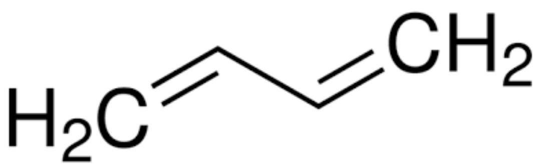
United States
Environmental Protection Agency

November 2024
Office of Chemical Safety and
Pollution Prevention

Draft Environmental Media Concentrations for 1,3-Butadiene

Technical Support Document for the Draft Risk Evaluation

CASRN 106-99-0



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ABBREVIATIONS AND ACRONYMS

AMTIC	Ambient Monitoring Technology Information Center
AQS	Air Quality System
COU	Condition of use
CSATAM	Community-Scale Air Toxics Ambient Monitoring
DMR	Discharge Monitoring Report
EPA	Environmental Protection Agency
GC/MS	Gas chromatograph mass spectrometer
HAP	Hazardous Air Pollutant
K_{OA}	Octanol-Air partition coefficient
K_{OC}	Organic Carbon-Water partition coefficient
LDAQ	Louisiana Department of Environmental Quality
MDL	Method Detection Limit
MIT	Massachusetts Institute of Technology
NADP	National Atmospheric Deposition Program
NATTS	National Air Toxics Trends Sites
NEI	National Emissions Inventory
NOAA	National Oceanic and Atmospheric Administration
PWS	Public water system
SDWA	Safe Drinking Water Act
SCAQMD	South Coast Air Quality Management District
TCEQ	Texas Commission on Environmental Quality
TRI	Toxic Release Inventory
TSCA	Toxic Substances Control Act
UATMP	Urban Air Toxics Monitoring Program
UCMR3	Third Unregulated Contaminant Monitoring Rule
WQP	Water Quality Portal

ACKNOWLEDGEMENTS

The Assessment Team gratefully acknowledges the participation, review, and input from U.S. Environmental Protection Agency (EPA or the Agency) Office of Pollution Prevention and Toxics (OPPT) and Office of Chemical Safety and Pollution Prevention (OCSPP) senior managers and science advisors.

Docket

Supporting information can be found in the public docket, Docket ID: EPA-HQ-OPPT-2024-0425.

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This draft technical support document was reviewed and cleared for release by OPPT and OCSPP leadership.

SUMMARY

This draft technical document is in support of the Toxic Substances Control Act (TSCA) *Draft Risk Evaluation for 1,3-Butadiene*. See the draft risk evaluation for a complete list of all the technical support documents for 1,3-butadiene.

1,3-Butadiene – Environmental Media Concentration: Key Points

EPA evaluated the reasonably available information for various exposure media pathways (air, water, and land) to quantify the presence of 1,3-butadiene in the environment. This draft evaluation aids in determining the type of exposure assessment (quantitative or qualitative) that would be appropriate for each exposure pathway. The key points are summarized below:

- EPA assessed environmental concentrations of 1,3-butadiene for the air (ambient and indoor air), water (surface water, drinking water), and land pathways (groundwater) to inform the environmental exposure and general population exposure assessment.
    - For the air pathway, 1,3-butadiene releases are not expected to undergo air deposition or long-range transport based on a low log K_{OA} of 1.5 and a short half-life in the atmosphere.
    - For the water pathway, biodegradation is expected to be fast in aerobic sediments and slower under anaerobic conditions. Based on a high Henry's Law constant (0.076 $atm \cdot m^3/mol$ at 25 °C) and a high vapor pressure (1,900 mm Hg at 20 °C), volatilization is expected to be the most important removal process for 1,3-butadiene in aquatic environments. Due to its high volatility and low sorption potential to organic matter, 1,3-butadiene is not expected to significantly partition into sediments in water.
    - For the land pathway, 1,3-butadiene is not reported to be appreciably released to soil, and air to soil deposition is not expected to be significant because 1,3-butadiene is volatile and has low affinity for organic matter with a log K_{OC} of 1.73 and log K_{OW} of 1.99. Any release of 1,3-butadiene to soil (such as air deposition) is expected to volatilize rapidly. Therefore, soil and groundwater concentrations were not quantified but are discussed qualitatively.
- Based on the physical and chemical properties, as well as concentrations reported from databases and scientific literature, the air pathway is expected to be the main pathway contributing to general population exposures to 1,3-butadiene. Therefore, a quantitative assessment was conducted for the air pathway.
- Based on the low amounts of releases to land and water and high frequencies of non-detects reported in several federal databases—(Water Quality Portal (WQP), Discharge Monitoring Report (DMR), and Third Unregulated Contaminant Monitoring Rule (UCMR3—and scientific literature, the water and land pathways are not expected to contribute to general population exposures to 1,3-butadiene. Therefore, a qualitative assessment was conducted for the water and land pathways.

1 INTRODUCTION

1,3-Butadiene is a colorless gas that is produced during petroleum processing and is primarily used for synthetic rubber production; however, small amounts can be found in plastics and fuel. It is released into the environment by industrial operations involved with manufacturing, processing, formulation, disposal, and other practices. 1,3-Butadiene is also released into the ambient air by constant motor vehicle emissions as well as from combustion and other activities related to fuel use and products. For detailed information on 1,3-butadiene releases to the environment, see the *Draft Environmental Release Assessment for 1,3-Butadiene* (U.S. EPA, 2024c).

1,3-Butadiene is a high priority chemical undergoing the Toxic Substances Control Act (TSCA) risk evaluation process for existing chemicals, following passage of the Frank R. Lautenberg Chemical Safety for the 21st Century Act in 2016, and is subject to the TSCA regulations as described in Table 2-1 of the *Draft Risk Evaluation for 1,3-Butadiene* (U.S. EPA, 2024g). This draft assessment/TSD serves the risk management needs of EPA's Office of Pollution Prevention and Toxics (OPPT) and is one of many documents, spreadsheets, and other files supporting the *Draft Risk Evaluation for 1,3-Butadiene* (U.S. EPA, 2024g).

1.1 Risk Evaluation Scope

The TSCA draft risk evaluation (RE) of 1,3-butadiene includes several human health, environmental, fate, and exposure assessment modules, and a risk evaluation document. A diagram showing the relationships between assessments is provided in Figure 1-1. This draft environmental media concentrations assessment is one of the five technical support documents that are outlined in green.

