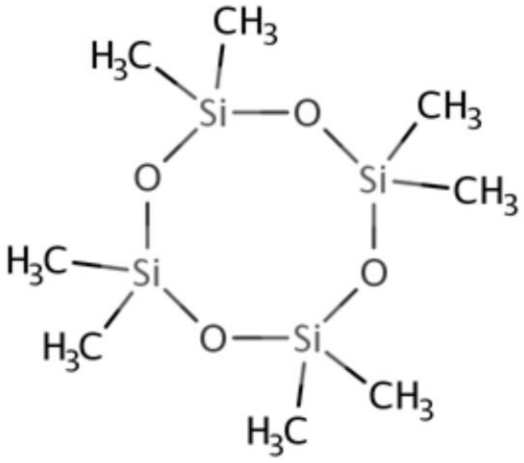
United States
Environmental Protection Agency

EPA Document# EPA-740-D-25-027
September 2025
Office of Chemical Safety and
Pollution Prevention

Draft Environmental Media and General Population Exposure for Octamethylcyclotetrasiloxane (D4)

Technical Support Document for the Draft Risk Evaluation

CASRN 556-67-2



September 2025

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDIX TABLES

LIST OF APPENDIX FIGURES

ABBREVIATIONS AND ACRONYMS

7Q10	Lowest 7-day flow in a 10-year period
30Q5	30 consecutive days of lowest flow over a 5-year period
ADD	Average daily dose
ADR	Acute dose rate
AERMOD	American Meteorological Society (AMS)/EPA Regulatory Model
BAF	Bioaccumulation factor
BCF	Bioconcentration factor
CDR	Chemical Data Reporting
COU	Condition of use
CT	Central tendency
D4	Octamethylcyclotetrasiloxane
dw	Dry weight
ECA	Enforceable Consent Agreement
ECHO	EPA's Enforcement and Compliance History Online Database
EPA	Environmental Protection Agency (U.S.)
HE	High-end

HEC	Human equivalent concentration
HED	Human equivalent dose
IIOAC	Integrated indoor-outdoor air calculator
K_{OC}	Organic carbon/water partition coefficient
MOE	Margin of exposure
NAICS	North American Industry Classification System
NPDES	National Pollutant Discharge Elimination System
OCSPP	Office of Chemical Safety and Pollution Prevention
OES	Occupational exposure scenario
OPPT	Office of Pollution Prevention and Toxics
P50	50th (Median) flow
P75	75th percentile flow
P90	90th percentile flow
PESS	Potentially exposed or susceptible subpopulations
POD	Point of departure
TRI	Toxics Release Inventory
TSCA	Toxic Substances Control Act
ww	Wet weight
WWTP	Wastewater treatment plant

ACKNOWLEDGEMENTS

This technical support document was developed by the United States Environmental Protection Agency (EPA), Office of Chemical Safety and Pollution Prevention (OCSPP), Office of Pollution Prevention and Toxics (OPPT). The Assessment Team gratefully acknowledges the participation, input, and review comments on this draft technical support document (TSD) from OPPT and OCSPP senior managers and science advisors. The Agency also gratefully acknowledges assistance from EPA contractors for the preparation of this draft technical support document: ICF, Inc. (Contract No. 68HERC23D0007).

Docket

Supporting information can be found in the public docket, Docket ID EPA-HQ-OPPT-2018-0443.

Disclaimer

Reference herein to any specific commercial products, process, or service by trade name, trademark, manufacturer, or otherwise does not constitute or imply its endorsement, recommendation, or favoring by the United States Government.

Authors: Susanna Wegner (Assessment Lead), Christopher C. Green (Assessment Lead), Kesha Forrest (Management Lead), Andrea Amati, Catherine Ngo, and Olivia Wrightwood.

Contributors: Maiko Arashiro.

Technical Support: Mark Gibson and Hillary Hollinger.

SUMMARY

Environmental Media Concentration and General Population Exposure: Key Points

EPA evaluated the reasonably available information for various environmental media concentrations and estimated exposure using conservative exposure scenarios as a screening level approach. The conservative high-end exposure was assumed to result from the highest D4 releases associated with the corresponding Toxic Substances Control Act (TSCA) condition of use (COU) via different exposure pathways. The key points are summarized below:

- EPA assessed environmental concentrations of D4 in air, water, and land (soil, biosolids, and biogas) for use in the general population exposure assessment.
  - For the land pathway, EPA determined that D4 will not be persistent or mobile in soil or groundwater. D4 is expected to be present in biogas as indicated by vapor pressure and partitioning properties. However, the general population is unlikely to be exposed to biogas. Therefore, both the landfill and biogas pathways were assessed qualitatively.
  - Another land pathway is the incidental ingestion of biosolids-amended soil. This was quantitatively evaluated for the general population because adsorption to sludge is a key removal mechanism of D4 from wastewater. The maximum modeled soil concentration was 2.185 mg/kg dry weight (dw). The modeled value was several orders of magnitude above any monitored concentration likely due to conservative inputs. Therefore, EPA is confident that the use of the modeled concentration for screening level to estimate risk is protective.
  - For the water pathway, D4 in water releases is expected to predominantly partition into sediment and suspended particles in the water column. The high-end modeled total water column concentration of D4 for the acute human exposure scenarios was 5,291 µg/L. The modeled value was several orders of magnitude above any monitored concentration likely due to conservative inputs. Therefore, EPA is confident that the use of the modeled concentration to estimate risk is protective.
  - For the air pathway, D4 in air releases is expected to remain in the air. Modeled D4 concentrations in air are several orders of magnitude above any monitored concentrations likely due to the use of high-end releases and conservative meteorological data. Therefore, EPA is confident that the use of the modeled concentration to estimate risk is protective.
  - For the fish ingestion pathway, high-quality monitoring data for both surface water and fish tissues did not result in screening level risks estimates below the benchmark. However, monitoring data do not represent all COUs considered in this risk assessment. As such, EPA also considered modeled data which yielded margins of exposure (MOEs) below the benchmark in several scenarios. Refinements of the analysis using modeled data required consideration of the multiple inputs and the variance within each input. Overall, this pathway may be a concern for some scenarios.

1 ENVIRONMENTAL MEDIA CONCENTRATION OVERVIEW

This technical document supports the *Draft Risk Evaluation for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025j). D4 belongs to a group of cyclic volatile methylsiloxanes (cVMS) that consist of cyclic chains of alternating oxygen (O) and silicon (Si) atoms with methyl groups (CH_3) $[–Si(CH_3)_2–O–]_x$. D4 consists of four of these chains (x = 4). D4 is primarily used as an intermediate in the production of polymers used for products as silicone rubber, sealants, paint and coating manufacturing, and a wide variety of silicone fluids such as anti-foaming agents. It is also used as a laboratory chemical.

This document describes the use of reasonably available information to estimate environmental concentration of D4 in different environmental media and the use of the estimated concentrations to evaluate exposure to the general population from releases associated with Toxic Substances Control Act (TSCA) conditions of use (COUs). EPA evaluated the reasonably available information for releases of D4 from facilities that use, manufacture, or process D4 under industrial and/or commercial COUs. General population exposures occur when D4 is released into the environment and the environmental media is then a pathway for exposure. As described in the *Draft Environmental Release and Occupational Exposure Assessment for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025e), releases of D4 are expected in air, water, and disposal to landfills. Figure 2-1 provides a graphic representation of where and in which media D4 is estimated to be found due to environmental releases and the corresponding route of exposure for the general population.

EPA began its D4 exposure assessment using a screening level approach that relies on conservative assumptions. Conservative assumptions, including default input parameters for modeling environmental media concentrations, help to characterize exposure resulting from the upper range of the expected distribution. Screening level assessments are useful when there is little facility location- or scenario-specific information available, as is the case for D4. EPA used generic EPA models and default input parameter values to estimate environmental releases as described in the *Draft Environmental Release and Occupational Exposure Assessment for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025e). Details on the use of screening level analyses in exposure assessments can be found in EPA's *Guidelines for Human Exposure Assessment* (U.S. EPA, 2019b).

EPA considered a subset of the general population living near facilities releasing D4 to the ambient air (which includes fenceline communities) as part of the ambient air exposure assessment. EPA used a pre-screening methodology described in EPA's *Draft TSCA Screening Level Approach for Assessing Ambient Air and Water Exposures to Fenceline Communities (Version 1.0)* (U.S. EPA, 2022) for the ambient air exposure risk assessment. For other exposure pathways, EPA's screening method assessing high-end exposure scenarios used release data that reflect exposures expected to occur in proximity to releasing facilities, which would include fenceline populations.

EPA evaluated the reasonably available information for releases of D4 from facilities that use, manufacture, or process D4 under industrial and/or commercial COUs subject to TSCA regulations detailed in the *Draft Environmental Release and Occupational Exposure Assessment for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025e). In addition, EPA also integrated robust monitoring data representing a subset of D4 available in the *D4 Environmental Testing Report* (ERM, 2017a, b). The report was prepared in accordance with an Enforceable Consent Agreement (ECA) between EPA and five signatory companies (Dow Corning Corporation, Evonik Corporation, Momentive Performance Materials USA Inc., Shin-Etsu Silicones of America, Inc., and Wacker Chemical Corporation). It is hereafter referred to as the ECA. The environmental testing program collected environmental media samples from 14 wastewater treatment plants (WWTPs): four were

297 manufacturing/processing plants that treated wastewater on-site and discharged directly into receiving
298 water (direct discharge or "DD"); five received wastewater for treatment from industrial sites known to
299 be D4 processors or formulators (indirect discharge or "I"), and five received less than 15 percent of
300 wastewater for treatment from industrial facilities that were not D4 manufacturing, processing, or
301 formulating sites (non-industrial or "R" WWTPs). A map of their locations is provided in Figure_Apx
302 D-1. The environmental testing program undertaken by the signatory companies was conducted in
303 accordance with a Study Plan and Quality Assurance Project Plan that EPA reviewed and approved. The
304 quality of data in the ECA is thus high. Table 1-1 provides a crosswalk between COUs and OESs. Table
305 1-2 shows the type of releases to the environment by OES.
306
307 **Table 1-1. Crosswalk of Conditions of Use to Assessed Occupational Exposure Scenarios**

Life Cycle Stage	Category	Subcategory	OES
Manufacturing	Manufacturing	Manufacturing	Manufacture of D4
	Importing	Import	Import
Processing	Repackaging	All other basic inorganic chemical manufacturing; all other chemical product and preparation manufacturing; miscellaneous manufacturing	Repackaging
	Processing as a reactant	Adhesives and sealant chemicals; all other basic inorganic chemical manufacturing; all other basic organic chemical manufacturing; all other chemical product and preparation manufacturing; plastic material and resin manufacturing; synthetic rubber manufacturing	Processing as a reactant
	Incorporation into formulation, mixture, or reaction product	Adhesives and sealants	Formulation of adhesives and sealants (neat D4)
		Computer and electronic product manufacturing (potting agents)	Formulation of adhesives and sealants (residual D4, *i.e.*, PDMS)
		Synthetic rubber manufacturing; rubber product manufacturing; electrical equipment, appliance, and component manufacturing	Rubber compounding
			Rubber converting
		Paint and coating manufacturing; asphalt paving, roofing, and coating materials manufacturing; computer and electronic product manufacturing (surrogate for conformal coatings)	Formulation of paints and coatings (neat D4)
			Formulation of paints and coatings (residual D4, *i.e.*, PDMS)

Life Cycle Stage	Category	Subcategory	OES
		All other chemical product and preparation manufacturing; miscellaneous manufacturing (repackaging); personal care product manufacturing	Formulation of products containing greater than residual D4, *i.e.*, PDMS (automotive care, fabric finishing, animal grooming)
		All other basic inorganic chemical manufacturing; cyclic crude and intermediate manufacturing (anti-foam); processing aid (*e.g.*, component in an antifoaming agent, lubricants, wetting agents, and leveling agents); miscellaneous manufacturing; soap, cleaning compound, and toilet preparation; oil and gas industry products (fuel additive, mixture contains 0.1–1% D4); pesticides	Formulation of products containing residual D4, *i.e.*, PDMS (printing inks, anti-foam; metal cutting fluids, release agents, cleaning/polishing formulations, laundry, working fluids, lubricants, other uncertain residual level products)
Industrial and/or Commercial Uses	Adhesive and sealants	Electric equipment, appliance, and component manufacturing; computer and electronic product manufacturing; construction; automotive manufacturing; aerospace; transportation	Use of adhesives
	Paints and coatings	Electric equipment, appliance, and component manufacturing; computer and electronic product manufacturing; construction; fabric, textile, and leather manufacturing; automotive manufacturing; aerospace; transportation	Use of paints and coatings – spray application
	Lubricant and greases	Aircraft maintenance; fabricated metal product manufacturing	Use of solvents, lubricants, greases, and/or working fluids (penetrant and cold cleaning)
	Working fluids	Transportation; aerospace; manufacturing	
	Automotive care products	Automotive care products	Use of automotive detailing products
	Animal grooming products	Animal grooming products	Use of animal grooming product
	Laboratory chemicals	Laboratory chemicals	Use of laboratory chemical
	Furnishing, cleaning, treatment/care products	Cleaning and furnishing care products	Use of cleaning products (residual) Environmental releases represented by
		Laundry and dishwashing products	

Life Cycle Stage	Category	Subcategory	OES
	Release agents	Wood product manufacturing; fabricated metal product manufacturing; rubber and plastic manufacturing; paper manufacturing; welding; other	1) Use of fabric finishing products, 2) Use of cleaning products, and 3) Commercial/institutional laundry
	Polyurethane foam (additive)	Construction; electric equipment, appliance, and component manufacturing; utilities	
	Oil and gas industry	Oil and gas industry	
	Plastic and rubber products not covered elsewhere	Plastic and rubber products not covered elsewhere	
	Polyurethane foam	Construction	
	Pesticides	Pesticides	
Distribution in Commerce			Distribution in commerce
Waste Handling, Disposal, and Treatment			Waste handling, disposal, and treatment

308
309

Table 1-2. Type of Release to the Environment by Occupational Exposure Scenario

OES[a]	Type of Discharge,[b] Air Emission,[c] or Transfer for Disposal[d]
Manufacturing	Fugitive air
	Stack air
	Wastewater to on-site treatment or discharge to POTW
	Waste disposal (incineration, or landfill)
Import and repackaging	Fugitive air
	Wastewater to on-site treatment, discharge to POTW, or landfill
	Waste disposal (incineration or landfill)
Processing as a reactant	Fugitive air
	Stack air
	Wastewater to on-site treatment or discharge to POTW
	Surface water
	Waste disposal (incineration or landfill)
Formulation of adhesives and sealants (neat or residual D4)	Fugitive air
	Stack air
	Water, incineration, or landfill
Rubber compounding (neat or residual D4)	Fugitive or stack air
	Stack air
	Water (to on-site treatment or off-site POTW)
	Fugitive air, water (to on-site treatment or off-site POTW), incineration, or landfill
	Water (to on-site treatment or off-site POTW), incineration, or landfill
Rubber converting	Fugitive or stack air
	Stack air
	Fugitive air, water (to on-site treatment or off-site POTW), incineration, or landfill
	Fugitive air, stack air, water (to on-site treatment or off-site POTW), incineration, or landfill
	Water (to on-site treatment or off-site POTW), incineration, or landfill
	Water (to on-site treatment or off-site POTW)
	Incineration or landfill
Formulation of paints and coatings (neat or residual D4)	Fugitive or stack air
	Water, incineration, or landfill
	Incineration or landfill

OES[a]	Type of Discharge,[b] Air Emission,[c] or Transfer for Disposal[d]
Processing or formulations containing greater than residual D4	Fugitive air
	Stack air
	Water, incineration, or landfill
	Incineration or landfill
Formulation of residual D4 products	Fugitive air
	Stack air
	Water, incineration, or landfill
	Incineration or landfill
Use of adhesives and sealants	Fugitive air
	Incineration or landfill
Use of paints and coatings (1-, 2-, 250-day application at 100 kg/day and 1-, 2-, 250-day application at 1,000 kg/day)	Fugitive air
	Water, incineration, landfill
Use of solvents, lubricants, greases, or working fluids – penetrant product; what-if scenario 50% or 100% of total production volume (PV)	Fugitive air
	Incineration or landfill
Use of solvents, lubricants, greases, or working fluids – cold cleaning product; what-if scenario 50% of total PV; daily, monthly, or biannual changeout	Fugitive air
	Water (to on-site treatment or off-site POTW), incineration, or landfill
	Incineration or landfill
Use of solvents, lubricants, greases, or working fluids – cold cleaning product; what-if scenario 100% of total PV; daily, monthly, or biannual changeout	Fugitive air
	Water (to on-site treatment or off-site POTW), incineration, or landfill
	Incineration or landfill
Use of automotive care products	Fugitive air
	Fugitive air, water (to on-site treatment or off-site POTW), or landfill
Use of animal grooming products	Fugitive Air
	POTW or landfill
	Unknown
Laboratory use	Fugitive or stack air
	Water, incineration, or landfill
Use in fabric finishing product	Fugitive air
	Water (to on-site treatment or off-site POTW), incineration, or landfill
	Water (to on-site treatment or off-site POTW)
	Landfill

OES[a]	Type of Discharge,[b] Air Emission,[c] or Transfer for Disposal[d]
Use of cleaning products	Fugitive air
	Water (to on-site treatment or off-site POTW), incineration, or landfill
Use of laundry products – industrial	Fugitive air
	Stack air or water (to on-site treatment or off-site POTW)
	Water (to on-site treatment or off-site POTW), incineration, or landfill
Use of laundry products – institutional	Fugitive air
	Stack air or water (to on-site treatment or off-site POTW)
	Water (to on-site treatment or off-site POTW), incineration, or landfill

[a] Table 1-1 provides the crosswalk of OES to COUs
[b] Direct discharge to surface water; indirect discharge to non-POTW; indirect discharge to POTW
[c] Emissions via fugitive air or stack air, or treatment via incineration
[d] Transfer to surface impoundment, land application, or landfills

Releases from all OESs were considered, but EPA focused on estimating high-end concentrations of D4 from the largest estimated releases for its screening level assessment of environmental and general population exposures. This means that EPA considered the concentration of D4 in a given environmental media resulting from the OES that had the highest release compared to the other OESs. The OES resulting in the highest environmental concentration of D4 varied by environmental media as shown in Table 1-3. Additionally, EPA relied on its fate assessment to determine which environmental pathways to consider. Details on the environmental partitioning and media assessment can be found in the *Draft Physical Chemistry and Fate Assessment for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025h). Briefly, based on D4's fate parameters (*e.g.*, Henry's Law constant, log K_{OC}, water solubility, fugacity modeling), EPA anticipates D4 to preferentially partition to organic carbon, which suggests that the major environmental compartments for D4 will be air, soil, biosolids, and sediment. However, because D4 is released to ambient surface water from industrial facilities and processes, incidental ingestion and dermal contact while swimming and ingestion of drinking water are possible exposure pathways. EPA quantitatively assessed D4 concentrations in surface water, sediment, ambient air, and biosolids-amended soil. D4 concentrations in groundwater resulting from releases to landfills (Section 3.2) were not quantified but discussed qualitatively because D4 is not expected to be mobile in soils.

A screening level approach for assessing general population exposure is detailed in Section 2.1. EPA used a margin of exposure (MOE) approach discussed in Section 2.2, using high-end exposure estimates (Section 2.1) to screen for potential non-cancer risks. High-end exposure estimates were defined as those associated with the industrial and commercial releases from a COU and OES that resulted in the highest environmental media concentrations. EPA assumed that if there is no risk for an individual identified as having the potential for the highest exposure associated with a COU for a given pathway of exposure, then that pathway was determined not to be a pathway of concern for the general population and was not pursued further. If any pathways were identified as a pathway of concern for the general population, further exposure assessments for that pathway would be conducted to include higher tiers of modeling when available, refinement of exposure estimates, and exposure estimates for additional subpopulations and/or COUs/OES.

Table 1-3 summarizes the exposure pathways assessed for the general population and shows which

pathways were identified as a concern. For D4, exposures to the general population via surface water, drinking water, fish ingestion, ambient air, and soil concentrations from application of biosolids were quantified. Modeled concentrations were compared to environmental monitoring data when possible. Exposures via the land pathway (landfills) were qualitatively assessed because D4 is not expected to be mobile in soils. Further description of the qualitative and quantitative assessments for each exposure pathway can be found in the sections linked in Table 1-3. As summarized in Table 1-3, biosolids, landfills, surface water, drinking water, and ambient air are not pathways of concern for D4 for highly exposed populations based on the OES leading to highest concentrations of D4 in environmental media. Fish ingestion is a pathway of concern.

Table 1-3. Exposure Pathways Assessed for General Population Screening level Assessment

OES[a]	Exposure Pathway	Exposure Route	Exposure Scenario	Pathway of Concern[b]
All	Biosolids (Section 3.1)	Oral	Incidental ingestion to D4 in soil (Section 3.1.3)	No
All	Landfills (Section 3.2)	No specific exposure scenarios were assessed for qualitative assessments		No
Import – repackaging, HE	Surface water	Dermal	Dermal exposure to D4 in surface water during swimming (Section 5.1.1)	No
		Oral	Incidental ingestion of D4 in surface water during swimming (Section 5.1.2)	No
Import – repackaging, HE	Drinking water	Oral	Ingestion of drinking water (Section 6.1.1)	No
• Import – repackaging • Manufacturing based on CDR-reported PV • Processing as a reactant, 350 days • Manufacturing based on a generic scenario PV • Rubber compounding (neat or residual D4) • Rubber converting	Fish ingestion	Oral	Ingestion of fish for general population (Sections 7.2 and 7.3)	Yes, depending on exposure scenarios.[c] Many inputs and the variance within each input were considered.
			Ingestion of fish for subsistence fishers (Sections 7.2 and 7.3)	
			Ingestion of fish for Tribal populations (Sections 7.2 and 7.3)	
Processing as a reactant (Fugitive)	Ambient air	Inhalation	Inhalation of D4 in ambient air resulting from industrial releases (Section 9)	No
Manufacturing based on CDR-reported PV (Stack)				

HE = high-end; CDR = Chemical Data Reporting; PV = production volume
[a] Table 1-1 provides a crosswalk of industrial and commercial COUs to OES
[b] Using the MOE approach as a risk screening tool, an exposure pathway was determined to not be a pathway of concern if the MOE was equal to or exceeded the benchmark MOE of 30.
[c] Screening level assessment started with OES associated with highest surface water concentration (Import – repackaging). Additional OESs and data sources (*e.g.,* monitoring data) were considered if the screening MOE was below benchmark.

2 SCREENING LEVEL ASSESSMENT OVERVIEW

Screening level assessments are useful when there is little facility location- or scenario-specific information reasonably available. EPA began its D4 exposure assessment using a screening level approach because of the absence of location data for D4 releases. A screening level analysis relies on conservative assumptions, including default input parameters for modeling exposure, to assess exposures that would be expected to be on the high-end of the exposure distribution. Details on the use of screening- level analyses in exposure assessment can be found in EPA's *Guidelines for Human Exposure Assessment* (U.S. EPA, 2019b).

High-end exposure estimates used for screening level analyses were defined as those associated with the industrial and commercial releases from a COU and OES that resulted in the highest environmental media concentrations. Additionally, individuals with the greatest intake rate of D4 per body weight were considered to be those at the upper end of the exposure distribution. Taken together, these exposure estimates are conservative because they were determined using the highest environmental media concentrations and greatest intake rate of D4 per kilogram of body weight. These exposure estimates are also protective of individuals having less exposure either due to a lower intake rate or exposure to lower environmental media concentrations. This is explained further in Section 2.1.

For the general population screening level assessment, EPA used an MOE approach using high-end exposure estimates to determine which exposure pathways were pathways of concern for non-cancer risks. Using the MOE approach, an exposure pathway associated with a COU was determined to not be a pathway of concern if the MOE was equal to or exceeded the benchmark MOE of 30. Further details of the MOE approach are described in Section 2.2.

If there is no risk for an individual identified as having the potential for the highest exposure associated with a COU, then that pathway was determined not to be a pathway of concern. If any pathways were identified as having potential for risk to the general population, further exposure assessments for that pathway would be conducted to include higher tiers of modeling, additional subpopulations, and additional OES/COUs.

2.1 Estimating High-End Exposure

General population exposures occur when D4 is released into the environment and the environmental media is then a pathway for exposure. As described in the *Draft Environmental Release and Occupational Exposure Assessment for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025e) and summarized in Table 1-2 of this assessment, releases of D4 are expected to occur to air, water, and land. Figure 2-1 provides a graphic representation of where and in which media D4 is expected to be found due to environmental releases and the corresponding route of exposure.

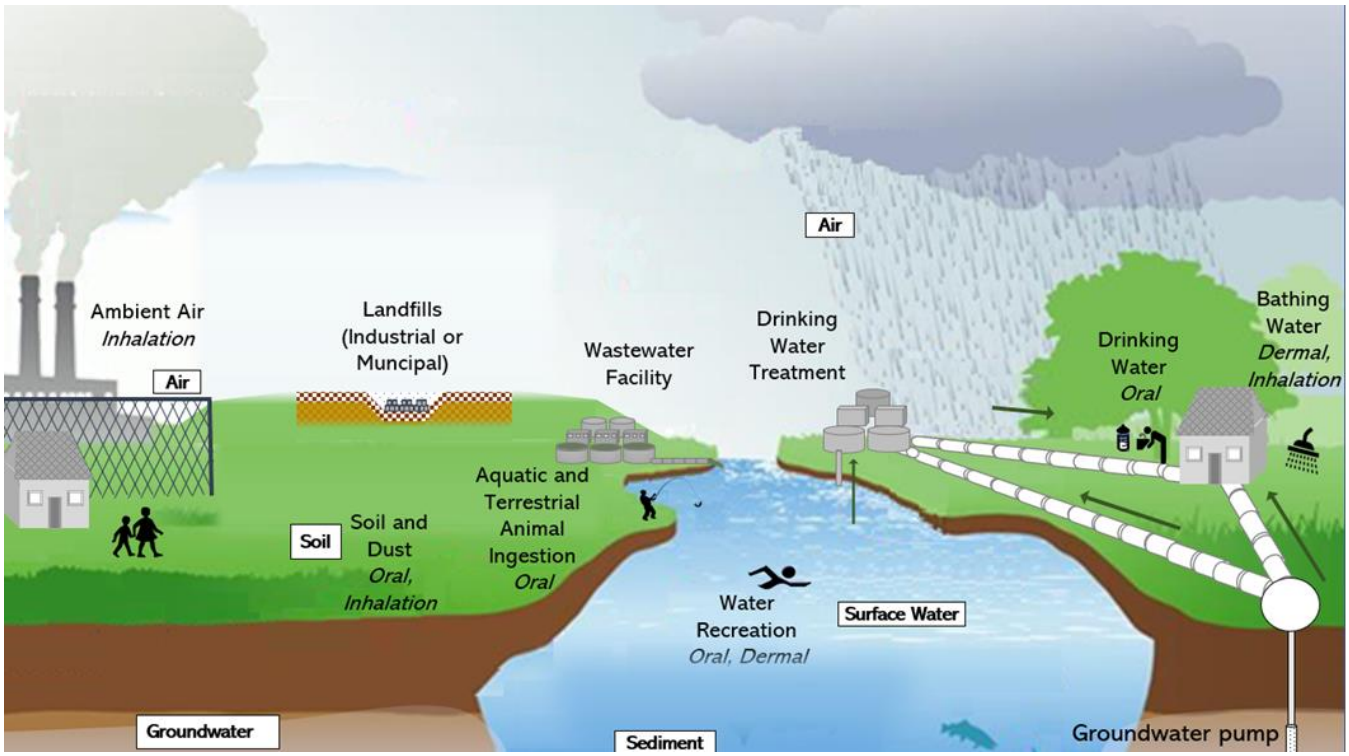


Figure 2-1. Potential Human Exposure Pathways for the General Population
The diagram presents the media (white text boxes) and routes of exposure (italics for oral, inhalation, or dermal) for the general population. Sources of drinking water from surface or water pipes is depicted with grey arrows.

For a screening level analysis, high-end exposures were estimated for each exposure pathway assessed. EPA's *Guidelines for Human Exposure Assessment* defined high-end exposure estimates as a "plausible estimate of individual exposure for those individuals at the upper end of an exposure distribution, the intent of which is to convey an estimate of exposure in the upper range of the distribution while avoiding estimates that are beyond the true distribution" (U.S. EPA, 2019b). If risk is not found for these individuals with high-end exposure, no risk is anticipated for central tendency exposures, which is defined as "an estimate of individuals in the middle of the distribution."

Identifying individuals at the upper end of an exposure distribution included consideration of high-end exposure scenarios defined as those associated with the industrial and commercial releases from a COU and OES that resulted in the highest environmental media concentrations. Additionally, individuals with the greatest intake rate of D4 per body weight were considered to be those at the upper end of the exposure. Intake rate and body weight are dependent on life stage as shown in Appendix A.

Table 2-2 summarizes the high-end exposure scenarios that were considered in the screening level analysis including the life stage assessed as the most potentially exposed population based on intake rate and body weight. Exposure scenarios were assessed quantitatively only when environmental media concentrations were quantified for the appropriate exposure scenario. Because D4 environmental releases from landfills and landfill leachate (and therefore, resulting groundwater concentrations) were not quantified, exposure from groundwater resulting from D4 release to the environment via landfill leachate was not quantitatively assessed. However, the scenarios were assessed qualitatively for exposures potentially resulting from landfills.

Table 2-1. Exposure Scenarios Assessed in Risk Screening for D4

OES[a]	Exposure Pathway	Exposure Route	Exposure Scenario	Life Stage	Analysis (Quantitative or Qualitative)
Formulation of adhesives and sealants (neat D4)	Biosolids	Oral	Incidental ingestion of D4 in soil	Children	Quantitative, Section 3.1.3
All	Landfills	No specific exposure scenarios were assessed for qualitative assessments			Qualitative, Section 3.2
All	Biogas	No specific exposure scenarios were assessed for qualitative assessments			Qualitative, Section 3.3
Import – repackaging, HE	Surface water	Dermal	Dermal exposure to D4 in surface water during swimming	Adult, youth, and children	Quantitative, Section 5.1.1
		Oral	Incidental ingestion of D4 in surface water during swimming	Adult, youth, and children	Quantitative, Section 5.1.2
Import – repackaging, HE	Drinking water	Oral	Ingestion of drinking water	Adult, youth, and children	Quantitative, Section 6.1.1
• Import – repackaging, HE • Manufacturing based on CDR-reported PV • Processing as a reactant, 350 days • Manufacturing based on a generic scenario PV • Rubber compounding (neat or residual D4) • Rubber converting • Use of fabric finishing products	Fish ingestion	Oral	Ingestion of fish for general population	Adult and toddlers (1 to <2 years)	Quantitative, Section 7
			Ingestion of fish for subsistence fishers	Adult	Quantitative, Section 7
			Ingestion of fish for Tribal populations	Adult	Quantitative, Section 7
Processing as a reactant (fugitive)	Ambient air	Inhalation	Inhalation of D4 in ambient air resulting from industrial releases	All	Quantitative, Section 9
Manufacturing based on CDR-reported PV (stack)					

HE = high-end; CDR = Chemical Data Reporting; PV = production volume
[a] Table 1-1 provides a crosswalk of industrial and commercial COUs to OES

As part of the general population exposure assessment, EPA considered fenceline populations in proximity to releasing facilities as part of the ambient air exposure assessment by using pre-screening methodology described in EPA's *Draft TSCA Screening Level Approach for Assessing Ambient Air and Water Exposures to Fenceline Communities (Version 1.0)* (U.S. EPA, 2022) (also referred to as the "Draft Fenceline report"). For other exposure pathways, EPA's screening method assessing high-end exposure scenarios used release data that reflect exposures expected to occur in proximity to releasing facilities, which would include fenceline populations.

Modeled soil concentrations from biosolids application were used to estimate oral (Section 3.1.3) exposures. Modeled surface water concentrations (Section 4.1) were used to estimate incidental dermal exposures (Section 5.1.1) and incidental oral exposures (Section 5.1.2) during swimming, oral drinking water exposures (Section 6.1.1), and fish ingestion exposure (Section 7). Modeled ambient air concentrations (Section 8.1) were used to estimate inhalation exposures.

