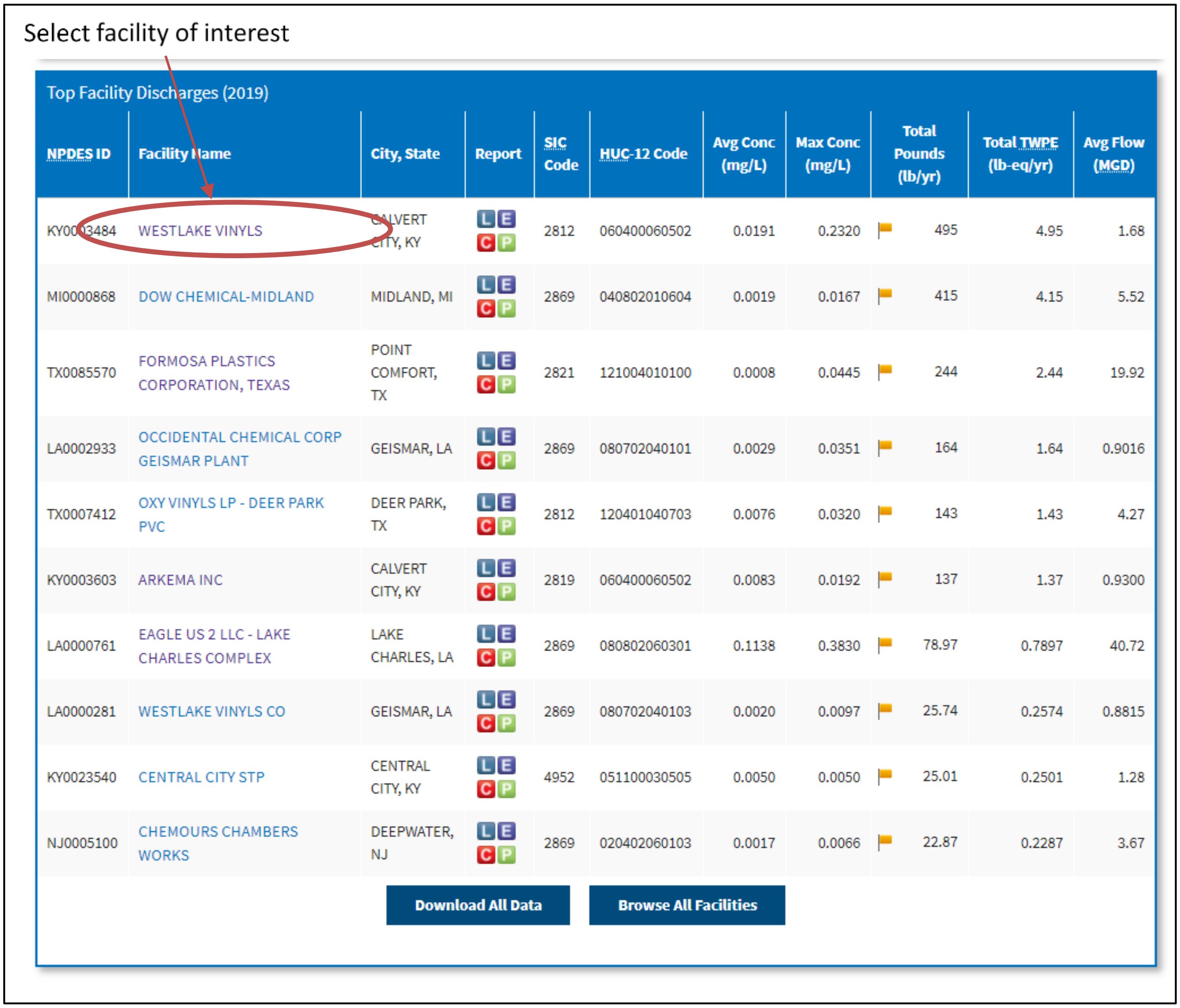
[19] If the facility of interest is not listed in this table, the user can select “browse all facilities” to bring up a list of all facilities monitoring for the chemical of interest.



