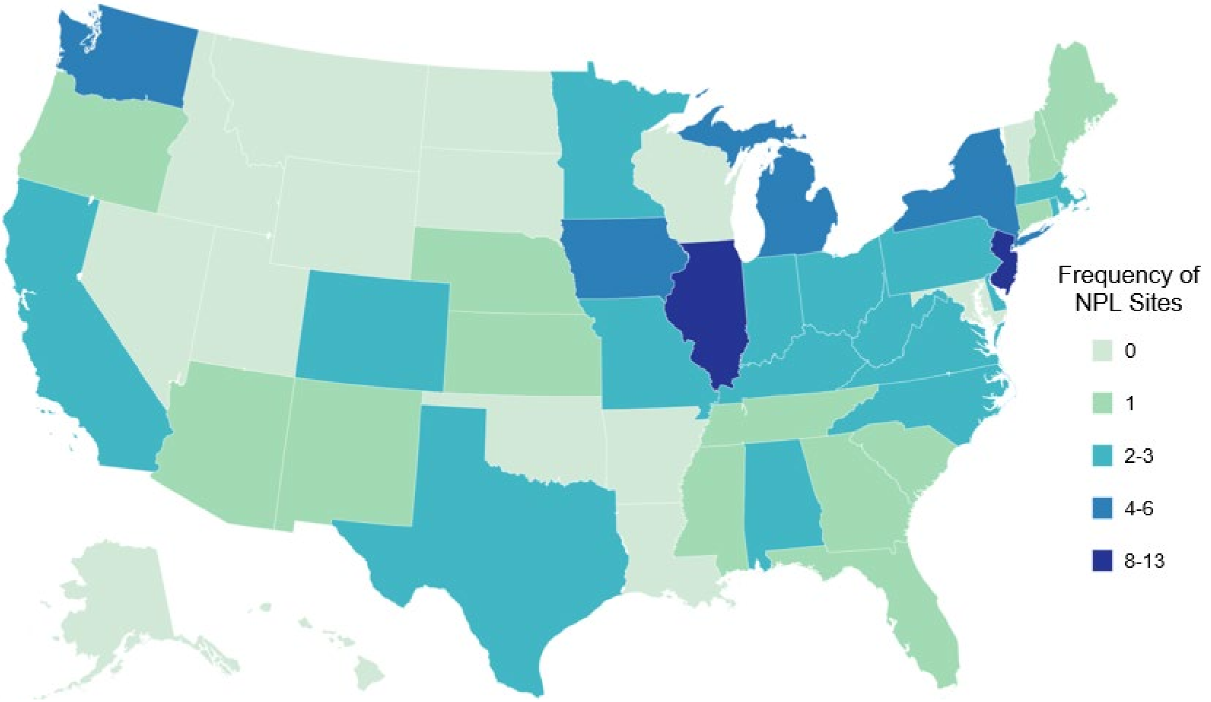
CHAPTER 5. POTENTIAL FOR HUMAN EXPOSURE

5.1 OVERVIEW

Nitrobenzene has been identified in at least 92 of the 1,868 hazardous waste sites that have been proposed for inclusion on the EPA National Priorities List (NPL) (ATSDR 2022a). However, the number of sites evaluated for nitrobenzene is not known. The number of sites in each state is shown in Figure 5-1.

Figure 5-1. Number of NPL Sites with Nitrobenzene Contamination



Source: ATSDR 2022a

- The most likely routes of occupational exposure to nitrobenzene occurs through dermal exposure and inhalation of workplace air.

- Employees working in explosive, pharmaceutical, aniline, pesticide, and dye-stuff manufacturing are at a higher risk of exposure to nitrobenzene than the general population since nitrobenzene is used in these industries.

- The general population may be exposed to nitrobenzene via inhalation of air and possibly from drinking water.

- Nitrobenzene has the potential to volatilize if released to surface waters. Nitrobenzene is not expected to bioconcentrate or bioaccumulate in aquatic organisms. In water, nitrobenzene has been shown to undergo photolysis and biodegradation is expected under both aerobic and anaerobic conditions. Nitrobenzene does not contain any functional groups that are susceptible to hydrolysis; therefore, this will not be an important environmental fate process in water.