If any pathways were identified as a pathway of concern for the general population, further exposure assessments for that pathway would be conducted to include higher tiers of modeling when available and exposure estimates for additional subpopulations and COUs.

2.2 Margin of Exposure Approach

EPA used an MOE approach using high-end exposure estimates to determine if the pathway analyzed is a pathway of concern. The MOE is the ratio of the non-cancer hazard value (or point of departure [POD]) divided by a human exposure dose. Acute, intermediate, and chronic MOEs for non-cancer inhalation and dermal risks were calculated using the following equation:

Equation 2-1. Margin of Exposure Calculation

$$MOE = \frac{Non-cancer\ Hazard\ Value\ (POD)}{Human\ Exposure}$$

Where:

MOE	=	Margin of exposure for acute, short-term, or chronic risk comparison (unitless)
$Non-cancer\ Hazard\ Value\ (POD)$	=	Human equivalent concentration (HEC, mg/m^3) or human equivalent dose (HED, in units of mg/kg-day)
$Human\ Exposure$	=	Exposure estimate (mg/m^3 or mg/kg-day)

MOE risk estimates may be interpreted in relation to benchmark MOEs. Benchmark MOEs are typically the total uncertainty factor for each non-cancer POD. The MOE estimate is interpreted as a human health risk of concern if the MOE estimate is less than the benchmark MOE (*i.e.*, the total uncertainty factor). On the other hand, for this screening analysis, if the MOE estimate is equal to or exceeds the benchmark MOE, the exposure pathway is not analyzed further. Typically, the larger the MOE, the more unlikely it is that a non-cancer adverse effect occurs relative to the benchmark. When determining whether a chemical substance presents unreasonable risk to human health or the environment, calculated risk estimates are not "bright-line" indicators of unreasonable risk, and EPA has the discretion to consider other risk-related factors in addition to risks identified in the risk characterization.

EPA did not identify human data examining cancer from exposure to D4 as detailed in the *Draft Human Health Hazard Assessment for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025g). EPA concluded that there is only *suggestive evidence of carcinogenic potential.* Hazard values were based on a single non-cancer effect and were used to screen for risks. EPA's choice of human equivalent concentrations (HECs) and human equivalent doses (HEDs) differed depending on exposure duration, with one set of HECs/HEDs for acute and a second set for intermediate exposure and chronic scenarios (Table 2-2). HECs are based on daily continuous (24-hour) exposure and HEDs are daily values.

Table 2-2. Non-Cancer HECs and HEDs Used to Estimate Risks

Exposure Route	Units	Acute (1 day)	Intermediate (30 days)/Chronic (Steady State)	Benchmark MOE	Critical Endpoint
Inhalation	mg/m^3	107	55.8	30 *[UF_A = 3 UF_H = 10]*	Decreased mean live litter size in a 2-generation reproductive inhalation study (WIL Research, 2001)
	ppm	8.82	4.60		
Oral	mg/kg-bw/day	8.93	3.60		
Dermal (unoccluded)		394	326		
Dermal (occluded)		216	179		

Using the MOE approach in a screening level analysis, an exposure pathway associated with a COU was determined to not be a pathway of concern for non-cancer risk if the MOE was equal to or exceeded the benchmark MOE of 30.

3 LAND PATHWAY

D4 exposure from each land pathway (*i.e.*, biosolids, landfills, and biogas) was assessed following a fit-for-purpose approach based on the amount and quality of reasonably available information for each pathway. D4 may be present in biosolids, landfills, and biogas resulting from commercial and consumer uses of D4 (see Table 1-2 for expected media of release for the relevant TSCA COUs).

Release information from reporting databases (*e.g.*, the Toxics Release Inventory [TRI] and Discharge Monitoring Report [DMR]) was not available for D4. EPA searched peer-reviewed literature, gray literature, and databases of environmental monitoring data identified during systematic review to obtain concentrations of D4 in terrestrial land pathways (*i.e.*, biosolids, wastewater sludge, agricultural soils, landfills, landfill leachate, and biogas). D4 concentrations in biosolids resulting from non-industrial and industrial (known to include D4) wastewater treatment are available in the ECA (SEHSC, 2021; ERM, 2017a). The ECA does not have a study quality metric because it was not reviewed as part of the systematic review process. However, the environmental testing program undertaken by the signatory companies was conducted in accordance with a Study Plan and Quality Assurance Project Plan that EPA reviewed and approved. The quality of data in the ECA is thus high.

The data provided by the ECA, while valuable for indicating possible concentrations of D4 in biosolids in the United States, do not comprise all TSCA COUs and respective exposure scenarios. Therefore, EPA also modeled the D4 concentration in biosolids resulting from estimated releases to WWTPs, as described in *Draft Environmental Release and Occupational Exposure Assessment for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025e). Using the modeled biosolids concentrations from release estimates as well as ECA biosolids concentrations, EPA modeled resulting soil concentrations from the TSCA COUs presented in Table 1-1 via biosolids application. Because of this, exposure of D4 to the general population from incidental ingestion of soil was assessed quantitatively using a screening approach as outlined in Section 2.

No monitoring data were available from a review of government regulatory and reporting databases related to landfills or biogas. Several non-U.S. academic experimental and field studies have identified D4 in landfill leachate and biogas (Xu et al., 2017; Raich-Montiu et al., 2014; Piechota et al., 2013; Cheng et al., 2011; Badjagbo et al., 2010; Rasi et al., 2010; Badjagbo et al., 2009; Kaj et al., 2005b; Wang et al., 2001; Schweigkofler and Niessner, 1999). Because of differing uses of siloxanes outside of the United States, EPA cannot associate these D4 media concentrations from the reviewed studies to specific releases associated with D4 TSCA COUs. As such, the present assessments of D4 exposure via landfills and biogas are qualitative, relying on the fate and physical and chemical characteristics of D4. When possible, data from the existing literature including experimental and field data were used to support the qualitative assessment.

Section 3.1.1 presents a summary of the available monitoring data for D4 in biosolids. Section 3.1.2 presents the EPA modeled soil concentrations resulting from biosolids application. Section 3.1.3 presents the screening level risk estimates of general population exposure to D4 via incidental ingestion of biosolids-amended soil. Sections 3.2 and 3.3 present the qualitative assessments of D4 exposures via landfills and biogas, respectively.

3.1 Biosolids

"Biosolids" refers to treated sludge that meet the EPA pollutant and pathogen requirements for land application and surface disposal and can be beneficially recycled (40 CFR part 503) (U.S. EPA, 1993). Biosolids generated during the treatment of industrial and municipal wastewater may be applied to

agricultural fields or pastures as fertilizer in either its dewatered form or as a water-biosolid slurry. Biosolids that are not applied to agricultural fields or pastures may be disposed of by incineration or landfill. Landfill disposal will be discussed in further depth in Section 3.2. D4 may be introduced to biosolids by the absorption or adsorption of D4 to particulate or organic material during wastewater treatment and is expected to be a primary removal mechanism. Based on empirical studies conducted in the United States, wastewater treatment is expected to remove between 88 to 98 percent of D4 via both volatilization/air stripping and sorption processes (Wang et al., 2015a; Wang et al., 2013; Hydroqual, 1993). The STPWIN™ model in EPI Suite™ predicts greater than 99 percent removal of D4 in wastewater treatment assuming no biodegradation, with approximately 60 percent and 40 percent removal due to sorption to sludge and volatilization, respectively (U.S. EPA, 2017a). The relative contributions of volatilization and sorption may vary among treatment systems, as discussed in the *Draft Environmental Release and Occupational Exposure Assessment for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025e). Because D4 is highly likely to be present in biosolids that are applied to soil, EPA performed a quantitative, screening level assessment of exposure to general populations via incidental ingestion of biosolids-amended soil. Estimated soil concentrations of D4 in biosolids-amended soil are also used to assess exposure to terrestrial organisms, as presented in the *Draft Environmental Exposure Assessment for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025c).

3.1.1 Measured Concentrations in Sludge and Biosolids

Data on D4 concentrations in sludge and biosolids from WWTPs in the United States are very limited. D4 concentrations in biosolids resulting from non-industrial and industrial (siloxane) wastewater treatment are available in the final report of the ECA (SEHSC, 2021; ERM, 2017a). Briefly, D4 concentrations in biosolids from non-industrial WWTPs ranged from 55 to 659 µg/kg dry weight (dw), while those from industrial WWTPs ranged from 455 to 6,160 µg/kg dw (SEHSC, 2021; ERM, 2017a). Because these biosolids concentrations are from known industrial facilities relevant to TSCA COUs, there is more confidence in the representativeness of these data over the other monitoring data that are summarized below. A summary of D4 concentrations in biosolids provided as part of the ECA are available in the *Draft Biosolids-Amended Soil Concentration Results and Risk Calculations for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025b).

The remaining available information on D4 concentration in sludge in North America is limited to two studies reporting D4 concentrations ranging from 200 to 1,770 µg/kg dw in sludge samples from WWTPs located in the United States (Zhang, 2014) and Canada (Wang et al., 2015a). All monitoring studies only provide context to modeling results and were not used as part of the analysis for quantifying exposure estimates.

Five studies were identified that report measured D4 concentrations in sludge from European countries. Bletsou et al. (2013) reported D4 concentrations of 90 to 130 µg/kg dw from one WWTP in Greece, with a mean of 110 µg/kg. D4 was measured in three Swedish WWTPs treating wastewater from a mixture of industries resulting in sludge concentrations of 280 to 430 µg/kg (Olofsson et al., 2013). Two studies reported sludge concentrations in Norwegian WWTPs: as part of a monitoring survey of the Oslofjord, Norway, D4 concentrations in sludge from two wastewater treatment plants ranged from <180 and 2,700 µg/kg dw (Schlabach et al., 2007). A more recent screening of suspected PBTs in Norway reported a range of 22 to 63 µg/kg dw from two WWTPs (COWI AS, 2018). Similarly, Kaj et al. (2005b) reported sludge concentrations ranging from 96 to 960 µg/kg dw, with a mean of 414.7 µg/kg dw from a survey of various Nordic countries.

Six studies were identified reporting D4 concentrations in sludge and biosolids from WWTPs in Asia. In sludge collected from WWTPs located along the Songhua River, China, D4 ranged from 41.8 to 103

µg/kg dw (Zhang et al., 2011). Slightly greater concentrations ranging from 400 to 900 µg/kg dw were measured in excess and aerobic sludge from a large WWTP in Harbin, China treating 80 percent municipal/20 percent industrial wastewater (Li et al., 2016). Similarly, a mean D4 concentration range of 423 to 2,260 µg/kg dw was reported in sludge from a municipal WWTP that discharges to the Bohai Sea (Wang et al., 2015b). Shi et al.(2015) reported large total cVMS (D4, D5, and D6) concentrations across three different oil production WWTPs ranging from 1.67×10^4 to 2.33×10^5 µg/kg dw, of which D4 typically represented less than 10 percent of the cVMS mass. Last, Horii et al. (2019) reported D4 concentrations ranging from 170 to 560 µg/kg wet weight (ww) from nine conventional WWTPs in Japan.

Based on monitoring studies, D4 is expected to be present in sludge from municipal and mixed WWTPs at concentrations on the order of approximately 10 to 10^3 µg/kg dw, with elevated concentrations possible at WWTPs treating industrial waste. However, for the purposes of this risk evaluation, monitoring values collected in the United States provided by the ECA are carried forward as part of the exposure and risk screening.

3.1.2 Modeling Approach for Estimating D4 Concentrations in Biosolids-Amended Soil

Estimation of D4 Concentration in Biosolids using SimpleTreat

SimpleTreat v. 4.1.0 (RIVM, 2015) was used to estimate the concentration of D4 in sludge following wastewater treatment. SimpleTreat is a tool that models the fate of chemicals in conventional wastewater treatment that accounts for processes including volatilization, mixing, adsorption to sludge, and biodegradation. The high-end daily release estimate for the top-releasing OES discharging to on-site treatment or POTWs (Formulation of Adhesives and Sealants [Neat D4]) was inputted to SimpleTreat to represent the high-end, conservative release scenario. This release estimate is based on the upper-bound PV of 500,000,000 lb per year. Physical and chemical characteristics for D4 presented in the *Draft Physical Chemistry and Fate Assessment for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025h) were also used as inputs to SimpleTreat and are presented in *Draft Biosolids-Amended Soil Concentration Results and Risk Calculations for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025b). Briefly, a vapor pressure of 124.48 Pa, Henry's law constant (HLC) of 1.2×10^6 Pa-m^3/mole, K_{OC} of 16,032 L/kg, and a K_{OW} 3.08×10^6 were used for D4 (U.S. EPA, 2025h). Default WWTP mode of operation parameters were kept at default values for a municipal WWTP facility (RIVM, 2015).

The combined sludge concentration (*i.e.*, primary sludge and surplus sludge) outputted from SimpleTreat was used as an input to the Biosolids Tool v.1 (BST) (U.S. EPA, 2023) to estimate corresponding soil concentrations under generic biosolids application scenarios: here, the sludge concentration of D4 modeled with SimpleTreat was used directly as a biosolids concentration, therefore assuming no pretreatment of the sludge prior to becoming land-applicable biosolids. Because sludge designated for biosolids application is expected to be treated as per 40 CFR part 503 (U.S. EPA, 1993), this approach provides a conservative estimate of the amount of D4 reaching the application site, as abiotic transport/degradation expected during sludge treatment (*e.g.*, hydrolysis, volatilization) has not been accounted for. The outputted combined sludge concentration from SimpleTreat is 57,049 mg/kg dw. For comparison, the ranges of D4 concentration in biosolids reported in the ECA are 0.455 to 6.16 mg/kg from POTWs treating industrial wastewater and from 0.055 to 0.659 mg/kg from POTWs treating non-industrial POTWs (SEHSC, 2021; ERM, 2017a). Complete results are available in the *Draft Biosolids-Amended Soil Concentration Results and Risk Calculations for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025b).

Estimation of D4 Concentration in Biosolids-Amended Soil using Biosolids Tool (BST)

BST was leveraged to estimate D4 soil concentrations resulting from biosolids application (U.S. EPA, 2023). In addition to the modeled biosolids concentration of D4 resulting from the highest-releasing OES (Formulation of adhesives and sealants [neat D4]), both the mean and the 95th percentile biosolids concentrations from industrial and non-industrial WWTPs provided in the ECA were used as biosolid concentration inputs to BST. The following discussion presents only the 95th percentile information for this screening level assessment. Complete results are available in the *Draft Biosolids-Amended Soil Concentration Results and Risk Calculations for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025b).

Two land application scenarios were run for each of the high-end biosolids concentrations to determine D4 concentrations relevant for incidental ingestion exposure: (1) Crop: default biosolids application rate of 10 metric tons (MT) dw per hectare per application *with* tilling; and (2) Pasture: biosolids application rate of 10 MT dw hectare per application *without* tilling (U.S. EPA, 2023). The land application mode was used as this scenario represents biosolids application under agronomic operating conditions. Additionally, three different climate scenarios (average, dry, and wet) were applied to assess the impact of precipitation on the persistence of D4 in the biosolids-amended soil. The physical and chemical properties for D4 used in the SimpleTreat model were also applied in the BST. Additionally, because hydrolysis is the main degradation mechanism for D4 in soil, the average of the hydrolysis rates reported by Durham et al. (2005) and Gatidou et al. (2016) at pH 7 was used as a first-order hydrolysis rate (Kh) for D4 in the pore water of the soil compartment. The remaining parameters were kept at their default values (U.S. EPA, 2023). A summary of the modeled soil concentrations resulting from biosolids-amendment under the average climate scenarios is provided in Table 3-1.

Table 3-1. Summary of High-end Estimates of D4 Concentrations in Biosolids and Biosolids-Amended Soil

Data Source/OES[a]	Sampling Location	D4 Biosolids Concentration (mg/kg dw)	Soil Concentration (mg/kg dw)[b]	
			Crop (Till)	Pasture (No-Till)
Formulation of adhesives and sealants (neat D4)	N/A (modeled from estimated releases)	57,049	0.7676[c]	1.876[c]
Industrial WWTPs *95th percentile* (SEHSC, 2021; ERM, 2017a)	United States, Industrial WWTPs (n = 5)	5.407	7.22E–05	1.76E–04
Non-industrial WWTPs *95th percentile* (SEHSC, 2021; ERM, 2017a)	United States, Non-industrial WWTPs (n = 5)	0.6364	8.50E–06	2.08E–05

[a] Table 1-1 provides the crosswalk of OES to COUs
[b] Soil concentrations presented were calculated from 'Average' climate years. Complete BST outputs are presented in *Draft Biosolids-Amended Soil Concentration Results and Risk Calculations for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025b).
[c] The solubility limit of D4 was exceeded in the model run. Therefore, there is lower confidence in the value of these concentrations. This does not reduce confidence in the protectiveness of the screening approach.

A comparison of the modeled D4 concentration of 57,049 mg/kg dw in biosolids to monitoring information presented in Section 3.1.1 indicates that the model likely overestimates D4 levels in biosolids. Additionally, modeled soil concentrations using the high-end screening scenario are much greater than D4 concentrations reported in biosolids-amended soil from experimental and commercial agricultural soils in Canada (<0.008–0.017 mg/kg dw (Wang et al., 2013)). While there is low

confidence in the magnitude of the modeled D4 biosolids concentration (and therefore the soil concentration), the modeled value is several orders of magnitude greater than the D4 concentrations in biosolids reported in the ECA.

Once in soil, D4 is expected to have minimal persistence. With a low water solubility (0.056 mg/L at 23 °C) (NCBI, 2021; Varaprath et al., 1996; Dow Corning, 1991) and affinity for sorption to organic matter in soil (log K_{OC} = 4.19–4.22 at 24.4–24.8 °C) (Kozerski et al., 2014; Miller and Kozerski, 2007), D4 is unlikely to migrate to groundwater and surface water via runoff after land application of biosolids. D4 in soil is expected to undergo appreciable volatilization and hydrolysis, with the relative contributions of hydrolytic and volatilization processes to D4 depending on the mineralogy of the soil and the percentage of relative humidity (soil moisture) (Xu, 2007; Xu and Chandra, 1999). As mentioned above, both volatilization and hydrolysis of D4 in biosolids-amended soil are accounted for in the BST model (U.S. EPA, 2023). Additional details on the fate of D4 in soil are available in the *Draft Physical Chemistry and Fate Assessment for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025h).

3.1.3 Oral Incidental Ingestion Exposure

The general population may come into contact with soil affected by D4 contamination from the application of D4-containing biosolids. A conservative screening approach as described in Section 2 was used to assess potential risk to the general population via incidental ingestion of biosolids-amended soil containing D4. The following equations were used to calculate incidental ingestion doses:

Equation 3-1. Acute Incidental Soil Ingestion Calculation

$$ADR = \frac{(C_{soil} \times IR \times CF)}{(BW \times AT_{EF})}$$

Where:

ADR	=	Acute dose rate (mg/kg-day)
C_{soil}	=	Soil concentration (mg/kg)
IR	=	Ingestion rate (mg/day)
CF	=	Conversion factor (1×10^{-6} kg/mg)
BW	=	Body weight (kg)
AT_{EF}	=	Exposure factor averaging time (years)

Equation 3-2. Average Daily Incidental Soil Ingestion Calculation

$$ADD = \frac{(C_{soil} \times IR \times EF \times ED \times CF)}{(BW \times AT)}$$

Where:

ADD	=	Average daily dose (mg/kg-day)
C_{soil}	=	Soil concentration (mg/kg)
IR	=	Ingestion rate (mg/day)
EF	=	Exposure factor (days/year)
ED	=	Exposure duration (years)
CF	=	Conversion factor (1×10^{-6} kg/mg)
BW	=	Body weight (kg)
AT	=	Averaging time (years)

A summary of the exposure factor inputs (*e.g.*, ingestion rate) used for calculating the ADR and ADD are available in Appendix A and in the *Draft Biosolids-Amended Soil Concentration Results and Risk Calculations for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025b). As part of the screening approach, EPA used the parameters for the greatest ingestion rate-to-body weight ratio to calculate upper-bound acute and chronic exposure values. In this case, an ingestion rate (IR) of 200 (mg/day) was used for infants (6 months to <12 months), with a correlating body weight (BW) of 9.2 kg. The number of years within an age group (*i.e.*, 6 months for infants) was used for the exposure duration and averaging time to estimate non-cancer exposure. The exposures calculated using the highest releasing OES and the monitored biosolids concentrations from the ECA are presented in Table 3-2. Corresponding screening level risk estimates are shown in Appendix B. No MOEs were below the benchmark. Therefore, incidental ingestion of biosolids-amended soil is not expected to be a pathway of concern for the general population based on the conservative screening level risk estimates using an upper-bound of exposure.

Table 3-2. Doses for Incidental Ingestion of Biosolids-Amended Soil Using Dry Climate Soil Concentration Estimates

Scenario Data Source/OES[a]	Soil Concentration (µg/kg dw)[b]	Acute ADR (mg/kg-day)	Chronic ADD (mg/kg-day)
Formulation of adhesives and sealants (neat D4) *Pasture/no till* (Engineering estimate from generic scenario)	2,185[c]	9.50E–05	1.19E–02
Industrial WWTPs *95th percentile, Pasture/no till* (SEHSC, 2021; ERM, 2017a)	2.05E–01	8.93E–09	1.12E–06
Non-industrial WWTPs *95th percentile, Pasture/no till* (SEHSC, 2021; ERM, 2017a)	2.42E–02	1.05E–09	1.31E–07

[a] Table 1-1 provides the crosswalk of OES to COUs
[b] Only pasture soil concentrations from dry climate scenarios are presented here, as these settings resulted in greater soil concentrations as compared to the other climate scenarios and the crop/till scenarios.
[c] The solubility limit of D4 was exceeded in the model run, therefore there is lower confidence in the value of these concentrations. This does not reduce confidence in the protectiveness of the screening approach.

3.1.4 Weight of Scientific Evidence Conclusions

There is considerable uncertainty in the applicability of generic release scenarios and wastewater treatment plant modeling software to estimate concentrations of D4 in biosolids. Any limitations and uncertainties of the estimated releases described in the *Draft Environmental Release and Occupational Exposure Assessment for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025e) are carried over to this biosolids assessment. Additionally, there is uncertainty in the relevance of the biosolids monitoring data to the COUs considered in this evaluation, as there are several known non-TSCA uses of D4 that result in releases to WWTPs and thus contribute to biosolids concentrations. However, because EPA used conservative model inputs and obtained D4 concentrations well above monitoring values, EPA has high confidence in the protectiveness of the screening level risk assessment. Overall, due to the high confidence in the protectiveness of the screening level risk estimates, there is robust confidence that exposure to D4 through incidental ingestion of biosolids-amended soil is not expected to be a pathway of concern for the general population.

3.2 Landfills

With a water solubility of 0.056 mg/L at 23 °C (NCBI, 2021; Varaprath et al., 1996; Dow Corning, 1991) and a high affinity for sorption to organic matter in soil (log K_{OC} = 4.19–4.22 at 24.4–24.8 °C) (Kozerski et al., 2014; Miller and Kozerski, 2007), D4 is unlikely to migrate to groundwater or surface water via runoff from landfills or in leachate (U.S. EPA, 2025h). D4 is not listed under Subtitle C of the Resource Conservation and Recovery Act (RCRA) (40 CFR 261). D4 may be disposed into landfills through various waste streams such as consumer waste, residential waste, industrial waste, and municipal waste including dewatered wastewater biosolids. No studies were identified through systematic review determining the concentration of D4 in waste entering landfills. Similarly, no landfill leachate or groundwater monitoring studies were identified for D4 in the United States. Because of very limited reasonably available information on the occurrence and fate of D4 in landfills, D4 exposure via landfills was assessed qualitatively using high-quality physical and chemical data, as well as limited non-U.S. monitoring studies.

Because D4 is highly volatile from both dry (vapor pressure 0.9338 mm Hg at 25 °C (Lei et al., 2010)) and wet (HLC of 11.8 atm·m^3/mol at 21.7 °C (Xu and Kropscott, 2014, 2012)) surfaces, a substantial portion of D4 in landfill waste is expected to partition to air, for example, via biogas (see Section 3.3). Moreover, D4 is slightly soluble in water (0.056 mg/L 23 °C (U.S. EPA, 2025h)) and has a strong affinity for sorption to organic matter (log K_{OC} = 4.19–4.22 at 24.4–24.8 °C) (Kozerski et al., 2014; Miller and Kozerski, 2007)): although not an exact match for a typical soil matrix, some level of sorption to organic matter present in landfill materials is also expected. Therefore, only a small portion of D4 is expected to be present in landfill leachate. Once in soils, D4 is expected to dissipate via abiotic processes such as hydrolysis and volatilization (see the *Draft Physical Chemistry and Fate Assessment for Octamethylcyclotetrasiloxane (D4)* for additional detail on the fate of D4 in soil (U.S. EPA, 2025h)).

Two studies were identified reporting D4 in landfill leachates from outside the United States. The measured concentrations identified through systematic review were only used to provide context to modeling results and not to quantify exposure estimates. One study of siloxanes in six Nordic countries (Denmark, Finland, Faroe Islands, Iceland, Norway, Sweden) reported that D4 was detected at a concentration of 1.1 µg/L in leachate from the Alfsnes Landfill near Reykjavík, Iceland but was not detected in leachate from the remaining nine landfill sites (Kaj et al., 2005b). D4 was also measured in concentrations ranging from 0.338 to 7.18 µg/L in influent leachate to a leachate storage pond at a municipal landfill in the Shandong province, China (Xu et al., 2017). As highlighted above, EPA cannot associate these D4 leachate concentrations from the reviewed studies to specific releases associated with D4 TSCA COUs due to differing uses of siloxanes outside of the United States.

Limited foreign studies reported D4 concentrations in landfill leachate at low levels. Overall, monitoring studies are still consistent with expectations that D4 is unlikely to be present in landfill leachate in elevated concentrations and is unlikely to be mobile in soils or groundwater. Additionally, there is high uncertainty in attributing landfill concentrations of D4 to TSCA COU sources. Therefore, modeling of groundwater contamination due to landfill leachate containing D4 was not performed. Because D4 is not expected to be transported from landfills to other terrestrial media, exposures to the general population are expected to be negligible. Therefore, EPA concludes that further assessment of D4 in landfill leachate is not informative, and exposure to D4 from landfills is not expected to be a pathway of concern for the general population.

3.2.1 Weight of Scientific Evidence Conclusions

There is uncertainty in the relevancy of the landfill leachate monitoring data to the TSCA COUs considered in this evaluation. Based on vapor pressure and Henry's law constant of D4, there is high

confidence that D4 will partition to air from liquids and solids present in landfills. Because of this, D4 is expected to be present in landfill biogas as discussed in Section 3.3. Following the assessment of high-quality physical and chemical property data, there is robust confidence that D4 is unlikely to be present at elevated concentrations in leachate and is unlikely to be mobile in soils or groundwater. Therefore, there is moderate to robust confidence that exposure to D4 from landfills is not expected to be a pathway of concern for the general population.

3.3 Biogas

Biogas is formed when organic matter undergoes anaerobic degradation that primarily produces methane and carbon dioxide. As such, biogas is produced in landfills and in anaerobic sludge digesters following wastewater treatment. EPA expects D4 to be present in the biogases produced in landfills and wastewater/sludge treatment processes, as D4 will preferentially partition to the gaseous phase due to its Henry's law constant of 11.8 atm·m^3/mol at 21.7 °C (Xu and Kropscott, 2014, 2012). In systems open to the air (*e.g.*, above uncovered treatment basins or stabilization ponds), biogas can be a point source of D4. Biogas collected from engineered, closed systems (*e.g.*, anaerobic digesters, landfill extraction well systems) may be disposed of via incineration or further purified and combusted to produce energy.

EPA did not identify any experimental or monitoring data from the United States providing D4 concentrations in biogas. However, the Agency identified nine peer-reviewed studies reporting both ambient and raw biogas concentrations in several countries in Canada, Europe, and Asia. For the purposes of this risk evaluation, biogas measurements labeled as "ambient" were taken on-site at a WWTP or landfill, though not from a biogas production or collection system. Exposure to ambient biogas is expected for populations that access WWTP and/or landfill facilities. Biogas measurements labeled "raw" indicate measurements were taken directly from a biogas system, such as an anaerobic sludge digester or a landfill biogas extraction well system.

The reasonably available information on D4 concentrations in biogas is presented in Table 3-3. The measured concentrations identified through systematic review were only used to provide context to modeling results and not to quantify exposure estimates. Briefly, raw biogas produced from the anaerobic digestion of sludge at WWTPs ranged from 30 to approximately 10,100 µg/m^3, while ambient samples collected from around the WWTPs were much lower (0.29–4.0 µg/m^3) (Raich-Montiu et al., 2014; Piechota et al., 2013; Rasi et al., 2010; Kaj et al., 2005b; Wang et al., 2001; Schweigkofler and Niessner, 1999). Similarly, D4 concentrations collected from biogas collection and extraction systems in landfills ranged from less than 0.67 to approximately 29,100 µg/m^3, whereas ambient landfill D4 concentrations ranged from 0.08 to 17.5 µg/m^3 (Xu et al., 2017; Piechota et al., 2013; Cheng et al., 2011; Badjagbo et al., 2010; Rasi et al., 2010; Badjagbo et al., 2009; Kaj et al., 2005b; Wang et al., 2001; Schweigkofler and Niessner, 1999). While informative of the fate of D4 in landfill and sludge digestion systems, D4 concentrations in biogas from non-U.S. facilities may not be directly applied to this risk evaluation due to differing chemical use patterns, as well as differing waste management regulations that impact D4 emissions.

Table 3-3. Summary of D4 Concentrations in Biogas from Monitoring Studies

Facility Type	Sample Type	Reference[a]	Country	D4 Concentration (µg/m^3)	Sampling Notes
Landfill	Ambient	Wang et al. (2001)	China	Mean ± SD (Range): 11.4 ± 5.5 (2.2–17.5)	Sampled at the active, municipal Datianshan landfill

Facility Type	Sample Type	Reference[a]	Country	D4 Concentration (µg/m³)	Sampling Notes
		Kaj et al. (2005b)	Finland	0.29	Sampled at the Ämmässuo landfill near the large leachate pool
			Sweden	Range: 0.08–0.09	Sampled on upwind side of the municipal Högbytorp landfill
		Cheng et al. (2011)	Canada	Range: 0.471–1.840	Sampled at active landfills (n = 2) in Ontario
	Raw	Schweigkofler and Niessner (1999)	Germany	Range: 4,240–8,840	Sampled from domestic/non-industrial landfills (n = 2; age not specified) in Augsburg and Munich; raw biogas assumed given context of study for use in energy production
		Badjagbo et al. (2009)	Canada	Mean range: 257–7,851	Sampled from biogas extraction wells at a municipal landfill in Montreal, including inactive areas
		Badjagbo et al. (2010)	Canada	Range: 131–1,275	Sampled from biogas extraction wells at a landfill in Montreal
		Rasi et al. (2010)	Finland	Range: <0.67–670	Sampled from biogas collection pipes at active, municipal (industrial and domestic) landfills (n = 4)
		Piechota et al. (2013)	Germany and Poland	Mean range: 3,600–29,100	Sampled from the main pipes of the biogas extraction well systems of active municipal landfills (n = 4)
		Xu et al. (2017)	China	Range: 753–2,330	Sampled from biogas exhaust pipe at an active, municipal landfill in Shandong Province
WWTP	Ambient	Wang et al. (2001)	China	Mean ± SD (Range): 10.3 ± 5.6 (3.0–16.2)	Sampled at a WWTP in Guangzhou (exact location not specified)
		Kaj et al. (2005b)	Finland	0.29	Sampled at the Nokia WWTP near the exterior effluent pools
			Denmark	0.66	Sampled at the Bjergmarken WWTP close to the aeration basins
			Faroe	4.0	Sampled at the

Facility Type	Sample Type	Reference[a]	Country	D4 Concentration (µg/m³)	Sampling Notes
			Islands		Sersjantvíkin WWTP (exact location not specified)
			Norway	1.0 and 0.85	Sampled at the Bekkelaget WWTP, 2 m above untreated and mechanically treated wastewater, respectively
	Raw	Rasi et al. (2010)	Finland	Range: 30–870	Sampled from anaerobic sludge digesters in mesophilic municipal WWTPs (n = 4)
		Schweigkofler and Niessner (1999)	Germany	Range: 2,870–6,980	Sampled from municipal WWTPs (n = 2)
		Piechota et al. (2013)	Germany and Poland	Mean range: 500–8,100 Mean: 2,625	Sampled from anaerobic sludge digester tank prior to gas purification at WWTPs in Germany (n = 3) and Poland (n = 1)
		Raich-Montiu et al. (2014)	Spain, France, and England	Mean range: 1,500–10,100 Mean: 4,560	Sampled from the outlets of biosolids/biogas anaerobic digester tanks at WWTPs (n = 5)

[a] Measured concentrations identified through systematic review were only used to provide context to modeling results and not to quantify exposure estimates.