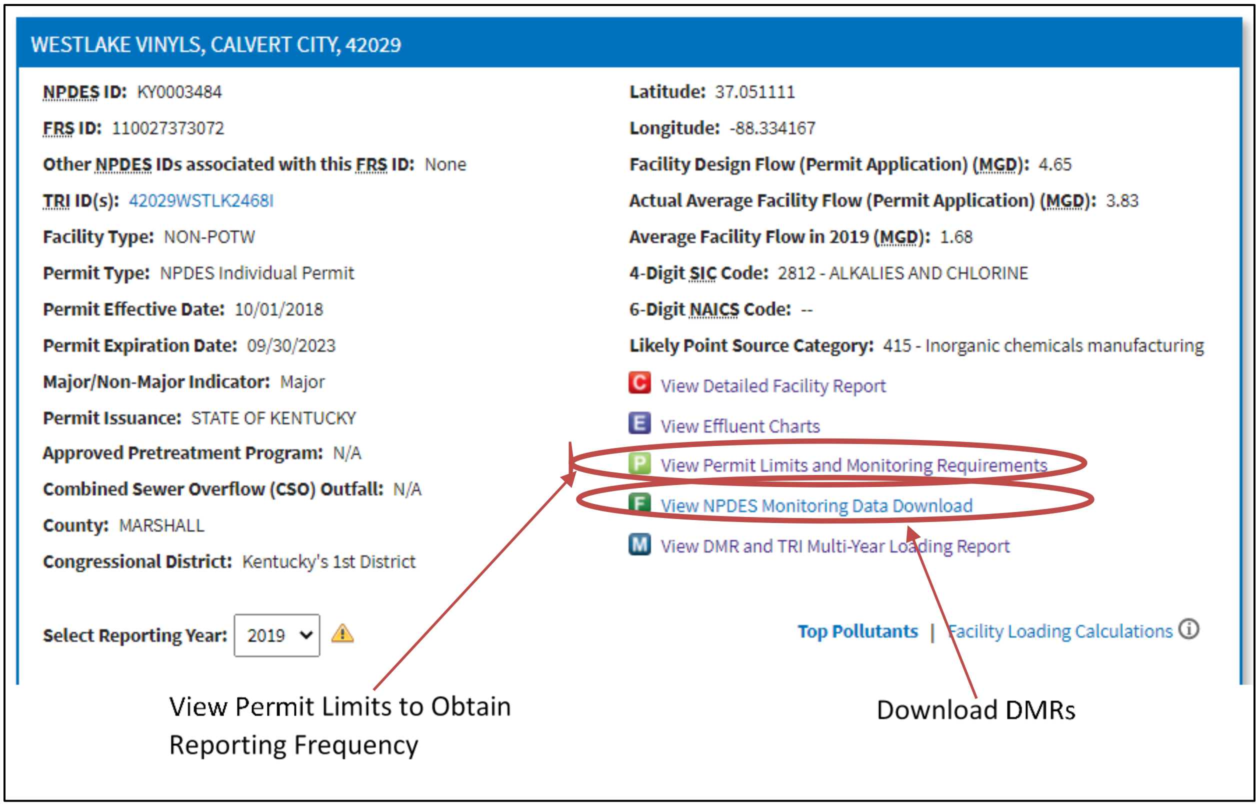
Select facility of interest

Top Facility Discharges (2019)

NPDES ID	Facility Name	City, State	Report	SIC Code	HUC-12 Code	Avg Conc (mg/L)	Max Conc (mg/L)	Total Pounds (lb/yr)	Total TWPE (lb-eq/yr)	Avg Flow (MGD)
KY0003484	WESTLAKE VINYLS	CALVERT CITY, KY	L E C P	2812	060400060502	0.0191	0.2320	⚑ 495	4.95	1.68
MI0000868	DOW CHEMICAL-MIDLAND	MIDLAND, MI	L E C P	2869	040802010604	0.0019	0.0167	⚑ 415	4.15	5.52
TX0085570	FORMOSA PLASTICS CORPORATION, TEXAS	POINT COMFORT, TX	L E C P	2821	121004010100	0.0008	0.0445	⚑ 244	2.44	19.92
LA0002933	OCCIDENTAL CHEMICAL CORP GEISMAR PLANT	GEISMAR, LA	L E C P	2869	080702040101	0.0029	0.0351	⚑ 164	1.64	0.9016
TX0007412	OXY VINYLS LP - DEER PARK PVC	DEER PARK, TX	L E C P	2812	120401040703	0.0076	0.0320	⚑ 143	1.43	4.27
KY0003603	ARKEMA INC	CALVERT CITY, KY	L E C P	2819	060400060502	0.0083	0.0192	⚑ 137	1.37	0.9300
LA0000761	EAGLE US 2 LLC - LAKE CHARLES COMPLEX	LAKE CHARLES, LA	L E C P	2869	080802060301	0.1138	0.3830	⚑ 78.97	0.7897	40.72
LA0000281	WESTLAKE VINYLS CO	GEISMAR, LA	L E C P	2869	080702040103	0.0020	0.0097	⚑ 25.74	0.2574	0.8815
KY0023540	CENTRAL CITY STP	CENTRAL CITY, KY	L E C P	4952	051100030505	0.0050	0.0050	⚑ 25.01	0.2501	1.28
NJ0005100	CHEMOURS CHAMBERS WORKS	DEEPWATER, NJ	L E C P	2869	020402060103	0.0017	0.0066	⚑ 22.87	0.2287	3.67