- If released to soil, nitrobenzene is expected to possess moderate to high mobility and may leach to groundwater. It is expected to undergo biodegradation under both aerobic and anaerobic conditions.
- If released to air, nitrobenzene will be slowly degraded through reactions with hydroxyl radicals but may also undergo direct photolysis.

Human exposure to nitrobenzene results from releases to air and wastewater from industrial sources and from nitrobenzene as an air pollutant in ambient air, especially in urban areas. Its low volatility and weak sorption on soil suggests that surface waters and groundwater could be a route of exposure for the general population. Exposure is mitigated by environmental degradation, including photolysis and microbial biodegradation. Nitrobenzene is poorly bioaccumulated and is not biomagnified through the food chain. A number of fairly stable degradation products of nitrobenzene are formed during environmental degradation; some have similar effects, while others operate by different mechanisms. Moreover, whether or not nitrobenzene will be completely broken down (mineralized) at a particular site seems to be questionable. Nitrobenzene may be degraded in sewage treatment plants in aerobic conditions (WHO 2009), and when present at high concentrations, it also may inhibit the biodegradation of other wastes.

Monitoring studies reveal low and highly variable exposures through air and with a generally downward trend in exposure levels over two decades (Bozzelli and Kebbekus 1982; EPA 1985; Harkov et al. 1983; LaRegina et al. 1986). Occupational exposure is of concern due to the fact that nitrobenzene can be taken up very readily through the skin as well as by inhalation.

5.2 PRODUCTION, IMPORT/EXPORT, USE, AND DISPOSAL

5.2.1 Production

Nitrobenzene is produced commercially by the exothermic nitration of benzene with fuming nitric acid in the presence of a sulfuric acid catalyst at 50–65°C and then purified by washing and distilling with steam and redistilling (Booth 2012).

According to the Chemical Data Reporting (CDR) database, seven companies in the United States reported data for nitrobenzene: Malinckrodt, LLC; Huntsman Corporation; Tedia Company, Inc.; The

Chemours Company; The Dow Chemical Co.; Covestro, LLC; and BASF Corporation (EPA 2022). The total national aggregate production volumes estimated for 2016–2019 ranged from 1,000,000,000 to <5,000,000,000 pounds each year (these figures include imports); however, most of the individual company data for production volumes, imports, and exports were declared as confidential business information (CBI).

Table 5-1 lists the facilities in each state that manufacture or process nitrobenzene, the intended use, and the range of maximum amounts of nitrobenzene that are stored on site.

Table 5-1. Facilities that Produce, Process, or Use Nitrobenzene

State[a]	Number of facilities	Minimum amount on site in pounds[b]	Maximum amount on site in pounds[b]	Activities and uses[c]
AL	1	10,000	99,999	1, 13
AR	1	10,000	99,999	9, 12
CA	1	10,000	99,999	6
DE	1	1,000,000	9,999,999	6
IL	1	1,000	9,999	12
IN	1	100	999	12
KY	1	10,000	99,999	12
LA	2	1,000,000	9,999,999	1, 3, 6
NC	1	1,000,000	9,999,999	2, 3, 6
NE	1	1,000	9,999	9, 12
NY	1	1,000	9,999	12
OH	2	1,000	99,999	12
PA	2	1,000	99,999	10, 12
SC	1	1,000	9,999	6
TX	4	1,000	9,999,999	1, 3, 5, 6, 9, 12, 13

[a]Post office state abbreviations used.
[b]Amounts on site reported by facilities in each state.
[c]Activities/uses:

1. Produce
2. Import
3. Used Processing
4. Sale/Distribution
5. Byproduct
6. Reactant
7. Formulation Component
8. Article Component
9. Repackaging
10. Chemical Processing Aid
11. Manufacture Aid
12. Ancillary
13. Manufacture Impurity
14. Process Impurity

Source: TRI21 2022 (Data are from 2021)

5.2.2 Import/Export

According to the CDR, Mallinckrodt LLC and Tedia Company imported 28,287,333 and 33,331 pounds of nitrobenzene, respectively, into the United States in 2019 (EPA 2022). All of the other manufacturers reported no imports or declared this information as CBI. All manufacturers also reported no exports or declared export volumes as CBI in 2019.