D4 that is released to the atmosphere from open treatment systems is expected to degrade by reaction with photochemically produced hydroxyl radicals (•OH) in the atmosphere, with a half-life ranging from 4.7 to 11.4 days (Alton and Browne, 2020; Bernard et al., 2018; Kim and Xu, 2017; Safron et al., 2015; Xiao et al., 2015; Sommerlade et al., 1993; Atkinson, 1991). Additionally, D4 has the potential to undergo long-range transport in the atmosphere. Details on the atmospheric fate and transport of D4 are available in the *Draft Physical Chemistry and Fate Assessment for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025h).

Exposure to raw biogas is expected to be limited to populations that work directly with biogas production and collection systems. Similarly, exposure to ambient levels of D4 within landfill and WWTP facilities are limited to populations that work at these facilities. Occupational exposure at these facilities is not assessed because they are not TSCA-relevant COUs for D4. D4 emissions from these facilities may not be directly attributable to TSCA COUs because of the large variety of materials and waste sent to WWTPs and landfills. Because exposure to both ambient and raw biogas is not expected for the general population, as well as very limited information on D4 in biogas relevant to TSCA COUs in the United States, exposure to D4 originating from TSCA uses in biogas is not expected to be a pathway of concern for the general population.

3.3.1 Weight of Scientific Evidence Conclusions

Based on high-quality physical and chemical property data available for D4, as well as evidence from the available monitoring data, there is high confidence that D4 will be likely present in biogas

originating from landfills and WWTPs. However, there is uncertainty in the relevance of the biogas monitoring data to the TSCA COUs considered in this evaluation. Moreover, because biogas produced in WWTP and landfill facilities are not generally open to the public, exposure to biogas is not expected for the general population. Therefore, *there is moderate to robust confidence that exposure to D4 from biogas is not expected to be a pathway of concern for the general population*.

4 SURFACE WATER CONCENTRATION

EPA conducted modeling of estimated industrial releases to surface water to assess the expected resulting environmental media concentrations from TSCA COUs presented in Table 1-1. EPA searched peer-reviewed literature, gray literature, and databases of environmental monitoring data to obtain concentrations of D4 in ambient surface water and aquatic sediments. D4 has been found in detectable concentration in both surface water and sediment. Section 4.1 reports EPA modeled surface water concentrations and modeled sediment concentrations. Section 4.2.1 includes a summary of monitoring concentrations for ambient surface water, and Section 4.2.2 includes monitoring concentrations for sediment found from the systematic review process.

4.1 Modeling Approach for Estimating Concentrations in Surface Water

EPA conducted modeling with EPA's Variable Volume Water Model (VVWM) in Point Source Calculator tool (PSC) (U.S. EPA, 2019c) to estimate concentrations of D4 within surface water and sediment. PSC inputs include physical and chemical properties of D4 (*i.e.*, K_{OW}, K_{OC}, water column half-life, photolysis half-life, hydrolysis half-life, and benthic half-life) and reported or estimated D4 releases to water (U.S. EPA, 2025d), which are used to predict receiving water column concentrations. PSC was also used to estimate D4 concentrations in settled sediment in the benthic region of streams.

Site-specific parameters influence how partitioning occurs over time. For example, the concentration of suspended sediments, water depth, and weather patterns all influence how a chemical may partition between compartments. Physical and chemical properties of the chemical itself also influence partitioning and half-lives into environmental media. D4 has a log K_{OC} of 5.17 (Panagopoulos et al., 2015), indicating a high potential to sorb to suspended particles in the water column and settled sediment in the benthic environment.

Physical, chemical, and environmental fate properties selected by EPA for this assessment were applied as inputs to the PSC model (Table 4-1). Selected values are described in detail in the *Draft Physical Chemistry and Fate Assessment for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025h).

Table 4-1. PSC Model Inputs (Chemical Parameters)

Parameter	Value[a]
K_{OC}	16,032 mL/g
Water Column Half-Life	4.15 days at 25 °C
Photolysis Half-Life	Since D4 is not expected to be susceptible to direct photolysis by sunlight, no value was provided.
Hydrolysis Half-Life	3.8 days at 25 °C
Benthic Half-Life	365 days at 25 °C
Molecular Weight	296.61 g/mol
Vapor Pressure	0.9338 torr
Water Solubility	0.056 mg/L
Henry's Law Constant	11.8 atm·m^3/mol at 21.7 °C
Heat of Henry	39,400 J/mol
Reference Temp	25 °C

[a] For details on selected values, see *Draft Physical Chemistry and Fate Assessment for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025h).

A common setup for the model environment and media parameters was applied consistently across all PSC runs. The standard EPA "farm pond" water body characteristics were used to parameterize the water column and sediment parameters (Table 4-2), which is applied consistently as a conservative screening scenario. Standardized water body geometry was also applied consistently across runs, with a standardized width of 5 m, length of 40 m, and depth of 1 m. Only the release parameters (daily release amount and days of release) and the hydrologic flow rate were changed between model runs for this chemical to reflect differences in COU scenarios.

Table 4-2. Standard EPA "Farm Pond" Waterbody Characteristics for PSC Model Input

Parameter	Value
DFAC (represents the ratio of vertical path lengths to depth as defined in EPA's exposure analysis modeling system [EXAMS]) (U.S. EPA, 2019c))	1.19
Water column suspended sediment	30 mg/L
Chlorophyll	0.005 mg/L
Water column f_{oc} (fraction of organic carbon associated with suspended sediment)	0.04
Water column dissolved organic carbon (DOC)	5.0 mg/L
Benthic depth	0.05 m
Water column biomass	0.4 mg/L
Benthic porosity	0.50
Benthic bulk density	1.35 g/cm³
Benthic f_{oc}	0.04
Benthic DOC	5.0 mg/L
Benthic biomass	0.006 g/m²
Mass transfer coefficient	0.00000001 m/s

A required input for the PSC model is the hydrologic flow rate of the receiving water body. Since there were no reported data from available sources (*e.g.*, TRI and DMR), EPA used modeling approaches to assess releases of D4 to water for all OESs (U.S. EPA, 2025e). Without TRI and DMR data, EPA cannot identify the receiving water bodies and their location-specific hydrological flow data. Thus, EPA generated a distribution of flow metrics by collecting flow data for facilities across a North American Industry Classification System (NAICS) code associated with each COU for a D4-releasing facility. Databases that were queried to develop the distribution include EPA's Enforcement and Compliance History Online (ECHO) that contains facilities with a National Pollutant Discharge Elimination System (NPDES) permit, National Hydrography Dataset Plus (NHDPlus), and NHDPlus V2.1 Flowline Network Enhanced Runoff Method (EROM) Flow. This modeled distribution of hydrological flow data is specific to an industry sector rather than a facility but provides a reasonable estimate of the distribution of location-specific values. The complete methods for retrieving and processing flow data by NAICS code are detailed in Appendix C.

A number of hydrologic flow rates were estimated from the distribution to represent higher and lower flows and to therefore capture a range of corresponding surface water concentrations. The 30Q5 flows (lowest 30-day average flow that occurs in a 5-year period) are used to estimate acute, incidental human exposure through swimming or recreational contact. The annual average flow represents long-term flow

rates, but a harmonic mean (HM) provides a more conservative estimate and is preferred for assessing potential chronic human exposure via drinking water. The harmonic mean is also used for estimating human exposure through fish ingestion because it takes time for chemical concentrations to accumulate in fish. Lastly, for aquatic or ecological exposure, a 7Q10 flow (lowest 7-day average flow that occurs in a 10-year period) is used to estimate exceedances of concentrations of concerns for aquatic life (U.S. EPA, 2007). The regression equations for deriving the harmonic mean and 7Q10 flows are provided in Appendix B. Hydrologic flows in the receiving water bodies were added to facility effluent flows because the rate of effluent can contribute a substantial amount of flow to receiving water bodies in many cases. For D4, an average minimum effluent in the generic distributions based on the available effluent data in the NAICS codes was added. The median, 75th percentile, and 90th percentile (P50, P75, P90, respectively) flows from the distribution were applied to represent variation in the potential receiving water bodies. The median (P50), 75th percentile (P75), and 90th percentile (P90) values from the distribution of each flow metric (7Q10, 30Q5, and HM) were applied as the flow rates for generic scenarios. Due to the highly skewed nature of these flow distributions, the P50 flows are considered highly conservative. Particularly for the high-end release loadings from the distribution of modeled releases in the generic scenario, EPA considers flows from the upper percentiles of the generic distribution (*i.e.*, P75 and P90) to be more appropriately paired with release estimates in this analysis (see Appendix C for more details).

Surface water releases are based on an upper-bound PV of 500,000,000 lb per year. For each COU with modeled surface water releases of wastewater effluent, surface water release values from the Import – repackaging, HE OES (OES with the highest estimated release to surface water) were used as a conservative screening analysis. The total days of release value associated with the Import – repackaging, HE OES was applied as continuous days of release per year as a conservative approach (for example, a scenario with 250 days of release per year was modeled as 250 consecutive days of release, followed by 115 days of no release per year). The highest water column concentration averaged over the number of release days (*i.e.*, 250) was used to estimate general population and aquatic exposure. Appendix C describes the methods to calculate the rolling averages.

The modeled releases were evaluated for resulting environmental media concentrations at the point of discharge (*i.e.*, in the immediate receiving water body receiving the effluent). Due to uncertainty about the prevalence of wastewater treatment from D4-releasing facilities, all modeled releases were assumed to be released to surface water without treatment. However, due to D4's volatilization and partitioning to sediment, wastewater treatment is expected to be highly effective at removing D4 from the water column prior to discharge. The mean removal efficiency reported in three U.S. and Canadian studies is 94 percent (see the *Draft Physical Chemistry and Fate Assessment for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025h). Water column, pore water and benthic sediment concentration estimates assuming the 7Q10 low hydrologic flow are presented in Table 4-3. These values are carried through to the ecological risk assessment for further evaluation as a conservative high-end approach to screen for ecological risk discussed in the *Draft Environmental Exposure Assessment for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025c).

Table 4-3. Concentrations of D4 in Water and Benthic Sediment in the Receiving Waterbody at

7Q10 Flow

OES[a]	Number of Operating Days per Year	Daily Release (kg/day)[a]	Removal Efficiency Applied (%)	7Q10 Total Water Column Concentration (µg/L)	7Q10 Benthic Pore Water Concentration (µg/L)	7Q10 Benthic Sediment Concentration (µg/kg)
Import – repackaging, HE, P50 Flow *Without Wastewater Treatment*	250	116.5	0.0	6257.7	4992.3	3,205,100
Import – repackaging, HE, P50 Flow *With Wastewater Treatment*	250	116.5	94.0	375.5	299.5	192,306
Import – repackaging, HE, P75 Flow *Without Wastewater Treatment*	250	116.5	0.0	514.2	410	263,210
Import – repackaging, HE, P75 Flow *With Wastewater Treatment*	250	116.5	94.0	30.9	24.6	15,793

7Q10 = lowest 7-day flow in a 10-year period; HE = high-end
[a] Details on operating days and daily releases are provided in the *Draft Environmental Release and Occupational Exposure Assessment for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025e)

The OES with the highest total water column concentration (Import – repackaging, HE) was additionally run under harmonic mean and 30Q5 flow conditions (Table 4-4). These additional results were selected to screen for risks to human health. Two scenarios were run for this high-end release: one without any wastewater treatment applied to reduce D4 concentrations and another with a wastewater treatment removal efficiency of 94 percent applied, reducing the modeled concentrations in the receiving water body. The D4 surface water concentration after application of the removal efficiency represents the likely human exposure to D4 in drinking water, as drinking water treatment systems are anticipated to be effective in removing D4.

Table 4-4. High-End PSC Modeling Results for Total Water Column Using a Harmonic Mean and 30Q5 Flow Based on P50 Flow Rate and

Scenario	Daily Release (kg/day)[a]	Median 30Q5 Flow (m^3/d)	Median Harmonic Mean Flow (m^3/d)	Removal Efficiency Applied (%)	Harmonic Mean Conc. (µg/L)	30Q5 Conc. (µg/L)
Import – repackaging, HE, *Without wastewater treatment*	116.5	21,932	26,235	0.0	4,428	5,294
Import – repackaging, HE, *With wastewater treatment*	116.5	21,932	26,235	94.0	266	318

30Q5 = 30 consecutive days of lowest flow over a 5-year period; HE = high-end
[a] Details on operating days and daily releases are provided in the *Draft Environmental Release and Occupational Exposure Assessment for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025e).

4.2 Measured Concentrations

4.2.1 Measured Concentrations in Surface Water

EPA identified monitoring studies through systematic review to provide context to modeling results. The monitoring studies presented here were not used as part of the analysis for quantifying exposure estimates. In the United States and Canada, concentrations of D4 in surface water were reported in three studies (ERM, 2017a, b; Wang et al., 2013; Simon and Paulson, 1985) (Table 4-5). The *D4 Environmental Testing Final Report* (ERM, 2017a, b) collected samples from 14 wastewater treatment plants (WWTPs) located in New York, Michigan, Ohio, West Virginia, Kentucky, Illinois, Kansas, Iowa, Colorado, and Oregon during two sampling events in 2016–2017. Four of the 14 sites were manufacturing/processing plants that treated wastewater on-site and discharged directly into receiving water (referred to as direct discharge or "DD" WWTPs). Five of the WWTPs received wastewater for treatment from industrial sites known to be D4 processors or formulators (referred to as indirect discharge or "I" WWTPs). The last five WWTPs received less than 15 percent of wastewater for treatment from industrial facilities that were not D4 manufacturing, processing, or formulating sites (referred to as non-industrial or "R" WWTPs). Surface water samples were collected from the midpoint of the edge of the adequately mixed zone. D4 was detected between 30 to 100 percent of the time at the direct discharge WWTPs. The highest concentration was 0.7 µg/L at the location in Friendly, WV where D4 was detected at 100 percent frequency. D4 was not detected in surface water samples from the indirect WWTPs. For the non-industrial WWTPs, D4 was found in most samples at one location during the first sampling event, but levels were below the laboratory method detection limit (<0.037 µg/L) during the second event. D4 was not detected in the remaining "R" WWTPs.

Monitoring data in the ECA were used to quantify exposure estimates but was submitted to EPA as part of this manufacturer requested risk evaluation and not identified through systematic review. Measured concentrations identified through systematic review were only used to provide context to modeling results and not to quantify exposure estimates. Simon and Paulson (1985) collected samples of final effluent from three WWTPs across the United States and reported D4 concentrations at below detection limits (<0.5 µg/L) for all sites.

Table 4-5. Summary of Measured D4 Concentrations in Surface Water from the United States and Canada

Reference	Sampling Location	D4 Concentration (µg/L)	Notes
D4 Environmental Testing Final Report (ERM, 2017a, b)[a]	United States	DD1 [FOD; median (range)] Effluent: 100%; 151 (10.9–307) Surface water: 33%; 0.015 (<0.06–0.151) DD2 [FOD; median (range)]: Effluent: 100%; 0.828 (0.288–2.51) Surface water: 50%; 0.117 (<0.06–0.425) DD3 [FOD; median (range)]: Effluent: 100%; 23.8 (1.92–54.4) Surface water: 100%; 0.221 (0.07–0.70) DD4 [FOD; median (range)]: Effluent: 100%; 1.15 (0.805–1.23)	Samples collected from media at or downstream of 14 WWTPs receiving direct ("DD") or indirect ("I") D4 discharges or other wastewater contaminants from non-industrial ("R") facilities.

Reference	Sampling Location	D4 Concentration (µg/L)	Notes
		Surface water: 100%; 0.055 (<0.06–0.146) "I" WWTPs [FOD; median (range)]: Influent: 100%; 0.434 (0.0883–17.1) Effluent: 44%; 0.030 (<0.031–0.07) Surface water: 4%; 0.020 (<0.06–0.06) "R" WWTPs [FOD; median (range)]: Influent: 100%; 0.336 (0.0963–0.866) Effluent: 40%; 0.020 (<0.031–0.148) Surface water: 14%; 0.010 (<0.06–0.275)	
Simon and Paulson (1985)	United States	Treated effluent (n = 3): ND	3 WWTPs Data study quality is medium.
Wang et al. (2013)	Canada	Range of mean across all locations Influent (n = 11): 0.282–6.69 Treated effluent (n = 11): <0.009–0.045 Receiving water (n = 11): <0.009–0.023	11 WWTPs and in receiving lakes impacted by wastewater discharges Data study quality is high.

FOD = frequency of detection; ND = non-detect; WWTP = wastewater treatment plant

[a] The ECA does not have a study quality metric because it was not reviewed as part of the systematic review process. However, the environmental testing program undertaken by the signatory companies was conducted in accordance with a Study Plan and Quality Assurance Project Plan that EPA reviewed and approved. The quality of data in the ECA is thus high.

The concentrations of D4 in surface water from nine non-U.S. studies are presented in Figure 4-1. Overall, concentrations ranged from non-detect to 0.987 µg/L from 160 samples collected between 2006 and 2017 in five countries. Location types were categorized as general population, remote, and near facility. All studies earned a high data quality rating except Hong et al. (2014) and Schlabach et al. (2007) that earned a medium. The measured concentrations identified through systematic review were only used to provide context to modeling results and not to quantify exposure estimates.

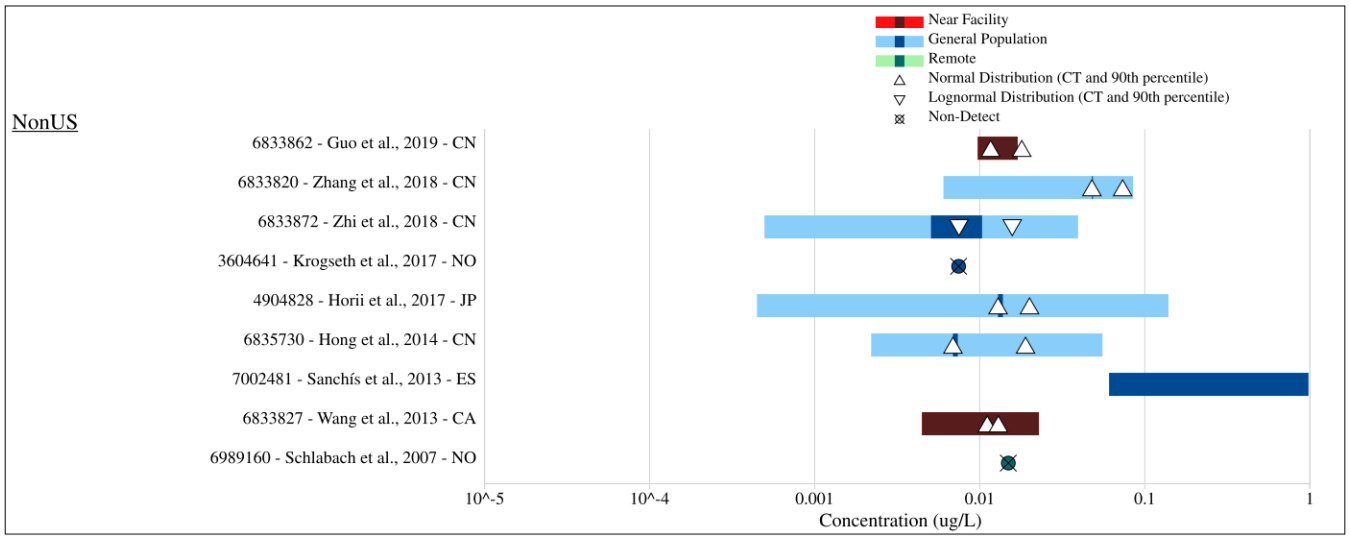


Figure 4-1. Concentrations of D4 (µg/L) in Surface Water from 2006 to 2017
Notes: CA = Canada; CN = China; ES = Spain; JP = Japan; NO = Norway. The lighter bar for each study represents the range of the reported concentrations, and the darker bar represents the range of reported central tendencies. A study with only dark bars indicates that the only data reported was a measure of central tendency.

4.2.2 Measured Concentrations in Sediment

EPA identified sediment monitoring studies through systematic review to provide context to modeling results. The monitoring studies presented here were not used as part of the analysis for quantifying exposure estimates. Five studies reported D4 concentrations in sediment from the United States and Canada (ERM, 2017a, b; Wang et al., 2013; Powell et al., 2010; Powell et al., 2009; Simon and Paulson, 1985) (Table 4-6).

Sediment samples collected as part of the ECA (ERM, 2017a, b) were collected very near, or as close as practicable, to the surface water sampling locations. D4 was detected in all sediment samples collected at the direct WWTPs. The highest levels (18,000 ng/g dw) were found at the location in Waterford, NY where samples were collected approximately 60 m downstream from the effluent outfall. Results varied for the indirect and non-industrial WWTPs. Of the ten indirect and non-industrial WWTPs, D4 was detected at a maximum concentration of 7.7 ng/g dw.

Simon and Paulson (1985) collected saltwater and freshwater sediments in areas of deposition highly impacted by human activities in the United States. D4 concentration were below detection levels (<0.5 mg/kg dw) among sediment samples collected from saltwater/estuary systems. D4 was detected in only one of the six freshwater sediment samples at 0.07 mg/kg dw.

In accordance with provisions of Section 8(e) of TSCA, Powell et al. (2009) evaluated D4 in surface sediment samples collected in Lake Pepin, Minnesota. Concentrations were expressed in terms of dry weight, wet weight, and total organic carbon (TOC). For all units of measure, mean levels of D4 were higher in downstream vs. upstream locations (see Table 4-6). D4 dry weight concentrations were detected in all 25 samples ranging from 0.97 to 2.3 ng/g. In terms of wet weight concentrations, 10 out of 25 samples were greater than the level of detection with a maximum value of 0.514 ng/g.

Table 4-6. Summary of Measured D4 Concentrations in Sediment in the United States and

Canada

Reference[a]	Sampling Location	D4 Concentration (ng/g)	Sampling Notes
D4 Environmental Testing Final Report (ERM, 2017a, b)[b]	United States	DD1 [FOD; median (range)]: 100%; 1,630 (171–5,980) ww; 2,620 (200–12,400) dw DD2 [FOD; median (range)]: 100%; 34.3 (18.7–105) ww; 55.3 (30.4–185) dw DD3 [FOD; median (range)]: 100%; 66.3 (23.6–416) ww; 84.4 (29.2–563) dw DD4 [FOD; median (range)]: 100%; 9,410 (7,470–11,000) ww; 15,700 (12,900–18,000) dw "I" WWTPs [FOD; median (range)]: 24%; 0.150 (<2.4–7.7) ww; 0.177 (−0.129 to 11.1) dw "R" WWTPs [FOD; median (range)]: 30%; 1.00 (<2.4–7.37) ww; 1.29 (0.637–8.94) dw	Samples collected from media at or downstream of 14 WWTPs receiving direct ("DD") or indirect ("I") D4 discharges or other wastewater contaminants from non-industrial ("R") facilities.
Simon and Paulson (1985)	Curtis Bay, Delaware and Potomac Rivers, Great Lakes, United States	Saltwater sediment (n = 15): ND Freshwater sediment (n = 6): <50–70	
Powell et al. (2009)	Minnesota, United States	Upstream (mean): 1.27 (dw), 0.337 (ww) Downstream (mean): 2.16 (dw) 0.403 (ww)	
Powell et al. (2010)	Ontario, Canada	<MDL (ww)	
Wang et al. (2013)	Ontario and Quebec, Canada	Mean (range of site means) (n = 11): 37 (<3–49) dw	

FOD = frequency of detection; ww = wet weight; dw = dry weight; WWTP = wastewater treatment plant; ND = non-detect; MDL = method detection limit

[a] EPA identified monitoring studies through systematic review to provide context to modeling results. The monitoring studies presented here were not used as part of the analysis for quantifying exposure estimates.

[b] ECA does not have a study quality metric because it was not reviewed as part of the systematic review process. However, the environmental testing program undertaken by the signatory companies was conducted in accordance with a Study Plan and Quality Assurance Project Plan that EPA reviewed and approved. The quality of data in the ECA is thus high.

The concentrations of D4 in sediment or sediment core from 19 non-US and Canadian studies are presented in Figure 4-2. Overall, D4 concentrations for wet weight ranged from non-detect to 199 ng/g from samples collected in three countries, and dry weight ranged from not-detect to 86 ng/g from samples collected in six countries. Lastly, one Chinese study measured D4 concentrations in sediment that ranged from 3.98 to 360 ng/L (Zhang et al., 2018). It is excluded from Figure 4-2 because the unit of ng/L cannot be compared with studies measuring in ng/g.

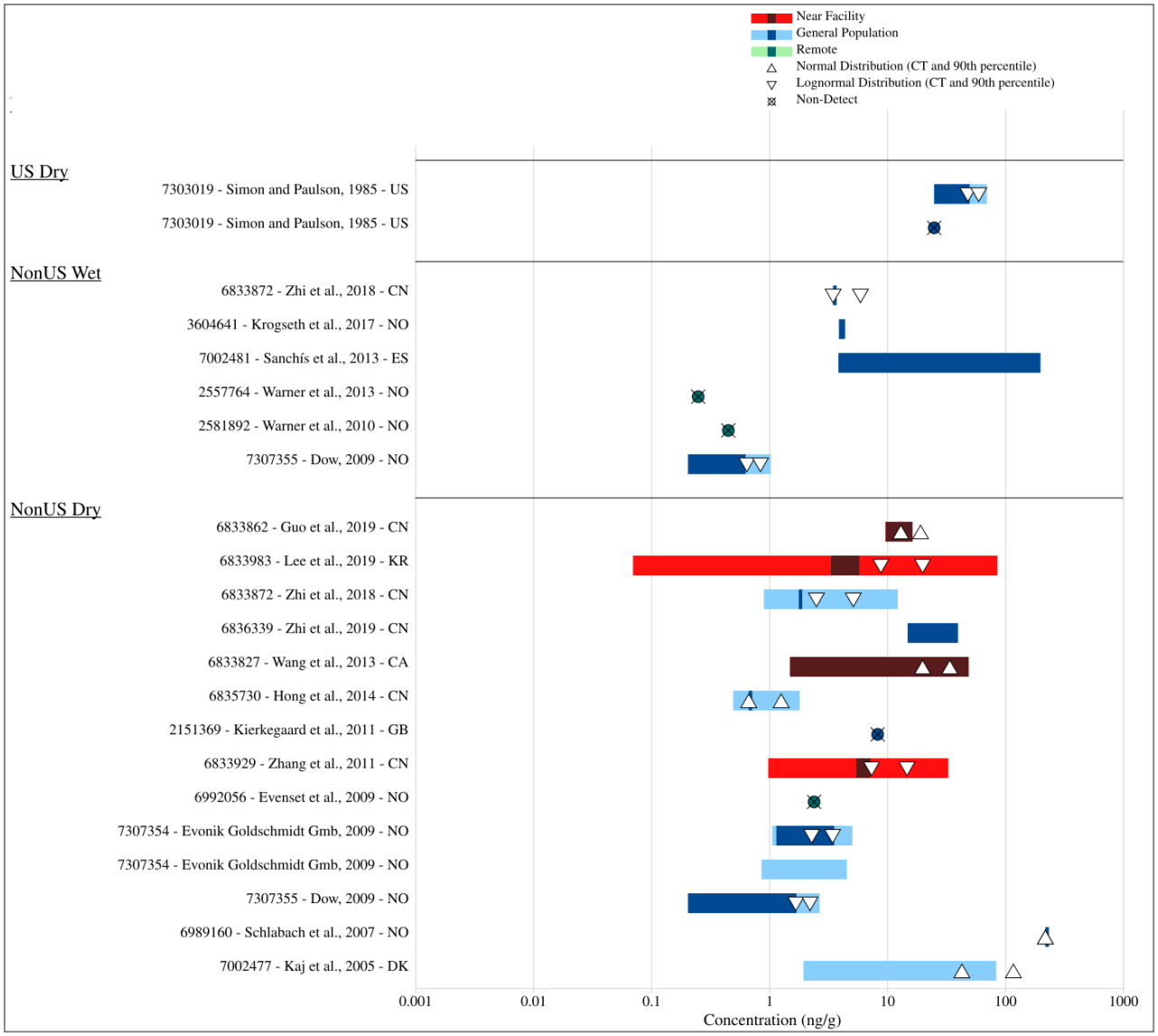


Figure 4-2. Concentrations of D4 (ng/g) in Sediment from 1985 to 2017
Note: CN = China; CA = Canada; DK = Denmark; ES = Spain; GB = United Kingdom; KR = South Korea; NO = Norway. The lighter bar for each study represents the range of the reported concentrations, and the darker bar represents the range of reported central tendencies. A study with only dark bars indicates that the only data reported was a measure of central tendency.

4.3 Evidence Integration for Surface Water and Sediment

4.3.1 Strengths, Limitations, and Sources of Uncertainty for Modeled and Monitored Surface Water Concentration

EPA conducted modeling with VVWM-PSC to estimate concentrations of D4 within surface water and sediment. VVWM-PSC considers model inputs of physical and chemical properties of D4 (*i.e.*, K_{OW}, K_{OC}, water column half-life, photolysis half-life, hydrolysis half-life, and benthic half-life) allowing EPA to estimate surface water and sediment concentrations. The use of vetted physical and chemical properties of D4 increases confidence in the application of the VVWM-PSC model. A standard EPA water body was used to represent a consistent and conservative receiving water body scenario. Uncertainty associated with location-specific model inputs (*e.g.*, flow parameters and meteorological data) is present as no facility locations were identified for D4 releases. EPA has moderate confidence in

the estimated releases from facilities to surface water which were applied as inputs to the surface water modeling conducted in this assessment.

The modeled data represent estimated surface water (water column, benthic porewater, and sediment) concentrations near facilities that would be releasing D4 to surface water. Because the release of D4 to surface water is expected, but the specific locations and amounts of releases are unknown, the release scenarios were estimated using the data available to EPA. The reported measured concentrations represent sampled ambient water concentrations of D4. However, with the exception of the ECA data, monitored concentrations are not necessarily tied to TSCA COUs, and the origin of these concentrations are unknown and could represent aggregation of multiple sources. EPA prioritized integration of the ECA data because they can be linked to D4 manufacturers and processors. Comparison of the modeled and monitored data from the ECA helps to verify that exposure estimates from modeled releases are not underestimating environmental concentrations reported in monitoring data. Differences in magnitude between modeled and measured concentrations may be due to measured concentrations not being geographically or temporally close to known releases of D4. In addition, when modeling with PSC, EPA assumed all releases were directly discharged to surface waters without prior treatment, and that no releases were routed through publicly owned treatment works prior to release. EPA recognizes that this is a conservative assumption that results in no removal of D4 prior to release to surface water.

Concentrations of D4 within the sediment were estimated using the high-end release estimates from generic scenarios and estimates of 7Q10 hydrologic flow data for the receiving water body that were derived from National Hydrography Dataset (NHD) modeled EROM flow data. The 7Q10 flow represents the lowest 7-day flow in a 10-year period and is a conservative approach for examining a condition where a potential contaminant may be predicted to be elevated due to periodic low flow conditions. Surrogate flow data collected via the EPA ECHO API and the NHDPlus V2.1 EROM flow database include self-reported hydrologic reach codes on NPDES permits and the best available flow estimations from the EROM flow data. The confidence in the flow values used, with respect to the universe of facilities for which data were pulled, should be considered moderate-to-robust. However, there is uncertainty in how representative the median flow rates are as applied to the facilities and COUs represented in the D4 release modeling. Additionally, a regression-based calculation was applied to estimate flow statistics from NHD-acquired flow data, which introduces some additional uncertainty. EPA assumes that the results presented in this section include a bias toward over-estimation of resulting environmental concentrations due to conservative assumptions that remain protective where there are uncertainties in release details.