Figure_Apx H-6. Loading Tool—Accessing Facility-Specific Data

From the facility's DMR, the user can select the "View Permit Limits and Monitoring Requirements" to determine the reporting frequency and the "View NPDES Monitoring Data Download" to obtain the facility's DMRs for each pollutant at each outfall for each reporting period and the reporting period's corresponding wastewater flowrate in an Excel Spreadsheet, as shown in Figure_Apx H-7 and Figure_Apx H-8.



WESTLAKE VINYLS, CALVERT CITY, 42029

NPDES ID: KY0003484
FRS ID: 110027373072
Other NPDES IDs associated with this FRS ID: None
TRI ID(s): 42029WSTLK2468I
Facility Type: NON-POTW
Permit Type: NPDES Individual Permit
Permit Effective Date: 10/01/2018
Permit Expiration Date: 09/30/2023
Major/Non-Major Indicator: Major
Permit Issuance: STATE OF KENTUCKY
Approved Pretreatment Program: N/A
Combined Sewer Overflow (CSO) Outfall: N/A
County: MARSHALL
Congressional District: Kentucky's 1st District

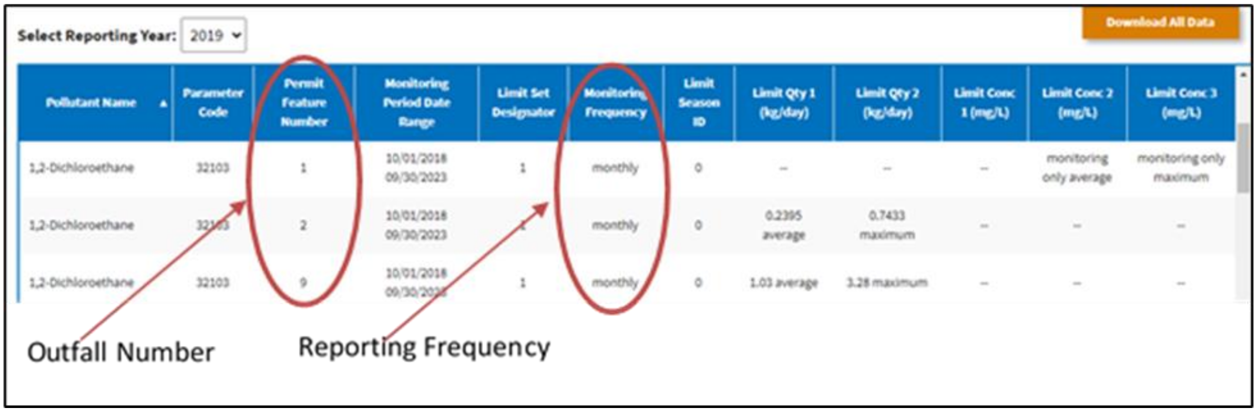
Select Reporting Year: 2019

Latitude: 37.051111
Longitude: -88.334167
Facility Design Flow (Permit Application) (MGD): 4.65
Actual Average Facility Flow (Permit Application) (MGD): 3.83
Average Facility Flow in 2019 (MGD): 1.68
4-Digit SIC Code: 2812 - ALKALIES AND CHLORINE
6-Digit NAICS Code: --
Likely Point Source Category: 415 - Inorganic chemicals manufacturing

View Permit Limits to Obtain Reporting Frequency

Download DMRs

Figure_Apx H-7. Loading Tool—Accessing Monitoring Requirements and Reporting Period Discharge Data