5.2.3 Use

Approximately 90% of the worldwide production of nitrobenzene is used to produce aniline (Gatermann et al. 1995). Nitrobenzene is also widely used to produce other raw materials like quinolone antibiotics, azobenzene, and trinitrotoluene to make explosives, rubbers, pesticides, herbicides, insecticides, pharmaceuticals, and dyes (Dai et al. 2010b; Dong et al. 2010). Nitrobenzene is also used as a solvent in petroleum refining and as a solvent for coating materials and dye (Dai et al. 2010a; Dasgupta et al. 2018). It is also used to manufacture cellulose ethers and acetates, dinitrobenzene, dichloroaniline, and acetaminophen (Dasgupta et al. 2018). Nitrobenzene is used as a solvent for shoe dyes, and has been used in very small amounts as a flavoring agent and a perfume for soaps (Dunlap 1981; EPA 1981, 1985).

5.2.4 Disposal

Because nitrobenzene is listed as a hazardous substance, disposal of waste nitrobenzene is controlled by a number of federal regulations (see Chapter 7). Land disposal restrictions (treatment standards) apply to wastes containing nitrobenzene. These wastes may be chemically or biologically treated or incinerated by the liquid injection or fluidized bed methods (EPA 1988, 1989). In the past, EPA has not believed that releases of nitrobenzene to the environment are substantial (EPA 1984b).

5.3 RELEASES TO THE ENVIRONMENT

Most (97–98%) of the nitrobenzene produced is retained in closed systems for use in synthesizing aniline and other substituted nitrobenzenes and anilines (CMR 1987; EPA 1976). Most of these products go into the manufacture of various plastic monomers and polymers (50%) and rubber chemicals (27%); a smaller proportion goes into synthesis of hydroquinones (5%), dyes and intermediates (6%), drugs (3%), and pesticides and other specialty items (9%) (Dunlap 1981). A small fraction of the production is used directly in other processes or in consumer products (principally metal and shoe polishes).

The nitration of benzene in air leads to variable ambient levels in urban areas, making the assessment of releases to the air from waste sites difficult. Nevertheless, limited studies of municipal waste disposal facilities and the more complete evaluation of hazardous waste sites have found nitrobenzene infrequently present and, when present, concentrations have been generally low.

The Toxics Release Inventory (TRI) data should be used with caution because only certain types of facilities are required to report (EPA 2005). This is not an exhaustive list. Manufacturing and processing facilities are required to report information to the TRI only if they employ ≥10 full-time employees; if their facility is included in Standard Industrial Classification (SIC) Codes 10 (except 1011, 1081, and 1094), 12 (except 1241), 20–39, 4911 (limited to facilities that combust coal and/or oil for the purpose of generating electricity for distribution in commerce), 4931 (limited to facilities that combust coal and/or oil for the purpose of generating electricity for distribution in commerce), 4939 (limited to facilities that combust coal and/or oil for the purpose of generating electricity for distribution in commerce), 4953 (limited to facilities regulated under the Resource Conservation and Recovery Act (RCRA) Subtitle C, 42 U.S.C. section 6921 et seq.), 5169, 5171, and 7389 (limited S.C. section 6921 et seq.), 5169, 5171, and 7389 (limited to facilities primarily engaged in solvents recovery services on a contract or fee basis); and if their facility produces, imports, or processes ≥25,000 pounds of any TRI chemical or otherwise uses >10,000 pounds of a TRI chemical in a calendar year (EPA 2005).

5.3.1 Air

Estimated releases of 15,993 pounds (~7.25metric tons) of nitrobenzene to the atmosphere from 21 domestic manufacturing and processing facilities in 2021, accounted for about 5% of the estimated total environmental releases from facilities required to report to the TRI (TRI21 2022). These releases are summarized in Table 5-2.