4.4 Weight of Scientific Evidence Conclusions

Due to the lack of reported release data for facilities discharging D4 to surface waters, releases were modeled, and the high-end estimate for each COU was applied for surface water modeling. Additionally, due to the lack of site-specific release information, a generic distribution of hydrologic flows was developed from facilities which had been classified under relevant NAICS code, and which had NPDES permits. Due to the lower flow rates selected from the generated distributions, coupled with high-end release scenarios, *EPA has moderate confidence in the modeled concentrations as being representative of actual releases, with a slight bias toward over-estimation. Additionally, EPA has robust confidence that no surface water release scenarios result in water concentrations that exceed the concentrations presented in this evaluation due to the conservative assumptions used*. Other model inputs were derived from reasonably available literature collected and evaluated through EPA's systematic review process for TSCA risk evaluations. All monitoring and experimental data included in this analysis were from articles rated "medium" or "high" quality from this process.

The high-end modeled concentrations in surface water exceed the highest values available from monitoring studies by about several orders of magnitude. This confirms EPA's expectation that modeled concentrations presented here are biased toward overestimation to be applied as a screening evaluation.

5 GENERAL POPULATION EXPOSURE FROM SURFACE WATER

Concentrations of D4 in surface water resulting from TSCA COU releases can lead to different exposure scenarios including dermal exposure (Section 5.1.1) or incidental ingestion exposure (Section 5.1.2) to the general population swimming in affected waters. Additionally, D4 surface water concentrations may impact drinking water exposure (Section 6) and fish ingestion exposure (Section 7).

For a screening level assessment, exposure scenarios were assessed using the highest concentration of D4 in surface water for the highest releasing OES (Import – repackaging, HE) as estimated in Section 4.1 for various life stages (*e.g.*, adult, youth, children). This modeled concentration of D4 in surface water is also based on an upper-bound PV of 500,000,000 lb per year. In addition, the maximum D4 concentration in effluent from the ECA was also included for comparison because it provides robust U.S. monitoring data for four D4 manufacturing or processing sites. It also reported the highest monitored data among all identified studies.

5.1 Modeling Approach

5.1.1 Dermal

The general population may swim in affected surface waters (streams and lakes) that are affected by D4 contamination. Modeled surface water concentrations estimated in Section 4.1 and monitored data from the ECA were used to estimate acute dose rates (ADRs) and average daily doses (ADDs) from dermal exposure while swimming.

The following equations were used to calculate incidental dermal (swimming) doses for adults, youth, and children:

Equation 5-1. Acute Incidental Dermal Calculation

$$ADR = \frac{(SWC \times K_p \times SA \times ET \times CF1 \times CF2)}{BW}$$

Where:

ADR	=	Acute dose rate (mg/kg-day)
SWC	=	Surface water concentration (ppb or µg/L)
K_p	=	Permeability coefficient (cm/h; Set to 1 because only a dermal loading value had to be calculated. The human health hazard values were derived from a PBPK model that estimated an internal dose (U.S. EPA, 2025g))
SA	=	Skin surface area exposed (cm^2)
ET	=	Exposure time (h/day)
$CF1$	=	Conversion factor (1.0×10^{-3} mg/µg)
$CF2$	=	Conversion factor (1.0×10^{-3} L/cm^3)
BW	=	Body weight (kg)

Equation 5-2. Average Daily Incidental Dermal Calculation

$$ADD = \frac{(SWC \times K_p \times SA \times ET \times RD \times ED \times CF1 \times CF2)}{(BW \times AT \times CF3)}$$

Where:

	ADD	=	Average daily dose (mg/kg-day)
	SWC	=	Chemical concentration in water (µg/L)
	K_p	=	Permeability coefficient (cm/h; Set to 1 because only a dermal loading value had to be calculated. The human health hazard data were derived from a PBPK model that estimated an internal dose (U.S. EPA, 2025g)
	SA	=	Skin surface area exposed (cm^2)
	ET	=	Exposure time (h/day)
	RD	=	Release days (days/year)
	ED	=	Exposure duration (years)
	BW	=	Body weight (kg)
	AT	=	Averaging time (years)
	$CF1$	=	Conversion factor (1.0×10^{-3} mg/µg)
	$CF2$	=	Conversion factor (1.0×10^{-3} L/cm^3)
	$CF3$	=	Conversion factor (365 days/year)

A summary of inputs used for these exposure estimates are provided in Appendix A.

Table 5-1 shows a summary of the estimates of ADRs and ADDs due to dermal exposure while swimming for adults, youth, and children. Dermal doses were calculated with Equation 5-1 and Equation 5-2 using the highest surface water concentration from the high-end Import – repackaging OES and the ECA. Dose values derived from the modeled concentrations are presented with and without a wastewater treatment efficiency applied. D4 removal by sorption to sludge or volatilization in an aeration tank are expected to be the two main treatment pathways, with an average of 94 percent removal across three U.S. and Canadian studies (U.S. EPA, 2025h). As details of the releasing facilities and their treatment technologies are not readily available, this hypothetical treated concentration is included for reference, and exposure screening is primarily conducted with the high-end untreated release estimate. Dermal doses were also calculated using the highest values from ambient surface water monitoring data (Section 4.2.1) as the surface water concentration. Dermal doses calculated using the surface water monitoring data from the ECA are up to two orders of magnitude lower than corresponding doses modeled using the high-end Import – repackaging OES.

Table 5-1. Dermal (Swimming) Doses Across Life Stages Using a PV of 500,000,000 lb per Year and Median (P50) Flow[1]

Scenario	Water Column Concentrations		Adult (21+ years)		Youth (11–15 years)		Child (6–10 years)	
	30Q5 Conc. (µg/L)	Harmonic Mean Conc. (µg/L)	ADR_{POT} (mg/kg-day)	ADD (mg/kg-day)	ADR_{POT} (mg/kg-day)	ADD (mg/kg-day)	ADR_{POT} (mg/kg-day)	ADD (mg/kg-day)
Import – repackaging, HE, *Without wastewater treatment*	5,294	4,428	3.24	2.65	2.48	2.03	1.50	1.23
Import – repackaging, HE, *With wastewater*	318	266	2.32E–01	1.59E–01	1.78E–01	1.22E–01	1.08E–01	7.40E–02

[1] Doses are calculated using Equation 5-1 and Equation 5-2.

Scenario	Water Column Concentrations		Adult (21+ years)		Youth (11–15 years)		Child (6–10 years)	
	30Q5 Conc. (µg/L)	Harmonic Mean Conc. (µg/L)	ADR_{POT} (mg/kg-day)	ADD (mg/kg-day)	ADR_{POT} (mg/kg-day)	ADD (mg/kg-day)	ADR_{POT} (mg/kg-day)	ADD (mg/kg-day)
treatment [a]								
Effluent from DD2 Carrollton, KY (ERM, 2017a, b)	307[b]	307[b]	2.24E–01	2.24E–01	1.72E–01	1.72E–01	1.04E–01	1.04E–01

30Q5 = 30 consecutive days of lowest flow over a 5-year period; HE = high-end

[a] D4 removal by sorption to sludge or volatilization in an aeration tank are expected to be the two main treatment pathways, with an average of 94 percent removal across three U.S. and Canadian studies (U.S. EPA, 2025h).

[b] ERM (2017a) and ERM (2017b) is a U.S. study that reported the highest monitored surface water and effluent concentrations across all monitored data as described further in Section 4.2.1. Samples were also collected from the effluent or receiving waters of WWTPs associated with D4 processors, manufacturers, or formulators. This is a single maximum value from the study and does not correspond to either the 30Q5 or harmonic mean concentrations.

5.1.2 Oral Ingestion

The general population may swim in affected surfaces waters (streams and lakes) that are affected by D4 contamination. Modeled surface water concentrations estimated in Section 4.1 and monitored data from the ECA were used to estimate ADRs and ADDs due to ingestion exposure while swimming.

The following equations were used to calculate incidental oral (swimming) doses for adults, youth, and children. A summary of their inputs is presented in Appendix A.

Equation 5-3. Acute Incidental Ingestion Calculation

$$ADR = \frac{(SWC \times IR \times CF1)}{BW}$$

Where:

ADR = Acute dose rate (mg/kg-day)
SWC = Surface water concentration (ppb or µg/L)
IR = Daily ingestion rate (L/day)
$CF1$ = Conversion factor (1.0×10^{-3} mg/µg)
BW = Body weight (kg)

Equation 5-4. Average Daily Incidental Calculation

$$ADD = \frac{(SWC \times IR \times ED \times RD \times CF1)}{(BW \times AT \times CF2)}$$

Where:

ADD = Average daily dose (mg/kg-day)
SWC = Surface water concentration (ppb or µg/L)
IR = Daily ingestion rate (L/day)

ED = Exposure duration (years)
RD = Release days (days/year)
$CF1$ = Conversion factor (1.0×10^{-3} mg/µg)
BW = Body weight (kg)
AT = Averaging time (years)
$CF2$ = Conversion factor (365 days/year)

Table 5-2. Incidental Ingestion Doses (Swimming) Across Life Stages Using a PV of 500,000,000 lb per Year and Median (P50) Flow

Scenario	Water Column Concentrations		Adult (21+ years)		Youth (11–15 years)		Child (6–10 years)	
	30Q5 Conc. (µg/L)	Harmonic Mean Conc. (µg/L)	ADR_{POT} (mg/kg-day)	ADD (mg/kg-day)	ADR_{POT} (mg/kg-day)	ADD (mg/kg-day)	ADR_{POT} (mg/kg-day)	ADD (mg/kg-day)
Import – repackaging, HE, *Without wastewater treatment*	5,294	4,428	1.53E–02	5.00E–05	2.37E–02	7.76E–05	1.34E–02	4.38E–05
Import – repackaging, HE, *With wastewater treatment*[a]	318	266	9.17E–04	3.00E–06	1.42E–03	4.66E–06	8.02E–04	2.63E–06
Effluent from DD2 Carrollton, KY (ERM, 2017a, b)	307[b]	307[b]	1.06E–03	1.06E–03	1.64E–03	1.64E–03	9.27E–04	9.27E–04

30Q5 = 30 consecutive days of lowest flow over a 5-year period

[a] D4 removal by sorption to sludge or volatilization in an aeration tank are expected to be the two main treatment pathways, with an average of 94 percent removal across three U.S. and Canadian studies (U.S. EPA, 2025h).

[b] ERM (2017a) and ERM (2017b) is a U.S. study that reported the highest monitored surface water and effluent concentrations across all monitored data as described further in Section 4.2.1. Samples were also collected from the effluent or receiving waters of WWTPs associated with D4 processors, manufacturers, or formulators. This is a single maximum value from the study and does not correspond to either the 30Q5 or harmonic mean concentrations.

5.2 Weight of Scientific Evidence Conclusions

No facility- or site-specific information was reasonably available when estimating release of D4 to the environment. Environmental releases to water were estimated using generic scenarios (U.S. EPA, 2025e). Due to uncertainties inherent in this approach, conservative assumptions and methods were used to evaluate an upper-bounding limit to be applied as a protective screening assessment. As stated in Section 4.4, there is moderate confidence in the modeled concentrations as being representative of actual releases, with a bias toward over-estimation. Exposure estimates derived from modeled surface water concentrations when no wastewater removal efficiency was applied are several orders of magnitude higher than those using ECA measured data from D4 facilities. This is expected as modeled concentrations were based on modeled release estimates and P50 flow rates. When wastewater treatment is considered, exposure estimates are mostly still higher than those from the ECA using the maximum

effluent concentrations. Use of the effluent concentrations are expected to overestimate exposure because it measures from the outfall of a WWTP, where people are unlikely to recreate.

Screening level risk estimates for all exposure scenarios using modeled and monitored surface water concentrations were above the benchmark (Appendix D). The OESs that were modeled for this screening level analysis were those with known discharges to water only. The screening approach applied for modeling, in conjunction with the available monitoring data showing lower concentrations than those modeled, provide multiple lines of evidence and robust confidence that releases to surface water will not exceed the release concentrations presented in this assessment.

Swimming Ingestion/Dermal Estimates

Two scenarios for two routes of exposure (youth being exposed dermally and through incidental ingestion while swimming in surface water) were assessed as high-end potential exposures to D4 in surface waters. EPA's *Exposure Factors Handbook* provided detailed information on the youth skin surface areas and event per day of the various scenarios (U.S. EPA, 2017b). Non-diluted surface water concentrations (*i.e.*, dilution was only considered for receiving water at the point of discharge as opposed to downstream dilution) were used when estimating dermal exposures to youth swimming in streams and lakes. D4 concentrations will dilute when released to surface waters, but it is unclear what level of dilution will occur when the general population swims in waters with D4 releases. Overall, EPA has robust confidence that these two routes of exposure are not pathways of concern because the screening level analysis relied on modeled concentrations that are overestimates and did not consider dilution.

6 GENERAL POPULATION EXPOSURE FROM DRINKING WATER

Drinking water in the United States typically comes from surface water (*i.e.*, lakes, rivers, reservoirs) and groundwater. The source water then flows to a treatment plant where it undergoes a series of water treatment steps before being distributed to homes and communities. Public drinking water systems often use a combination of treatment processes that include coagulation, flocculation, sedimentation, filtration, and disinfection to meet drinking water quality standards. The exact treatment processes used to meet drinking water quality standards differ between public water systems.

No information is available on the removal of D4 in drinking water treatment plants. For the purpose of a screening level assessment, EPA did not assume drinking water treatment. However, EPA does expect drinking water treatment to be effective in removing D4 from drinking water. Based on its water solubility (0.056 mg/L) and log K_{OW} (6.49), D4 is expected to mainly partition to suspended solids present in water. The available information suggest that the use of flocculants and filtering media could potentially help remove D4 during drinking water treatment by sorption into suspended organic matter, settling, and physical removal.

6.1 Modeling Approach for Estimating Concentrations in Drinking Water

6.1.1 Drinking Water Ingestion

Drinking Water Intake Estimates via Modeled Surface Water Concentrations

Modeled surface water concentrations estimated in Section 4.1 were used to estimate drinking water exposures. As a screening analysis, the highest modeled facility release based on the P50 and P75 flow rates was included in the drinking water exposure analysis, alongside the highest monitored effluent concentration from the ECA. EPA did not assume removal from drinking water treatment, but did reasonably assume wastewater treatment for drinking water exposure. A wastewater treatment efficiency of 94 percent averaged across three U.S. and Canadian studies (Wang et al., 2015a; Wang et al., 2013; Hydroqual, 1993) was applied. This treatment is assumed to occur at the facility prior to effluent discharge to the receiving water body and prior to becoming influent at a downstream drinking water treatment plant. No further drinking water treatment is considered, which is expected to be a conservative scenario for drinking water exposure in the general population.

Drinking water doses were calculated using the following equations:

Equation 6-1. Acute Drinking Water Ingestion Calculation

$$ADR_{POT} = \frac{(SWC \times \left(1 - \frac{DWT}{100}\right) \times IR_{dw} \times RD \times CF1)}{(BW \times AT)}$$

Where:

ADR_{POT}	=	Potential acute dose rate (mg/kg/day)
SWC	=	Surface water concentration (ppb or µg/L; 30Q5 conc for ADR, harmonic mean for ADD)
DWT	=	Removal during drinking water treatment (assume 0% for D4)
IR_{dw}	=	Drinking water intake rate (L/day)
RD	=	Release days (days/year for ADD; 1 day for ADR)

$CF1$ = Conversion factor (1.0×10^{-3} mg/µg)
BW = Body weight (kg)
AT = Exposure duration (years for ADD; 1 day for ADR)

Equation 6-2. Average Daily Drinking Water Ingestion Calculation

$$ADD = \frac{(SWC \times \left(1 - \frac{DWT}{100}\right) \times IR_{dw} \times ED \times RD \times CF1)}{(BW \times AT \times CF2)}$$

Where:

ADD = Potential average daily dose (mg/kg/day)
SWC = Surface water concentration (ppb or µg/L; 30Q5 conc for ADR, harmonic mean for ADD)
DWT = Removal during drinking water treatment (assume 0% for D4)
IR_{dw} = Drinking water intake rate (L/day)
ED = Exposure duration (year for ADD; 1 day for ADR)
RD = Release days (days/year for ADD; 1 day for ADR)
BW = Body weight (kg)
AT = Exposure duration (years for ADD; 1 day for ADR)
$CF1$ = Conversion factor (1.0×10^{-3} mg/µg)
$CF2$ = Conversion factor (365 days/year)

The ADR and ADD from drinking water for non-cancer effects were calculated using the 95th percentile ingestion rate for drinking water. EPA used the 30Q5 and harmonic mean to calculate the ADR and ADD, respectively. Table 6-1 summarizes the drinking water doses for adults, infants, and toddlers for a scenario applying no wastewater treatment and another scenario applying wastewater treatment. These estimates do not incorporate additional dilution beyond the point of discharge and in this case, it is assumed that the surface water outfall is located very close (within a few km) to the drinking water intake location. Applying dilution factors would decrease the dose for all scenarios.

Exposure estimates are highest for infants from birth to <1 year of age, which is expected because they have the highest drinking water ingestion rate per body weight among all life stages. Screening level risk estimates for this life stage are below the benchmark MOE using the most conservative assumptions (*e.g.,* P50 flow rate, highest-releasing OES, and no wastewater treatment). EPA expects larger releases to discharge to larger receiving waters consistent with a P75 and P90 flow rates and thus refined its screening analysis to estimate exposure based on the P75 flow. Risk estimates using the P75 flow and not considering wastewater treatment, drinking water treatment, or dilution were above benchmark for all life stages (Appendix F).

Table 6-1. Drinking Water Doses Across Life Stages Using a PV of 500,000,000 lb per Year

Scenario	Surface Water Concentrations		Adult (21+ years)		Infant (Birth to <1 Year)		Toddler (1–5 years)	
	30Q5 Conc. (µg/L)	Harmonic Mean Conc. (µg/L)	ADR_{POT} (mg/kg-day)	ADD (mg/kg-day)	ADR_{POT} (mg/kg-day)	ADD (mg/kg-day)	ADR_{POT} (mg/kg-day)	ADD (mg/kg-day)
P50 flow, Import – repackaging,	5,294	4,428	2.13E–01	3.33E–02	7.47E–01	8.52E–02	2.66E–01	3.65E–02

Scenario	Surface Water Concentrations		Adult (21+ years)		Infant (Birth to <1 Year)		Toddler (1–5 years)	
	30Q5 Conc. (µg/L)	Harmonic Mean Conc. (µg/L)	ADR_{POT} (mg/kg-day)	ADD (mg/kg-day)	ADR_{POT} (mg/kg-day)	ADD (mg/kg-day)	ADR_{POT} (mg/kg-day)	ADD (mg/kg-day)
HE, *Without wastewater treatment*								
P50 flow, Import – repackaging, HE, *With wastewater treatment*	318	266	1.28E–02	2.00E–03	4.48E–02	5.11E–03	1.59E–02	2.19E–03
P75 flow, Import – repackaging, HE, *Without wastewater treatment*	5,294	4,428	1.53E–02	1.83E–03	5.35E–02	4.67E–03	1.50E–02	2.00E–03
P75 flow, Import – repackaging, HE, *With wastewater treatment*	318	266	9.15E–04	1.10E–04	3.21E–03	2.80E–04	9.00E–04	1.20E–04
Effluent from DD2 Carrollton, KY (ERM, 2017a, b)	307[a]	307[a]	1.24E–02	3.38E–03	4.33E–02	8.62E–03	1.54E–02	3.70E–03

30Q5 = 30 consecutive days of lowest flow over a 5-year period; HE = high-end; POT = potential
[a] ERM (2017a) and ERM (2017b) is a U.S. study that reported the highest monitored surface water and effluent concentrations across all monitored data as described further in Section 4.2.1. Samples were also collected from the effluent or receiving waters of WWTPs associated with D4 processors, manufacturers, or formulators. This is a single maximum value from the study and does not correspond to either the 30Q5 or harmonic mean concentrations.

6.2 Measured Concentrations in Drinking Water

EPA searched peer-reviewed literature, gray literature, and databases of environmental monitoring data to obtain concentrations of D4 in drinking water. No studies were identified that reported concentrations of D4 in drinking water.

6.3 Evidence Integration for Drinking Water

EPA estimates low potential exposure to D4 via drinking water when considering expected treatment removal efficiencies, even under high-end release scenarios. These exposure estimates also assume that the drinking water intake location is very close (within a few km) to the point of discharge and do not incorporate any dilution beyond the point of discharge. Actual concentrations in raw and finished water are likely to be lower than these conservative estimates as applying dilution factors will decrease the exposure for all scenarios, and additional distances downstream would allow further partitioning and degradation. Additional qualitative considerations suggest that actual measured concentrations in raw and finished water would decrease further. EPA also expects drinking water treatment to further remove D4.

6.4 Weight of Scientific Evidence Conclusions

EPA has robust confidence in surface water as drinking water not being a pathway of concern for the general population because the high-end screening approach incorporates conservative assumptions presenting an upper-bound of exposure in which risk estimates do not fall below the benchmark. As described in Section 3.2, EPA did not assess drinking water estimates as a result of leaching from landfills to groundwater and subsequent migration to drinking water wells.

7 FISH INGESTION EXPOSURE

To estimate human exposure to D4 through fish ingestion, EPA used multiple surface water concentrations, as well as modeled and empirical fish tissue concentrations resulting from TSCA COUs. Measured surface water and fish tissue concentrations from the ECA provided high-confidence data for four D4 manufacturers and processors that were quantitatively used to estimate exposure from fish ingestion. However, the ECA did not provide any additional information to cross walk these four facilities to specific COUs or OESs listed in Table 1-1. The facilities monitored as part of the ECA do not represent all COUs identified in this risk evaluation either. Therefore, modeled surface water concentrations based on generic scenarios, with and without wastewater treatment, were incorporated into this assessment. The screening level assessment started with the OES resulted in the highest surface water concentration (Import – repackaging) without consideration of wastewater treatment. The water solubility limit of 0.056 mg/L (U.S. EPA, 2025h) and monitoring data were also used to contextualize the modeled surface water concentrations, which exceeded the water solubility limit and monitored data by several orders of magnitude.

Another important parameter in estimating human exposure to a chemical through fish ingestion is the bioaccumulation factor (BAF). BAF is preferred over bioconcentration factor (BCF) because it considers the animal's uptake of a chemical from both diet and the water column. However, there are considerable uncertainties associated with the field-measured BAF values available for D4 (*e.g.*, low detection frequency, unpaired fish/water field samples), whereas the laboratory-measured BCF dataset is more robust. Moreover, D4 undergoes appreciable biotransformation in fish when ingested from the dietary route, and dietary accumulation is not expected to contribute significantly to accumulation of D4 in fish. Therefore, in this fish ingestion analysis, a high-confidence BCF was used instead of a BAF. The selected BCF for D4 is 8,795 L/kg, which is an average of the four empirical lipid-normalized mean BCF values (see *Draft Physical Chemistry and Fate Assessment for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025h)). Table 7-1 compares the fish tissue concentration calculated using an empirical BCF with the measured fish tissue concentrations obtained from literature. The monitoring studies identified through systematic review (*i.e.*, all studies other than the ECA data) provide context to modeling results and were not used to quantify exposure estimates. D4 concentrations in fish tissue calculated with the water solubility limit and modeled surface water concentrations were up to six and eight orders of magnitude above any empirical fish tissue data, respectively.

In addition, EPA calculated fish tissue concentrations using measured D4 concentrations after the effluent plume from the ECA direct discharges was well mixed with the river water (ERM, 2017a). EPA did not use the effluent concentrations because the ECA reported very limited aquatic organisms adjacent to WWTPs and direct dischargers due to water quality impairment. As a result, calculating fish tissue concentrations using effluent concentrations is unlikely to reflect real-world conditions (Table 7-1).

Table 7-1. Fish Tissue Concentrations Calculated from Modeled and Measured Surface Water Concentrations and Fish Tissue Monitoring Data

Data Description and Source	Surface Water Concentration	Fish Tissue Concentration
Water solubility limit (U.S. EPA, 2025h)	0.056 mg/L (U.S. EPA, 2025h)	4.93E02 mg/kg ww
Modeled surface water concentration based on a PV of 500,000,000 lb/year and (Section 4.1)	4.43 mg/L for Import – repackaging, HE, *Without wastewater treatment*	3.89E04 mg/kg ww

Data Description and Source	Surface Water Concentration	Fish Tissue Concentration
	2.66E–01 mg/L for Import – repackaging, HE, *With wastewater treatment*	2.34E03 mg/kg ww
Monitored surface water concentration Highest measured value from the well-mixed zone of each direct discharge site (ERM, 2017a) and empirical BCF 8,795 L/kg ww (U.S. EPA, 2025h)	SW1: 1.51E–04 mg/L SW2: 4.25E–04 mg/L SW3: 7.0E–04 mg/L SW4: 1.46E–04 mg/L	SW1: 1.33 mg/kg ww SW2: 3.74 mg/kg ww SW3: 6.16 mg/kg ww SW4: 1.28 mg/kg ww
Fish tissue monitoring data (wild-caught)[a] 9 studies from over 50 different species, including the ECA, 4 Chinese and 4 European studies (Radermacher et al., 2020; Cui et al., 2019; Norwegian Environment Agency, 2019; Xue et al., 2019; ERM, 2017a; Jia et al., 2015; Hong et al., 2014; Borgå et al., 2013; Schlabach et al., 2007)	N/A	Range for U.S. study (ECA): 7.17E–03 to 1.41E01 mg/kg ww Range for all 8 foreign studies: <1.00E–04 to 9.33E–02 mg/kg ww

7.1 Estimating Fish Ingestion Exposure

The ADR and ADD for non-cancer exposure estimates via fish ingestion are calculated with the following equation:

Equation 7-1. Fish Ingestion Calculation

$$ADR\ or\ ADD\ = \frac{(SWC \times BCF \times IR \times CF1 \times CF2 \times ED)}{AT}$$

Where:

ADR	=	Acute dose rate (mg/kg-day)
ADD	=	Average daily dose (mg/kg-day)
SWC	=	Surface water (dissolved) concentration (µg/L)
BCF	=	Bioconcentration factor (L/kg wet weight)
IR	=	Fish ingestion rate (g/kg-day)
$CF1$	=	Conversion factor for mg/µg (1.0×10^{-3} mg/µg)
$CF2$	=	Conversion factor for kg/g (1.0×10^{-3} kg/g)
ED	=	Exposure duration (year)
AT	=	Averaging time (year)

The inputs to this equation can be found in the *Draft Fish Ingestion Risk Calculator for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025f). The number of years within an age group (*i.e.*, 62 years for adults) was used for the exposure duration and averaging time to estimate non-cancer exposure. Fish ingestion rates vary for the population being evaluated.

7.1.1 Ingestion Rate for General Population

EPA estimated general population exposure from fish consumption using age-specific ingestion rates (Table_Apx A-2). Adults have the highest 50th percentile fish ingestion rate (IR) per kilogram of body weight for the general population, as shown in Table_Apx A-2. A young toddler between 1 and 2 years old has the highest 90th fish IR per kilogram of body weight among all life stages. EPA used these two values to estimate exposure and risks in the screening level analysis. Higher fish ingestion rates for subsets of the general population are considered separately, as explained in the following sections. See *Draft Fish Ingestion Risk Calculator for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025f) for all exposure estimates.

7.1.2 Ingestion Rate for Subsistence Fisher

Subsistence fishers represent a potentially exposed or susceptible subpopulations (PESS) group due to their greatly increased exposure via fish ingestion (average of 142.4 g/day of fish consumed compared to a 90th percentile of 22.2 g/day for the general population) (U.S. EPA, 2000). The ingestion rate for subsistence fishers applies to only adults aged 16 to less than 70 years. EPA calculated exposure for subsistence fishers using Equation 7-1 and the same inputs as the general population, except the ingestion rate. EPA was unable to determine subsistence fishers' exposure estimates specific to younger life stages based on lack of reasonably available information. Furthermore, unlike the general population fish ingestion rates, there is no central tendency or 90th percentile ingestion rate for the subsistence fisher. The same ingestion rate was used to estimate both the ADD and ADR. See *Draft Fish Ingestion Risk Calculator for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025f) for all exposure estimates.

7.1.3 Ingestion Rate for Tribal Populations

Tribal populations represent another PESS group. In the United States there are a total of 574 federally recognized American Indian tribes and Alaska Native villages and 63 state recognized tribes. Tribal cultures are inextricably linked to their lands, which provide all their needs from hunting, fishing, food gathering, and grazing horses to commerce, art, education, health care, and social systems. These services flow among natural resources in continuous interlocking cycles, creating a multi-dimensional relationship with the natural environment and forming the basis of *Tamanwit* (natural law) (Harper et al., 2012). Such an intricate connection to the land and the distinctive lifeways and cultures between individual tribes create many unique exposure scenarios that can expose Tribal members to higher doses of contaminants in the environment. However, EPA quantitatively evaluated only the Tribal fish ingestion pathway for D4 because of data limitations and recognizes that this overlooks many other unique exposure scenarios.

U.S. EPA (2011) (Chapter 10, Table 10-6) summarizes relevant studies on current Tribal-specific fish ingestion rates that covered 11 tribes and 94 Alaskan communities. The highest central tendency value (a mean) ingestion rate per kilogram of body weight was reported in a 1997 survey of adult members (16+ years) of the Suquamish Tribe in Washington. Adults from the Suquamish Tribe reported a mean ingestion rate of 2.7 g/kg-day, or 216 g/day assuming an adult body weight of 80 kg. In comparison, the ingestion rates for the adult subsistence fishers and general population are 142.2 and 22.2 g/day, respectively. A total of 92 adults responded to the survey funded by the Agency for Toxic Substances and Disease Registry (ATSDR) through a grant to the Washington State Department of Health, of which 44 percent of those surveyed reported consuming less fish/seafood today compared to 20 years ago. One reason for the decline is restricted harvesting caused by increased pollution and habitat degradation (Duncan, 2000).

In addition to the current mean fish ingestion rate, EPA reviewed literature and surveys to identify a high-end (*i.e.*, 90th or 95th percentile) current fish ingestion rate. The surveys asked participants to

estimate their daily fish consumption over the course of a year by meal size and meal frequency. The highest 95th percentile fish and shellfish ingestion rate was 874 g/day, or 10.9 g/kg-day assuming a body weight of 80 kg, for male adults (18+ years) of the Shoshone-Bannock Tribes in Idaho (Polissar et al., 2016). The 95th percentile ingestion rate for males and females combined was not much lower at 10.1 g/kg-day. The Suquamish Tribe also reported similar high-end (90th percentile) current ingestion rates for adults ranging from 8.56 to 9.73 g/kg-day (Duncan, 2000). Estimated high-end fish ingestion rates were lower for other tribes in Alaska, the Pacific Northwest, Great Lakes region, and northeastern North America. To evaluate a current high-end exposure scenario, EPA used the highest 95th percentile ingestion rate of 10.9 g/kg-day.

Current ingestion rates are considered more representative of contemporary rates of fish consumption. However, because current fish consumption rates are suppressed by contamination, degradation, or loss of access, EPA reviewed existing literature for heritage rates. Heritage ingestion rates refer to typical fish ingestion prior to non-indigenous settlement on Tribal fisheries resources, as well as changes in culture and lifeways (U.S. EPA, 2016). Heritage ingestion rates were identified for four tribes, all located in the Pacific Northwest region. The highest heritage ingestion rate was reported for the Kootenai Tribe in Idaho at 1,646 g/day, or 20.6 g/kg-day assuming an adult body weight of 80 kg (RIDOLFI, 2016; Northcote, 1973). Northcote (1973) conducted a comprehensive review and evaluation of ethnographic literature, historical accounts, harvest records, archaeological and ecological information, as well as other studies of consumption. The heritage ingestion rate is estimated for Kootenai members living in the vicinity of Kootenay Lake in British Columbia, Canada; the Kootenai Tribe once occupied territories in parts of Montana, Idaho, and British Columbia. It is based on a 2,500 calorie per day diet, assuming 75 percent of the total caloric intake comes from fish, which may overestimate fish intake. However, the higher ingestion rate also accounted for salmon fat loss during migration to spawning locations by using a lower caloric value for whole raw fish. Northcote (1973) assumed a caloric content of 113.0 cal/100 g ww. In comparison, the U.S. Department of Agriculture's Agricultural Research Service (1963) estimates a caloric content for fish sold in the United States to range from 142 to 242 cal/100 g of fish. Ultimately, EPA did not quantitatively evaluate Tribal exposure to D4 through fish ingestion at the heritage rate because no available information can substantiate if these rates reflect current consumption patterns.