Select Reporting Year: 2019

Pollutant Name	Parameter Code	Permit Feature Number	Monitoring Period Date Range	Limit Set Designator	Monitoring Frequency	Limit Season ID	Limit Qty 1 (kg/day)	Limit Qty 2 (kg/day)	Limit Conc 1 (mg/L)	Limit Conc 2 (mg/L)	Limit Conc 3 (mg/L)
1,2-Dichloroethane	32103	1	10/01/2018 09/30/2023	1	monthly	0	--	--	--	monitoring only average	monitoring only maximum
1,2-Dichloroethane	32103	2	10/01/2018 09/30/2023	1	monthly	0	0.2395 average	0.7433 maximum	--	--	--
1,2-Dichloroethane	32103	9	10/01/2018 09/30/2023	1	monthly	0	1.03 average	3.28 maximum	--	--	--

Outfall Number

Reporting Frequency

Figure_Apx H-8. Loading Tool—Reviewing Facility Reporting Frequency for Each Outfall

Westlake Vinyls is required to report 1,2-dichloroethane monthly for three outfalls; however, review of Westlake Vinyl's NPDES permit indicates outfalls 002 and 009 are internal outfalls that discharge into outfall 001, and, therefore, are not included for further analysis.[20] For 1,2-dichloroethane, Westlake Vinyls reports a monthly average concentration and a maximum daily concentration. Westlake Vinyls must also report a monthly average wastewater flow rate and a maximum daily wastewater flow rate. The reporting period load is then calculated by multiplying the monthly average concentration by the monthly average wastewater flow and multiplying by the number of days in the period as shown in the

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[20] Review of NPDES permits is generally outside the scope of this methodology document; however, permit information for Westlake Vinyls can be found here: https://dep.gateway.ky.gov/eSearch/AgencyInterest.

equation below.

$$PR = C \times FR \times 3.785 \frac{L}{gal} \times 1 \times 10^{-6} \frac{kg}{mg} \times PD$$

Where:

PR = Period discharge (kg/period)
C = Pollutant concentration (mg/L)
FR = Wastewater flowrate (gal/day)
PD = Number of days in the period (days/period)

The results from these calculations for Westlake Vinyl for 1,2-dichloroethane in 2019 are presented in Table_Apx H-3.

Table_Apx H-3. Westlake Vinyl Total Period Discharge Results

Reporting Period End Date	Monthly Average Concentration (mg/L)	Monthly Average Wastewater Flow (MGD)	Days per Period	Period Discharge (kg/period)
01/31/2019	0.014	3.3756	31	5.5
02/28/2019	0.004	3.6760	28	1.6
03/31/2019	0.232	3.6855	31	100
04/30/2019	0.015	3.5123	30	6.0
05/31/2019	0.007	3.3281	31	2.7
06/30/2019	0.122	3.2704	30	45
07/31/2019	0.060	3.0358	31	21
08/31/2019	0.013	3.0535	31	4.7
09/30/2019	0.027	3.1075	30	9.5
10/31/2019	0.012	2.5449	31	3.6
11/30/2019	0.012	3.1966	30	4.3
12/31/2019	0.010	3.6309	31	4.3

MGD = million gallons per day

As shown in Table_Apx H-3, the period ending March 31, 2019, has the highest total discharge for Westlake Vinyls. Using the highest period discharge, the high-end daily discharge can be calculated using the following equation:

$$HDR = \frac{MPR}{PD} = \frac{100\ kg/period}{31\ day/period} = 3.2\ kg/day$$

$$HDR = \frac{MPR}{PD} = \frac{100\ kg/period}{31\ day/period} = 3.2\ kg/day$$

Where:

HDR = High-end daily discharge (kg/day)
MPR = Maximum period discharge (kg/period)
PD = Number of days in the period (days/period)

- **High-End Daily Discharges for Facilities without DMRs**

To estimate the high-end daily discharge for TRI facilities without DMRs, a generic factor developed using data from facilities mapped to the same OES with DMRs should be applied to the discharge from facilities without DMRs. The first step is to identify facilities with DMRs for the same chemical, same year, and same OES as the TRI facility and report DMRs monthly. For purposes of this example, only the Westlake Vinyl's facility will be considered; however, in many instances data from multiple facilities will be considered.