Table 5-2. Releases to the Environment from Facilities that Produce, Process, or Use Nitrobenzene[a]

		Reported amounts released in pounds per year[b]							
							Total release		
State[c]	RF[d]	Air[e]	Water[f]	UI[g]	Land[h]	Other[i]	On-site[j]	Off-site[k]	On- and off-site
AL	1	1,798	0	0	0	0	1,798	0	1,798
AR	1	0	0	0	174	0	0	174	174
CA	1	0	0	0	0	0	0	0	0
DE	1	1	0	0	0	0	1	0	1
IL	1	1	0	0	5	0	1	5	7
IN	1	0	0	0	0	0	0	0	0
KY	1	221	0	0	0	0	221	0	221
LA	2	7,008	0	280,000	82	0	287,008	82	287,090
NE	1	27	0	0	0	0	27	0	27
NY	1	1	0	0	0	0	1	0	1
NC	1	4,959	0	0	0	0	4,959	0	4,959
OH	2	0	0	0	0	0	0	0	0
PA	2	4	0	0	0	250	4	250	254
SC	1	5	0	0	0	0	5	0	5
TX	4	1,969	0	3,215	0	0	5,184	0	5,184
Total	21	15,993	0	283,215	261	250	299,208	511	299,719

[a] The TRI data should be used with caution since only certain types of facilities are required to report. This is not an exhaustive list. Data are rounded to nearest whole number.
[b] Data in TRI are maximum amounts released by each facility.
[c] Post office state abbreviations are used.
[d] Number of reporting facilities.
[e] The sum of fugitive and point source releases are included in releases to air by a given facility.
[f] Surface water discharges, wastewater treatment (metals only), and publicly owned treatment works (POTWs) (metal and metal compounds).
[g] Class I wells, Class II-V wells, and underground injection.
[h] Resource Conservation and Recovery Act (RCRA) subtitle C landfills; other onsite landfills, land treatment, surface impoundments, other land disposal, other landfills.
[i] Storage only, solidification/stabilization (metals only), other off-site management, transfers to waste broker for disposal, unknown.
[j] The sum of all releases of the chemical to air, land, water, and underground injection wells.
[k] Total amount of chemical transferred off-site, including to POTWs.

RF = reporting facilities; UI = underground injection

Source: TRI21 2022 (Data are from 2021)

Direct release of nitrobenzene to air during its manufacture is minimized by the passage of contaminated air through activated charcoal (EPA 1980a), and its subsequent use in closed systems as an intermediate similarly limits direct exposure during industrial processing. Nevertheless, as much as 8.3 million pounds/year may be released from industrial processes (EPA 1976). The fraction of these manufacturing losses to air is not known.

Use of nitrobenzene as a chemical intermediate or in consumer products such as metal and shoe polishes could contribute to losses via fugitive emissions, wastewater, spills, and end-product usage. The extent to which these sources contribute to human exposure has not been evaluated quantitatively.

Nitrobenzene is a compound that has air emission data from the National Emissions Inventory (NEI), which is a comprehensive and detailed estimate of air emissions of criteria pollutants, criteria precursors, and hazardous air pollutants (HAPs) from air emissions sources (EPA 2017). Data from the 2017 NEI for nitrobenzene are presented in Table 5-3.

Table 5-3. Nitrobenzene Air Emissions as Reported to the National Emissions Inventory Database for 2017

Sector	Pollutant type	Emissions (pounds)
Industrial processes; chemical manufacturing	HAP	9,985
Industrial processes; not elsewhere classified	HAP	9,805
Industrial processes; storage and transfer	HAP	2,966
Fuel combustion; electric generation; coal	HAP	1,774
Industrial processes; petroleum refineries	HAP	667
Waste disposal	HAP	330
Fuel combustion; industrial boilers, industrial combustion engines; other	HAP	45
Industrial processes; pulp and paper	HAP	7
Industrial processes; ferrous metals	HAP	6
Industrial processes; cement manufacturing	HAP	5

HAP = hazardous air pollutant

Source: EPA 2017

The third principal source of nitrobenzene is the atmospheric photochemical reaction of nitrogen oxides with benzene, which presumably is derived from automobile fuels and, to a lesser extent, solvent uses of benzene (EPA 1976). As benzene releases decline, this source (not quantified) should diminish as well. The contribution of this source is difficult to estimate since most measurements of ambient atmospheric nitrobenzene have been made in urban areas near sites of nitrobenzene manufacture, use, and disposal (see Section 5.5.1). Seasonal variations and those associated with air pollution episodes suggest that this source, although limited, may form a significant proportion of non-occupational human exposure.