EPA proceeded with using two current ingestion rates: 216 g/day (2.7 g/kg-day) for a central tendency and 874 g/day (10.9 g/kg-day) as a high-end or 95th percentile. The remaining inputs to Equation 7-1 are the same as the general population. EPA used the same ingestion rate to estimate both the ADD and ADR for Tribal populations. For current mean ingestion rates, U.S. EPA (2011) provides values specific to younger life stages, but adults still consume higher amounts of fish per kilogram of body weight. An exception is for the Squaxin Island Tribe in Washington that reported an ingestion rate of 2.9 g/kg-day for children under 5 years old. That ingestion rate for children is nearly the same as the adult ingestion rate of 2.7 g/kg-day for the Suquamish Tribe. As a result, exposure estimates based on current ingestion rates (IR) focused on adults. See *Draft Fish Ingestion Risk Calculator for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025f) for all exposure estimates.

7.2 Fish Ingestion Risk Screening Results

Use of the water solubility limit as the surface water concentration resulted in MOEs below the benchmark for all except the general population. However, the screening level analysis using the highest modeled surface water concentration (Import – repackaging OES, PV of 500,000,000 lb per year, high-end release, P50 flow rate, no wastewater treatment) resulted in risk estimates below the benchmark for all populations. This is expected because the highest modeled surface water concentrations exceeded the water solubility limit by an order of magnitude because of the conservative assumptions incorporated

into a screening level analysis. EPA proceeded to refine the fish ingestion exposure estimates by considering multiple inputs and the variance within each input. The following subsections summarize the results using the multiple approaches for deriving fish tissue concentration. For the general population, the following subsections only present results for adults even though exposure and risk estimates were calculated for toddlers 1 to less than 2 years of age. See Appendix G and *Draft Fish Ingestion Risk Calculator for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025f) for results for all life stages and populations.

7.2.1 Results Using Import – Repackaging OES Without Wastewater Treatment and Higher Flow Rates

As previously discussed, the screening level analysis started with the highest modeled surface water concentration for Import – repackaging OES, without wastewater treatment, and under P50 (*i.e.*, low-flow) conditions. Section 4.1 explains why the P50 flows are considered highly conservative, and that pairing higher flows (*i.e.*, P75 and P90) with release estimates in this analysis is more appropriate. The first refinement step thus excluded all modeled data based on P50 flow rates from further consideration.

Risk estimates using the same OES, without consideration of treatment, and P75 or P90 flow rates fell on either side of the benchmark MOE of 30. At the selected mean empirical BCF of 8,795 L/kg (U.S. EPA, 2025h), the exposure variables delineating where risk potential was observed were the receiving water body flow rate (P75 or P90), release distribution (HE or CT), and the fish ingestion rate. Figure 7-1 illustrates the MOEs across screened exposure scenarios.

All population groups had at least one exposure scenario that yielded screening level risk estimates below the benchmark MOE. For the general population, acute and chronic MOEs were below the benchmark for only HE releases at the P75 flow rate. For the subsistence fisher, MOEs for all exposure scenarios were below the benchmark at the P75 flow rate but above the benchmark at the P90 flow rate.

For Tribal populations, all exposure scenarios yielded risk estimates below the benchmark at P75 flow rates. At the P90 flow rate, risk estimates from CT releases were just below the benchmark (MOE = 29) at the current 95th percentile ingestion rate for chronic exposure. Under HE releases, risk estimates for chronic exposure were below the benchmark at the current mean ingestion rate, whereas both acute and chronic risk estimates at the current 95th percentile ingestion rate fell below the benchmark.

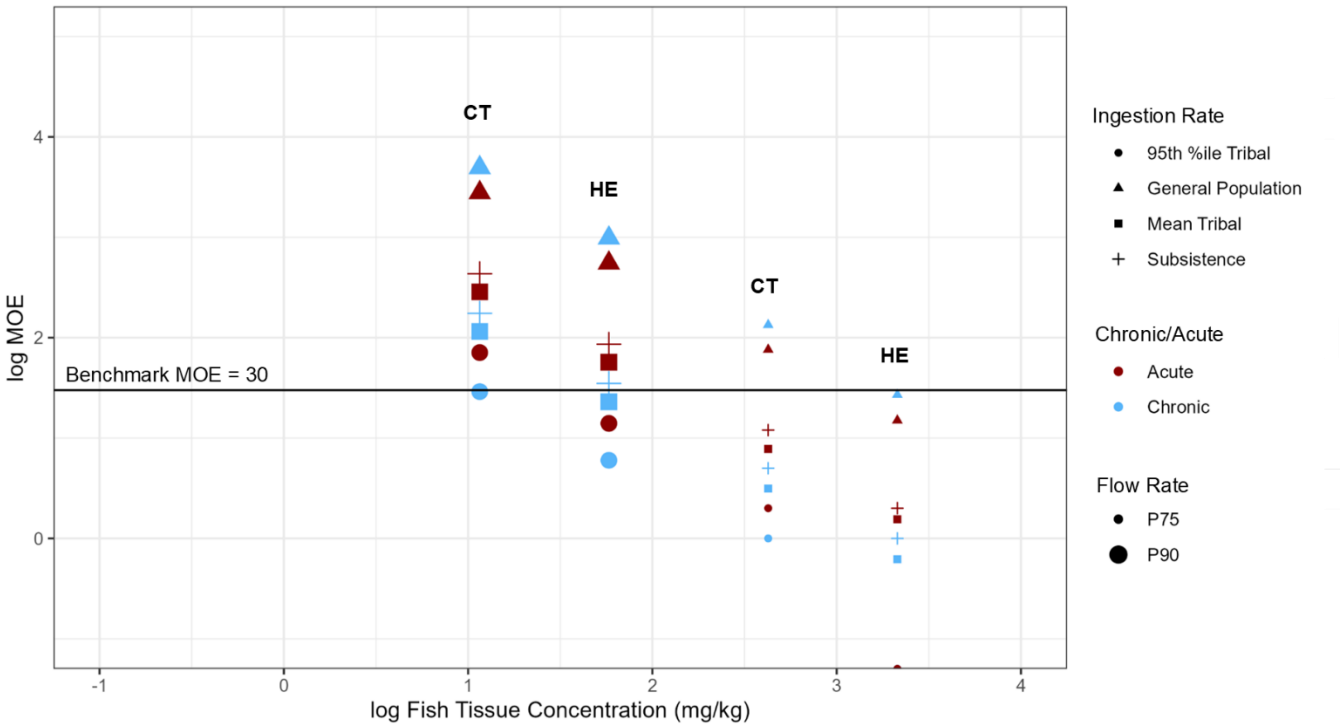


Figure 7-1. Summary of MOE Estimates from Import – Repackaging OES Without Wastewater Treatment Release and Exposure Scenarios

Overall, using the Import – repackaging OES *without* wastewater treatment, fish ingestion is potentially a pathway of concern for all populations at the P75 flow regimes. At P90 flow rate, fish ingestion may or may not be a pathway of concern for Tribal populations depending on the release distribution and ingestion rate.

7.2.2 Results Using Import – Repackaging OES with Wastewater Treatment

Wastewater treatment of D4 is highly effective (94 percent) because of the chemical's high volatility and affinity for sorption to organic matter. Application of a removal efficiency will greatly reduce the modeled D4 concentrations in surface water. However, EPA recognizes that there are uncertainties regarding the prevalence of wastewater treatment from all D4 facilities nationwide. EPA still estimated exposure after considering treatment as a comparison with no treatment and with monitoring data.

Risk estimates calculated from the Import – repackaging OES assuming wastewater treatment were on either side of the benchmark MOE of 30 depending on assumptions and conditions used. Figure 7-2 illustrates the MOE estimates across exposure scenarios.

Under P90 flow conditions, all MOEs fell above the benchmark for all permutations of release distribution and fish ingestion rates. When the receiving water body flow rate was reduced to P75, results varied by population. No MOEs were below benchmark for the general population. For subsistence fishers, HE releases yielded an MOE below the benchmark for chronic exposure. HE releases also yielded MOEs below the benchmark for Tribal populations at all ingestion rates for both acute and chronic exposures. Under CT releases, MOEs were below the benchmark for only Tribal populations at the current 95th percentile ingestion rate for chronic exposure.

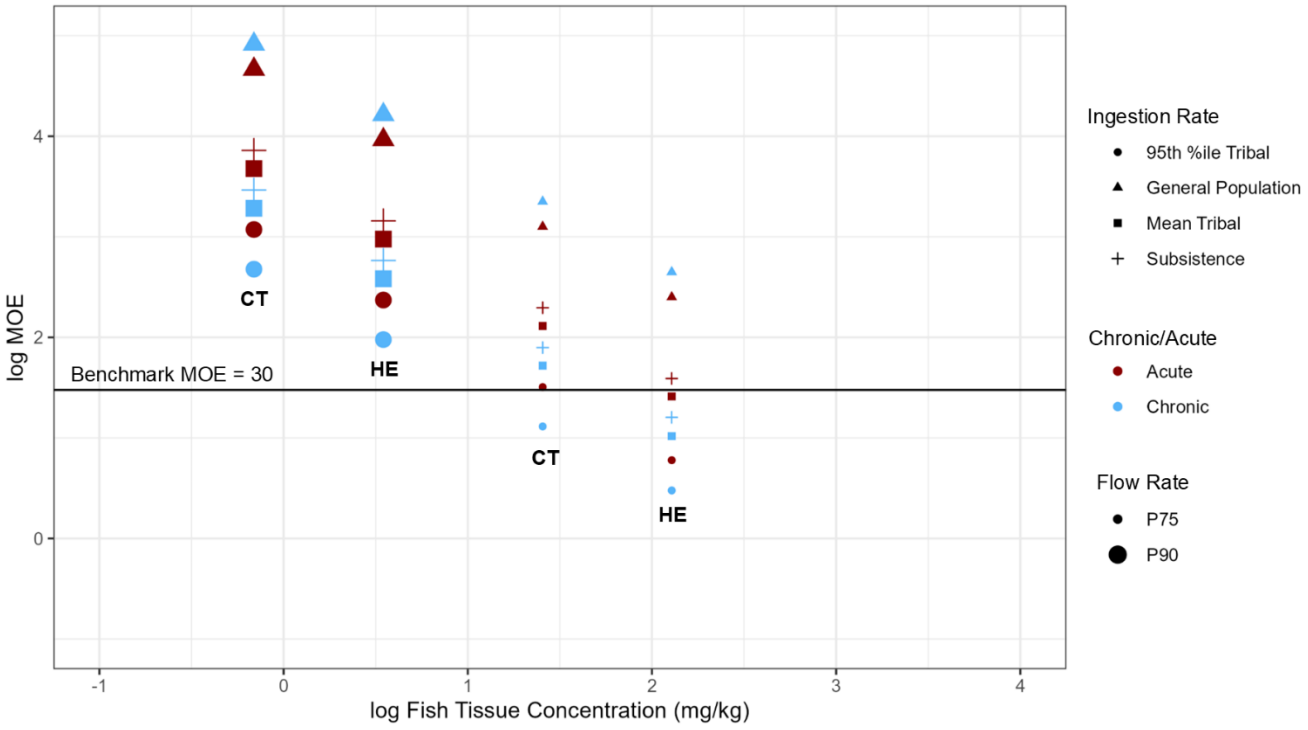


Figure 7-2. Summary of MOE Estimates from Import – Repackaging OES With Wastewater Treatment Release and Exposure Scenarios

Overall, using the Import – repackaging OES *with* wastewater treatment in the screening assessment, fish ingestion is not expected to be a pathway of concern for the general population. Fish ingestion may be a pathway of concern to subsistence fishers and tribes when HE releases occur to surface waters with the P75 flow regime. Given that MOEs were still below benchmark for some scenarios and the uncertainties in the prevalence of wastewater treatment across all D4 facilities, EPA proceeded to move beyond a screening analysis.

7.3 Moving Beyond a Screening Level Analysis

Section 7.2 presented screening level risk estimates for all the possible exposure scenarios using the Import – repackaging OES that resulted in the highest modeled surface water concentration. Because screening level risk estimates were sometimes below the benchmark MOE after refining the screening level analysis to use higher flow rates, EPA evaluated all remaining water-releasing only OESs. OESs that had modeled environmental releases to combinations of water, wastewater (POTW), incineration, landfill, and air were not evaluated because of the slight confidence and high uncertainty inherent in assuming what portion, if any, of a release may be discharged to surface water (See Appendix J of the *Draft Risk Evaluation for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025j) for more information on these OESs). The OESs that were quantitatively assessed are listed below:

- Manufacturing based on
  - Chemical Data Reporting (CDR) reported PV
  - Generic scenario PV
- Processing as a reactant
  - Wastewater to on-site treatment or discharge to POTW, 350 days release
  - Surface water, 316 or 321 days of release
- Rubber compounding
  - Neat D4

- Residual D4
- Rubber converting
- Use of fabric finishing products

The exposure estimates for all permutations are presented in Appendix G. Risk estimates can be found in the *Draft Fish Ingestion Risk Calculator for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025f) and *Draft Risk Evaluation for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025j). The draft risk evaluation also includes a risk characterization that describes how EPA integrated ECA monitoring data. Briefly, exposure was calculated using the highest measured surface water concentration (well-mixed zones) from four manufacturing and processing facilities (DD1 through DD4) in the ECA. Exposure was also estimated using empirical fish tissue concentrations from samples collected from these four D4 facilities as presented in the ECA. (The exposure estimates are presented in Table_Apx G-1 and Table_Apx G-2 of this document.) ECA data informed which of the remaining OESs and which permutation indicate a potential concern for D4 exposure through fish ingestion.

7.4 Weight of Scientific Evidence Conclusions

7.4.1 Strength, Limitations, Assumptions, and Key Sources of Uncertainty

The components of the fish ingestion analysis each have respective sources of variability and uncertainty. To account for variability in fish consumption rates across the United States, fish intake estimates were considered for general population, subsistence fishers, and Tribal populations. Additionally, the BCF directly and proportionately impacts estimated fish tissue concentrations from surface water concentrations. Whereas there is robust confidence in the selection of 8,795 L/kg as a representative central tendency value, it should be noted that bioconcentration of D4 can vary widely by species and environment. BCF measurements for D4 are greatly influenced by parameters such as surface water dissolved organic carbon concentration or fish lipid content, and thus, the range of empirical values (1,740–13,400 L/kg) is large (U.S. EPA, 2025h). For this assessment, a BCF of 8,795 L/kg was used to calculate fish tissue concentrations from monitored and estimated surface water concentrations. Despite EPA's high confidence in the range of BCF values obtained for D4, the variation across BCF values remains a source of variation in risk estimates. This leads to greater uncertainty in modeled fish concentrations compared to those directly measured (*i.e.*, the ECA fish tissue dataset).

Another uncertainty is the use of estimated releases as direct inputs to the PSC model to derive surface water concentrations. D4 did not have any reported releases in the databases EPA typically relies upon for facility reported release data (*e.g.*, TRI or NEI). Therefore, releases of D4 from facilities were estimated using generic scenarios. These estimated releases have limitations and uncertainties as described in the *Draft Environmental Release and Occupational Exposure Assessment for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025e). However, calculated fish tissue concentrations using estimated releases consistently exceeded empirical values from the ECA (ERM, 2017a).

The assumption and application of wastewater treatment prior to discharge to surface water is also a source of uncertainty. D4 is efficiently removed (as high as 94 percent) from aqueous phase during wastewater treatment. Applying a removal rate significantly reduces both exposure potential and resulting risk estimates (see Figure 7-2 with treatment and Figure 7-1 without treatment). Whereas the D4 facilities sampled as part of the ECA treat its wastewater EPA cannot rule out the possibility that facilities may not treat wastewater prior to discharging to surface water. However, EPA expects most (especially large) industrial facilities to employ on-site treatment and/or route wastewater to POTWs prior to releasing to surface waters.

The above assumptions and sources of variability and uncertainty associated with each line of evidence are integrated into EPA's overall level of confidence for each assessed scenario. For more details, refer to the risk characterization in Section 5.1.2.4 of the *Draft Risk Evaluation for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025j)).

8 AMBIENT AIR CONCENTRATION

EPA modeled ambient air concentrations to assess inhalation exposure to D4. Monitoring data from published literature were considered to compare with the modeled concentrations.

8.1 Approach for Estimating Concentrations in Ambient Air

EPA used the Integrated Indoor/Outdoor Air Calculator (IIOAC) model to estimate daily- and annual-average concentrations of D4 in the ambient air. IIOAC is a spreadsheet-based tool that estimates outdoor air concentrations using pre-run results from a suite of dispersion scenarios in a variety of meteorological and land-use settings within EPA's American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD). It can also estimate annual average wet, dry, and total deposition rates of a chemical from ambient air. However, D4 deposition to soil or water was not considered because D4 exists predominantly as a gas in air given its high volatility. Additional information on IIOAC can be found in the user guide (U.S. EPA, 2019d).

In line with previously peer-reviewed methodology (U.S. EPA, 2022), EPA used the IIOAC model to estimate ambient D4 concentrations at three distances (*e.g.*, 100; 100 to 1,000; and 1,000 meters) from the releasing facility. For the screening level assessment, EPA used the maximum estimated release across all COUs from the *Draft Environmental Release and Occupational Exposure Assessment for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025e) as direct inputs to the IIOAC model to estimate ambient air concentrations.

8.1.1 Release and Exposure Scenarios Evaluated

The release and exposure scenarios evaluated for this analysis are summarized below.

- Release: Maximum release (kg/site-day)
- Release dataset: Engineering estimate (no TRI or National Emissions Inventory [NEI] release data reported)
- Release type:
  - Stack – Manufacturing based on CDR-reported PV OES (288 kg/site-day)
  - Fugitive – Processing as a reactant OES (116 kg/site-day)
- Distances evaluated: 100 meters, 100-1,000 meters, and 1,000 meters
- Meteorological station (selected to represent high-end meteorologic data based on a sensitivity analysis of the 14 meteorological stations included within the IIOAC model that tended to result in high-end (more conservative) concentrations:
  - South (coastal): Surface and upper air stations at Lake Charles, Louisiana
- Operating scenario: 365 days per year; 8 and 24 hours per day to identify the scenario resulting in the maximum ambient air concentration
- Topography: Urban and rural
- Particle Size: No particles (vapor only)

EPA used default release input parameters integrated within the IIOAC model for both stack and fugitive releases along with a user-defined length and width for fugitive releases as listed in Table 8-1.

Table 8-1. IIOAC Input Parameters for Stack and Fugitive Air Releases

Stack Release Parameters	Value
Stack height (m)	10
Stack diameter (m)	2
Exit velocity (m/sec)	5
Exit temperature (K)	300
Fugitive Release Parameters	**Value**
Length (m)	10
Width (m)	10
Angle (degrees)	0
Release height (m)	3.05

8.1.2 IIOAC Model Output Values

The IIOAC model provides multiple output values (see *D4 Draft Ambient Air IIOAC Exposure Results and Risk Calculations for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025a). A description of select outputs relied upon in this assessment are provided below.

Fenceline Average represents the daily-average and annual-average concentrations at 100 meters distance from a releasing facility. Annual averages can be lower if there are days of no releases, but without further information, EPA assumes releases occur 365 days a year to be conservative.

High-end, Daily-average represents the 95th percentile daily average of all modeled hourly concentrations across the entire distribution of modeled concentrations at 100 meters.

High-end, Annual-average is the 95th percentile annual-average concentration across the entire distribution of modeled concentrations at 100 meters.

8.1.3 Modeled Results from IIOAC

All results for each scenario described in Section 8.1.1 are included in the *Draft Ambient Air IIOAC Exposure Results and Risk Calculations for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025a). EPA used the highest estimated concentrations across all modeled scenarios to evaluate exposures near a releasing facility. This exposure scenario represents a national level exposure estimate inclusive of sensitive and locally impacted populations who live next to a releasing facility.

The IIOAC model provides source apportioned concentrations (fugitive and stack) based on the respective releases. To evaluate exposures for this ambient air assessment, EPA assumes the fugitive and stack releases occur simultaneously throughout the day and year. Therefore, the total concentration used to evaluate exposures and derive risk estimates in this ambient air assessment is the sum of the separately modeled fugitive and stack concentrations at 100 meters from a releasing facility. The source apportioned concentrations and the total concentrations for the scenario used are provided in Table 8-2. Because of the 365-day operating scenario, the daily and annual-average concentrations are the same.

Table 8-2. Source Apportioned and Total Daily-Averaged and Annual-Averaged IIOAC Modeled

Concentrations at 100 m from Releasing Facility

Source Type	Daily-Average Concentration (µg/m^3)	Annual-Average Concentration (µg/m^3)
Fugitive (Processing as a reactant OES)	198.9	198.9
Stack (Manufacturing based on CDR-reported PV OES)	20.7	20.7
Total	219.5	219.5

8.2 Measured Concentrations in Ambient Air

EPA reviewed published literature as described in the *Draft Systematic Review Protocol for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025k) to identify studies that present measured ambient air concentrations of D4. The monitoring studies presented here provide context to modeling results and were not used as part of the analysis for quantifying exposure estimates. Four U.S. studies reported D4 concentrations in ambient air (Rauert et al., 2018; Yucuis et al., 2013; Genualdi et al., 2011; Shields et al., 1996). The highest (145 ng/m^3 from a remote location in Hawaii) and lowest (<0.005 ng/m^3 in Point Reyes, CA) concentrations were reported from a large, international study of remote and urban sites (Rauert et al., 2018). Shields et al. (1996) found a geometric mean of D4 concentrations of 100 ng/m^3 outside 70 U.S. commercial buildings during the spring, with concentrations positively correlated with increasing numbers of building occupants per unit area.

Six studies reported D4 concentrations in ambient air in Canada that ranged from 2.6 to 2,110 ng/m^3 (Figure_Apx H-1). The highest reported D4 concentration in ambient air in Canada was reported by Cheng et al. (2011) at two meters above an aeration tank of a wastewater treatment plant.

About a dozen studies from Europe and Asia reported D4 concentrations in ambient air ranging from below detection to 20,500 ng/m^3 (Figure_Apx H-1). Wang et al. (2001) measured the highest level of 20,500 ng/m^3 in the Pearl River Delta, China's most populated and economically developed region. Among studies form Europe and Asia, some of the highest values were reported in heavily populated areas or at sewage treatment plants.

8.3 Evidence Integration

EPA relied on the IIOAC-modeled concentrations to characterize human exposures for the ambient air exposure assessment. Modeled D4 ambient air concentrations were estimated using the maximum ambient air release, conservative meteorological data, and a distance of 100 m from a releasing facility. The modeled concentrations – stack (20.7 µg/m^3), fugitive (198.9 µg/m^3), or stack and fugitive combined (219.5 µg/m^3) – are higher than measured concentrations across all studies (0.19 µg/m^3 for U.S. and 20.5 µg/m^3 overall from a Chinese study). Caution is needed when interpreting such a comparison, however, because modeled concentrations are near a releasing facility (100 meters away), and it is unknown if the sampling sites are located at a similar distance from a site.

8.3.1 Strengths, Limitations, and Sources of Uncertainty for Modeled Air Concentrations

The approach and methodology used in this ambient air exposure assessment replicates previously peer-reviewed approaches and methods, as well as incorporates recommendations provided during peer review of other ambient air exposure assessments.

D4 did not have any reported releases in the databases EPA typically relies upon for facility reported release data (*e.g.*, TRI or NEI). Therefore, D4 releases were estimated and used as a direct input to the

IIOAC model. Any limitations and uncertainties of these estimated releases described in the *Draft Environmental Release and Occupational Exposure Assessment for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025e) are carried over to this ambient air exposure assessment.

The IIOAC model also has limitations in what inputs can and cannot be changed. Because it is based on pre-run scenarios within AERMOD, default input parameters (*e.g.*, stack characteristics and 2011–2015 meteorological data) are already predefined. Site-specific information like building dimensions, stack heights, elevation, and land use cannot be changed in IIOAC and therefore presents a limitation on the modeled results for D4. This is in addition to the data gaps that EPA has on certain parameters like building dimensions, stack heights, and release elevation because such information has not been provided by industry to EPA for consideration. This lack of information creates additional limitations on using other models to their full potential. Furthermore, IIOAC does not consider the presence or location of residential areas relative to the 100 meters distance from releasing facilities, the size of the facility, and the release point within a facility. For larger facilities, 100 meters from a release point may still fall within the facility property where individuals within the general population are unlikely to live or frequent. In contrast, for smaller facilities, there may be individuals within the general population living 100 meters away from the release point and therefore could be exposed continuously. However, most individuals are not likely to stay within their residences 24 hours per day, 7 days per week throughout the year.

The use of estimated annual release data to calculate daily average releases can underestimate exposure. Because the maximum annual release value (for stack and fugitive emissions) from each release point is used in this assessment, EPA assumed operations are continuous, and releases are the same for each day of operation when calculating daily average concentrations. This assumption may result in modeled concentrations that miss true peak releases (and associated exposures) that may be of concern when compared with relevant hazard values.

8.4 Weight of Scientific Evidence Conclusions

EPA has moderate confidence in the IIOAC modeled results used to characterize ambient air exposure. Despite the limitations and uncertainties (Section 8.3) potentially under- or overestimating ambient air exposure, this screening level analysis presents a reasonable upper-bound of exposure. Multiple conservative inputs (*e.g.*, maximum estimated ambient air release) and assumptions (*e.g.*, an individual lives at the same location 100m from a facility for their entire lifetime and spends the entirety of their day every day at that location) bias the resulting exposure estimates toward overestimation.

9 AMBIENT AIR EXPOSURE

9.1 Exposure Calculations

Modeled ambient air concentrations from IIOAC need to be converted to estimates of exposures to derive risk estimates. For this exposure assessment, EPA assumed the general population is continuously exposed (*i.e.*, 24 hours per day, 365 days per year) to outdoor ambient air concentrations. Therefore, daily average modeled ambient air concentrations are equivalent to daily average exposure concentrations, and annual average modeled ambient air concentrations are equivalent to annual average exposure concentrations used to derive risk estimates (Section 8.1.3). Calculations for general population exposure to ambient air via inhalation for life stages expected to be highly exposed based on exposure factors can be found in *Draft Ambient Air IIOAC Exposure Results and Risk Calculations for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025a).

Table 9-1. General Population Ambient Air Inhalation Exposure

OES[a]	Acute (Daily Average)[b]	Chronic (Annual Average)[b]
	Air Concentration[c] (µg/m^3)	Air Concentration[c] (µg/m^3)
Processing as a reactant (fugitive)	219.5	219.5
Manufacturing based on CDR-reported PV (stack)		

AC = acute concentration; ADC = average daily concentration; CDR = Chemical Data Reporting
[a] Table 1-1 provides a crosswalk of industrial and commercial COUs to OES.
[b] EPA assumes the general population is continuously exposed (*i.e.,* 24 hours per day, 365 days per year) to outdoor ambient air concentrations. Therefore, daily average modeled ambient air concentrations are equivalent to acute exposure concentrations, and annual average modeled ambient air concentrations are equivalent to chronic exposure concentrations.
[c] Air concentrations are reported for the high-end (95th percentile) modeled value at 100 m from the emitting facility and stack plus fugitive releases combined.

9.2 Overall Conclusions

Based on the results from the analysis of the maximum estimated release and high-end exposure concentrations presented in this document, EPA does not expect an inhalation risk from ambient air following exposure to D4 from industrial releases. Table_Apx H-1 shows that the screening level risk estimates are all above benchmark. Because no exposures of concern were identified at the maximum release scenario, EPA does not expect a different finding for smaller releases. Therefore, additional or more detailed analyses for exposure to D4 through inhalation of ambient air are not necessary.

10 HUMAN MILK EXPOSURE

Infants are potentially susceptible because of their higher ingestion per body weight, immature metabolic systems, and the potential for chemical toxicants to disrupt sensitive developmental processes. EPA considered whether infants may be exposed to D4 through milk and determined the most scientifically supportable appropriate approach to evaluate risks from those exposures based on available exposure (Section 10.1) and hazard (Section 10.2) information.

As described in more detail below, EPA concluded that infant exposure to D4 through milk is possible. To evaluate risks from infant exposure through milk, EPA concluded that risk estimates based on adult (maternal) exposure are expected to be protective of nursing infants as well. EPA therefore did not calculate exposure and risk estimates for infant exposure through milk.

10.1 Potential for Exposure through Milk

10.1.1 Biomonitoring Information

D4 has the potential to accumulate in human milk because of its small mass (296.61 Daltons or g/mol) and lipophilicity (Log K_{OW} = 6.49). EPA identified one Swedish biomonitoring study that evaluated D4 concentrations in human milk (Kaj et al., 2005a). The study measured D4 above the limit of quantification (2 µg/L) in three of 39 milk samples. Concentrations of D4 detected in milk ranged from 2.9 to 10 µg/L. This biomonitoring study provides evidence that D4 may be present in human milk but was not used to quantify exposure estimates. The degree to which these limited milk samples may be representative of current D4 exposures in the United States is not known. In addition, biomonitoring data are not linked to specific exposure routes or pathways. Therefore, the potential contributions of specific TSCA COUs to overall exposure cannot be determined from this type of biomonitoring information.

10.1.2 Potential to Model D4 Concentrations in Milk

EPA considered the potential to model D4 concentrations in human milk resulting from specific sources of maternal exposures to provide quantitative estimates of COU-specific milk exposures and risks. EPA identified a pharmacokinetic model described in Kapraun et al. (2022) as the best available model to estimate milk concentrations resulting from the transfer of lipophilic chemicals from mothers to infants during gestation and lactation. The only chemical-specific parameter required by the Kapraun model is the elimination half-life in the animal species of interest.

EPA concluded that although such modeling may be possible for D4, it is not needed to adequately assess exposures and risks to infants exposed through milk. As described in Section 10.2 below, EPA did not identify an infant-specific hazard POD that would be directly comparable to infant exposure estimates that could be derived from modeling milk concentrations. Furthermore, EPA concluded that the PODs applied to assess risks to workers, consumers, and the general population in this assessment are expected to be protective of nursing infants.

10.2 Potential for Hazards Unique to Nursing Infants

EPA considered the available hazard data to determine the extent to which there is evidence of increased susceptibility associated with infant exposure. None of the available studies evaluated the effect of infant-specific exposures (such as lactational exposure from birth to weaning from quantified levels of D4 or its metabolites in milk). The available information does not support derivation of an infant-specific POD that would be directly comparable to infant exposures via milk.

Several studies report reproductive and developmental effects associated with exposure to D4 in adults and/or across life stages. As described in the *Draft Human Health Hazard Assessment for D4* (U.S. EPA, 2025g), the hazard PODs underlying risk estimates in this assessment are based on reductions in live litter size observed following maternal inhalation exposure in a two-generation reproduction study. Because the key study includes exposure during gestation and lactation, the POD derived from this study is expected to be protective of any effects that may result from exposure through lactation. The hazard values designed to be protective for adult (maternal) exposure are therefore expected to also be protective of nursing infants.

Because EPA does not have hazard data to support derivation of infant-specific hazard values and hazard values based on adult exposure are expected to be protective of nursing infants, EPA concluded that direct quantification of infant exposure through human milk ingestion is not needed to assess risks to infants exposed through milk.

10.3 Weight of Scientific Evidence Conclusions

EPA concluded that human milk is a relevant exposure pathway for D4. The available information on physical chemistry and fate properties and biomonitoring data suggest that D4 can be present in human milk. The available hazard data demonstrate that reproductive and developmental outcomes may be particularly susceptible to the effects of D4.

EPA concluded that risk estimates based on adult (maternal) exposure scenarios considered throughout this assessment are expected to be protective of nursing infants. The human health hazard values used throughout the D4 risk assessment are expected to be protective of risks from exposure through milk because they are based on studies that identify the most sensitive fetal and infant effects following long-term maternal exposures that include gestation and lactation. EPA has therefore concluded that further modeling to quantify milk concentrations and infant exposures is not needed. In the absence of an infant-specific hazard value to compare to, quantifying direct infant exposures through modeling could not be used to derive meaningful risk estimates and would not add value to the assessment. EPA has confidence that the risk estimates calculated based on adult (maternal) exposures to D4 in this assessment are also protective of a nursing infant's greater susceptibility during this unique life stage whether due to sensitivity or greater exposure per body weight.