After identifying the relevant facility, the percentage of the total annual discharge that occurred in the highest 1-month period should be calculated using the equation below and values from Westlake Vinyls:

$$GF = \frac{MPR}{YR} = \frac{100\ kg/period}{209\ kg/yr} \times 100 = 48\%$$

Where:

GF = Generic factor (year/period)
MPR = Maximum period discharge (kg/period)
YR = Annual discharge (kg/year)

If multiple facilities are included in the analysis, the GF used in the next steps should be the average of the factors calculated for each facility. For this example, the factor of 48% will be used.
To calculate the high-end daily discharge from TRI sites without DMRs, the reported annual discharge should be multiplied by the generic factor and divide by the number of days in a month (30 days) as shown in the equation below using values for Axiall LLC:

$$HDR = \frac{GF \times YR}{30\ days} = 48\% \times 10\ kg = \ 0.2\ kg/day$$

Where:

HDR = High-end daily discharge (kg/day)
GF = generic factor (unitless)
YR = Annual discharge (kg/year)

This value is assessed over 30 days/period to approximate the high-end period of one month the results are based on. Note, the GF calculated in this example is based on a facility with monthly reporting periods which is the preferred method for estimating the GF and hence assesses over 30 days. In situations where the GF is calculated using data from facilities with longer reporting periods, the number of days should be adjusted accordingly.

- **1-Day Discharges**

Data to estimate 1-day discharges can be obtained using a similar method as the high-end daily discharges from DMR except concentration and flowrate values reported for the daily maximum for each period should be used. The daily discharge is simply the daily maximum concentration multiplied by the daily maximum flowrate (with proper unit conversions) as shown in the equation below.

$$ODR = C \times FR \times 3.785 \frac{L}{gal} \times 1 \times 10^{-6} \frac{kg}{mg}$$

Where:

ODR = 1-day discharge (kg/day)
C = Pollutant concentration (mg/L)
FR = Wastewater flowrate (gal/day)

The daily maximum for each period for Westlake Vinyls is provided in Table_Apx H-4.

Table_Apx H-4. Westlake Vinyl 1-Day Discharges

Reporting Period End Date	Daily Maximum Concentration (mg/L)	Daily Maximum Wastewater Flow (MGD)	Period Discharge (kg/day)
01/31/2019	0.014	4.0153	0.2
02/28/2019	0.004	5.6582	0.1
03/31/2019	0.232	3.9410	3.5
04/30/2019	0.015	3.7962	0.2
05/31/2019	0.007	3.6638	0.1
06/30/2019	0.122	3.5840	1.7
07/31/2019	0.060	3.4168	0.8
08/31/2019	0.013	3.9349	0.2
09/30/2019	0.027	3.6647	0.4
10/31/2019	0.012	2.7171	0.1
11/30/2019	0.012	3.9522	0.2
12/31/2019	0.010	3.7360	0.1

MGD = million gallons per day

- **Summary of Results**

The detailed results from each facility are provided in the accompanying spreadsheet; however, an overview of the results for each facility are provided in Table_Apx H-5.

5399 **Table_Apx H-5. Summary of Discharge Estimates for 2019 Example Facilities**

Facility	Annual Surface Water Discharge from Loading Tool (kg)	Annual Reported Discharge from TRI (kg)	Average Daily Discharge (kg/day)	Release Days for Average Daily Discharge (days/yr)	High-End Daily Discharge (kg/day)	Release Days for High-End Daily Discharge (days/period)	Maximum 1-day Discharge (kg/day)
Westlake Vinyls in Calvert City, KY	209 kg	212 kg to surface water 0 kg to POTW and non-POTW WWT	0.6 (DMR) 0.6 (TRI)	350	3.2	31	3.5
Axiall LLC in Plaquemine, LA	N/A: No DMR data for this facility	10 kg to surface water 0 kg to POTW and non-POTW WWT	0.03	350	0.2	30	N/A: data not available to estimate 1-day discharge

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Appendix I GUIDANCE FOR USING THE NATIONAL EMISSIONS INVENTORY AND TOXIC RELEASE INVENTORY FOR ESTIMATING AIR RELEASES

This section provides guidance for using EPA's National Emissions Inventory (NEI) and Toxics Release Inventory (TRI) data to estimate air releases for certain chemicals undergoing risk evaluation under the Toxic Substances Control Act (TSCA). These estimates will be used as inputs to air modeling for the purposes of estimating ambient air concentrations.