5.3.2 Water

No nitrobenzene was released to surface water from domestic manufacturing or processing facilities required to report to the TRI (TRI21 2022).

The effluent discharge produced during nitrobenzene manufacture is the principal source of nitrobenzene release to water. Products from leather manufacturing, like nitrobenzene, are often released to streams or rivers despite regulations (Baby et al. 2000). Nitrobenzene can be found in wastewater from pesticide, explosive, colorant, and paper pulp production industries (Li et al. 2010). Lin et al. (2013) noted that nitrobenzene has been so widely used in the creation of chemicals like aniline, aniline dyes, drugs, explosives, paint, pesticides, shoe polishes, floor polishes, and metal polishes that wastewater may contaminate surface and groundwater. Losses to wastewater have been observed to be 0.09% of production in one plant and 2.0% in another (EPA 1976).

The nitrobenzene in wastewater may be lost to the air, degraded by sewage organisms or, rarely, carried through to finished water. The EPA has surveyed nitrobenzene levels reported in effluents from 4,000 publicly-owned treatment works (POTWs) and industrial sites. The highest value in effluent was >100 ppm in the organic chemicals and plastics industries (Shackelford et al. 1983). Nitrobenzene was detected in 1 of 33 industrial effluents at a concentration >100 µg/L (EPA 1979a). Reported nitrobenzene concentrations in raw and treated industrial wastewaters from several industries range from 1.4 to 91,000 µg/L (EPA 1983).

Nitrobenzene was reported at above detectable levels in 1.8% of the 1,245 reporting industrial stations (Staples et al. 1985) and in the finished effluent of only 3 of the POTWs and 1 oil refinery (Ellis et al. 1982). In analysis of runoff samples from 51 catchments in 19 cities, the National Urban Runoff Program found no nitrobenzene (Cole et al. 1984). These results suggest that commercial and industrial users of nitrobenzene are dispersed throughout the country, so that concern regarding sources must extend beyond those four states in which nitrobenzene is manufactured.

In 2005, there was an explosion at a petrochemical plant in Jilin, Jilin Province, China that resulted in approximately 100 tons of chemicals including benzene, aniline, and nitrobenzene being released into the Songhua River (Dai et al. 2010b).

Although nitrobenzene is sparingly soluble in water (2.1 g/L) (Haynes 2015), its pungent, characteristic odor ("bitter almonds" [Budavari 1983]; "shoe polish" [Ruth 1986]) is detectable at water concentrations as low as 30 ppb (EPA 1980a). Hence, human exposures to large releases or accumulations in the environment are likely noticeable.

5.3.3 Soil

Estimated releases of 261 pounds (~0.1 metric tons) of nitrobenzene to soil from 21 domestic manufacturing and processing facilities in 2021, accounted for <1% of the estimated total environmental releases from facilities required to report to the TRI (TRI21 2022). An additional 283,215 pounds (~128.46 metric tons), accounted for about 94.49% of the total environmental emissions, were released via underground injection (TRI21 2022). These releases are summarized in Table 5-2.

As a source of nitrobenzene exposure of humans, soil appears to rank a distant third in terms of its contribution. Nelson and Hites (1980) reported 8 ppm in the soil of a former dye manufacturing site along the Buffalo River, but failed to detect nitrobenzene in river sediments, as noted above. The presence of nitrobenzene in the soils of abandoned hazardous waste sites is inferred by its presence in the atmosphere above several sites (Harkov et al. 1985; LaRegina et al. 1986).

5.4 ENVIRONMENTAL FATE

5.4.1 Transport and Partitioning

Air. Nitrobenzene's measured vapor pressure of 0.245 torr at 25°C and measured Henry's Law constant of 2.4×10^{-5} atm- m^3/mol suggests it can volatilize to air from water and moist soils (Lyman et al. 1990). The vapor density reported for nitrobenzene relative to air is 4.1–4.25 (WHO 2003). Removal processes for nitrobenzene in air may involve settling of vapor due to its higher density relative to air (Bidleman 1988; EPA 1976). Washout by rainfall (either through solution in rain drops or by removal of nitrobenzene sorbed onto particulates) and dry fall of particulates are negligible, as estimated by EPA

(1980b) and expressly measured in field releases (EPA 1984c). Atmospheric residence time was estimated to be 190 days (EPA 1980b).