11 GENERAL POPULATION SCREENING CONCLUSIONS

The general population can be exposed to D4 from various exposure pathways. As shown in Table 1-3, exposures to the general population via surface water, drinking water, fish ingestion, and biosolids-amended soil were quantified whereas exposures via the land pathway (*i.e.*, landfills) were qualitatively assessed. Based on the high-end estimates of environmental media concentrations summarized in Table 11-1, general population exposures were estimated for the life stage that would be most exposed based on intake rate and body weight.

Table 11-1. Summary of High-End D4 Concentrations in Various Environmental Media from Environmental Releases

OES[a]	Release Media	Environmental Media	D4 Concentration
Import – repackaging, HE, *Without wastewater treatment*	Water	Surface water (30Q5, P50 flow)	5,294 µg/L
		Surface water (harmonic mean, P50 flow)	4,428 µg/L
Import – repackaging, HE, *With wastewater treatment*		Surface water (30Q5, P50 flow)	318 µg/L
		Surface water (harmonic mean, P50 flow)	226 µg/L
Processing as a reactant (fugitive)	Ambient air	Daily-averaged total (fugitive and stack, 100m)	219.5 µg/m^3
Manufacturing based on CDR-reported PV (stack)		Annual-averaged total (fugitive and stack, 100m)	219.5 µg/m^3

HE = high-end; CDR = Chemical Data Reporting; PV = production volume
[a] Table 1-1 provides the crosswalk of OES to COUs.

Table 11-2 summarizes the conclusions for the exposure pathways and life stages that were assessed for the general population. EPA conducted a quantitative evaluation for the following: ingestion of soil after biosolids application, incidental dermal and incidental ingestion from swimming in surface water, drinking water ingestion, fish ingestion, and ambient air inhalation. Landfills were assessed qualitatively in Sections 3.2, respectively. Results indicate that no pathways were of concern for D4 for the highest exposed populations, except for fish ingestion.

Table 11-2. Risk Screen for High-End Exposure Scenarios for Highest Exposed Populations

OES[a]	Exposure Pathway	Exposure Route	Exposure Scenario	Life Stage	Pathway of Concern[b]
All	Biosolids	Oral	Incidental ingestion of D4 in soil (Section 3.1.3)	Children	No
All	Landfills	No specific exposure scenarios were assessed for qualitative assessments			No
Import – repackaging , HE	Surface water	Dermal	Dermal exposure to D4 in surface water during swimming (Section 5.1.1)	Adult (21+ years)	No

OES[a]	Exposure Pathway	Exposure Route	Exposure Scenario	Life Stage	Pathway of Concern[b]
		Oral	Incidental ingestion of D4 in surface water during swimming (Section 5.1.2)	Youth (11–15 years)	No
	Drinking water	Oral	Ingestion of drinking water (Section 6.1.1)	Infant (<1 year)	No
• Import – repackaging • Manufacturing based on CDR-reported PV • Processing as a reactant, 350 days • Manufacturing based on a generic scenario PV • Rubber compounding (neat or residual D4) • Rubber converting	Fish ingestion	Oral	Ingestion of fish for general population (Sections 7.2 and 7.3)	Adult (16+ years)	Yes, depending on exposure scenarios. Many inputs and the variance within each input were considered.
			Ingestion of fish for subsistence fishers (Sections 7.2 and 7.3)	Adult (16+ years)	
			Ingestion of fish for Tribal populations (Sections 7.2 and 7.3)	Adult (18+ years)	
Processing as a reactant (fugitive)	Ambient air	Inhalation	Inhalation of D4 in ambient air resulting from industrial releases (Section 9)	All	No
Manufacturing based on CDR-reported PV[b] (stack)					

HE = high-end; CDR = Chemical Data Reporting; PV = production volume

[a] Table 1-1 provides a crosswalk of industrial and commercial COUs to OES

[b] Using the MOE approach as a risk screening tool, an exposure pathway was determined to not be a pathway of concern if the MOE was equal to or exceeded the benchmark MOE of 30.

[c] For more information, see Section 7, Appendix G, and the *Draft Risk Evaluation for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025i).

11.1 Weight of Scientific Evidence Conclusions

The weight of scientific evidence supporting the exposure estimate is decided based on the strengths, limitations, and uncertainties associated with the exposure estimates, which are discussed in detail for biosolids (Section 3.1.4), landfills (Section 3.2.1), surface water (Section 4.3.1), drinking water (Section 6.4), fish ingestion (Section 7.4.1), ambient air (Section 8.3.1), and human milk (Section 10.3). EPA summarized its weight of scientific evidence using confidence descriptors: robust, moderate, slight, or indeterminate. EPA used general considerations (*i.e.*, relevance, data quality, representativeness, consistency, variability, uncertainties) as well as chemical-specific considerations for its weight of scientific evidence conclusions.

EPA determined moderate to robust confidence in its qualitative assessment and conclusions pertaining to exposures from landfills (3.2.1). For its quantitative assessment, EPA modeled exposure due to various exposure scenarios resulting from different pathways of exposure. Exposure estimates used high-end inputs for the purpose of risk screening. When available, monitoring data were compared to modeled estimates to evaluate overlap, magnitude, and trends. For its quantitative exposure assessment of biosolids (Section 3.1), surface water (Sections 4 and 5), drinking water (Section 6), ambient air

(Sections 8 and 9), and human milk (Section 10), EPA has robust confidence that the screening level analysis was appropriately conservative to determine that no environmental pathway has the potential for non-cancer risks to the general population. Despite slight and moderate confidence in the estimated absolute values themselves, confidence in exposure estimates capturing high-end exposure scenarios was robust given the many conservative assumptions which yielded modeled values exceeding those of monitored values. Furthermore, risk estimates for high-end exposure scenarios were still consistently above the benchmarks, adding to confidence that non-cancer risks are not expected except for the fish ingestion pathway (Section 7.2) for certain populations. The *Draft Risk Evaluation for Octamethylcyclotetrasiloxane (D4)* (U.S. EPA, 2025i) describes additional refinements and their results for the fish ingestion pathway in detail.

REFERENCES

Alton, MW; Browne, EC. (2020). Atmospheric chemistry of volatile methyl siloxanes: Kinetics and products of oxidation by OH radicals and CL atoms. Environ Sci Technol 54: 5992-5999. http://dx.doi.org/10.1021/acs.est.0c01368

Atkinson, R. (1991). Kinetics of the gas-phase reactions of a series of organosilicon compounds with OH and NO3 radicals and O-3 at 297 +/- 2-K. Environ Sci Technol 25: 863-866. http://dx.doi.org/10.1021/es00017a005

Badjagbo, K; Furtos, A; Alaee, M; Moore, S; Sauvé, S. (2009). Direct analysis of volatile methylsiloxanes in gaseous matrixes using atmospheric pressure chemical ionization-tandem mass spectrometry. Anal Chem 81: 7288. http://dx.doi.org/10.1021/ac901088f

Badjagbo, K; Heroux, M; Alaee, M; Moore, S; Sauve, S. (2010). Quantitative Analysis of Volatile Methylsiloxanes in Waste-to-Energy Landfill Biogases Using Direct APCI-MS/MS. Environ Sci Technol 44: 600-605. http://dx.doi.org/10.1021/es902741k

Bernard, F; Papanastasiou, DK; Papadimitriou, VC; Burkholder, JB. (2018). Temperature dependent rate coefficients for the gas-phase reaction of the OH radical with linear (L2, L3) and cyclic (D3, D4) permethylsiloxanes. J Phys Chem A 122: 4252-4264. http://dx.doi.org/10.1021/acs.jpca.8b01908

Bletsou, AA; Asimakopoulos, AG; Stasinakis, AS; Thomaidis, NS; Kannan, K. (2013). Mass loading and fate of linear and cyclic siloxanes in a wastewater treatment plant in Greece. Environ Sci Technol 47: 1824-1832. http://dx.doi.org/10.1021/es304369b

Borgå, K; Fjeld, E; Kierkegaard, A; Mclachlan, MS. (2013). Consistency in trophic magnification factors of cyclic methyl siloxanes in pelagic freshwater food webs leading to Brown Trout. Environ Sci Technol 47: 14394. http://dx.doi.org/10.1021/es404374j

Cheng, Y; Shoeib, M; Ahrens, L; Harner, T; Ma, J. (2011). Wastewater treatment plants and landfills emit volatile methyl siloxanes (VMSs) to the atmosphere: Investigations using a new passive air sampler. Environ Pollut 159: 2380-2386. http://dx.doi.org/10.1016/j.envpol.2011.07.002

COWI AS. (2018). Screening programme 2017: Suspected PBT compounds. Trondheim, Norway: The Norwegian Environment Agency. https://www.miljodirektoratet.no/globalassets/publikasjoner/m1063/m1063.pdf

Cui, S; Fu, Q; An, L; Yu, T; Zhang, F; Gao, S; Liu, D; Jia, H. (2019). Trophic transfer of cyclic methyl siloxanes in the marine food web in the Bohai Sea, China. Ecotoxicol Environ Saf 178: 86-93. http://dx.doi.org/10.1016/j.ecoenv.2019.04.034

Dow Corning. (1991). Aqueous solubility studies of octamethylcyclotetrasiloxane [TSCA Submission]. In Letter from Dow Corning Corporation to USEPA submitting enclosed submissions of list and copies of health and safety studies on octamethylcyclotetrasiloxane with attachments. (1991-I0000-36551. OTS0543156. 86-920001037. TSCATS/426856). Dow Corning Corp.

Duncan, M. (2000). Fish consumption survey of the Suquamish Indian Tribe of the Port Madison Indian Reservation, Puget Sound Region. Suquamish, WA: The Suquamish Tribe, Port Madison Indian Reservation. http://www.deq.state.or.us/wq/standards/docs/toxics/suquamish2000report.pdf

Durham, J. (2005). Hydrolysis of octamethylcyclotetrasiloxane (D4). (HES study no. 2005-I0000-55551). Auburn, MI: Dow Corning Corporation, Health and Environmental Sciences.

ERM. (2017a). D4 environmental testing report, Enforceable Consent Agreement (ECA): Testing consent order for octamethylcyclotetrasiloxane (D4), CASRN: 556-67-2, volume 1 of 2, text, figures, tables, and appendices A through J. (Docket No. EPA-HQ-OPPT-2012-0209). Washington, DC: American Chemistry Council and Silicones Environmental, Health, and Safety Center. https://www.regulations.gov/document?D=EPA-HQ-OPPT-2012-0209-0117

ERM. (2017b). D4 environmental testing report, Enforceable Consent Agreement (ECA): Testing consent order for octamethylcyclotetrasiloxane (D4), CASRN: 556-67-2, volume 2 of 2, appendices K through ZA. (Docket No. EPA-HQ-OPPT-2012-0209). Washington, DC:

American Chemistry Council and Silicones Environmental, Health, and Safety Center. https://www.regulations.gov/document/EPA-HQ-OPPT-2012-0209-0121

Gatidou, G; Arvaniti, OS; Stasinakis, AS; Thomaidis, NS; Andersen, HR. (2016). Using mechanisms of hydrolysis and sorption to reduce siloxanes occurrence in biogas of anaerobic sludge digesters. Bioresour Technol 221: 205-213. http://dx.doi.org/10.1016/j.biortech.2016.09.018

Genualdi, S; Harner, T, om; Cheng, Y, u; Macleod, M; Hansen, K; van Egmond, R; Shoeib, M; Lee, S. (2011). Global distribution of linear and cyclic volatile methyl siloxanes in air. Environ Sci Technol 45: 3349-3354. http://dx.doi.org/10.1021/es200301j

Harper, B; Harding, A; Harris, S; Berger, P. (2012). Subsistence Exposure Scenarios for Tribal Applications. Hum Ecol Risk Assess 18: 810-831. http://dx.doi.org/10.1080/10807039.2012.688706

Hong, WJ; Jia, H; Liu, C; Zhang, Z; Sun, Y; Li, YF. (2014). Distribution, source, fate and bioaccumulation of methyl siloxanes in marine environment. Environ Pollut 191: 175-181. http://dx.doi.org/10.1016/j.envpol.2014.04.033

Horii, Y; Nojiri, K; Minomo, K; Motegi, M; Kannan, K. (2019). Volatile methylsiloxanes in sewage treatment plants in Saitama, Japan: Mass distribution and emissions. Chemosphere 233: 677-686. http://dx.doi.org/10.1016/j.chemosphere.2019.05.247

Hydroqual. (1993). Sampling and analysis for D4 (octamethylcyclotetrasiloxane) at selected wastewater treatment plants with cover letter dated 06/11/93 [TSCA Submission]. (SHCO0020. OTS0557025. 86940000615. TSCATS/442495). Silicones Health Co.

Jia, H; Zhang, Z; Wang, C; Hong, WJ; Sun, Y; Li, YF. (2015). Trophic transfer of methyl siloxanes in the marine food web from coastal area of Northern China. Environ Sci Technol 49: 2833-2840. http://dx.doi.org/10.1021/es505445e

Kaj, L; Andersson, J; Cousins, AP; Remberger, M; Brorström-Lundén, E; Cato, I. (2005a). Results from the Swedish National Screening Programme 2004. Subreport 4: Siloxanes. (B1643). Stockholm, Sweden: IVL Swedish Environmental Research Institute. https://www.ivl.se/download/18.34244ba71728fcb3f3f6e6/1591704429963/B1643.pdf

Kaj, L; Schlabach, M; Andersson, J; Cousins, AP; Schmidbauer, N; Brorström-Lundén, E. (2005b). Siloxanes in the Nordic environment. Copenhagen, Denmark: Nordic Council of Ministers. http://10.6027/TN2005-593

Kapraun, D, ustin F.; Zurlinden, T, odd J.; Verner, M, arc-André; Chiang, C, atheryne; Dzierlenga, M, ichael W.; Carlson, L, aura M.; Schlosser, P, aul M.; Lehmann, G, eniece M. (2022). A generic pharmacokinetic model for quantifying mother-to-offspring transfer of lipophilic persistent environmental chemicals. Toxicol Sci 2022: kfac084. http://dx.doi.org/10.1093/toxsci/kfac084

Kim, J; Xu, S. (2017). Quantitative structure-reactivity relationships of hydroxyl radical rate constants for linear and cyclic volatile methylsiloxanes. Environ Toxicol Chem 36: 3240-3245. http://dx.doi.org/10.1002/etc.3914

Kozerski, GE; Xu, S; Miller, J; Durham, J. (2014). Determination of soil-water sorption coefficients of volatile methylsiloxanes. Environ Toxicol Chem 33: 1937-1945. http://dx.doi.org/10.1002/etc.2640

Lei, YD; Wania, F; Mathers, D, an. (2010). Temperature-Dependent Vapor Pressure of Selected Cyclic and Linear Polydimethylsiloxane Oligomers. Journal of Chemical and Engineering Data 55: 5868-5873. http://dx.doi.org/10.1021/je100835n

Li, B; Li, WL; Sun, SJ; Qi, H; Ma, WL; Liu, LY; Zhang, ZF; Zhu, NZ; Li, YF. (2016). The occurrence and fate of siloxanes in wastewater treatment plant in Harbin, China. Environ Sci Pollut Res Int 23: 13200-13209. http://dx.doi.org/10.1007/s11356-016-6481-z

Miller, J; Kozerski, GE. (2007). Soil–water distribution of octamethylcyclotetrasiloxane (D4) using a batch equilibrium method. (2007-I0000-58266). Auburn, MI: Dow Corning Corporation, Health and Environmental Sciences.

NCBI. (2021). PubChem database: compound summary: Octamethylcyclotetrasiloxane. Available online at https://pubchem.ncbi.nlm.nih.gov/compound/11169 (accessed May 17, 2021).

Northcote, TG. (1973). Some impacts of man on Kootenay Lake and its salmonoids. (Technical Report No. 25). Great Lakes Fishery Commission. http://glfc.org/pubs/TechReports/Tr25.pdf

Norwegian Environment Agency. (2019). Monitoring of environmental contaminants in freshwater ecosystems 2018 - Occurrence and biomagnification. (Report M-1411). https://www.miljodirektoratet.no/publikasjoner/2019/juni-2019/monitoring-of-environmental-contaminants-in-freshwater-ecosystems-2018--occurrence-and-biomagnification/

Olofsson, U; Brorström-Lundén, E; Kylin, H; Haglund, P. (2013). Comprehensive mass flow analysis of Swedish sludge contaminants. Chemosphere 90: 28-35. http://dx.doi.org/10.1016/j.chemosphere.2012.07.002

Panagopoulos, D; Jahnke, A; Kierkegaard, A; Macleod, M. (2015). Organic carbon/water and dissolved organic carbon/water partitioning of cyclic volatile methylsiloxanes: Measurements and polyparameter linear free energy relationships. Environ Sci Technol 49: 12161-12168. http://dx.doi.org/10.1021/acs.est.5b02483

Piechota, G; Igliński, B; Buczkowski, R. (2013). Development of measurement techniques for determination main and hazardous components in biogas utilised for energy purposes. Energ Convers Manag 68: 219-226. http://dx.doi.org/10.1016/j.enconman.2013.01.011

Polissar, NL; Salisbury, A; Ridolfi, C; Callahan, K; Neradilek, M; Hippe, D; Beckley, WH. (2016). A fish consumption survey of the Shoshone-Bannock Tribes: Vols. I-III. Polissar, NL; Salisbury, A; Ridolfi, C; Callahan, K; Neradilek, M; Hippe, D; Beckley, WH. https://www.epa.gov/sites/production/files/2017-01/documents/fish-consumption-survey-shoshone-bannock-dec2016.pdf

Powell, DE; Durham, J; Huff, DW. (2010). Preliminary assessment of cyclic volatile methylsiloxane (cVMS) materials in surface sediments, cores, zooplankton, and fish of Lake Opeongo, Ontario, Canada. (HES study no. 10806-108). Auburn, MI: Dow Corning Corporation, Health and Environment Sciences. https://chemview.epa.gov/chemview/proxy?filename=tscats/88100000163_556672_F6C05951E8742B528525773800631900.pdf

Powell, DE; Woodburn, KB; Drotar, KD; Durham, J; Huff, DW. (2009). Trophic dilution of cyclic volatile methylsiloxane (cVMS) materials in a temperate freshwater lake [TSCA Submission]. (Report no. 2009-I0000-60988; HES study no. 10771-108). Auburn, MI: Dow Corning Corporation.

Radermacher, G; Rüdel, H; Wesch, C; Böhnhardt, A; Koschorreck, J. (2020). Retrospective analysis of cyclic volatile methylsiloxanes in archived German fish samples covering a period of two decades. Sci Total Environ 706: 136011. http://dx.doi.org/10.1016/j.scitotenv.2019.136011

Raich-Montiu, J; Ribas-Font, C; De Arespacochaga, N; Roig-Torres, E; Broto-Puig, F; Crest, M; Bouchy, L; Cortina, JL. (2014). Analytical methodology for sampling and analysing eight siloxanes and trimethylsilanol in biogas from different wastewater treatment plants in Europe. Anal Chim Acta 812: 83-91. http://dx.doi.org/10.1016/j.aca.2013.12.027

Rasi, S; Lehtinen, J; Rintala, J. (2010). Determination of organic silicon compounds in biogas from wastewater treatments plants, landfills, and co-digestion plants. Renew Energ 35: 2666-2673. http://dx.doi.org/10.1016/j.renene.2010.04.012

Rauert, C; Shoieb, M; Schuster, JK; Eng, A; Harner, T. (2018). Atmospheric concentrations and trends of poly- and perfluoroalkyl substances (PFAS) and volatile methyl siloxanes (VMS) over 7 years of sampling in the Global Atmospheric Passive Sampling (GAPS) network. Environ Pollut 238: 94-102. http://dx.doi.org/10.1016/j.envpol.2018.03.017

RIDOLFI. (2016). Heritage fish consumption rates of the Kootenai Tribe of Idaho. Washington, DC: U.S. Environmental Protection Agency. https://www.epa.gov/sites/default/files/2017-

01/documents/heritage-fish-consumption-rates-kootenai-dec2016.pdf
RIVM. (2015). SimpleTreat [Computer Program]. Bilthoven, The Netherlands: National Institute for Public Health and the Environment. Retrieved from https://www.rivm.nl/en/soil-and-water/simpletreat
Safron, A; Strandell, M; Kierkegaard, A; Macleod, M. (2015). Rate Constants and Activation Energies for Gas-Phase Reactions of Three Cyclic Volatile Methyl Siloxanes with the Hydroxyl Radical. Int J Chem Kinet 47: 420-428. http://dx.doi.org/10.1002/kin.20919
Schlabach, M; Andersen, MS; Green, N; Schøyen, M; Kaj, L. (2007). Siloxanes in the environment of the inner Oslofjord (Statlig program for forurensningsovervåking). (NILU OR 986/2007). Schlabach, M; Andersen, MS; Green, N; Schøyen, M; Kaj, L.
Schweigkofler, M; Niessner, R. (1999). Determination of siloxanes and VOC in landfill gas and sewage gas by canister sampling and GC-MS/AES analysis. Environ Sci Technol 33: 3680-3685. http://dx.doi.org/10.1021/es9902569
SEHSC. (2021). Terrestrial ecological risk assessment for the octamethylcyclotetrasiloxane (D4) manufacturer-requested risk evaluation. Washington, DC: American Chemistry Council.
Shi, Y; Xu, S; Xu, L; Cai, Y. (2015). Distribution, Elimination, and Rearrangement of Cyclic Volatile Methylsiloxanes in Oil-Contaminated Soil of the Shengli Oilfield, China. Environ Sci Technol 49: 11527-11535. http://dx.doi.org/10.1021/acs.est.5b03197
Shields, HC; Fleischer, DM; Weschler, CJ. (1996). Comparisons among VOCs measured in three types of US commercial buildings with different occupant densities. Indoor Air 6: 2-17. http://dx.doi.org/10.1111/j.1600-0668.1996.t01-3-00002.x
Simon, PB; Paulson, EB. (1985). Organosiloxanes in fresh water and salt water sediments [TSCA Submission]. (TSCA docket OPTS-42071B). Ann Arbor, Michigan: Ann Arbor Technical Services Inc.
Sommerlade, R; Parlar, H; Wrobel, D; Kochs, P. (1993). Product analysis and kinetics of the gas-phase reactions of selected organosilicon compounds with OH radicals using a smog chamber-mass spectrometer system. Environ Sci Technol 27: 2435. http://dx.doi.org/10.1021/es00048a019
U.S. EPA. (1989). Risk assessment guidance for superfund, volume I: Human health evaluation manual (Part A). Interim final. (EPA/540/1-89/002). Washington, DC. https://www.epa.gov/sites/production/files/2015-09/documents/rags_a.pdf
U.S. EPA. (1993). Standards for the use or disposal of sewage sludge: Final rules [EPA Report]. (EPA 822/Z-93-001). Washington, DC.
U.S. EPA. (2000). Methodology for deriving ambient water quality criteria for the protection of human health (2000). (EPA/822/B-00/004). Washington, DC: U.S. Environmental Protection Agency, Office of Water. https://www.nj.gov/drbc/library/documents/EPA_human-health-criteria2000.pdf
U.S. EPA. (2004). Risk Assessment Guidance for Superfund (RAGS), volume I: Human health evaluation manual, (part E: Supplemental guidance for dermal risk assessment). (EPA/540/R/99/005). Washington, DC: U.S. Environmental Protection Agency, Risk Assessment Forum. https://www.epa.gov/risk/risk-assessment-guidance-superfund-rags-part-e
U.S. EPA. (2007). Exposure and Fate Assessment Screening Tool (E-FAST), Version 2.0 [Computer Program]. Washington, DC.
U.S. EPA. (2011). Exposure factors handbook: 2011 edition [EPA Report]. (EPA/600/R-090/052F). Washington, DC: U.S. Environmental Protection Agency, Office of Research and Development, National Center for Environmental Assessment. https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P100F2OS.txt
U.S. EPA. (2014). Estimated fish consumption rates for the U.S. population and selected subpopulations (NHANES 2003-2010) [EPA Report]. (EPA-820-R-14-002). Washington, DC. https://www.epa.gov/sites/production/files/2015-01/documents/fish-consumption-rates-2014.pdf

U.S. EPA. (2015). Evaluation of Swimmer Exposures Using the SWIMODEL Algorithms and Assumptions. Available online at https://www.epa.gov/sites/production/files/2016-11/documents/swimodel_final.pdf

U.S. EPA. (2016). Guidance for conducting fish consumption surveys. (823B16002). https://www.epa.gov/sites/production/files/2017-01/documents/fc_survey_guidance.pdf

U.S. EPA. (2017a). Estimation Programs Interface Suite™ v.4.11. Washington, DC: U.S. Environmental Protection Agency, Office of Pollution Prevention Toxics. Retrieved from https://www.epa.gov/tsca-screening-tools/download-epi-suitetm-estimation-program-interface-v411

U.S. EPA. (2017b). Update for Chapter 5 of the Exposure Factors Handbook: Soil and dust ingestion [EPA Report]. (EPA/600R-17/384F). Washington, DC: National Center for Environmental Assessment, Office of Research and Development. https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P100TTX4.txt

U.S. EPA. (2019a). Exposure factors handbook chapter 3 (update): Ingestion of water and other select liquids [EPA Report]. (EPA/600/R-18/259F). Washington, DC. https://cfpub.epa.gov/ncea/efp/recordisplay.cfm?deid=343661

U.S. EPA. (2019b). Guidelines for human exposure assessment [EPA Report]. (EPA/100/B-19/001). Washington, DC: Risk Assessment Forum. https://www.epa.gov/sites/production/files/2020-01/documents/guidelines_for_human_exposure_assessment_final2019.pdf

U.S. EPA. (2019c). Point Source Calculator: A Model for Estimating Chemical Concentration in Water Bodies. Washington, DC: U.S. Environmental Protection Agency, Office of Chemical Safety and Pollution Prevention.

U.S. EPA. (2019d). User's Guide: Integrated Indoor-Outdoor Air Calculator (IIOAC). Washington, DC: U.S. EPA.

U.S. EPA. (2021). About the Exposure Factors Handbook. Available online at https://www.epa.gov/expobox/about-exposure-factors-handbook

U.S. EPA. (2022). Draft TSCA screening level approach for assessing ambient air and water exposures to fenceline communities (version 1.0) [EPA Report]. (EPA-744-D-22-001). Washington, DC: Office of Chemical Safety and Pollution Prevention, U.S. Environmental Protection Agency. https://www.epa.gov/system/files/documents/2022-01/draft-fenceline-report_sacc.pdf

U.S. EPA. (2023). Biosolids Tool (BST) User's Guide: Version 1, February 2023. (822D23002). Washington, DC: U.S. Environmental Protection Agency, Office of Water.

U.S. EPA. (2025a). Draft Ambient Air IIOAC Exposure Results and Risk Calculations for Octamethylcyclotetrasiloxane (D4). Washington, DC: Office of Pollution Prevention and Toxics.

U.S. EPA. (2025b). Draft Biosolids-Amended Soil Concentration Results and Risk Calculations for Octamethylcyclotetrasiloxane (D4). Washington, DC: Office of Pollution Prevention and Toxics.

U.S. EPA. (2025c). Draft Environmental Exposure Assessment for Octamethylcyclotetrasiloxane (D4). Washington, DC: Office of Pollution Prevention and Toxics.

U.S. EPA. (2025d). Draft Environmental Release And Occupational Exposure Assessment For Dibutyl Phthalate (DBP). Washington, DC: Office of Pollution Prevention and Toxics.

U.S. EPA. (2025e). Draft Environmental Release and Occupational Exposure Assessment for Octamethylcyclotetrasiloxane (D4). Washington, DC: Office of Pollution Prevention and Toxics.

U.S. EPA. (2025f). Draft Fish Ingestion Risk Calculator for Octamethylcyclotetrasiloxane (D4). Washington, DC: Office of Pollution Prevention and Toxics.

U.S. EPA. (2025g). Draft Human Health Hazard Assessment for Octamethylcyclotetrasiloxane (D4). Washington, DC: Office of Pollution Prevention and Toxics.

U.S. EPA. (2025h). Draft Physical Chemistry and Fate Assessment for Octamethylcyclotetrasiloxane (D4). Washington, DC: Office of Pollution Prevention and Toxics.