I.1 Background

EPA's National Emissions Inventory (NEI) and Toxics Release Inventory (TRI) programs require individual facilities, as well as state, local, and tribal (SLT) Air Agencies, to report information on airborne chemical releases to the EPA. While the chemicals reported under each program differ, both inventories include data for some of the chemicals undergoing TSCA risk evaluation. When available, the NEI and TRI data include information on the sources, magnitude, and nature (*e.g.*, stack vs. fugitive, stack height, stack gas velocity/temperature) of airborne releases from industrial/commercial facilities and other smaller emissions sources. Thus, these databases may provide useful information for estimating air releases of TRI- and/or NEI-covered chemicals, for certain occupational exposure scenarios (OES).

As the NEI and TRI programs operate under separate regulatory frameworks, the data reported under these programs do not always overlap. For example, in 2017, approximately 745,000 lb of perchloroethylene (PERC) air emissions were reported to TRI, whereas approximately 16.6 million lb of PERC air emissions were reported to NEI. This document provides an approach for using NEI data, in combination with TRI data, to estimate air emissions.

I.2 Obtaining Air Emissions Data

I.2.1 Obtaining NEI Data

The first step in using NEI data to estimate air releases is to obtain the NEI data in a workable format that provides the requisite data for release estimation and modeling. The NEI data are available on EPA's public website as downloadable zip files, divided into onroad, nonroad, nonpoint, and point source data files.[21] The zipped point source data files are extremely large and require specialized database experience to query and manipulate. As an alternative, EPA's EIS Gateway allows registered EPA users, registered SLT users, and approved contractors to query and download NEI data and associated reporting code descriptions. As a result, this methodology uses the EIS Gateway to query point source data. Following download, the point and nonpoint emissions data for the chemical of interest will be imported into Microsoft (MS) Excel (or using an alternative tool, if the data exceeds Excel's size threshold), to be filtered and manipulated. At this point, EPA will use the EIS lookup tables to populate field descriptions for data fields reported as numerical codes (*e.g.*, NAICS code).

I.2.2 Obtaining TRI Data

TRI data may be downloaded from EPA's public TRI Program, TRI Data and Tools website.[22] Once the csv file(s) has (have) been downloaded, the data are filtered by the chemical of interest using the CAS number and/or chemical name. Relevant NEI data fields include reporting year, facility identifying

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[21] https://www.epa.gov/air-emissions-inventories/2017-national-emissions-inventory-nei-data#datas
[22] https://www.epa.gov/toxics-release-inventory-tri-program/tri-data-and-tools

information (*e.g.*, name, address, FRS ID, and TRIFID), chemical information (chemical name, CAS), primary NAICS codes, fugitive air releases, and stack air releases.

I.3 Mapping NEI and TRI DATA to Occupational Exposure Scenarios

Once TRI and NEI data is obtained, the next step is to map the data to OESs. For procedures for mapping facilities from TRI and NEI to occupational exposure scenarios, refer to Appendix G.

I.4 Estimating Air Releases Using NEI and TRI Data

EPA will use the mapped NEI and TRI data to develop facility- and/or release-point-specific emissions estimates for chemicals undergoing TSCA risk evaluation. The data summary will include pertinent information for risk evaluation and emission modeling, such as facility location, annual releases, daily releases, operating information, release type (*i.e.*, stack vs. fugitive), and stack parameters.

I.4.1 Linking NEI and TRI Data

Although NEI and TRI have different reporting requirements, some major sources are expected to report to both databases. The most reliable way to link the data sets is with a common identifier. NEI reports EIS Facility Identifier and Facility Registry Identifier (FRSID), although the latter is not reliably populated for all NEI records. TRI reports TRI Facility ID and FRSID. EPA will use its database of EIS Alternate Facility Identifiers (“EISAltFacilityIdentifiers_20211221.accdb”) to link TRIFID to an EIS Facility Identifier. Linkages may be confirmed and/or refined using facility names and addresses, if necessary.

Following linkage, EPA will review the linked NEI/TRI data to ensure that facilities with records in both databases are assigned to a consistent OES. When discrepancies arise, EPA will resolve these discrepancies using the data set with the greatest level of detail. In general, NEI provides more detailed air emissions data than TRI. For example, NEI reports SCC levels 1 to 4, which provide insight into the specific operations and/or process units associated with NEI-reported air emissions. For example, “Chemical Evaporation Organic Solvent Evaporation Degreasing Entire Unit: Open-top Vapor Degreasing” is a SCC description used in the NEI. This SCC description identifies the emission unit, not only as a degreaser, but as a specific type of degreaser. NEI also includes free text fields where reporters can include additional information about a particular facility and/or emission unit. TRI does not provide this level of detail.