Water. Based on a study of benzene and other aromatic compounds, observations of nitrobenzene in water suggest that it does not bioaccumulate; it does not accumulate in soils and sediments, can be taken up by plants, has been reported in groundwater, and has not been associated with either direct or indirect effects in the atmosphere (Korte and Klein 1982). Korte and Klein (1982) noted that chemical concentration will affect biodegradability in water. Compared to benzene, which Korte and Klein (1982) concluded is readily biodegradable based on mineralization, nitrobenzene is not as readily biodegraded.

Piwoni et al. (1986) found that nitrobenzene was totally degraded before significant volatilization occurred in microcosms simulating land-application of wastewater. The EXAMS computer model (EPA 1982a) predicts volatilization half-lives of 12 days (river) to 68 days (eutrophic lake) and up to 2% sediment sorption for nitrobenzene.

In a study modeling a spill of nitrobenzene and benzene into the Songhua River in China on November 13, 2005 at 1:00 pm, Fu et al. (2008) stated that the pollution front was expected to meet a monitoring point approximately 500 km downstream at 5:00 am on November 24, 2005. They found that over time and distance, concentrations decreased due to dispersion and pollutant mass decreased due to volatilization from the river water to the air.

Activated carbon and activated carbon materials developed from woody biomass have been shown to be effective adsorbents to remove nitrobenzene from water (Dai et al. 2010a).

Sediment and Soil. Sediment sorption is not likely to be significant (EPA 1985). Nitrobenzene preferentially sorbs to soils with higher organic carbon content and soils containing weaker hydrated cations or negatively charged siloxane sites (Briggs 1981). Leaching through soil may occur.

In soil, nitrobenzene has a high to moderate mobility. In two Danish subsoils, the K_{oc} values were 170 and 370 (Løkke 1984). In another study, nitrobenzene, in conjunction with other pollutants, was added to a column of Lincoln fine sand over a 45-day period, which resulted in a retardation factor of 1.9. In river sediment and coal wastewater pond sediment, nitrobenzene K_{oc} reported values were 89 and 105.6, respectively. In snow, nitrobenzene has a logarithmic sorption coefficient (Log $K_{i\ \text{snow surface/air}}$) of -2.89 m^3/m^2 at -6.8°C (Roth et al. 2004).

Seip et al. (1986) explored the retardation factors of nitrobenzene in three typical Norwegian soils. One soil was sandy with a low organic content and two were organic soils. The K_{oc} and retardation factor for the sandy soil were 30.6 and 1.27, respectively, while the other two organic soils had K_{oc} values of 42.8 and 69.6. The retardation factors of the two organic soils were 3.36 and 5.52. Briggs (1981) compared the soil sorption coefficient (K_d) expressed in terms of organic matter (K_{om}), where K_{om}=100xK_d (percent organic matter), for a wide variety of chemicals and soils, to the K_{ow}.

Jury et al. (1984) also classified nitrobenzene as intermediately mobile but noted that its loss from soil would be enhanced by evaporation of water. Moreover, because nitrobenzene has relatively poor diffusive flux, the material would tend to move as a bolus within soil. Jury et al. (1984) hypothesized that a deposit 10 cm deep in soil would have a half-life for effective volatilization of about 19 days.

Other Media. The National Institute of Technology and Evaluation (NITE) organization of Japan conducts standardized bioconcentration studies on pollutants or other chemicals of concern. Bioconcentration factors (BCF) of 3.1–4.8 and 1.6–7.7 were measured for carp exposed to 0.125 and 0.0125 mg/L nitrobenzene, respectively, over a 6-week exposure period (NITE 2022). Veith et al. (1979) found that the 28-day flow-through test for fathead minnows (*Pimephales promelas*) yielded a BCF of 15. A 3-day static measurement gave a BCF of <10 for the golden orfe (Freitag et al. 1982). In the Metcalf model "farm pond" microcosm (Lu and Metcalf 1975), the Ecological Magnification Index (EM: ratio of concentration of parent material in organism to concentration of parent material in water) was about 8 in mosquitofish (*Gambusia affinis*) after a 24-hour exposure. Longer exposures of other species, however, did not increase the value; the EM values were 0.7 in snails (*Physa sp.*); 0.8 in mosquito (*Culex quinquifasciatus*) larvae; 0.15 in *Daphnia magna*; and 0.03 in alga (*Oedogonium*). Bioaccumulation is not expected to be significant in terrestrial animals (EPA 1985). These data suggest that the potential for bioconcentration and bioaccumulation in aquatic organisms is low.