U.S. EPA. (2025i). Draft Risk Evaluation for Dibutyl Phthalate (DBP). Washington, DC: Office of

Pollution Prevention and Toxics.
U.S. EPA. (2025j). Draft Risk Evaluation for Octamethylcyclotetrasiloxane (D4). Washington, DC: Office of Pollution Prevention and Toxics.
U.S. EPA. (2025k). Draft systematic review protocol for octamethylcyclotetrasiloxane (D4). Washington, DC: Office of Pollution Prevention and Toxics.
USDA. (1963). Composition of foods: Raw, processed, prepared: U.S. Department of Agriculture, Agriculture Handbook No. 8. Washington, DC.
Varaprath, S; Frye, CL; Hamelink, J. (1996). Aqueous solubility of permethylsiloxanes (silicones). Environ Toxicol Chem 15: 1263-1265. http://dx.doi.org/10.1002/etc.5620150803
Versar. (2014). Exposure and Fate Assessment Screening Tool (E-FAST 2014) - Documentation manual. Washington, DC: U.S. Environmental Protection Agency. https://www.epa.gov/tsca-screening-tools/e-fast-exposure-and-fate-assessment-screening-tool-version-2014
Wang, DG; Aggarwal, M; Tait, T; Brimble, S; Pacepavicius, G; Kinsman, L; Theocharides, M; Smyth, SA; Alaee, M. (2015a). Fate of anthropogenic cyclic volatile methylsiloxanes in a wastewater treatment plant. Water Res 72: 209-217. http://dx.doi.org/10.1016/j.watres.2014.10.007
Wang, DG; Du, J; Pei, W, ei; Liu, Y; Guo, M. (2015b). Modeling and monitoring cyclic and linear volatile methylsiloxanes in a wastewater treatment plant using constant water level sequencing batch reactors. Sci Total Environ 512-513: 472-479. http://dx.doi.org/10.1016/j.scitotenv.2015.01.081
Wang, DG; Steer, H; Tait, T; Williams, Z; Pacepavicius, G; Young, T; Ng, T; Smyth, SA; Kinsman, L; Alaee, M. (2013). Concentrations of cyclic volatile methylsiloxanes in biosolid amended soil, influent, effluent, receiving water, and sediment of wastewater treatment plants in Canada. Chemosphere 93: 766-773. http://dx.doi.org/10.1016/j.chemosphere.2012.10.047
Wang, XM; Lee, SC; Sheng, GY; Chan, LY; Fu, JM; Li, XD; Min, YS. (2001). Cyclic organosilicon compounds in ambient air in Guangzhou, Macau and Nanhai, Pearl River Delta. Appl Geochem 16: 1447-1454. http://dx.doi.org/10.1016/S0883-2927(01)00044-0
WIL Research. (2001). 2-Generation inhalation reproductive toxicity and developmental neurotoxicity study of octamethylcyclotetrasiloxane (D4) in rats, w/cvr ltr dtd 010302 [TSCA Submission]. (2001-I0000-50855. 8713. OTS0574394. 86020000003. TSCATS/454735). Dow Corning Corporation.
Xiao, R; Zammit, I; Wei, Z; Hu, WP; Macleod, M; Spinney, R. (2015). Kinetics and Mechanism of the Oxidation of Cyclic Methylsiloxanes by Hydroxyl Radical in the Gas Phase: An Experimental and Theoretical Study. Environ Sci Technol 49: 13322-13330. http://dx.doi.org/10.1021/acs.est.5b03744
Xu, L; Xu, S; Zhi, L; He, X; Zhang, C; Cai, Y. (2017). Methylsiloxanes release from one landfill through yearly cycle and their removal mechanisms (especially hydroxylation) in leachates. Environ Sci Technol 51: 12337-12346. http://dx.doi.org/10.1021/acs.est.7b03624
Xu, S. (2007). Estimation of degradation rates of cVMS in soils. (HES study no. 10787-102). Auburn, MI: Dow Corning Corporation, Health and Environmental Sciences.
Xu, S; Kropscott, B. (2012). Method for simultaneous determination of partition coefficients for cyclic volatile methylsiloxanes and dimethylsilanediol. Anal Chem 84: 1948-1955. http://dx.doi.org/10.1021/ac202953t
Xu, S; Kropscott, B. (2014). Evaluation of the three-phase equilibrium method for measuring temperature dependence of internally consistent partition coefficients (KOW , KOA , and KAW) for volatile methylsiloxanes and trimethylsilanol. Environ Toxicol Chem 33: 2702-2710. http://dx.doi.org/10.1002/etc.2754
Xu, SH; Chandra, G. (1999). Fate of cyclic methylsiloxanes in soils. 2. Rates of degradation and volatilization. Environ Sci Technol 33: 4034-4039. http://dx.doi.org/10.1021/es990099d
Xue, X; Jia, H; Xue, J. (2019). Bioaccumulation of methyl siloxanes in common carp (cyprinus carpio)

and in an estuarine food web in northeastern China. Arch Environ Contam Toxicol 76: 496-507. http://dx.doi.org/10.1007/s00244-018-0569-z

Yucuis, RA; Stanier, CO; Hornbuckle, KC. (2013). Cyclic siloxanes in air, including identification of high levels in Chicago and distinct diurnal variation. Chemosphere 92: 905-910. http://dx.doi.org/10.1016/j.chemosphere.2013.02.051

Zhang, Y. (2014) Analysis of octamethylcyclotetrasiloxane and decamethylcyclopentasiloxane in wastewater, sludge and river samples by headspace gas chromatography/mass spectrometry. (Master's Thesis). Colorado State University, Fort Collins, Colorado. Retrieved from http://hdl.handle.net/10217/84580

Zhang, Y; Zeng, G; Shen, M; Tian, Y. (2018). Cyclic volatile methylsiloxanes in sediment, soil, and surface water from Dongting Lake, China. Journal of Soils and Sediments 18: 2063-2071. http://dx.doi.org/10.1007/s11368-018-1948-9

Zhang, Z; Qi, H; Ren, N; Li, Y; Gao, D; Kannan, K. (2011). Survey of cyclic and linear siloxanes in sediment from the Songhua River and in sewage sludge from wastewater treatment plants, Northeastern China. Arch Environ Contam Toxicol 60: 204-211. http://dx.doi.org/10.1007/s00244-010-9619-x

APPENDICES

Appendix A EXPOSURE FACTORS

Table_Apx A-1. Body Weight by Age Group

Age Group[a]	Mean Body Weight (kg)[b]
Infant (<1 year)	7.83
Young toddler (1 to <2 years)	11.4
Toddler (2 to <3 years)	13.8
Small child (3 to <6 years)	18.6
Child (6 to <11 years)	31.8
Teen (11 to <16 years)	56.8
Adult (16+ years)	80.0

[a] Age group weighted average
[b] See Table 8-1 of U.S. EPA (2011)

Table_Apx A-2. Fish Ingestion Rate by Age Group

Age Group	Fish Ingestion Rate (g/kg-day)[a]	
	50th Percentile	90th Percentile
Infant (<1 year)[b]	N/A	N/A
Young toddler (1 to <2 years)[b]	0.053	0.412
Toddler (2 to <3 years)[b]	0.043	0.341
Small child (3 to <6 years)[b]	0.038	0.312
Child (6 to <11 years)[b]	0.035	0.242
Teen (11 to <16 years)[b]	0.019	0.146
Adult (16+ years)[c]	0.063	0.277
Subsistence fisher (adult)[d]	1.78	

[a] Age group weighted average, using body weight from Table_Apx A-1
[b] See Table 20a of U.S. EPA (2014)
[c] See Table 9a of U.S. EPA (2014)
[d] U.S. EPA (2000)

2254 **Table_Apx A-3. Recommended Default Values for Common Exposure Factors**

Symbol	Definition	Recommended Default Value	Recommended Default Value	Source
		Occupational	Residential	
ED	Exposure duration (hrs/day)	8	24	
EF	Exposure frequency (days/year)	250	365	
EY	Exposure years (years)	40	Varies for adults chronic, non-cancer 78 (lifetime) 1 Infant (birth to <1 year) 5 Toddler (1–5 year) 5 Child (6–10 year) 5 Youth (11–15 year) 5 Youth (16–20 year)	Number of years in age group Note: These age bins may vary for different measurements and sources
AT	Averaging time non-cancer	Equal to total exposure duration or 365 days/year × EY; whichever is greater	Equal to total exposure duration or 365 days/year × EY; whichever is greater	See pg. 6–23 of Risk assessment guidance for superfund, volume I: Human health evaluation manual (Part A). (U.S. EPA, 1989)
	Averaging time cancer	78 years (28,470 days)	78 years (28,470 days)	See Table 18-1 of the *Exposure Factors Handbook* (U.S. EPA, 2011)
BW	Body weight (kg)	80	80 Adult 7.83 Infant (birth to <1 year) 16.2 Toddler (1–5 years) 31.8 Child (6–10 years) 56.8 Youth (11–15 years) 71.6 Youth (16–20 years) 65.9 Adolescent woman of childbearing age (16 to <21) – apply to all developmental exposure scenarios	See Table 8-1 of the *Exposure Factors Handbook* (U.S. EPA, 2011) (Refer to Figure 31 for age-specific BW) Note: These age bins may vary for different measurements and sources See Table 8-5 of the *Exposure Factors Handbook* (U.S. EPA, 2011)

Symbol	Definition	Recommended Default Value	Recommended Default Value	Source
		Occupational	Residential	
$IR_{dw\text{-}acute}$	Drinking water ingestion rate (L/day) – acute	3.219 Adult	3.219 Adult 1.106 Infant (birth to <1 year) 0.813 Toddler (1–5 years) 1.258 Child (6–10 years) 1.761 Youth (11–15 years) 2.214 Youth (16–20 years)	See Tables 3-15 and 3-33; weighted average of 90th percentile consumer-only ingestion of drinking water (birth to <6 years) (U.S. EPA, 2011)
$IR_{dw\text{-}chronic}$	Drinking water ingestion rate (L/day) – chronic	0.880 Adult	0.880 Adult 0.220 Infant (birth to <1 year) 0.195 Toddler (1–5 years) 0.294 Child (6–10 years) 0.315 Youth (11–15 years) 0.436 Youth (16–20 years)	Chapter 3 of the *Exposure Factors Handbook* (U.S. EPA, 2011), Table 3-9 per capita mean values; weighted averages for adults (years 21–49 and 50+), for toddlers (years 1–2, 2–3, and 3 to <6).
IR_{inc}	Incidental water ingestion rate (L/hr)		0.025 Adult 0.05 Child (6 to < 16 years)	Evaluation of Swimmer Exposures Using the SWIMODEL Algorithms and Assumptions (U.S. EPA, 2015)
IR_{soil}	Soil ingestion rate (mg/day)	50 Indoor workers 100 Outdoor workers	100 Infant (<6 months) 200 Infant to Youth (6 months to <12 years) 100 Youth to Adult (12+ years) 1,000 Soil Pica Infant to Youth (1 to <12 years) 50,000 Geophagy (all ages)	U.S. EPA Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (1991) Chapter 5 of the *Exposure Factors Handbook* (U.S. EPA, 2011), Table 5-1, Upper percentile daily soil and dust ingestion
SA_{water}	Skin surface area exposed (cm^2) used for incidental water dermal contact		19,500 Adult 7,600 Child (3 to < 6 years) 10,800 Child (6 to < 11 years) 15,900 Youth (11 to < 16 years)	Chapter 7 of the *Exposure Factors Handbook* (U.S. EPA, 2011), Table 7-1, Recommended Mean Values for Total Body Surface Area, for Children (sexes combined) and Adults by Sex

Symbol	Definition	Recommended Default Value	Recommended Default Value	Source
		Occupational	Residential	
K_p	Permeability constant (cm/hr) used for incidental water dermal contact	Not applicable for D4 because of the availability of a PBPK to estimate internal dose.		
SA_{soil}	Skin surface area exposed (cm^2) used for soil dermal contact	3,300 Adult	5,800 Adult 2,700 Child	EPA Risk Assessment Guidance for Superfund RAGS Part E for Dermal Exposure (U.S. EPA, 2004)
AF_{soil}	Adherence factor (mg/cm^2) used for soil dermal contact	0.2 Adult	0.07 Adult 0.2 Child	EPA Risk Assessment Guidance for Superfund RAGS Part E for Dermal Exposure (U.S. EPA, 2004)

Table_Apx A-4. Mean and Upper Milk Ingestion Rates by Age

Age Group	Milk Ingestion (mL/kg day)	
	Mean	Upper (95th percentile)
Birth to <1 month	150	220
1 to <3 month	140	190
3 to <6 month	110	150
6 to <12 month	83	130
Birth to <1 year	104.8	152.5

A.1 Surface Water Exposure Activity Parameters

Table_Apx A-5. Incidental Dermal (Swimming) Modeling Parameters

Input	Description (Units)	Adult (21+ years)	Youth (11–15 years)	Child (6–10 years)	Notes	Reference
BW	Body weight (kg)	80	56.8	31.8	Mean body weight. Chapter 8 of the *Exposure Factors Handbook*, Table 8-1	U.S. EPA (2021)
SA	Skin surface area exposed (cm^2)	19,500	15,900	10,800	U.S. EPA Swimmer Exposure Assessment Model (SWIMODEL)	U.S. EPA (2015)
ET	Exposure time (hr/day)	3	2	1	High-end default short-term duration from U.S. EPA Swimmer Exposure Assessment Model (SWIMODEL)	U.S. EPA (2015)
ED	Exposure duration (years for ADD)	57	5	5	Number of years in age group,	U.S. EPA (2021)
AT	Averaging time (years for ADD)	57	5	5	Number of years in age group,	U.S. EPA (2021)
K_p	Permeability coefficient (cm/hr)	NA for D4 because used a value of 1				

Table_Apx A-6. Incidental Oral Ingestion (Swimming) Modeling Parameters

Input	Description (Units)	Adult (21+ years)	Youth (11–15 years)	Child (6–10 years)	Notes	Reference
IR_{inc}	Ingestion rate (L/hr)	0.092	0.152	0.096	Upper percentile ingestion while swimming. Chapter 3 of the *Exposure Factors Handbook*, Table 3-7.	U.S. EPA (2019a)
BW	Body weight (kg)	80	56.8	31.8	Mean body weight. Chapter 8 of the *Exposure Factors Handbook*, Table 8-1.	U.S. EPA (2021)
ET	Exposure time (hr/day)	3	2	1	High-end default short-term duration from U.S. EPA Swimmer Exposure Assessment Model (SWIMODEL); based on competitive swimmers in the age class	U.S. EPA (2015)
$IR_{inc\text{-}daily}$	Incidental daily ingestion rate (L/day)	0.276	0.304	0.096	Calculation: ingestion rate × exposure time	
IR/BW	Weighted incidental daily ingestion rate (L/kg-day)	0.0035	0.0054	0.0030	Calculation: ingestion rate/body weight	
ED	Exposure duration (years for ADD)	57	5	5	Number of years in age group,	U.S. EPA (2021)
AT	Averaging time (years for ADD)	57	5	5	Number of years in age group,	U.S. EPA (2021)
CF1	Conversion factor (mg/µg)	1.00E−03				
CF2	Conversion factor (days/year)	365				

Appendix B GENERAL POPULATION INCIDENTAL INGESTION OF BIOSOLIDS-AMENDED SOIL RISK SCREENING RESULTS

A summary of the generic human health inputs (*e.g.*, exposure factors, ingestion rate) used for calculating acute dose rate (ADR) and average daily dose (ADD) are available in Appendix A. EPA used the life stage parameters for the greatest ingestion rate-to-body weight ratio to calculate acute and chronic exposure values (an ingestion rate [IR] of 200 and body weight [BW] of 9.2 kg for the Infant [6 months to <12 months] life stage). Table_Apx B-1 summarizes the acute and chronic MOEs based on the ingestion doses presented in Table 3-2. Using the greatest modeled soil concentrations for the high-end release estimate and ECA monitoring data (SEHSC, 2021; ERM, 2017a), the MOEs are greater than the benchmark of 30. *Based on the conservative modeling parameters for biosolid-amended soil concentration and exposure factors parameters, risk for non-cancer health effects for incidental ingestion of biosolids-amended soil is not expected.*

Table_Apx B-1. Risk Screen for Incidental Oral Ingestion of Biosolids-Amended Soil for Children for the High-end Release Estimate from Modeling and ECA Monitoring Data

Scenario Data Source/OES[a]	Soil Concentration (µg/kg dw)[b]	Acute MOE[d]	Chronic MOE[d]
Formulation of adhesives and sealants (neat D4) *Pasture/no till* (Engineering estimate from generic scenario)	2,185[c]	9.40E04	303
Industrial WWTPs *95th percentile, Pasture/no till* (SEHSC, 2021; ERM, 2017a)	2.05E–01	1.00E09	3.22E06
Non-industrial WWTPs *95th percentile, Pasture/no till* (SEHSC, 2021; ERM, 2017a)	2.42E–02	8.49E09	2.74E07

[a] Table 1-1 provides the crosswalk of OES to COUs

[b] Only pasture soil concentrations from dry climate scenarios are presented here, as these settings resulted in greater soil concentrations as compared to the other climate scenarios and the Crop/till scenarios. MOEs for the crop scenarios exceeded those for the pasture scenarios. Similarly, results for the 95th percentile ECA data concentrations are presented, and the MOEs for the mean ECA data concentrations exceeded those for the 95th percentile concentrations.

[c] The solubility limit of D4 was exceeded in the model run, therefore there is lower confidence in the value of these concentrations. This does not reduce confidence in the protectiveness of the screening approach.

[d] Threshold MOE = 30

Appendix C ESTIMATING HYDROLOGICAL FLOW DATA FOR SURFACE WATER MODELING

A distribution of flow metrics was generated by collecting flow data for facilities across one North American Industry Classification System (NAICS) code associated with D4-releasing facilities (Table_Apx C-1). EPA's Enforcement and Compliance History Online (ECHO) database was accessed via the Application Programming Interface (API) and queried for facilities regulated under the Clean Water Act. All available National Pollutant Discharge Elimination System (NPDES) permit IDs were retrieved from the facilities returned by the query. An additional query of the Discharge Monitoring Report (DMR) REST (REpresentional State Transfer) service was conducted via the ECHO API to return the National Hydrography Dataset Plus (NHDPlus) reach code associated with the receiving water body for each available facility. Modeled flow metrics were then extracted for the retrieved reach codes from the NHDPlus V2.1 Flowline Network's Enhanced Runoff Method (EROM) Flow database. The EROM database provides modeled monthly average flows for each month of the year. While the EROM flow database represents averages across a 30-year time period, the lowest of the monthly average flows was selected as a substitute for the 30Q5 flow used in modeling, as both approximate the lowest observed monthly flow at a given location. The substitute 30Q5 flow was then plugged into the regression equation used by EPA's Exposure and Fate Assessment Screening Tool (E-FAST) (U.S. EPA, 2007) to convert between these flow metrics and solved for the 7Q10 using Equation_Apx C-1. In previous assessments, the EPA has selected the 7Q10 flow as a representative low flow scenario for biological impacts due to effluent in streams, while the harmonic mean represents a more average flow for assessing chronic drinking water exposure.

Equation_Apx C-1. Calculating the 7Q10 Flow

$$7Q10 = \frac{\left(0.409\,\frac{cfs}{MLD} \times \frac{30Q5}{1.782}\right)^{1.0352}}{0.409\,\frac{cfs}{MLD}}$$

Where:

$7Q10$	=	Modeled 7Q10 flow, in million liters per day (MLD)
$30Q5$	=	Lowest monthly average flow from NHD, in MLD

Further, the harmonic mean (HM) flow was calculated using Equation_Apx C-2, derived from the relevant E-FAST regression (U.S. EPA, 2007).

Equation_Apx C-2. Calculating the Harmonic Mean Flow

$$HM = 1.194 \times \frac{\left(0.409\,\frac{cfs}{MLD} \times AM\right)^{0.473} \times \left(0.409\,\frac{cfs}{MLD} \times 7Q10\right)^{0.552}}{0.409\,\frac{cfs}{MLD}}$$

Where:

HM	=	Modeled harmonic mean flow, in MLD
AM	=	Annual average flow from NHD, in MLD
$7Q10$	=	Modeled 7Q10 flow from the previous equation, in MLD

Table_Apx C-1. Relevant NAICS Codes for Facilities Associated with D4 Releases

NAICS Code	Category	Subcategory of Use	OES
325199	Manufacturing	Manufacturing	Manufacturing
325180 325998 339999	Processing – repackaging	All other basic inorganic chemical manufacturing; All other chemical product and preparation manufacturing; Miscellaneous manufacturing	Import – repackaging
325520	Processing as a reactant	Adhesives and sealant chemicals	Formulation of adhesives and sealants (neat D4) Formulation of adhesives and sealants (residual D4, *i.e.,* PDMS)
325180, 325199, 325998, 325211, 325212	Processing as a reactant	All other basic inorganic chemical manufacturing; all other basic organic chemical manufacturing; all other chemical product and preparation manufacturing; plastic material and resin manufacturing; synthetic rubber manufacturing	Processing as a reactant
325510, 334111	Incorporation into formulation, mixture, or reaction product	Asphalt paving, roofing, and coating materials manufacturing, paint and coating manufacturing, computer and electronic product manufacturing, electrical equipment, appliance, and component manufacturing	Formulation of paints and coatings (neat D4) Formulation of paints and coatings (residual D4, *i.e.,* PDMS)
325212	Processing as a reactant; incorporation into formulation, mixture, or reaction product	Plastic material and resin manufacturing; synthetic rubber manufacturing; rubber product manufacturing	Rubber compounding (neat D4) Rubber compounding (residual D4, *i.e.,* PDMS)
326299	Processing as a reactant; incorporation into formulation, mixture, or reaction product	Plastic material and resin manufacturing; synthetic rubber manufacturing; rubber product manufacturing	Rubber converting
325180, 325998, 339999	Processing – Repackaging	All other basic inorganic chemical manufacturing; all other chemical product and preparation manufacturing; miscellaneous manufacturing	Import – repackaging
488190	Other industrial uses	Aircraft maintenance	Use of aircraft maintenance products (cold cleaning product) (all what-if scenarios and changeout frequencies)

NAICS Code	Category	Subcategory of Use	OES
325998, 325611, 325194, 339999, 332999	Incorporation into formulation, mixture, or reaction product	All other basic inorganic chemical manufacturing; all other chemical product and preparation manufacturing, cyclic crude and intermediate manufacturing, miscellaneous manufacturing, processing aid	Formulation of downstream products with neat D4 (fabric finishing, automotive detailing, aircraft maintenance, animal grooming products) Formulation of downstream products with residual D4, *i.e.,* PDMS (printing inks, cleaning, and laundry)
313310	Furnishing, cleaning, treatment/care products	Fabric, textile, and leather products not covered elsewhere	Use of fabric finishing products
811121	Automotive care products	Automotive care products	Use of automative care products
325612	Furnishing, cleaning, treatment, care products	Cleaning and furnishing care products Laundry and dishwashing products	Use of cleaning products Use of laundry products – Industrial Use of laundry products – Institutional
325130	Ink, toner, and colorant products	Ink, toner, and colorant products	Use of printing ink
541380	Laboratory chemicals	Laboratory chemicals	Use of laboratory chemicals
238320	Paints and coatings	Paints and coatings	Use of paints and coatings (for all days and all units in kg/day of application)
339999	Other commercial uses	Use of animal grooming products	Animal grooming products

2324

In addition to the hydrologic flow data retrieved from the NHDPlus database, information about the facility effluent rate was collected, as available, from the ECHO API. A minimum effluent flow rate of six cubic feet per second, derived from the average reported effluent flow rate across facilities, was applied. The receiving water body 7Q10 flow was then calculated as the sum of the hydrologic 7Q10 flow estimated from regression and the facility effluent flow. From the distribution of resulting receiving water body flow rates across the pooled flow data of all relevant NAICS codes, the median 7Q10 flow rate was selected to be applied as a conservative low flow condition across the modeled releases. Additional refined analyses were conducted for the scenarios resulting in the greatest environmental concentrations by applying the 75th and 90th percentile (P75 and P90, respectively) flow metrics from the distribution, which were expected to be more representative of the flow conditions associated with high-end releases.

Quantified release estimates to surface water were evaluated with PSC modeling, applying the receiving water body flows estimated from the developed distribution. For each COU with surface water releases, the highest estimated release of D4 to surface water was used to estimate the corresponding D4 concentrations in the receiving water body. The total days of release associated with the highest COU release was applied as continuous days of release per year (*e.g.*, a scenario with 250 days of release per year was modeled as 250 consecutive days of release, followed by 115 days of no release, per year). Raw daily concentration estimates from PSC were manually evaluated for the highest resulting concentrations in an averaging window equal to the total days of release (*e.g.*, a scenario with 250 days of release was evaluated for the highest 250-day average concentration). The frollmean function in the data.table package in R was used to calculate the rolling averages. The function takes in the concentration values to be averaged (extracted from the PSC Daily Output File) and the number of values to include in the averaging window which was total days of release (extracted from the PSC Summary Output File). The function outputs a list of averages from consecutive averaging windows (for example, the first average will be for values 1- total days of release and the second average will be for values 2- total days of release +1).

C.1 Representativeness of Different Flow Metrics

The distribution of hydrologic flows representing 7Q10 flow for each of the water releasing OESs is represented with P50, P75, and P90 flow rates (Table_Apx C-2). Although the 7Q10 is used to estimate aquatic or ecological exposure, it can still be used to illustrate how different flow metrics may or may not represent real-world scenarios and is applicable to the general population assessment.

Table_Apx C-2. Flow Rate for P50, P75, and P90 7Q10 Flows and OESs

OES	P50 7Q10 flow		P75 7Q10 flow		P90 7Q10 flow	
	ft^3/sec	m^3/day	ft^3/sec	m^3/day	ft^3/sec	m^3/day
Processing as a reactant	13	32,781	73	177,492	2,223	5,439,150
Import – repackaging	7	17,616	92	226,528	5,621	13,754,574
Manufacturing	24	59,436	65	159,949	3,166	7,746,125
Rubber converting	2	4,256	13	31,483	212	517,997
Rubber compounding	9	21,808	68	166,168	2,985	7,303,657
Use of fabric finishing products	47	115,358	177	434,064	3,047	7,455,390

Generic scenario OESs contain uncertainties such as the number of sites, release volumes among sites,

and days of release that could contribute to variability in the estimation of instream chemical concentrations. When considering these factors and estimated flows for specific OESs, EPA determined that modeled surface water concentrations based on the P50 7Q10 flow conditions do not best reflect the industrial and commercial contexts where D4 releases occur. Many industrial activities involving D4, such as manufacturing, import and repackaging, and Processing as a reactant, are carried out at a limited number of sites. D4 facilities are characterized as high-volume releasers. Therefore, the flow rates of the receiving water bodies are more likely to be captured by the upper end of the distribution created by pooling flow data of all relevant NAICS codes. Furthermore, modeled water concentrations using the P50 7Q10 flow statistic were outside the bounds of solubility. For instance, environmental releases for the Import – repackaging OES paired with the lowest flow rates resulted in modeled surface water concentrations exceeding the water solubility limit by nearly seven-fold.

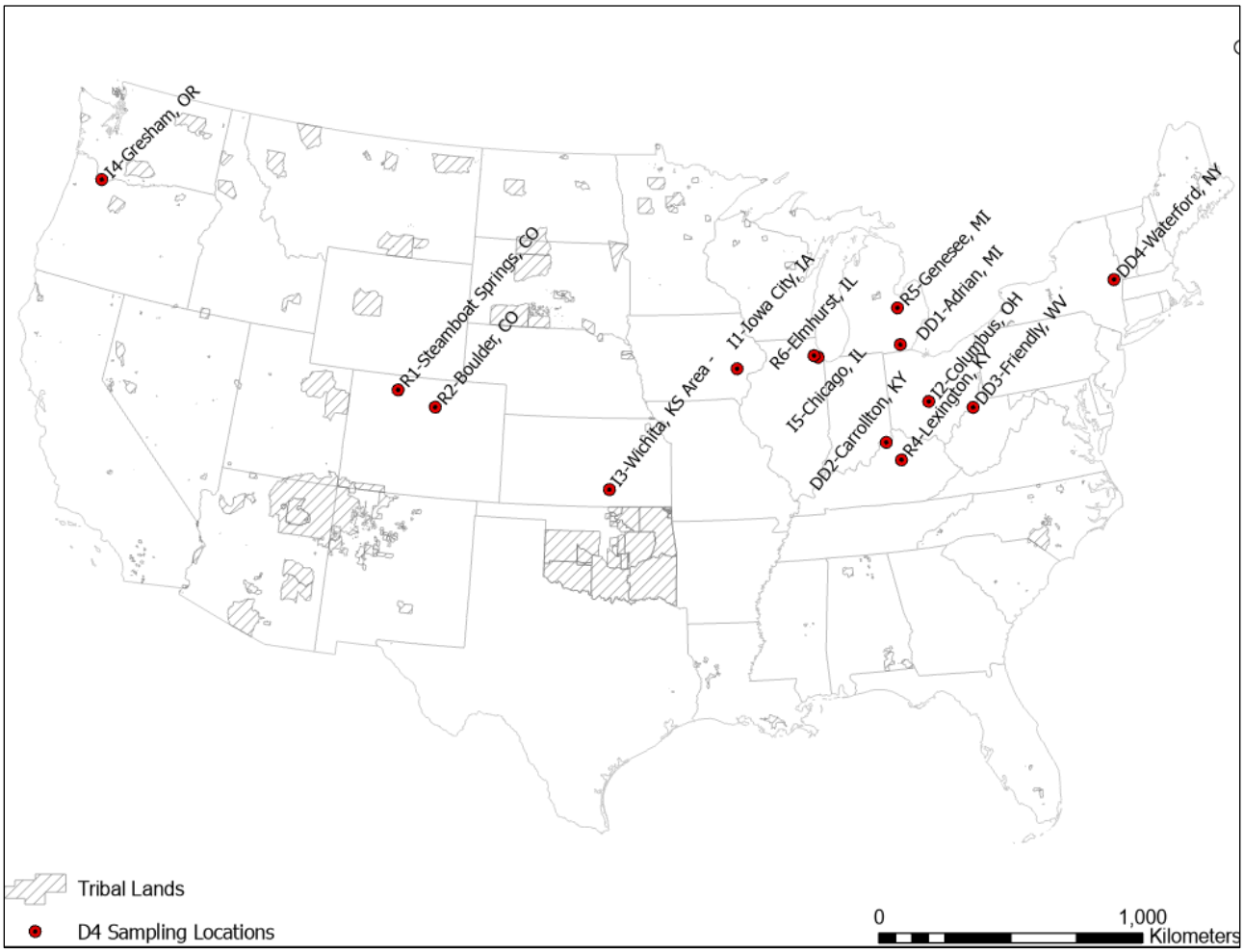
In addition to flows for the OESs based on generic scenarios, EPA also identified the receiving water body flows at facilities identified as direct dischargers within the ECA. EPA again pulled from the NHDPlus V2.1 EROM flow database (Table_Apx C-3). For DD1 and DD4, the flows shown represent the reach specified in the NPDES permit as the receiving water body, while DD2 and DD3 flows represent a larger river immediately downstream from a small channel or creek specified as the receiving water body in the facility's NPDES permit. The release and sample sites identified in the ECA for DD2 and DD3 were identified at the larger river locations (Ohio River) (ERM, 2017a). Mean annual and lowest monthly flows are taken directly from the EROM flow database, while the P50 7Q10 value is calculated using the regression equation from the EFAST model (Versar, 2014).

Processing as a reactant, involving an estimated 25 to 31 sites, and manufacturing activities, involving 5 sites, are partially captured in the ECA with direct discharges into river systems. The calculated P50 7Q10 flows for these facilities from the ECA are 65 to 31,514 ft^3 per second for DD1 and DD2, respectively (Table_Apx C-3). The P75 7Q10 estimated from the distribution of NAICS codes relevant to the manufacturing and Processing as a reactant OESs are 65 ft^3 and 73 ft^3 per second (Table_Apx C-2), respectively, encompassing the lowest 7Q10 from DD1 within the ECA. While the ECA does not provide site-specific data for other OESs, EPA assumes similar patterns for manufacturing and processing with known releases to larger flow streams. Therefore, a representative discharge from a hypothetical facility (*e.g.*, release to wastewater with on-site treatment or discharge to a POTW) would likely correspond better with a P75 and/or P90 7Q10 flow scenario.

Table_Apx C-3. Flow Rate from the NHDPlus V2.1 EROM Flow Database Near Facilities Identified as Direct Dischargers within the ECA (ERM, 2017a)

Direct Discharge – Company, City, State, River	NHDPlus Mean Annual		NHDPlus Lowest Monthly		Calculated P50 7Q10	
	ft^3/sec	m^3/day	ft^3/sec	m^3/day	ft^3/sec	m^3/day
DD1 - Wacker Chemical Corp., Adrian, MI, River Raisin	224	548,027	101	247,101	65	159,739
DD2 - Dow Corning Corp., Carrollton, KY, Ohio River	113,079	276,653,705	39,487	96,607,016	31,514	77,052,435
DD3 - Momentive Silicones, Friendly, WV, Ohio River	44,843	109,710,751	18,312	44,801,268	14,225	34,779,323
DD4 - Momentive Silicones, Waterford, NY, Hudson River	8,327	20,372,442	3,437	8,408,800	2,517	6,154,462

Appendix D MAP OF SITES IN THE ECA



Figure_Apx D-1. Map of Sites in the ECA Relative to Federally Recognized Tribes.
(DD – Direct Discharge, I – Indirect Discharge, R – Non-industrial)

Appendix E GENERAL POPULATION SURFACE WATER RISK SCREENING RESULTS

All general population surface water risk screening results are based on a PV of 500,000,000 lb per year.

E.1 Incidental Dermal Exposures (Swimming)

Based on the estimated dermal doses in Table 5-1, EPA screened for risk to adults (21+ years), youth (11–15 years), and children (6–10 years). Table_Apx E-1 summarizes the acute MOEs based on the dermal doses. Using the total acute dose based on the highest modeled 95th percentile and the P50 flow rate, the MOEs are greater than the benchmark of 30. *Based on the conservative modeling parameters for surface water concentration and exposure factors parameters, risk for non-cancer health effects for dermal absorption through swimming is not expected for OESs with water releases only.*

Table_Apx E-1. Risk Screen for Incidental Dermal (Swimming) Doses for Adults, Youths, and Children for the High-end Release Estimate from Modeling Using a PV of 500,000,000 lb per Year and Monitoring Results

Scenario	Water Column Concentrations		Adult (21+ years)	Youth (11–15 years)	Child (6–10 years)
	30Q5 Conc. (µg/L)	Harmonic Mean Conc. (µg/L)	Acute MOE	Acute MOE	Acute MOE
P50, Import – repackaging, HE, *Without wastewater treatment*	5,294	4,428	67	87	144
P50, Import – repackaging, HE, *With wastewater treatment*	318	266	930	1,220	2,000
Effluent from DD2 Carrollton, KY (ERM, 2017a, b)	307[a]	307[a]	960	1,260	2,070

30Q5 = 30 consecutive days of lowest flow over a 5-year period; HE = high-end
[a] ERM (2017a) and ERM (2017b) is a U.S. study that reported the highest monitored surface water and effluent concentrations across all monitored data as described further in Section 4.2.1. Samples were also collected from the effluent or receiving waters of WWTPs associated with D4 processors, manufacturers, or formulators. This is a single maximum value from the study and does not correspond to either the 30Q5 or harmonic mean concentrations.