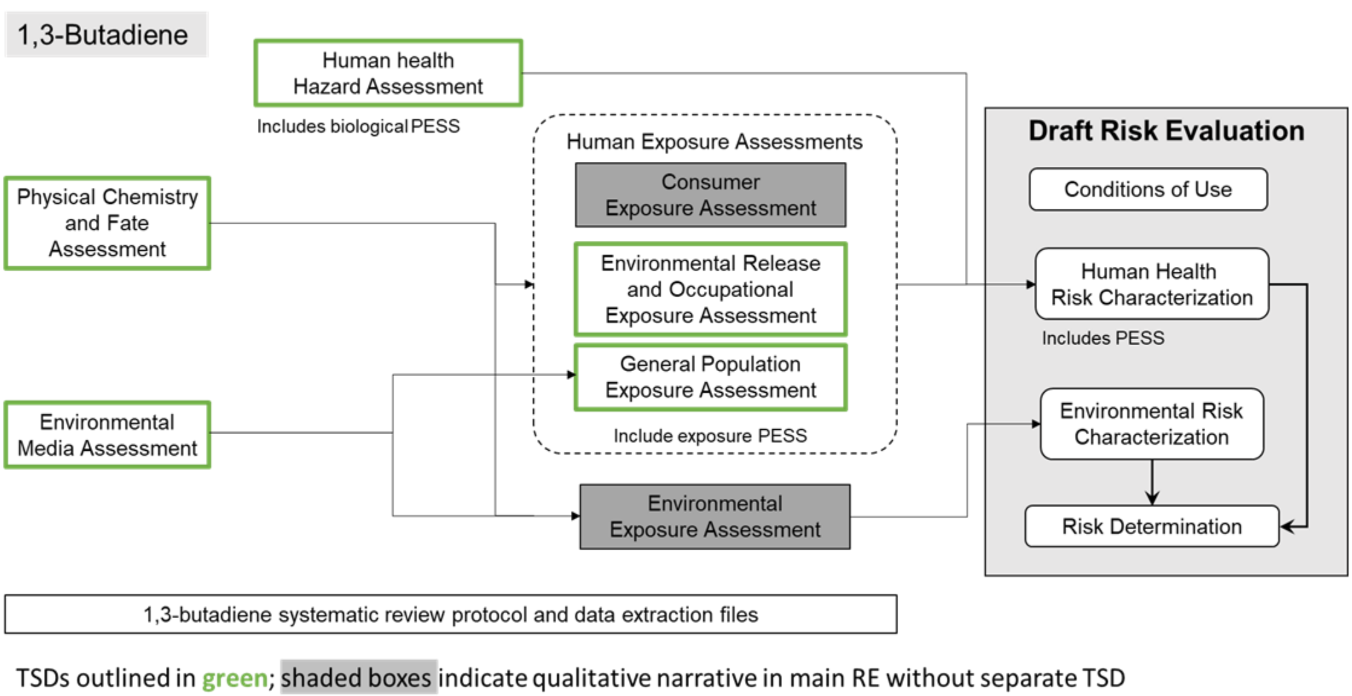

Figure 1-1. Draft Risk Assessment Document Map Summary

The purpose of this draft TSD is to (1) evaluate concentrations of 1,3-butadiene in the following environmental media pathways—air, water, and land—based on measurements reported in peer-reviewed literature, gray literature, and available databases ; and (2) determine whether EPA needs to conduct a quantitative or qualitative assessment accordingly for the *Draft Risk Evaluation for 1,3-*

Butadiene (U.S. EPA, 2024g). Comparisons to modeled data are provided for context.

1.2 Summary of the Chemistry, Fate, and Transport Assessment

1,3-Butadiene is a colorless gas with a mildly aromatic gasoline-like odor. 1,3-Butadiene is primarily transformed in ambient air by indirect photolysis through reaction with ozone, nitrates, and hydroxy radicals. Studies indicate 1,3-butadiene has a half-life range of 0.76 to 9 hours, with the longer half-lives corresponding to periods without sunlight. Industrial releases and vehicular emissions are major sources of 1,3-butadiene. It can also be formed in ambient air as a product of combustion of organic matter such as petroleum products, wood, and coal. 1,3-Butadiene is volatile and will evaporate from water and soil and does not sorb to sediment. Therefore, air is expected to be the major pathway of concern for 1,3-butadiene in the environment, while water, sediment and soil are expected to comprise minor pathways. Figure 1-2 below depicts the transportation and partitioning of 1,3-butadiene in the environment. For more details, see the *Draft Physical Chemistry and Fate Assessment for 1,3-Butadiene* (U.S. EPA, 2024f).

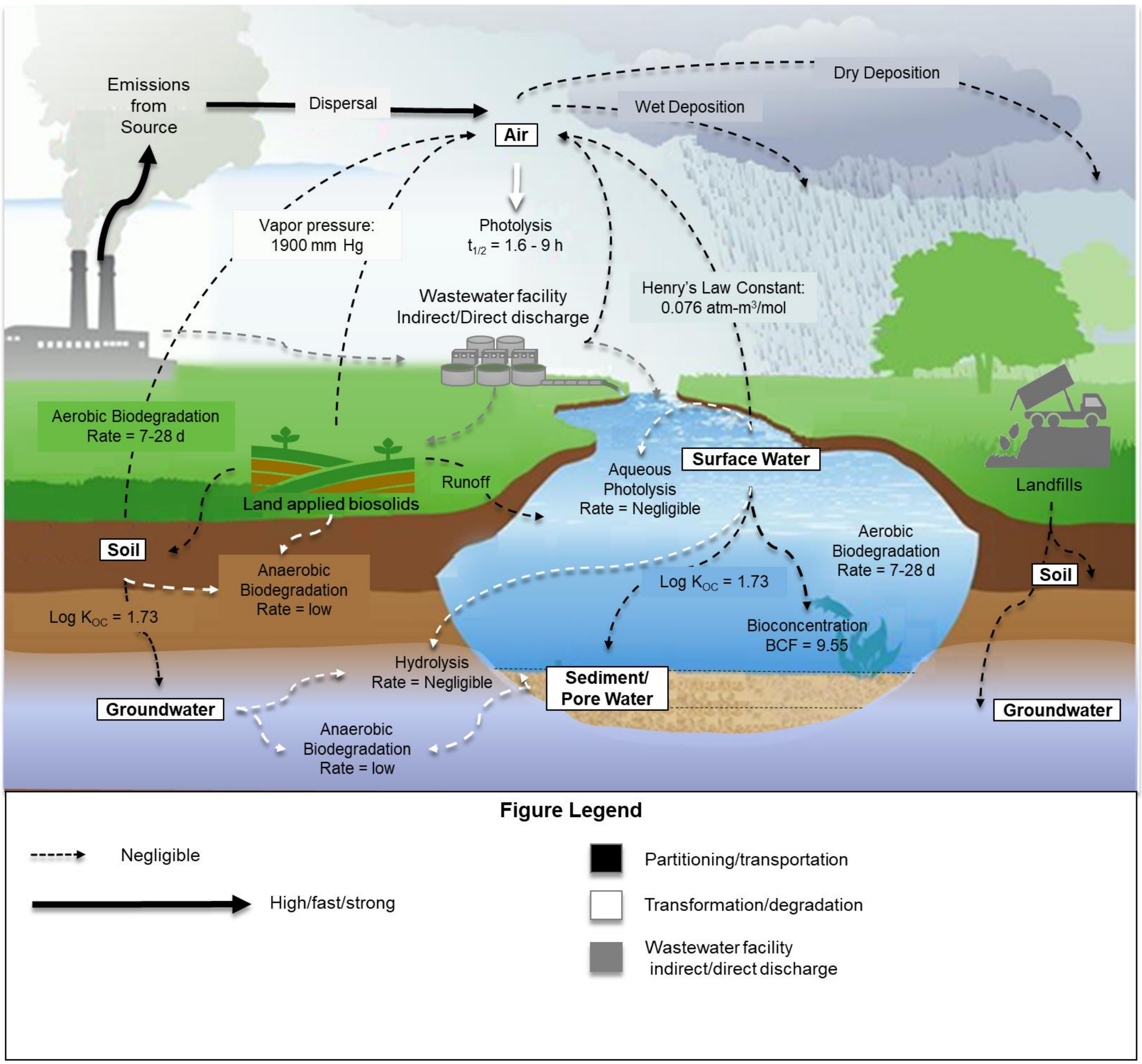

Figure 1-2. Transport, Partitioning, and Degradation of 1,3-Butadiene in the Environment

The diagram depicts the distribution (grey arrows), transport and partitioning (black arrows) as well as the transformation and degradation (white arrows) of 1,3-butadiene in the environment. The width of the arrow is a qualitative indication of the likelihood that the indicated partitioning will occur or the rate at which the indicated degradation will occur (*i.e.*, wider arrows indicate more likely partitioning or more rapid degradation).

2 APPROACH AND METHODOLOGY

EPA conducted a systematic review to identify peer-reviewed, gray literature and database sources of 1,3-butadiene measured concentrations in various media pathways (air, water, and land) to characterize environmental media concentrations. Modeled data is acknowledged when available. Environmental media concentration data from studies and databases identified through systematic review were evaluated and assigned an overall quality determination according to the 2021 *Draft Systematic Review Protocol Supporting TSCA Risk Evaluations for Chemical Substances, Version 1.0: A Generic TSCA Systematic Review Protocol with Chemical-Specific Methodologies* (also called the "2021 Draft Systematic Review Protocol Supporting TSCA Risk Evaluations" (U.S. EPA, 2021b). Studies assigned to medium and high quality determinations were extracted and integrated as part of the draft risk evaluation. For more details on the systematic review process as applied to 1,3-butadiene, see Section 2.3 of the *Draft Risk Evaluation of 1,3-Butadiene* (U.S. EPA, 2024g) and the *Draft Systematic Review Protocol for 1,3-Butadiene* (U.S. EPA, 2024h). Several references reported environmental media concentrations outside the United States and are included for global context in Figure 3-1 through Figure 3-4 below and Table_Apx A-1 in Appendix A. All studies identified, U.S. and non-U.S., support the conclusion that air is the major exposure pathway for 1,3-butadiene.