Following a review of OES assignments, the TRI and NEI data will be divided into separate tables by OES code, which may be linked using the EIS Facility Identifier.

I.4.2 Evaluation of Sub-annual Emissions

As air emissions data in TRI and NEI are reported as annual values, sub-annual (*e.g.*, daily) emissions must be calculated from information on release duration, release days, and release pattern. While TRI does not report information on release duration or pattern, this information may be estimated from operating data reported to the NEI.[23] Other sources of release duration and pattern information include GSs and ESDs, literature sources, process information, and standard engineering methodology for estimating number of release days. These sources are described in further detail below, in order of preference.

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[23] Note that the NEI operating hours fields are not populated for all, or in the case of ethylene dibromide, most, NEI entries.

Sources for Estimating Release Duration:

1. *NEI data:* The NEI data set includes facility-specific air emissions estimates for major sources and often includes data on the number of hours of operation per day for these facilities. The number of operating hours from NEI can be used to inform release duration for the specific facilities being assessed. Hours of operation for one facility in NEI are typically not used for a different facility; however, engineers may consider conducting an analysis of operating hours for multiple facilities in NEI that are a part of the same OES to develop a broader estimate of release duration at the OES-level. EPA has previously used this approach to inform development of GS/ESDs, but it is dependent on the amount of data and time available and should be discussed on a chemical-specific basis.

2. *Models:* Models used to estimate air emissions and associated inhalation exposures (*e.g.,* Tank Truck and Railcar Loading and Unloading Release and Inhalation Exposure Model, Open-Top Vapor Degreasing Near-Field/Far-Field Inhalation Exposure Model, Spot Cleaning Near-Field/Far-Field Inhalation Exposure Model, models from GS/ESDs) sometimes include data on release duration, which are usually either cited from literature or based on generic assumptions about the activity being modeled. Release duration information from models may be presented with non-modeled air emission data from NEI or TRI, if the model is applicable and expected to represent the primary release source for the OES (*e.g.*, release duration from the Tank Truck and Railcar Loading and Unloading Release and Inhalation Exposure Model may be used with estimates of air emissions for a facility in the Repackaging OES). For models that calculate release duration as a distribution, such as from Monte Carlo simulations, the mean and range of release durations from the model should be presented with the air emission estimate.

3. *Literature:* Literature sources from systematic review, including GS/ESDs, are another source of information for release duration. Often, release duration information from literature sources may be broad, such as a range of durations for a given operation. Alternatively, literature sources may describe release duration qualitatively, such as “on and off throughout the day” or “over half the day”. Therefore, literature sources may inform release duration at the OES-level, as opposed to at the facility-level. All details from literature sources on release duration, including qualitative descriptions, should be presented with air emission estimates if they are available and there is no other source of this data.

4. *List as “unknown”:* Often, no information on release duration is available at either the facility or OES-level from the above sources. In these cases, engineers should list that the release duration is unknown.

Sources for Estimating Release Pattern

1. *NEI data:* The NEI data set includes facility-specific air emissions estimates for major sources and often includes data on the number of days of operation per week and number of weeks of operation per year for these facilities. NEI does not indicate if the number of days per week or weeks per year of operation are consecutive or intermittent throughout the week/year; however, these data are still useful and should be provided by engineers with air emission estimates to help inform release patterns. Data on operational days per week and weeks per year for one facility in NEI is typically not used for a different facility; however, engineers may consider conducting an analysis of these data for multiple facilities in NEI that are a part of the same OES to develop a

broader estimate of release pattern at the OES-level. EPA has previously used this approach to inform development of GS/ESDs, but it is dependent on the amount of data and time available and should be discussed on a chemical-specific basis.

2. *Models:* Models used to estimate air emissions (*e.g.*, Tank Truck and Railcar Loading and Unloading Release and Inhalation Exposure Model, Open-Top Vapor Degreasing Near-Field/Far-Field Inhalation Exposure Model, Spot Cleaning Near-Field/Far-Field Inhalation Exposure Model, models from GS/ESDs) sometimes, but rarely, include data on release pattern from the underlying data sources. Release pattern information from models may be presented with non-modeled air emission data (*e.g.*, NEI, TRI) if the model is applicable and expected to represent the primary release source for the OES (*e.g.*, release pattern from the Tank Truck and Railcar Loading and Unloading Release and Inhalation Exposure Model may be used with estimates of air emissions for a facility in the Repackaging OES).