E.2 Incidental Ingestion Exposure

Based on the estimated incidental ingestion doses in Table 5-2, EPA screened for risk to adults, youth, and children. Table_Apx E-2 summarizes the acute MOEs based on the incidental ingestion doses. Using the total acute dose based on the highest modeled 95th percentile and P50 flow rate, the MOEs are greater than the benchmark of 30. *Based on the conservative modeling parameters for surface water concentration and exposure factors parameters, risk for non-cancer health effects for incidental ingestion through swimming is not expected for OESs with water releases only.*

Table_Apx E-2. Risk Screen for Incidental Ingestion Doses for Adults, Youths, and Children from

Modeling Using a PV of 500,000,000 lb per Year and Monitoring Results

Scenario	Water Column Concentrations		Adult (21+ years)	Youth (11–15 years)	Child (6–10 years)
	30Q5 Conc. (µg/L)	Harmonic Mean Conc. (µg/L)	Acute MOE	Acute MOE	Acute MOE
P50, Import – repackaging, HE, *Without wastewater treatment*	5,294	4,428	590	380	670
P50, Import – repackaging, HE, *With wastewater treatment*	318	266	9,740	6,280	11,000
Effluent from DD2 Carrollton, KY (ERM, 2017a, b)	307[a]	307[a]	8,430	5,440	9,640

30Q5 = 30 consecutive days of lowest flow over a 5-year period; HE = high-end

[a] ERM (2017a) and ERM (2017b) is a U.S. study that reported the highest monitored surface water and effluent concentrations across all monitored data as described further in Section 4.2.1. Samples were also collected from the effluent or receiving waters of WWTPs associated with D4 processors, manufacturers, or formulators. This is a single maximum value from the study and does not correspond to either the 30Q5 or harmonic mean concentrations.

Appendix F GENERAL POPULATION DRINKING WATER RISK SCREENING RESULTS

All general population drinking water risk screening results are based on a PV of 500,000,000 lb per year. Based on the estimated drinking water doses in Table 6-1, EPA screened for risk to adults (21+ years), infants (birth to <1 year), and toddlers (1–5 years). Table_Apx F-1 summarizes the acute and chronic MOEs based on the drinking water doses. Using the total acute and chronic dose based on the highest modeled 95th percentile and P50 flow for the Import – repackaging OES, the MOEs are greater than the benchmark of 30 except for the acute MOE for infants without wastewater treatment. However, the same OES using the P50 flow with wastewater treatment and the P75 flow rate with or without treatment did not have risks below the benchmark of 30. EPA expects high-end releases to discharge to surface waters with higher flow conditions like P75 or P90. *Based on the conservative modeling parameters for drinking water concentration and exposure factors parameters, risk for non-cancer health effects for drinking water ingestion is not expected for OESs with water releases only.*

Table_Apx F-1. Risk Screen for Modeled Drinking Water Exposure for Adults, Infants, and Toddlers from Modeling Using a PV of 500,000,000 lb per Year and Monitoring Results

Scenario	Water Column Concentrations		Adult (21+ years)		Infant (Birth to <1 year)		Toddler (1–5 years)	
	30Q5 Conc. (µg/L)	Harmonic Mean Conc. (µg/L)	Acute MOE	Chronic MOE	Acute MOE	Chronic MOE	Acute MOE	Chronic MOE
P50, Import – repackaging , HE, *Without wastewater treatment*	5,294	4,428	42	27,000	12	42	34	99
P50, Import – repackaging , HE, *With wastewater treatment*	318	266	700	450,000	200	700	560	1,640
P75, Import – repackaging , HE, *Without wastewater treatment*	380	242	590	490,000	170	770	470	1,800
P75, Import – repackaging , HE, *With wastewater treatment*	23	15	9,760	8,200,000	2,780	130	7,820	30,000
Effluent from DD2 Carrollton, KY (ERM, 2017a, b)	307[a]	307[a]	720	390,000	210	420	580	970

30Q5 = 30 consecutive days of lowest flow over a 5-year period; HE = high-end

[a] ERM (2017a) and ERM (2017b) is a U.S. study that reported the highest monitored surface water and effluent concentrations across all monitored data as described further in Section 4.2.1. Samples were also collected from the effluent or receiving waters of WWTPs associated with D4 processors, manufacturers, or formulators. This is a single maximum value from the study and does not correspond to either the 30Q5 or harmonic mean concentrations.

Appendix G FISH INGESTION EXPOSURE ESTIMATES

All fish ingestion exposure estimates are based on a PV of 500,000,000 lb per year unless indicated otherwise.

Table_Apx G-1. Acute Dose Rate for All Scenarios

Data Source	Flow Rate	Wastewater Treatment	Water Conc. (µg/L)	Fish Tissue Conc. (mg/kg)	Adult				Toddler (1 to <2 years)
					Gen Pop, 90th IR	Subsistence Fisher	Tribal Current Mean	Tribal Current 95th	Gen Pop, Mean IR
Water Solubility Limit	–	–	56	492.52	1.37E−01	8.77E−01	1.33E+00	5.37E+00	2.03E−01
SW1, well mixed	–	–	0.15	1.33	3.69E−04	2.36E−03	3.59E−03	1.45E−02	5.47E−04
SW2, well mixed	–	–	0.43	3.74	1.04E−03	6.65E−03	1.01E−02	4.07E−02	1.54E−03
SW3, well mixed	–	–	0.70	6.16	1.71E−03	1.10E−02	1.66E−02	6.71E−02	2.54E−03
SW4, well mixed	–	–	0.15	1.28	3.56E−04	2.29E−03	3.47E−03	1.40E−02	5.29E−04
Fish Tissue, DD1	–	–	–	1.78	4.94E−04	3.17E−03	4.81E−03	1.94E−02	7.33E−04
Fish Tissue, DD2	–	–	–	0.20	5.58E−05	3.58E−04	5.43E−04	2.19E−03	8.28E−05
Fish Tissue, DD3	–	–	–	14.10	3.91E−03	2.51E−02	3.81E−02	1.54E−01	5.81E−03
Fish Tissue, DD4	–	–	–	10.10	2.80E−03	1.80E−02	2.73E−02	1.10E−01	4.16E−03
HE, Import-repackaging	P75	No	243	2,133.93	5.92E−01	3.80E+00	5.76E+00	2.33E+01	8.79E−01
HE, Import-repackaging	P75	Yes	15	128.04	3.55E−02	2.28E−01	3.46E−01	1.40E+00	5.28E−02
CT, Import-repackaging	P75	No	48	424.99	1.18E−01	7.56E−01	1.15E+00	4.63E+00	1.75E−01
CT, Import-repackaging	P75	Yes	2.90	25.50	7.08E−03	4.54E−02	6.88E−02	2.78E−01	1.05E−02
CT and HE, Manufacturing based on CDR-reported PV	P75	No	156	1,374.92	3.82E−01	2.45E+00	3.71E+00	1.50E+01	5.66E−01
CT and HE, Manufacturing based on CDR-reported PV	P75	Yes	9.38	82.50	2.29E−02	1.47E−01	2.23E−01	8.99E−01	3.40E−02
HE, Processing as a reactant, 350 days	P75	No	135	1,188.38	3.30E−01	2.12E+00	3.21E+00	1.30E+01	4.90E−01
HE, Processing as a reactant, 350 days	P75	Yes	8.11	71.30	1.98E−02	1.27E−01	1.93E−01	7.77E−01	2.94E−02
CT, Processing as a reactant, 350 days	P75	No	77	681.46	1.89E−01	1.21E+00	1.84E+00	7.43E+00	2.81E−01
CT, Processing as a reactant, 350 days	P75	Yes	4.65	40.89	1.13E−02	7.28E−02	1.10E−01	4.46E−01	1.68E−02
HE, Processing as a reactant, 316 days	P75	NA [a]	1.44	12.66	3.51E−03	2.25E−02	3.42E−02	1.38E−01	5.22E−03
HE, Processing as a reactant, 316 days, PV of 375,000,000 lb/year	P75	NA [a]	1.08	9.50	2.64E−03	1.69E−02	2.56E−02	1.04E−01	3.91E−03
CT, Processing as a reactant, 321 days	P75	NA [a]	0.67	5.85	1.62E−03	1.04E−02	1.58E−02	6.38E−02	2.41E−03

Data Source	Flow Rate	Wastewater Treatment	Water Conc. (µg/L)	Fish Tissue Conc. (mg/kg)	Adult				Toddler (1 to <2 years)
					Gen Pop, 90th IR	Subsistence Fisher	Tribal Current Mean	Tribal Current 95th	Gen Pop, Mean IR
HE, Rubber-compounding-neatD4	P75	No	106	932.71	2.59E−01	1.66E+00	2.52E+00	1.02E+01	3.84E−01
HE, Rubber-compounding-neatD4	P75	Yes	6.36	55.96	1.55E−02	9.96E−02	1.51E−01	6.10E−01	2.31E−02
CT, Rubber-compounding-neatD4	P75	No	28	248.98	6.91E−02	4.43E−01	6.72E−01	2.71E+00	1.03E−01
CT, Rubber-compounding-neatD4	P75	Yes	1.70	14.94	4.15E−03	2.66E−02	4.03E−02	1.63E−01	6.15E−03
CT and HE, Manufacturing based on generic scenario PV	P75	No	73	644.37	1.79E−01	1.15E+00	1.74E+00	7.02E+00	2.65E−01
CT and HE, Manufacturing based on generic scenario PV	P75	Yes	4.40	38.66	1.07E−02	6.88E−02	1.04E−01	4.21E−01	1.59E−02
HE, Rubber-converting	P75	No	11	94.75	2.63E−02	1.69E−01	2.56E−01	1.03E+00	3.90E−02
HE, Rubber-converting	P75	Yes	0.65	5.68	1.58E−03	1.01E−02	1.53E−02	6.20E−02	2.34E−03
CT, Rubber-converting	P75	No	1.53	13.47	3.74E−03	2.40E−02	3.64E−02	1.47E−01	5.55E−03
CT, Rubber-converting	P75	Yes	9.19E−02	0.81	2.24E−04	1.44E−03	2.18E−03	8.81E−03	3.33E−04
HE, Rubber-compounding-residualD4	P75	No	7.63	67.08	1.86E−02	1.19E−01	1.81E−01	7.31E−01	2.76E−02
HE, Rubber-compounding-residualD4	P75	Yes	0.46	4.02	1.12E−03	7.16E−03	1.09E−02	4.39E−02	1.66E−03
CT, Rubber-compounding-residualD4	P75	No	1.92	16.90	4.69E−03	3.01E−02	4.56E−02	1.84E−01	6.96E−03
CT, Rubber-compounding-residualD4	P75	Yes	0.12	1.01	2.81E−04	1.80E−03	2.74E−03	1.11E−02	4.18E−04
CT, Use of fabric finishing products (high PV)	P75	No	3.68E−02	0.32	8.98E−05	5.76E−04	8.74E−04	3.53E−03	1.33E−04
CT, Use of fabric finishing products (high PV)	P75	Yes	2.21E−03	0.02	5.39E−06	3.46E−05	5.24E−05	2.12E−04	8.00E−06
HE, Use of fabric finishing products (high PV)	P75	No	0.21	1.83	5.08E−04	3.26E−03	4.94E−03	1.99E−02	7.54E−04
HE, Use of fabric finishing products (high PV)	P75	Yes	1.25E−02	0.11	3.05E−05	1.95E−04	2.96E−04	1.20E−03	4.52E−05
HE, Import-repackaging	P90	No	6.60	58.05	1.61E−02	1.03E−01	1.57E−01	6.33E−01	2.39E−02
HE, Import-repackaging	P90	Yes	0.40	3.48	9.67E−04	6.20E−03	9.40E−03	3.80E−02	1.44E−03
CT, Import-repackaging	P90	No	1.31	11.56	3.21E−03	2.06E−02	3.12E−02	1.26E−01	4.76E−03
CT, Import-repackaging	P90	Yes	7.89E−02	0.69	1.93E−04	1.23E−03	1.87E−03	7.56E−03	2.86E−04
HE, Processing as a reactant, 350 days	P90	No	6.60	58.05	1.61E−02	1.03E−01	1.57E−01	6.33E−01	2.39E−02
HE, Processing as a reactant, 350 days	P90	Yes	0.40	3.48	9.67E−04	6.20E−03	9.40E−03	3.80E−02	1.44E−03

Data Source	Flow Rate	Wastewater Treatment	Water Conc. (µg/L)	Fish Tissue Conc. (mg/kg)	Adult				Toddler (1 to <2 years)
					Gen Pop, 90th IR	Subsistence Fisher	Tribal Current Mean	Tribal Current 95th	Gen Pop, Mean IR
CT, Processing as a reactant, 350 days	P90	No	2.10	18.44	5.12E−03	3.28E−02	4.98E−02	2.01E−01	7.60E−03
CT, Processing as a reactant, 350 days	P90	Yes	0.13	1.11	3.07E−04	1.97E−03	2.99E−03	1.21E−02	4.56E−04
HE, Processing as a reactant, 316 days	P90	NA [a]	0.04	0.34	9.49E−05	6.09E−04	9.24E−04	3.73E−03	1.41E−04
CT, Processing as a reactant, 321 days	P90	NA [a]	0.02	0.16	4.39E−05	2.82E−04	4.27E−04	1.73E−03	6.52E−05
HE, Rubber-compounding-neatD4	P90	No	2.33	20.45	5.68E−03	3.64E−02	5.52E−02	2.23E−01	8.43E−03
HE, Rubber-compounding-neatD4	P90	Yes	0.14	1.23	3.41E−04	2.18E−03	3.31E−03	1.34E−02	5.06E−04
CT, Rubber-compounding-neatD4	P90	No	0.62	5.46	1.51E−03	9.72E−03	1.47E−02	5.95E−02	2.25E−03
CT, Rubber-compounding-neatD4	P90	Yes	3.72E−02	0.33	9.09E−05	5.83E−04	8.84E−04	3.57E−03	1.35E−04
CT and HE, Manufacturing based on CDR-reported PV	P90	No	1.69	14.89	4.13E−03	2.65E−02	4.02E−02	1.62E−01	6.13E−03
CT and HE, Manufacturing based on CDR-reported PV	P90	Yes	0.10	0.89	2.48E−04	1.59E−03	2.41E−03	9.74E−03	3.68E−04
CT and HE, Manufacturing based on generic scenario PV	P90	No	1.69	14.89	4.13E−03	2.65E−02	4.02E−02	1.62E−01	6.13E−03
CT and HE, Manufacturing based on generic scenario PV	P90	Yes	0.10	0.89	2.48E−04	1.59E−03	2.41E−03	9.74E−03	3.68E−04
HE, Rubber-converting	P90	No	0.72	6.33	1.76E−03	1.13E−02	1.71E−02	6.90E−02	2.61E−03
HE, Rubber-converting	P90	Yes	4.32E−02	0.38	1.05E−04	6.76E−04	1.02E−03	4.14E−03	1.56E−04
CT, Rubber-converting	P90	No	0.10	0.90	2.50E−04	1.60E−03	2.43E−03	9.81E−03	3.71E−04
CT, Rubber-converting	P90	Yes	6.14E−03	0.05	1.50E−05	9.61E−05	1.46E−04	5.88E−04	2.22E−05
HE, Rubber-compounding-residualD4	P90	No	0.17	1.47	4.08E−04	2.62E−03	3.97E−03	1.60E−02	6.06E−04
HE, Rubber-compounding-residualD4	P90	Yes	1.00E−02	0.09	2.45E−05	1.57E−04	2.38E−04	9.62E−04	3.64E−05
CT, Rubber-compounding-residualD4	P90	No	4.21E−02	0.37	1.03E−04	6.59E−04	1.00E−03	4.04E−03	1.53E−04
CT, Rubber-compounding-residualD4	P90	Yes	2.53E−03	0.02	6.17E−06	3.96E−05	6.00E−05	2.42E−04	9.16E−06
CT, Use of fabric finishing products (high PV)	P90	No	2.26E−03	0.02	5.52E−06	3.54E−05	5.37E−05	2.17E−04	8.19E−06
CT, Use of fabric finishing products (high PV)	P90	Yes	1.36E−04	0.00	3.31E−07	2.12E−06	3.22E−06	1.30E−05	4.91E−07
HE, Use of fabric finishing products (high PV)	P90	No	1.28E−02	0.11	3.12E−05	2.00E−04	3.04E−04	1.23E−03	4.64E−05
HE, Use of fabric finishing products (high	P90	Yes	7.68E−04	0.01	1.87E−06	1.20E−05	1.82E−05	7.36E−05	2.78E−06

Data Source	Flow Rate	Wastewater Treatment	Water Conc. (µg/L)	Fish Tissue Conc. (mg/kg)	Adult				Toddler (1 to <2 years)
					Gen Pop, 90th IR	Subsistence Fisher	Tribal Current Mean	Tribal Current 95th	Gen Pop, Mean IR
PV)									

CT = central tendency; DD = direct discharge, proceeding number indicates facility ID; HE = high-end; IR = ingestion rate; PV = production volume; CDR = Chemical Data Reporting; SW = surface water, proceeding number indicates facility ID

[a] Environmental release assessment indicates that these releases are discharged directly into surface water without prior treatment.

2447
2448
2449

Table_Apx G-2. Average Daily Dose for All Scenarios

Data Source	Flow Rate	Wastewater Treatment	Water Conc. (µg/L)	Fish Tissue Conc. (mg/kg)	Adult			
					Gen Pop, 90th IR	Subsistence Fisher	Tribal Current Mean	Tribal Current 95th
Water Solubility Limit	-	-	56	492.52	3.10E−02	8.77E−01	1.33E+00	5.37
SW1, well mixed	-	-	0.15	1.33	8.37E−05	2.36E−03	3.59E−03	1.45E−02
SW2, well mixed	-	-	0.43	3.74	2.35E−04	6.65E−03	1.01E−02	4.07E−02
SW3, well mixed	-	-	0.70	6.16	3.88E−04	1.10E−02	1.66E−02	6.71E−02
SW4, well mixed	-	-	0.15	1.28	8.09E−05	2.29E−03	3.47E−03	1.40E−02
Fish Tissue, DD1	-	-	–	1.78	1.12E−04	3.17E−03	4.81E−03	1.94E−02
Fish Tissue, DD2	-	-	–	0.20	1.27E−05	3.58E−04	5.43E−04	2.19E−03
Fish Tissue, DD3	-	-	–	14.10	8.88E−04	2.51E−02	3.81E−02	1.54E−01
Fish Tissue, DD4	-	-	–	10.10	6.36E−04	1.80E−02	2.73E−02	1.10E−01
HE, Import-repackaging	P75	No	243	2,133.93	1.34E−01	3.80E+00	5.76E+00	2.33E01
HE, Import-repackaging	P75	Yes	15	128.04	8.07E−03	2.28E−01	3.46E−01	1.40
CT, Import-repackaging	P75	No	48	424.99	2.68E−02	7.56E−01	1.15E+00	4.63
CT, Import-repackaging	P75	Yes	2.90	25.50	1.61E−03	4.54E−02	6.88E−02	2.78E−01
CT and HE, Manufacturing based on CDR-reported PV	P75	No	156	1,374.92	8.66E−02	2.45E+00	3.71E+00	6.33E−01
CT and HE, Manufacturing based on CDR-reported PV	P75	Yes	9.38	82.50	5.20E−03	1.47E−01	2.23E−01	3.80E−02
HE, Processing as a reactant, 350 days	P75	No	135	1,188.38	7.49E−02	2.12E+00	3.21E+00	1.26E−01
HE, Processing as a reactant, 350 days	P75	Yes	8.11	71.30	4.49E−03	1.27E−01	1.93E−01	7.56E−03

Data Source	Flow Rate	Wastewater Treatment	Water Conc. (µg/L)	Fish Tissue Conc. (mg/kg)	Adult			
					Gen Pop, 90th IR	Subsistence Fisher	Tribal Current Mean	Tribal Current 95th
CT, Processing as a reactant, 350 days	P75	No	77	681.46	4.29E−02	1.21E+00	1.84E+00	1.50E01
CT, Processing as a reactant, 350 days	P75	Yes	4.65	40.89	2.58E−03	7.28E−02	1.10E−01	8.99E−01
HE, Processing as a reactant, 316 days	P75	NA [a]	1.44	12.66	7.98E−04	2.25E−02	3.42E−02	1.38E−01
HE, Processing as a reactant, 316 days, PV of 375,000,000 lb/year	P75	NA [a]	1.08	9.50	5.98E−04	1.69E−02	2.56E−02	1.04E−01
CT, Processing as a reactant, 321 days	P75	NA [a]	0.665	5.85	3.68E−04	1.04E−02	1.58E−02	6.38E−02
HE, Rubber-compounding-neatD4	P75	No	106	932.71	5.88E−02	1.66E+00	2.52E+00	1.30E01
HE, Rubber-compounding-neatD4	P75	Yes	6.36	55.96	3.53E−03	9.96E−02	1.51E−01	7.77E−01
CT, Rubber-compounding-neatD4	P75	No	28	248.98	1.57E−02	4.43E−01	6.72E−01	7.43
CT, Rubber-compounding-neatD4	P75	Yes	1.70	14.94	9.41E−04	2.66E−02	4.03E−02	4.46E−01
CT and HE, Manufacturing based on generic scenario PV	P75	No	73	644.37	4.06E−02	1.15E+00	1.74E+00	7.02
CT and HE, Manufacturing based on generic scenario PV	P75	Yes	4.40	38.66	2.44E−03	6.88E−02	1.04E−01	4.21E−01
HE, Rubber-converting	P75	No	11	94.75	5.97E−03	1.69E−01	2.56E−01	1.02E+01
HE, Rubber-converting	P75	Yes	0.65	5.68	3.58E−04	1.01E−02	1.53E−02	6.10E−01
CT, Rubber-converting	P75	No	1.53	13.47	8.49E−04	2.40E−02	3.64E−02	2.71E+00
CT, Rubber-converting	P75	Yes	9.19E−02	0.81	5.09E−05	1.44E−03	2.18E−03	1.63E−01
HE, Rubber-compounding-residualD4	P75	No	7.63	67.08	4.23E−03	1.19E−01	1.81E−01	7.31E−01
HE, Rubber-compounding-residualD4	P75	Yes	0.46	4.02	2.54E−04	7.16E−03	1.09E−02	4.39E−02
CT, Rubber-compounding-residualD4	P75	No	1.92	16.90	1.06E−03	3.01E−02	4.56E−02	1.84E−01
CT, Rubber-compounding-residualD4	P75	Yes	0.12	1.01	6.39E−05	1.80E−03	2.74E−03	1.11E−02
CT, Use of fabric finishing products	P75	No	3.68E−02	0.32	2.04E−05	5.76E−04	8.74E−04	1.03
CT, Use of fabric finishing products	P75	Yes	2.21E−03	0.02	1.22E−06	3.46E−05	5.24E−05	6.20E−02
HE, Use of fabric finishing products	P75	No	0.21	1.83	1.15E−04	3.26E−03	4.94E−03	1.47E−01
HE, Use of fabric finishing products	P75	Yes	1.25E−02	0.11	6.91E−06	1.95E−04	2.96E−04	8.81E−03
HE, Import-repackaging	P90	No	6.60	58.05	3.66E−03	1.03E−01	1.57E−01	6.33E−01
HE, Import-repackaging	P90	Yes	0.40	3.48	2.19E−04	6.20E−03	9.40E−03	3.80E−02
CT, Import-repackaging	P90	No	1.31	11.56	7.28E−04	2.06E−02	3.12E−02	1.26E−01
CT, Import-repackaging	P90	Yes	7.89E−02	0.69	4.37E−05	1.23E−03	1.87E−03	7.56E−03

Data Source	Flow Rate	Wastewater Treatment	Water Conc. (µg/L)	Fish Tissue Conc. (mg/kg)	Adult			
					Gen Pop, 90th IR	Subsistence Fisher	Tribal Current Mean	Tribal Current 95th
HE, Processing as a reactant, 350 days	P90	No	6.60	58.05	3.66E−03	1.03E−01	1.57E−01	6.33E−01
HE, Processing as a reactant, 350 days	P90	Yes	0.40	3.48	2.19E−04	6.20E−03	9.40E−03	3.80E−02
CT, Processing as a reactant, 350 days	P90	No	2.10	18.44	1.16E−03	3.28E−02	4.98E−02	2.01E−01
CT, Processing as a reactant, 350 days	P90	Yes	0.13	1.11	6.97E−05	1.97E−03	2.99E−03	1.21E−02
HE, Processing as a reactant, 316 days	P90	NA [a]	0.04	0.34	2.16E−05	6.09E−04	9.24E−04	3.73E−03
CT, Processing as a reactant, 321 days	P90	NA [a]	0.02	0.16	9.97E−06	2.82E−04	4.27E−04	1.73E−03
HE, Rubber-compounding-neatD4	P90	No	2.33	20.45	1.29E−03	3.64E−02	5.52E−02	2.23E−01
HE, Rubber-compounding-neatD4	P90	Yes	0.14	1.23	7.73E−05	2.18E−03	3.31E−03	1.34E−02
CT, Rubber-compounding-neatD4	P90	No	0.62	5.46	3.44E−04	9.72E−03	1.47E−02	5.95E−02
CT, Rubber-compounding-neatD4	P90	Yes	3.72E−02	0.33	2.06E−05	5.83E−04	8.84E−04	3.57E−03
CT and HE, Manufacturing based on CDR-reported PV	P90	No	1.69	14.89	9.38E−04	2.65E−02	4.02E−02	1.62E−01
CT and HE, Manufacturing based on CDR-reported PV	P90	Yes	0.10	0.89	5.63E−05	1.59E−03	2.41E−03	9.74E−03
CT and HE, Manufacturing based on generic scenario PV	P90	No	1.69	14.89	9.38E−04	2.65E−02	4.02E−02	1.62E−01
CT and HE, Manufacturing based on generic scenario PV	P90	Yes	0.10	0.89	5.63E−05	1.59E−03	2.41E−03	9.74E−03
HE, Rubber-converting	P90	No	0.72	6.33	3.99E−04	1.13E−02	1.71E−02	6.90E−02
HE, Rubber-converting	P90	Yes	4.32E−02	0.38	2.39E−05	6.76E−04	1.02E−03	4.14E−03
CT, Rubber-converting	P90	No	0.10	0.90	5.67E−05	1.60E−03	2.43E−03	9.81E−03
CT, Rubber-converting	P90	Yes	6.14E−03	0.05	3.40E−06	9.61E−05	1.46E−04	5.88E−04
HE, Rubber-compounding-residualD4	P90	No	0.17	1.47	9.27E−05	2.62E−03	3.97E−03	1.60E−02
HE, Rubber-compounding-residualD4	P90	Yes	1.00E−02	0.09	5.56E−06	1.57E−04	2.38E−04	9.62E−04
CT, Rubber-compounding-residualD4	P90	No	4.21E−02	0.37	2.33E−05	6.59E−04	1.00E−03	4.04E−03
CT, Rubber-compounding-residualD4	P90	Yes	2.53E−03	0.02	1.40E−06	3.96E−05	6.00E−05	2.42E−04
CT, Use of fabric finishing products (high PV)	P90	No	2.26E−03	0.02	1.25E−06	3.54E−05	5.37E−05	2.17E−04
CT, Use of fabric finishing products (high PV)	P90	Yes	1.36E−04	0.00	7.51E−08	2.12E−06	3.22E−06	1.30E−05
HE, Use of fabric finishing products (high	P90	No	1.28E−02	0.11	7.09E−06	2.00E−04	3.04E−04	1.23E−03

Data Source	Flow Rate	Wastewater Treatment	Water Conc. (µg/L)	Fish Tissue Conc. (mg/kg)	Adult			
					Gen Pop, 90th IR	Subsistence Fisher	Tribal Current Mean	Tribal Current 95th
PV)								
HE, Use of fabric finishing products (high PV)	P90	Yes	7.68E−04	0.01	4.26E−07	1.20E−05	1.82E−05	7.36E−05

CT = central tendency; DD = direct discharge, proceeding number indicates facility ID; HE = high-end; IR = ingestion rate; PV = production volume; CDR = Chemical Data Reporting; SW = surface water, proceeding number indicates facility ID

[a] Environmental release assessment indicates that these releases are discharged directly into surface water without prior treatment.

2450

Appendix H AMBIENT AIR

Table_Apx H-1. Risk Screen for Modeled Ambient Air Inhalation Exposure

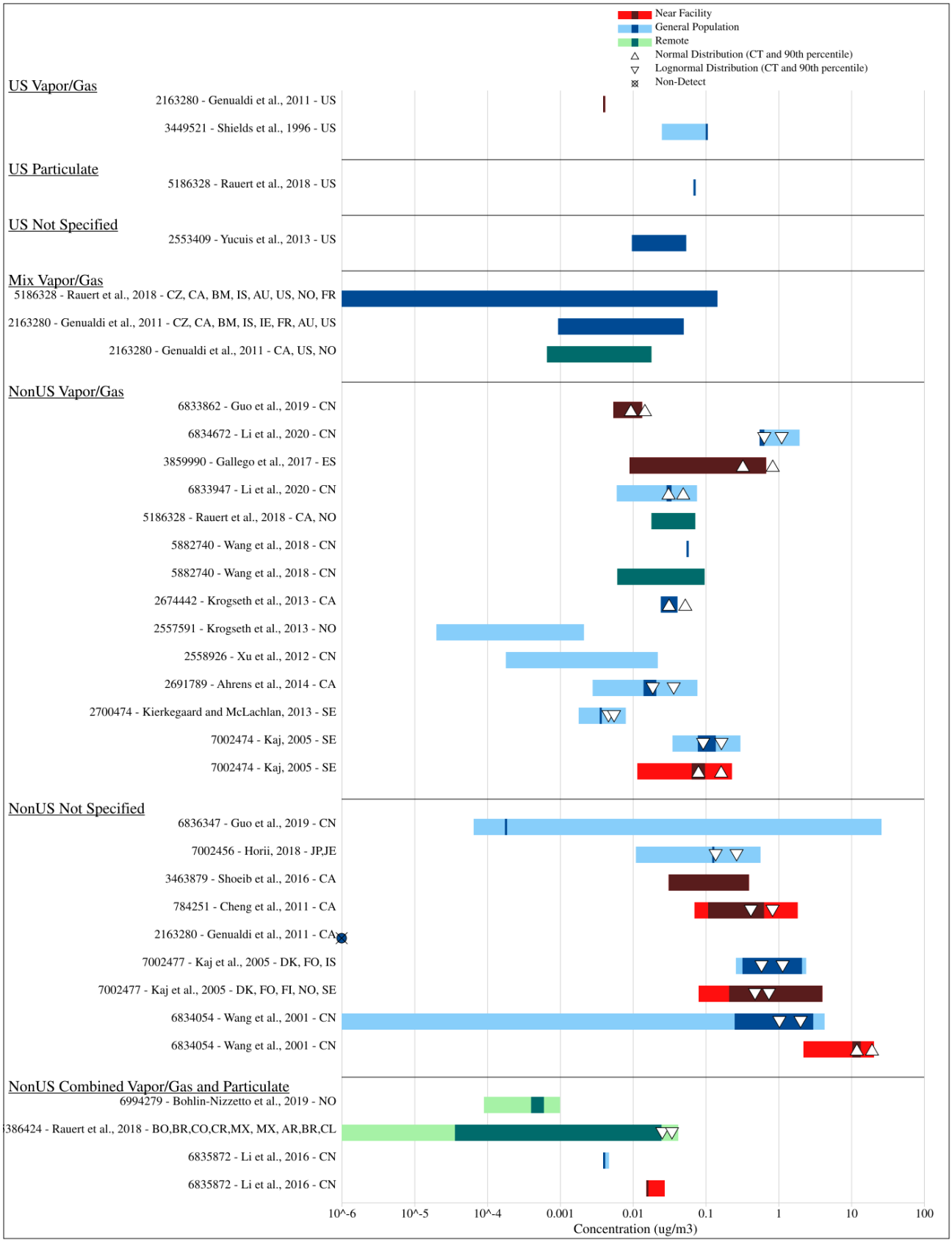
OES[a]	Acute (Daily Average)[b]		Chronic (Annual Average)[b]	
	Air Concentration[c] (µg/m^3)	MOE	Air Concentration[c] (µg/m^3)	MOE
Processing as a reactant (fugitive)	219.5	487	219.5	254
Manufacturing based on CDR-reported PV (stack)				

AC = acute concentration; ADC = average daily concentration; CDR = Chemical Data Reporting

[a] Table 1-1 provides a crosswalk of industrial and commercial COUs to OES.

[b] EPA assumes the general population is continuously exposed (*i.e.,* 24 hours per day, 365 days per year) to outdoor ambient air concentrations. Therefore, daily average modeled ambient air concentrations are equivalent to acute exposure concentrations, and annual average modeled ambient air concentrations are equivalent to chronic exposure concentrations.

[c] Air concentrations are reported for the high-end (95th percentile) modeled value at 100 m from the emitting facility and stack plus fugitive releases combined.



Figure_Apx H-1. Concentrations of D4 in Ambient Air from 1996 to 2020