3 AIR PATHWAY

EPA searched peer-reviewed and gray literature published through 2019, and databases through 2021, to obtain concentrations of 1,3-butadiene in ambient air. Sections 3.1 through 3.5 describe the aggregated results of measured and modeled concentrations of 1,3-butadiene in air. While the systematic review included studies conducted outside of the United States, discussion herein is focused on U.S. studies as these studies are most informative for this draft assessment. Studies conducted outside of the United States are presented for context but are not discussed further. Measured data from the EPA Ambient Monitoring Technology Information Center (AMTIC) (U.S. EPA, 2022a) is presented in Section 3.1.2. Table_Apx B-1 summarizes the 1,3-butadiene concentrations extracted from systematic review for the air pathway (ambient air, indoor air, landfill gas and personal exposure monitoring). For more details on the systematic review for 1,3-butadiene, see the *Draft Systematic Review Protocol for 1,3-Butadiene* (U.S. EPA, 2024h).

3.1 Measured Concentrations in Ambient Air

3.1.1 Peer-Reviewed Literature

3.1.1.1 Measured Concentrations

Measured concentrations of 1,3-butadiene in ambient air were extracted from five U.S. studies published between 1999 and 2015. These measured concentrations were classified as representing general population exposures (*i.e.*, ambient measurements taken in areas near residential populations with no known facility sources nearby) or near facility (*i.e.*, measurements collected in areas with industrial and/or commercial activities), denoted by blue and red, respectively, in Figure 3-1. Within the U.S., Logue, et al. (2010) collected measurements in Pittsburgh, Pennsylvania, and reported measurements from both near facility (0.01 to 0.33 $\mu g/m^3$) and general population (0.04 to 0.35 $\mu g/m^3$; downtown Pittsburgh) sites. For near facility measurements, 1,3-butadiene concentrations were attributed to emissions from chemical plants and metallurgic coke plants, while 1,3-butadiene concentrations at the downtown, general population sites were attributed to mobile emissions from vehicular traffic. Measurements collected at an exurban background site, outside of Pittsburgh, had a range of 0.0 to 0.15 $\mu g/m^3$. Bereznicki, et. al (2012) reported a residential general population concentration range of non-detect (ND) to 1.91$\mu g/m^3$ in Detroit, Michigan. Yu et al. (2014) reported a range of 0.01 to 1.35 $\mu g/m^3$ near industrial areas in Paterson, New Jersey.

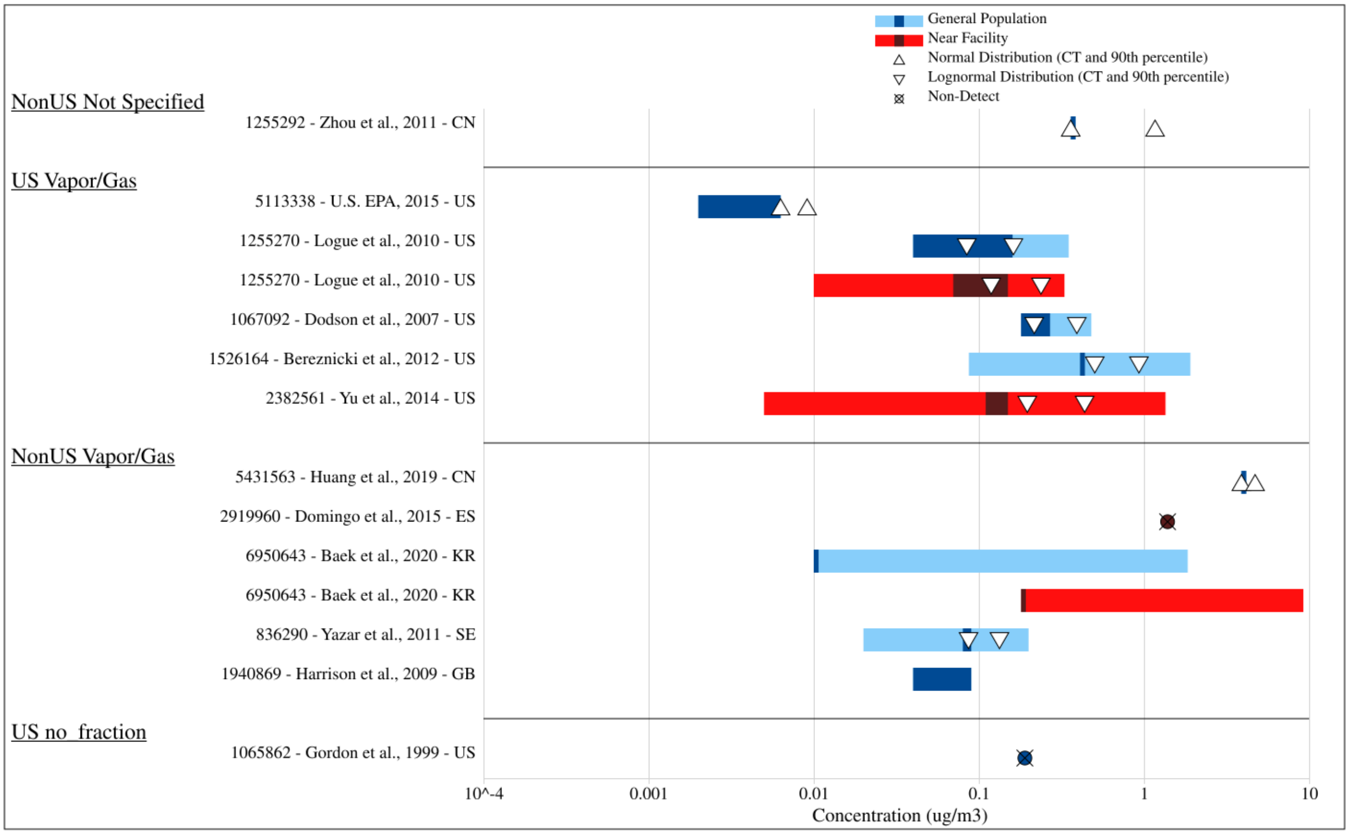

Figure 3-1. Measured Concentrations of 1,3-Butadiene (µg/m^3) in Ambient Air from 1998 to 2017

3.1.1.1 Modeled Concentrations

Modeled concentrations of 1,3-butadiene in ambient air were also captured during systematic review from five studies (four in the United States and one in Japan) with concentration results of a similar range as measured concentrations (Yu and Stuart, 2016; Loh et al., 2007; Luecken et al., 2006; Suzuki et al., 2004; Radian Engineering, 1997).

3.1.2 Monitoring Database

To complement measurements available in peer-reviewed literature, measured ambient air concentrations of 1,3-butadiene were obtained from the EPA's AMTIC[1] Ambient Monitoring Archive (AMA) for Hazardous Air Pollutants (HAPs) database (U.S. EPA, 2022a). The AMTIC-AMA houses data from over 5,000 ambient air monitoring sites across the United States collected from 1990 to 2021. Contributing data sources include the EPA's Air Quality System (AQS), the Texas Commission on Environmental Quality (TCEQ), the South Coast Air Quality Management District (SCAQMD), the National Atmospheric Deposition Program (NADP), the National Oceanic and Atmospheric Administration (NOAA), the Massachusetts Institute of Technology (MIT), the Louisiana Department of Environmental Quality (LDEQ), other state, local, tribal, and federal monitoring agencies, and academic, community, and short-term studies.

To be consistent with the TRI 2016 to 2021 reporting years, EPA evaluated monitoring data for samples collected from January 2016 through December 2021. The 1,3-butadiene AMTIC monitoring data included over 55,000 24-hour sampling entries from 12 monitoring programs covering 34 states and 331 census tracts. Samples were collected using pressurized canisters over

[1] See https://www.epa.gov/amtic/air-toxics-ambient-monitoring for more information.

24-hour durations and analyzed using gas chromatograph mass spectrometer (GC/MS). The resulting 1,3-butadiene concentrations were converted to μg/m^3. Monitored concentrations from the AMTIC archive ranged from 0.0 to 122.8 μg/m^3. The maximum concentration was reported from the State of Texas, which reported approximately 9.3 percent of all 1,3-butadiene monitoring data. The method detection limit (MDL) ranged from 0.002 to 1.106 μg/m^3 with 41.1 to 52.8 percent of samples collected between 2016 through 2021 reporting 1,3-butadiene concentrations below the MDL. See
Table_Apx C-1 for a summary of the AMTIC monitoring data, which includes other sampling durations beyond 24 hours. For more information on 1,3-butadiene ambient air monitoring data, see the supplemental file *Draft Ambient Monitoring Technology Information Center (AMTIC) Monitoring Data 2016 to 2021 for 1,3-Butadiene* (U.S. EPA, 2024b). Data for this supplemental file was downloaded from the AMTIC Ambient Monitoring Archive for HAPs Database (U.S. EPA, 2022a).