3. *Literature:* Literature sources from systematic review, including GS/ESDs, are another source of information for release pattern. Often, literature sources provide general release pattern information for a given operation. Therefore, literature sources may inform release pattern at the OES-level, as opposed to at the facility-level. All details from literature sources on release pattern, even if general and/or limited, should be presented with air emission estimates, if they are available and there is no other source of this information.

4. *List as "unknown" and provide operating days:* Often, no information on release pattern is available at either the facility or OES-level from the above sources. In these cases, engineers should do the following:

    a. List that the release pattern is unknown.
    b. Provide the number of operating days for the facility based on project-level engineering methodology, which is summarized below.
    c. Provide any information based on process knowledge (*e.g.*, commercial aerosol degreasing using cans may occur on/off throughout a day and year).

Estimating Number of Operating Days for Point Sources

For major sources that report operating data to NEI, EPA will use these data to calculate operating hours on a days per year basis. For major sources that do not report operating data in NEI (including facilities that only report to TRI), EPA will estimate operating hours using the other data sources described above. A hierarchical approach for estimating the number of facility operating days per year is described below.

1. *Facility-specific data:* Use facility-specific data, if available. NEI reports operating data as hours per year, hours per day, days per week, and weeks per year.

    a. If possible, calculate operating days per years as: Days/yr = hours per year ÷ hours per day.
    b. If hours per year and/or hours per day are not reported, calculate days per year as: Days/yr = Days per week x weeks per year

2. *Facility-specific use rates:* If information on facility-specific use rates is available, estimate days/yr using one of the following approaches:

   a. If facilities have known or estimated average daily use rates, calculate the days/yr as: Days/yr = Estimated Annual Use Rate for the Site (kg/yr) ÷ average daily use rate from sites with available data (kg/day).

   b. If sites without days/yr data do not have known or estimated average daily use rates, use the average number of days/yr from the sites with such data.

3. *Industry-specific data:* Industry-specific data may be available in the form of GSs, ESDs, trade publications, or other relevant literature. In such cases, these estimates should take precedent over other approaches, unless facility-specific data are available.

4. *Manufacture of large-production volume (PV) commodity chemicals:* For the manufacture of the large-PV commodity chemicals, a value of 350 days/yr should be used. This assumes the plant runs 7 day/week and 50 week/yr (with two weeks down for turnaround) and assumes that the plant is always producing the chemical.

5. *Manufacture of lower-PV specialty chemicals:* For the manufacture of lower-PV specialty chemicals, it is unlikely the chemical is being manufactured continuously throughout the year. Therefore, a value of 250 days/yr should be used. This assumes the plant manufactures the chemical 5 days/week and 50 weeks/yr (with two weeks down for turnaround).

6. *Processing as reactant (intermediate use) in the manufacture of commodity chemical*s: As noted above, the manufacture of commodity chemicals is assumed to occur 350 days/yr such that the use of a chemical as a reactant to manufacture a commodity chemical will also occur 350 days/yr.

7. *Processing as reactant (intermediate use) in the manufacture of specialty chemicals: As* noted above, the manufacture of specialty chemicals is not likely to occur continuously throughout the year. Therefore, a value of 250 days/yr can be used.

8. *Other chemical plant OES (e.g., processing into formulation and use of industrial processing aids):* For these OES, it is reasonable to assume that the chemical of interest is not always in use at the facility, even if the facility operates 24/7. Therefore, a value of 300 days/yr can be used, based on the European Solvent Industry Group's "SpERC fact sheet—Formulation & (re)packing of substances and mixtures—Industrial (Solvent-borne)" default of 300 days/yr for the chemical industry. However, in instances where the OES uses a low volume of the chemical of interest, 250 days/yr can be used as a lower estimate for the days/yr.

9. *All Other OESs:* Regardless of facility operating schedule, other OES are unlikely to use the chemical of interest every day. Therefore, a value of 250 days/yr should be used for these OESs.

Estimating Number of Operating Days for Area Sources

For area sources, EPA will also estimate operating days per year using information such as NEI operating data for major source facilities within the same OES, general information about the OES, and values from literature. Facility operating days per year will be used to calculate daily emissions from the NEI and TRI annual emissions data, as:

Daily emissions (kg/day) = Annual emissions (kg/yr) ÷ Operating days per year (days/yr)