3.2 Measured Concentrations in Indoor Air

3.2.1 Peer-Reviewed Literature

3.2.1.1 Measured Concentrations

Measured concentrations of 1,3-butadiene in indoor air were extracted from four U.S. studies published between the years 1999 and 2007 (Figure 3-2). Loh et. al (2006) reported a geometric mean concentration of 1.05 μg/m^3 and a maximum concentration of 35.5 μg/m^3 from measurements collected in a public dining space in Boston, Massachusetts, and a geometric mean concentration of 0.21 μg/m^3 and a maximum concentration of 2.20 μg/m^3 in retail stores. The study attributed 1,3-butadiene in the dining spaces to cooking and tobacco smoke. Sax, et. al (2006) reported a mean concentration of 1.01 μg/m^3 and a maximum concentration of 9.02 μg/m^3 in homes throughout New York City, New York, and a mean concentration of 0.41 μg/m^3 and maximum concentration of 1.47 μg/m^3 in homes in Los Angeles, California.

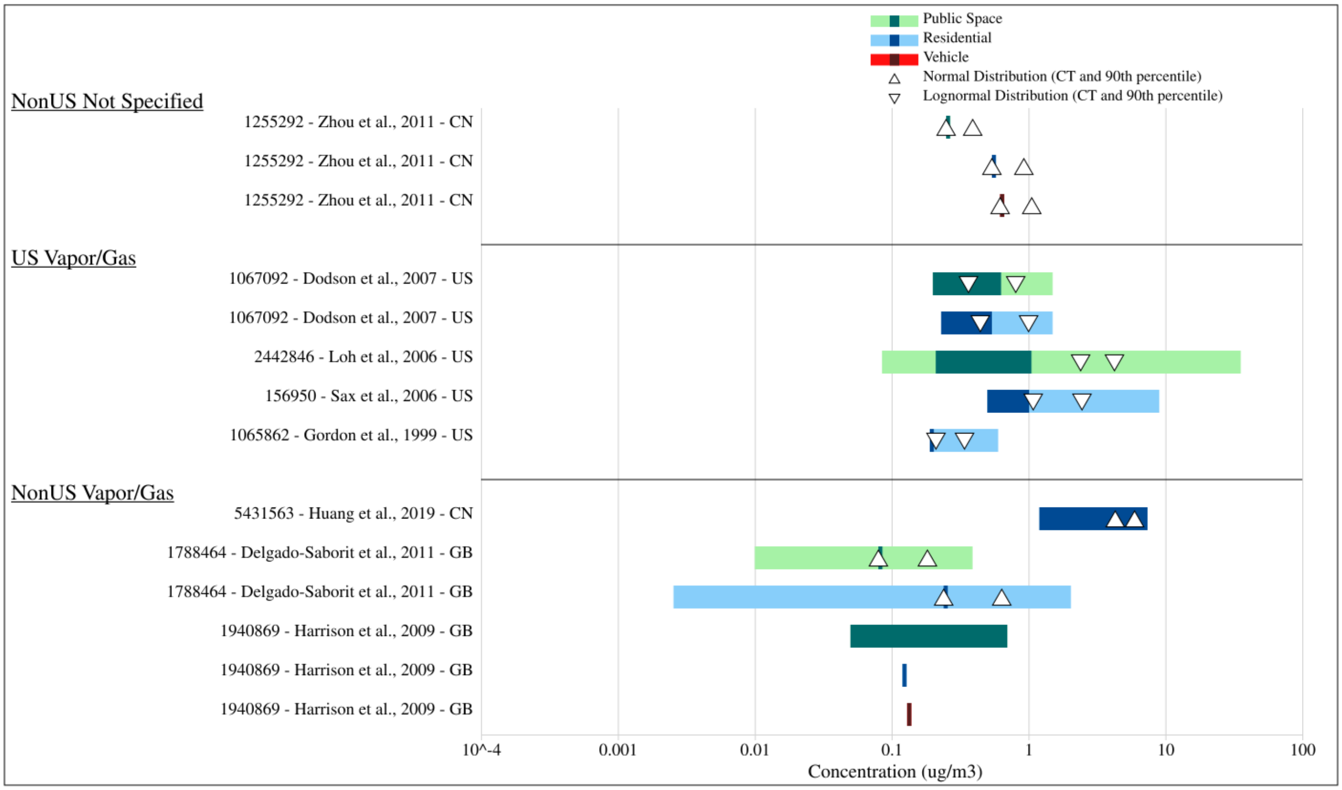

Figure 3-2. Concentrations of 1,3-Butadiene (µg/m^3) in Indoor Air from 1998 to 2011

3.2.1.2 Modeled Concentrations

Modeled concentrations of 1,3-butadiene in indoor air were also captured during systematic review from one study in the United States with results that were within range of measured concentrations (Loh et al., 2007).

3.3 Measured Concentrations in Landfill Gas

3.3.1 Peer-Reviewed Literature

Measured concentrations of 1,3-butadiene in landfill gas were extracted from 1 U.S. study with 12 samples collected in 1998 (Figure 3-3). The average concentration of 3.98 ppm (8,800 µg/m^3) was reported from measurements collected at a municipal solid-waste landfill in New York City, New York (Eklund et al., 1998). It is noted in this study that landfill gas is collected by an on-site gas collection system and treated for impurities before being sold to utility services. Therefore, exposure to the general population from landfill gas is not expected.

Figure 3-3. Concentrations of 1,3-Butadiene (ppm) in Landfill Gas from 1998

3.4 Personal Exposure Monitoring

3.4.1 Peer-Reviewed Literature

In addition to these studies, measured concentrations of 1,3-butadiene in personal exposure monitoring samples; that is, study participants wearing personal air samplers, were available from four U.S. studies conducted from 1996 and 2015 (Figure 3-4) (Shin et al., 2015; Dodson et al., 2007; Sax et al., 2006; Heavner et al., 1996). However, due to the relatively small sample sizes across these studies, which ranged from 46 to 104 participants, and varying exposure factors; for example, smoking, behavioral, and activity patterns, it is difficult to extrapolate results from individual exposures to expected population-based exposures.

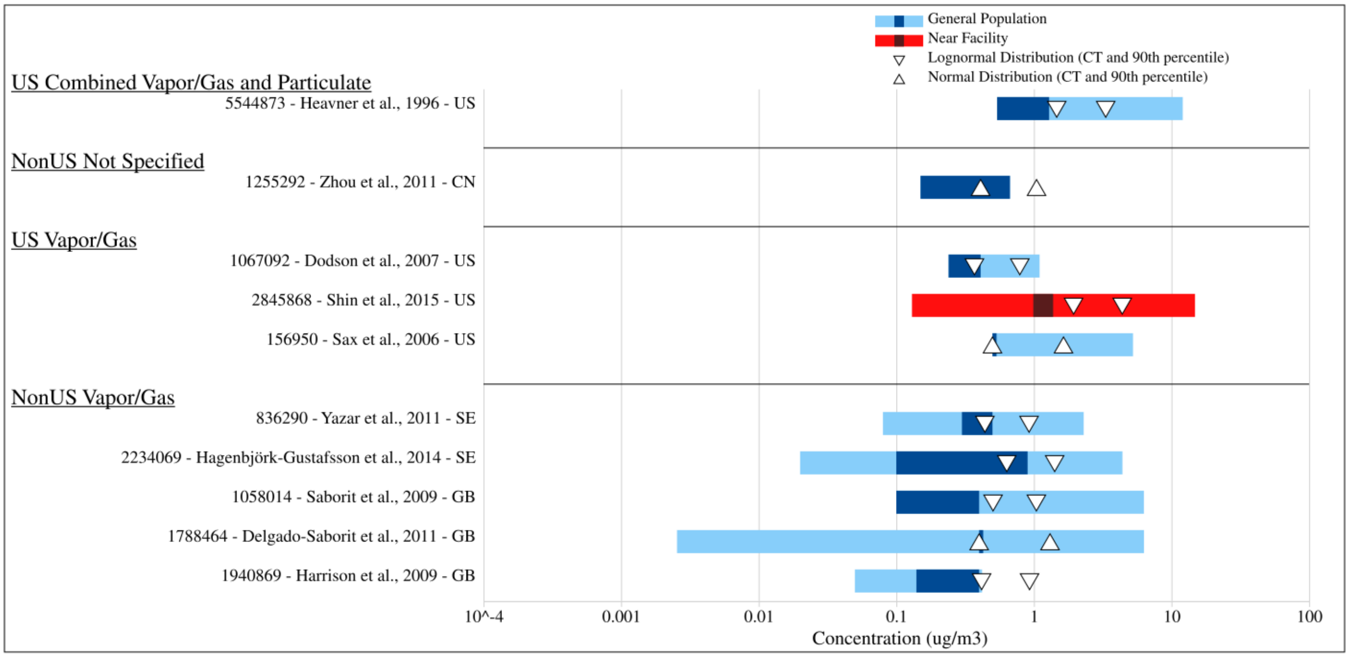

Figure 3-4. Personal Exposure Measurements of 1,3-Butadiene (μg/m^3) from 1996 to 2015

3.5 Evidence Integration

Measurements from the AMTIC ambient air monitoring sites database (U.S. EPA, 2022a) and concentrations reported in the literature provide evidence that exposure to 1,3-butadiene from the air pathway is expected in ambient air. Therefore, EPA conducted a quantitative assessment of exposure to 1,3-butadiene in ambient air for the general population. The Agency modeled ambient air concentrations based on releases from the TRI 2016 to 2021 database to assess general population exposure to ambient air from facility releases of 1,3-butadiene. For more details on environmental releases and general population exposure, see the *Draft Environmental Release for 1,3-Butadiene* (U.S. EPA, 2024c) and the *Draft General Population Exposure Assessment for 1,3-Butadiene* (U.S. EPA, 2024d), respectively.

4 WATER PATHWAY

The DMR (U.S. EPA, 2024a) recorded no releases of 1,3-butadiene from wastewater treatment facilities to surface water bodies. The TRI (U.S. EPA, 2022b) only recorded very small releases with the maximum being about 400 kg into Mississippi river in 2020 (see *Draft Environmental Release and Occupational Exposure Assessment for 1,3-Butadiene* (U.S. EPA, 2024e)). With average flow rate in the Mississippi of 1.15×10^{12} L/day, the estimated surface water concentration would be about 0.96 ng/L, not accounting for volatilization that would further drive down the concentration.

1,3-Butadiene has a low water solubility of 735 mg/L. In addition, volatilization of 1,3-butadiene from water surfaces is expected to occur rapidly due to a Henry's Law constant of 0.076 atm.m^3/mol. EPI Suite™ estimates volatilization rates of hours to a few days for a surface water body of 1 m depth, wind velocities ranging from 0.5 to 5 m/s, and water current velocity ranging from 0.0 to 1 m/s (see *Draft Chemistry, Fate and Transport Assessment for 1,3-Butadiene* (U.S. EPA, 2024f)).

4.1 Measured Concentrations in Surface Water

The WQP (NWQMC, 2022) is a publicly available resource that integrates water quality data from the USGS National Water Information System (NWIS) (USGS, 2013) and the EPA Water Quality Exchange (WQX) Data Warehouse (U.S. EPA, 2019). The NWIS database contains current and historical water data from more than 1.5 million sites across the nation. The WQX is the EPA's repository of water quality monitoring data collected by water resource management groups across the nation. The complete set of 1,3-butadiene monitoring results stored in the WQP (NWQMC, 2022) was retrieved in January 2024 with only the chemical name applied as a filter. The raw dataset included 10,206 samples from across the United States collected between 2011 and 2023. A higher number of samples were from California, New York, Texas, Georgia, North Carolina, and Florida (where >39% of the U.S. population resides) compared to other states. The WQP 1,3-butadiene dataset did not contain samples from Alaska, Delaware, Rhode Island, Hawaii, or Vermont (<2% of the U.S. population live in these states).

While the 1,3-butadiene WQP data set exceeded 10,000 samples, most of the samples were groundwater samples with only 231 samples available for surface water. The surface water samples were sourced from 23 states for the period of 2012 to 2020. Greater than 80 percent of the surface water samples were sourced from North Carolina (81), Georgia (47), Illinois (29), South Carolina (25), and Virginia (13). Most of samples were collected between 2012 to 2015 with about 75 percent of the samples being collected in 2014 alone. For more information and details, see the supplemental file *Draft Water Quality Portal (WQP) Monitoring Data 2011 to 2023 for 1,3-Butadiene* (U.S. EPA, 2024i). Without exception, all 231 surface water samples reported 1,3-butadiene concentrations below the MDL of 0.08 µg/L.

4.2 Evidence Integration for Surface Water

Based on the low reported releases to surface water (U.S. EPA, 2024e), physical and chemical properties (U.S. EPA, 2024f), and monitoring data reporting a 0 percent detection frequency of 1,3-butadiene (Section 4.1), EPA decided not to conduct a quantitative assessment of risk for surface water.

After systematic review and a review of the WQP database (NWQMC, 2022), EPA did not find reported measured sediment concentrations of 1,3-butadiene in the United States. As described in Sections 4.1 and 4.2, 1,3-butadiene is not expected to be found in surface water; therefore, there is no route for it to get into sediments. Furthermore, 1,3-butadiene has a low estimated organic carbon:water partition coefficient (Koc) value of 54 (U.S. EPA, 2012), indicating that if the chemical were to enter surface water, it would be unlikely to partition to sediment. As a result, EPA has decided not to conduct a quantitative assessment of risk for sediments.

4.3 Measured Concentrations in Drinking Water

Public water systems (PWSs) are regulated under the Safe Drinking Water Act (SDWA)[2] to enforce common standards for drinking water across the country. To assess concentrations of 1,3-butadiene in water known to be distributed as drinking water, monitoring data collected by PWSs were evaluated. Concentrations of 1,3-butadiene found in finished (*i.e.*, treated) drinking water were extracted from the EPA's publicly available UCMR3[3] dataset, which includes samples collected between 2013 to 2015 (U.S. EPA, 2017). The data covers all PWSs serving more than 10,000 people and 800 representative PWSs serving 10,000 or fewer people within all U.S. states and territories. The data shows that all but 2 of 36,839 tested drinking water samples (>99.9%) did not detect 1,3-butadiene (reporting limit [RL] of 0.1 µg/L). The two samples reported 1,3-butadiene at concentrations of 0.32 and 0.54 µg/L in Florida (PWSID FL3480962) and Puerto Rico (PWSID PR0002591), respectively. No additional information about the two detections in drinking water was found. EPA was not able to evaluate drinking water sourced outside the PWSs but expects no significant differences from the public drinking water based on the physical and chemical properties of 1,3-butadiene.

4.4 Evidence Integration for Drinking Water

Based on the physical and chemical properties of 1,3-butadiene—that is, its low water solubility and high tendency to volatilize from water as well as the monitored data showing that 1,3-butadiene is not detected in drinking water from PWSs—EPA has decided not to conduct a quantitative assessment of risk for drinking water.

[2] See https://www.epa.gov/sdwa for more information.
[3] See https://www.epa.gov/dwucmr/third-unregulated-contaminant-monitoring-rule for more information.

5 LAND PATHWAY

Land contamination from 1,3-butadiene may be expected to occur from releases to land, which mainly includes discharge of wastewater into underground injection wells and disposal of waste into landfills (see *Draft Environmental Release and Occupational Exposure Assessment for 1,3-Butadiene* (U.S. EPA, 2024e)).

According to reports in the 2016 CDR, the use of plastic and rubber products, including synthetic rubbers, were identified as consumer conditions of use for 1,3-butadiene. EPA has determined, however that 1,3-butadiene, a monomer used in polymer-derived consumer products such as synthetic rubbers, is stable in these products and not expected to degrade and expose the consumer to the 1,3-butadiene monomer (U.S. EPA, 2024g). Furthermore, rubber and plastic products in landfills would not be expected to form leachates containing any significant amount of 1,3-butadiene.

Sludge from water treatment systems in polymer production facilities are not expected to contain significant amounts of 1,3-butadiene due to its volatility and low affinity for organic matter. Any release of 1,3-butadiene to soil (such as air deposition) would volatilize rapidly and is not expected to remain in soil for any significant amount of time.

Releases to land make up less than 1 percent of releases of 1,3-butadiene to the environment (U.S. EPA, 2024e). Most of the releases of 1,3-butadiene to land are to class I underground injection wells. Oversight of these wells requires that the wells are designed and constructed to prevent the movement of injected waste streams into drinking water systems. Wells typically consist of three or more concentric layers of pipe including surface casing, long string casing, and injection tubing. In addition, wells must be sited at locations with geologies that mitigate any movement of contaminants outside of a confined layer if there were a well failure. Extensive pre-siting geological tests confirm that the injection zone is of sufficient lateral extent and thickness and is sufficiently porous so that fluids injected through the well can enter the rock formation without extensive buildup of pressure or possible displacement of injected fluids outside of the intended zone. Hence, it is unlikely that this disposal pathway could contaminate a drinking water source.

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5.1 Measured Concentrations in Groundwater

The complete set of 1,3-butadiene monitoring results stored in the WQP (NWQMC, 2022) were retrieved in January 2024 with only the chemical name applied as a filter. The raw dataset included 10206 samples from across the United States collected between 2011 and 2023. A higher number of samples were from California, New York, Texas, Georgia, North Carolina, and Florida (where >39% of the U.S. population resides) compared to other states and it did not contain samples from Alaska, Delaware, Rhode Island, Hawaii, and Vermont (<2% of the U.S. population live in these states). When samples of other types of water were excluded, 9,378 groundwater samples from 46 states for the period of 2011 to 2023 remained in the dataset. Greater than 50 percent of the samples were from Arizona with another 18 percent from California. None of the groundwater samples reported concentrations of 1,3-butadiene above the MDL. The MDL ranged from 0.81 to 40 ug/lFor more details on the monitoring data, see the supplemental file *Draft Water Quality Portal (WQP) Monitoring Data 2011 to 2023 for 1,3-Butadiene* (U.S. EPA, 2024i).

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5.2 Evidence Integration

Based on the low volume of releases to land, the low risk of failure of the predominant release scenario, the physical and chemical properties of 1,3-butadiene, as well as monitoring data indicating no detections of 1,3-butadiene, EPA did not perform a quantitative analysis for the land pathway because exposure to the general population is not expected to occur.

6 WEIGHT OF SCIENTIFIC EVIDENCE

6.1 Strengths, Limitations, Assumptions, and Key Sources of Uncertainty for Measured Concentrations in Ambient Air

AMTIC data has been previously reviewed and verified by the AMTICs Ambient Air Monitoring Group, which has taken various quality assurance steps to ensure data quality and has been certified in accordance with 40 CFR Part 58.15. Due to strictly regulated monitoring requirements, EPA has high confidence in the AMTIC ambient air data set (U.S. EPA, 2022a), which also received a high-quality rating from EPA's systematic review process. (U.S. EPA, 2021a).

A primary limitation of the AMTIC data is that the data have not been annualized and therefore represent a diverse collection of sampling durations (none of which are annual averages) that are not directly comparable to modeled data. Additionally, because monitored data represents a total aggregate concentration from all sources of 1,3-butadiene contributing to ambient air concentrations, the AMTIC data cannot be used to characterize exposures exclusively from TSCA COUs. See the *Draft General Population Exposures for 1,3-Butadiene* (U.S. EPA, 2024d) for more details comparing modeled and measured data.

The 1,3-butadiene concentrations from systematic review were extracted from 31 studies from 6 countries. All media types included studies and data collected in the United States with ratings of medium or high quality, which are representative of exposure for the general population in the United States. Studies from non-U.S. countries may not be representative of exposure for the general population in the United States; one study was given a rating of low quality from Spain. See Appendix A for study ratings for all peer-reviewed literature from systematic review. Notably, measured data from systematic review vary temporally, air concentrations are especially subject to season variation, and vary geospatially. Methodology for sample collection and analysis are specific to each peer-reviewed literature and vary with instrumentation and analysis. Concentrations of 1,3-butadiene across all media are attributed to many different sources, including but not limited to facility emissions, traffic emissions, heating and cooking combustion activities, and environmental tobacco smoke, and are not specific to only TSCA conditions of use.

6.2 Strengths, Limitations, Assumptions, and Key Sources of Uncertainty for Measured Concentrations in Water

The 1,3-butadiene data from the WQP has a strong bias of samples collected from California, New York, Texas, Georgia, North Carolina, and Florida (comprising >39% of the U.S. population) relative to other states and was missing data from Alaska, Delaware, Rhode Island, Hawaii and Vermont (comprising <2% of the U.S. population). The states with a higher number of data points are states where a higher percentage of the U.S. population resides. In addition, states with a concentration of facilities releasing 1,3-butadiene are included in the monitoring database. Due to the presence of 1,3-butadiene releasing facilities, these states would be expected to have the largest 1,3-butadiene releases. Because data reflects that 1,3-butadiene is typically not detected above the detection limit in water, EPA has robust confidence that in areas with less releases, 1,3-butadiene will not be in the water. In addition, based on the physical and chemical properties of 1,3-butadiene and low release quantities to water and land, EPA has confidence that the WQP data is representative of the entire United States. Again, WQP is not specific to only TSCA conditions of use.

The 1,3-butadiene data from the UCMR3 covered all PWSs serving more than 10,000 people and 800 representative PWSs serving 10,000 or fewer people. The PWSs were monitored during a 12-month period from January 2013 through December 2015. This data may have a bias towards states with greater populations (*e.g.*, California) due to a higher number of PWSs serving 10,000 or more people, compared to the representative 800 PWSs serving 10,000 or fewer people, including Tribal nations. In addition, the UCMR3 only required samples to be collected during a 12-month period between January 2013 through December 2015, which is a timespan of approximately 3 years, so it does not consider temporal variability beyond the 12-month sampling periods. Lastly, the UCMR3 data is not specific to only TSCA conditions of use. Nevertheless, EPA has robust confidence in the representativeness of the UCMR3 data.

7 CONCLUSIONS

Based on the (1) physical and chemical properties of 1,3-butadiene (*i.e.*, high volatility, low solubility, and low sorption tendencies) (U.S. EPA, 2024f); (2) low release volume to land and water (U.S. EPA, 2024e); and (3) minimal detection of 1,3-butadiene in U.S. surface and groundwaters, EPA has robust confidence that air is the major pathway of exposure for 1,3-butadiene and that contributions to exposure from the land and water pathways will be infrequent and at low levels. As a result, air is the only pathway that will be assessed quantitatively.

For regions where monitoring data are available, EPA has robust confidence in the overall characterization of environmental media concentrations for 1,3-butadiene as it relies upon standard reporting databases that are reviewed with quality control and assurance protocols, such as AMTIC, WQP, and UCMR, and extracted data from peer-reviewed literature that received medium- to high-quality ratings from EPA's systematic review process.

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Appendix A SUPPLEMENTAL INFORMATION OF PEER-REVIEWED LITERATURE AND STUDY RATINGS FOR MEASURED CONCENTRATIONS OF 1,3-BUTADIENE

Table_Apx A-1. Summary of Peer-Reviewed Literature that Measured 1,3-Butadiene (µg/m3) Levels in Ambient Air

Citation	Country	Location Type	Sampling Year(s)	Sample Size (Frequency of Detection)	Detection Limit (µg/m^3)	Overall Quality Level
Not specified						
Zhou et al. (2011)	CN	General Population	2008	8 (N/R)	N/R	Medium
Vapor/gas						
U.S. EPA (2015)	US	General Population	2010–2012	121 (N/R)	N/R	High
Logue et al. (2010)	US	General Population	2006–2008	244 (N/R)	N/R	High
Logue et al. (2010)	US	Near Facility	2006–2008	244 (N/R)	N/R	High
Dodson et al. (2007)	US	General Population	2007	89 (0.38)	N/R	High
Bereznicki et al. (2012)	US	General Population	2004–2007	992 (0.79)	0.174	Medium
Yu et al. (2014)	US	Near Facility	2005–2006	209 (0.84)	0.01	High
Huang et al. (2019)	CN	General Population	2016–2017	37 (N/R)	N/R	High
Domingo et al. (2015)	ES	Near Facility	2014	6 (0)	2.78	Low
Baek et al. (2020)	KR	General Population	2009–2010	384 (0.27)	N/R	Medium
Baek et al. (2020)	KR	Near Facility	2009–2010	384 (0.27)	N/R	Medium
Yazar et al. (2011)	SE	General Population	2009	9 (1)	0.01	Medium
Harrison et al. (2009)	GB	General Population	2005–2007	128 (N/R)	N/R	High
No fraction						
Gordon et al. (1999)	US	General Population	1998	14 (0)	0.38	Medium
N/R = not reported; CN = China; GB = Great Britain; SE = Spain; KR = South Korea; US = United States						

Table_Apx A-2. Summary of Peer-Reviewed Literature that Measured 1,3-Butadiene (µg/m3) Levels in Indoor Air

Citation	Country	Location Type	Sampling Year	Sample Size (Frequency of Detection)	Detection Limit (µg/m^3)	Overall Quality Level
Not specified						
Zhou et al. (2011)	CN	Public Space	2008	6 (N/R)	N/R	Medium
Zhou et al. (2011)	CN	Residential	2008	10 (0.90)	N/R	Medium
Zhou et al. (2011)	CN	Vehicle	2008	6 (N/R)	N/R	Medium
Vapor/gas						
Dodson et al. (2007)	US	Public Space	2007	178 (0.28)	N/R	High
Dodson et al. (2007)	US	Residential	2007	89 (0.31)	N/R	High
Loh et al. (2006)	US	Public Space	2004	71 (0.89)	0.17	Medium
Sax et al. (2006)	US	Residential	1999–2000	81 (0.67)	1	High
Gordon et al. (1999)	US	Residential	1998	24 (0.04)	0.38	Medium
Huang et al. (2019)	CN	Residential	2016–2017	88 (N/R)	N/R	High
Delgado-Saborit et al. (2011)	GB	Public Space	2005–2007	40 (N/R)	0.0051	High
Delgado-Saborit et al. (2011)	GB	Residential	2005–2007	155 (N/R)	0.0051	High
Harrison et al. (2009)	GB	Public Space	2005–2007	77 (N/R)	N/R	High
Harrison et al. (2009)	GB	Residential	2005–2007	152 (N/R)	N/R	High
Harrison et al. (2009)	GB	Vehicle	2005–2007	43 (N/R)	N/R	High
N/R, Not reported; CN = China; GB = Great Britain; US = United States						

Table_Apx A-3. Summary of Peer-Reviewed Literature that Measured 1,3-Butadiene (ppm) Levels in Landfill Gas

Citation	Country	Exposure Scenario	Location Type	Sampling Year	Sample Size (Frequency of Detection)	Detection Limit (ppm)	Overall Quality Level
Eklund et al. (1998)	US	Landfill Gas	Near Facility	1998	12 (N/R)	N/R	Medium
N/R = Not reported; US = United States							

Table_Apx A-4. Summary of Peer-Reviewed Literature that Measured 1,3-Butadiene (μg/m^3) Levels in Personal Inhalation

Citation	Country	Location Type	Sampling Year	Sample Size (Frequency of Detection)	Detection Limit (μg/m^3)	Overall Quality Level
Combined vapor/gas and particulate						
Heavner et al. (1996)	US	General Population	1992	168 (N/R)	N/R	Medium
Not specified						
Zhou et al. (2011)	CN	General Population	2008	20 (N/R)	N/R	Medium
Vapor/gas						
Dodson et al. (2007)	US	General Population	2007	89 (0.25)	N/R	High
Shin et al. (2015)	US	Near Facility	2005–2007	239 (N/R)	N/R	Medium
Sax et al. (2006)	US	General Population	1999–2000	81 (0.70)	1	High
Yazar et al. (2011)	SE	General Population	2009	39 (1)	0.01	Medium
Hagenbjörk-Gustafsson et al. (2014)	SE	General Population	2001–2008	275 (N/R)	N/R	Medium
Saborit et al. (2009)	GB	General Population	2005–2007	500 (N/R)	N/R	Medium
Delgado-Saborit et al. (2011)	GB	General Population	2005–2007	500 (N/R)	0.0051	High
Harrison et al. (2009)	GB	General Population	2005–2007	500 (N/R)	N/R	High
N/R = not reported; CN = China; GB = Great Britain; SE = Spain; US = United States						

Appendix B SUPPLEMENTAL INFORMATION OF PEER-REVIEWED LITERATURE FOR MEASURED CONCENTRATIONS OF 1,3-BUTADIENE

Table_Apx B-1. Summary Statistics of 1,3-Butadiene Concentrations Extracted from Systematic Review

Matrices	Location	Number of Studies with U.S. Data (N)	Number of Studies with Non-U.S. Data (N)	Total Number of Studies (N)	Unit	Fraction	Average of Arithmetic Mean Estimates for U.S. Data	Average of 90th Percentile Estimates for U.S. Data	Average of Arithmetic Mean Estimates for non-U.S. Data	Average of 90th Percentile Estimates for Non-US Data	Average of arithmetic Mean Estimates for All Data	Average of 90th Percentile Estimates for All Data
Ambient Air	General Population	4 (1,183)	3 (54)	7 (1237)	µg/m^3	Any	4.3E−01	8.0E−01	3.2E00	4.4E00	4.6E−01	7.8E−01
	Near Facility	2 (420)	0	2 (420)	µg/m^3	Any	1.51E−01	3.21E−01	–	–	1.5E−01	3.2E−01
Indoor Air	Public Spaces	2 (113)	2 (46)	4 (159)	µg/m^3	Any	1.7E00	3.1E00	3.9E00	6.9E00	1.5E00	2.3E00
	Residential	3 (83)	3 (253)	6 (335)	µg/m^3	Gas/vapor	8.6E−01	1.9E00	2.5E00	4.4E00	1.5E00	2.4E00
	Vehicles	–	1 (6)	1 (6)	µg/m^3	Any	–	–	6.2E−01	1.1E00	6.2E−01	1.1E00
Landfill Gas	Near Facility	–	–	–	ppm	Any	–	–	–	–	–	–
Personal Inhalation	General Population	4 (486)	5 (1,334)	9 (1,820)	µg/m^3	Any	1.5E00	3.5E00	1.5E00	3.5E00	6.9E−01	1.6E00

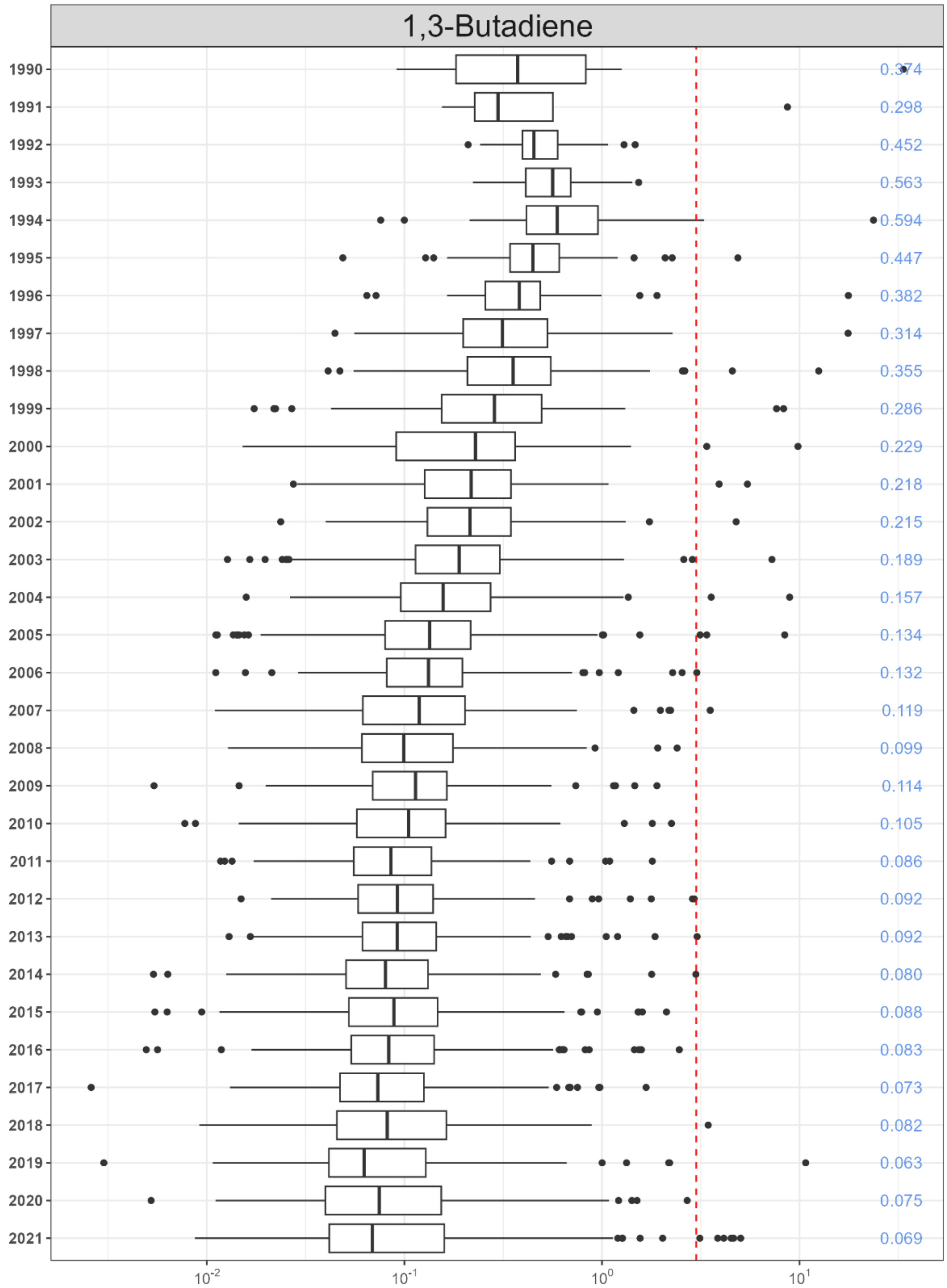
Appendix C SUPPLEMENTAL INFORMATION OF AIR MONITORING DATA FOR MEASURED CONCENTRATIONS OF 1,3-BUTADIENE

Table_Apx C-1. Summary of AMTIC Monitoring Data 2016-2021 for 1,3-Butadiene

Ambient Monitoring Technology Information Center Hazardous Air Pollutants							
Sample Duration	Statistic (µg/m³)	Year					
		2016	2017	2018	2019	2020	2021
24 hours	Maximum	1.45E01	1.74E01	1.90E01	4.56E01	5.29E01	1.23E02
	Mean	1.02E−01	7.99E−02	7.76E−02	6.84E−02	1.09E−01	1.56E−01
	Without NDs	1.73E−01	1.53E−01	1.53E−01	1.44E−01	2.24E−01	3.30E−01
	Median	2.49E−02	1.53E−02	8.95E−03	0.00E00	0.00E00	0.00E00
	Without NDs	7.28E−02	6.79E−02	6.95E−02	6.42E−02	6.81E−02	7.87E−02
	Minimum	0.00E00	0.00E00	0.00E00	0.00E00	0.00E00	0.00E00
	Without NDs	2.29E−03	2.26E−03	2.22E−03	2.27E−03	2.35E−03	4.42E−03
	Total Samples	9931	11211	11457	9799	10271	3219
	Total NDs (%)	4083	5365	5652	5151	5257	1700
	MDL	0.002 to 1.106	0.002 to 1.106	0.002 to 1.084	0.008 to 1.084	0.013 to 0.929	0.0044 to 0.553
3 hours	Maximum	8.21E−01	2.35E−01	3.24E00	2.38E−01	8.25E−01	6.58E−01
	Mean	4.13E−02	4.56E−03	3.43E−02	2.89E−03	1.08E−02	1.07E−01
	Without NDs	1.80E−01	1.85E−01	8.37E−01	1.85E−01	5.56E−01	1.58E−01
	Median	0.00E00	0.00E00	0.00E00	0.00E00	0.00E00	6.75E−02
	Without NDs	1.19E−01	1.63E−01	2.85E−01	1.85E−01	6.94E−01	1.21E−01
	Minimum	0.00E00	0.00E00	0.00E00	0.00E00	0.00E00	0.00E00
	Without NDs	3.74E−02	1.58E−01	1.39E−01	1.32E−01	1.50E−01	4.15E−02
	Total Samples	161	122	122	128	155	43
	Total NDs (%)	124	119	117	126	152	14
	MDL	0.055 to 0.0685	0.055307027	0.055307027	0.055307027	0.055307027	0.019468073

Ambient Monitoring Technology Information Center Hazardous Air Pollutants							
Sample Duration	**Statistic (µg/m^3)**	**Year**					
		2016	**2017**	**2018**	**2019**	**2020**	**2021**
1 hours	Maximum	2.55E00	4.14E00	7.23E01	2.65E02	4.23E02	2.95E02
	Mean	5.71E−02	6.91E−02	1.10E−01	1.25E−01	1.38E−01	2.27E−01
	Without NDs	9.42E−02	9.12E−02	1.40E−01	1.53E−01	2.06E−01	3.80E−01
	Median	3.88E−02	4.90E−02	5.24E−02	5.85E−02	4.64E−02	2.43E−02
	Without NDs	6.31E−02	5.99E−02	6.30E−02	7.07E−02	7.09E−02	6.98E−02
	Minimum	0.00E00	0.00E00	0.00E00	0.00E00	0.00E00	0.00E00
	Without NDs	5.44E−03	1.15E−03	2.32E−03	3.58E−03	5.23E−03	2.68E−03
	Total Samples	13,792	49,876	61,421	63,462	105,406	104,276
	Total NDs (%)	5,427	12,087	13,240	11,970	34,912	41,966
	MDL	0.055307027	0.055307027	0.055 to 0.221	0.022 to 0.221	0.016 to 0.0276	0.055 to 0.221
25 minutes	Maximum	4.27E02	1.49E01	1.49E02	8.90E02	3.41E01	1.97E01
	Mean	4.53E00	5.50E−01	1.68E00	8.52E00	1.26E00	1.84E00
	Without NDs	6.02E00	7.91E−01	2.71E00	1.84E01	2.48E00	5.15E00
	Median	1.59E−01	9.21E−02	8.94E−02	0.00E00	3.41E−02	0.00E00
	Without NDs	2.19E−01	2.25E−01	1.89E−01	4.53E−01	2.71E−01	1.72E00
	Minimum	0.00E00	0.00E00	0.00E00	0.00E00	0.00E00	0.00E00
	Without NDs	4.35E−02	2.20E−02	2.22E−02	4.46E−02	2.36E−02	4.42E−02
	Total Samples	101	105	153	186	104	28
	Total NDs (%)	25	32	58	100	51	18
	MDL	0.176982477	0.176982477	0.176982477	0.176982477	0.176982477	0.176982477

Ambient Monitoring Technology Information Center Hazardous Air Pollutants							
Sample Duration	**Statistic (μg/m³)**	**Year**					
		2016	**2017**	**2018**	**2019**	**2020**	**2021**
10 minutes	Maximum	–	–	–	–	4.25E00	–
	Mean	–	–	–	–	6.62E−02	–
	Without NDs	–	–	–	–	1.97E−01	–
	Median	–	–	–	–	0.00E00	–
	Without NDs	–	–	–	–	7.05E−02	–
	Minimum	–	–	–	–	0.00E00	–
	Without NDs	–	–	–	–	2.79E−02	–
	Total Samples	–	–	–	–	3,600	–
	Total NDs (%)	–	–	–	–	2,393	–
	MDL	–	–	–	–	0.026547372	–
5 minutes	Maximum	–	–	–	–	9.29E02	1.74E02
	Mean	–	–	–	–	3.59E00	3.16E00
	Without NDs	–	–	–	–	8.16E00	8.56E00
	Median	–	–	–	–	0.00E00	0.00E00
	Without NDs	–	–	–	–	6.02E00	6.90E00
	Minimum	–	–	–	–	0.00E00	0.00E00
	Without NDs	–	–	–	–	2.12E−02	2.16E−02
	Total Samples	–	–	–	–	141,890	317,245
	Total NDs (%)	–	–	–	–	79,566	200,239
	MDL	–	–	–	–	39.82105637	39.82105637



Figure_Apx C-1. Concentrations of Annual Averages (μg/m^3)