Nitrobenzene may accumulate in terrestrial plants. The relatively rapid uptake of ^{14}C-labeled nitrobenzene into mature soybean (*Glycine max* (L.) Merr) plants was reported by McFarlane et al. (1987a, 1987b). Plant uptake is, therefore, a possible route of human exposure to nitrobenzene.

5.4.2 Transformation and Degradation

Air. Atmospheric photochemical decomposition is an important removal route for nitrobenzene in the environment (EPA 1985). Nitrobenzene irradiated in a pyrex glass reaction vessel with a xenon lamp with wavelengths >300 nm was degraded 38% after a 5-hour exposure period (EPA 1985). p-Nitrophenol and nitrosobenzene were reported to be the principal photodegradation products of nitrobenzene vapors exposed to ultraviolet (UV) light in air (EPA 1985; Hastings and Matsen 1948). In another direct photolysis study, both o- and p-nitrophenols were observed as photodegradation products (Nojima and Kanno 1977). If released into the air, nitrobenzene exists solely as a vapor in the ambient atmosphere, with an estimated half-life for reaction with photochemically-produced hydroxyl radicals of 44 days (EPA, 2012). This reaction results in the formation of dinitrobenzene, nitrophenols, and dicarbonyls as reaction products (Kao 1994).

Water. Nitrobenzene does not hydrolyze; however, photolysis and biodegradation are significant degradation pathways in water (Bao et al. 2012). Nitrobenzene absorbs sunlight in the UV and blue spectral region, so direct photolysis may degrade nitrobenzene in aqueous systems (Wang et al. 2008). In near-surface water, the measured average annual photolytic half-life is 133 days (Simmons and Zepp1986). Near the surface of water bodies or in shallow waters, nitrobenzene may degrade by direct photolysis, with a half-life of 2.5–>6 days (Zepp et al. 1987). Wang et al. (2008) studied the kinetics and mechanism of phototransformation of nitrobenzene in four samples taken from different sections of the Songhua River. The study found that nitrobenzene had a relatively short half-life in natural river water (17.2–21.5 hours) that indicated indirect photodegradation may have played an important role in the loss of nitrobenzene. Under both natural and simulated solar irradiations, the main organic products of photodegradation were observed to be o-, m-, and p-nitrophenols and phenol (Wang et al. 2008).

Photochemical oxidation of nitrobenzene by hydrogen peroxide also yields p-, o-, and m-nitrophenols (Draper and Crosby 1984), with an estimated half-life of 250 days (NBS 1973). Through the reaction of hydrated electrons in eutrophic lakes or through reactions with nitrate in sunlight, degradation can occur with half-lives of 22 days and 11 hours, respectively (Zepp et al. 1987). Wang et al. (2008) found that nitrate concentration and alkalinity were the main factors affecting the photochemical fate of nitrobenzene in natural river water, suggesting that decomposition of nitrobenzene mediated by hydroxyl radicals was predominant in water solution with high nitrate concentrations.

Nitrobenzene was not readily biodegradable in a standardized ready test; however, it is expected to biodegrade under environmental conditions. Nitrobenzene achieved 3.3% of its theoretical biological oxygen demand (BOD) at a concentration of 100 mg/L using an activated sludge inoculum at 30 mg/L over the course of a 2-week incubation period and the MITI test (Organisation for Economic Cooperation and Development [OECD] 301C) (NITE 2022). In a laboratory-scale waste treatment study, Davis et al. (1981) estimated that 25% of the nitrobenzene was degraded and 75% was lost through volatility in a system yielding a loss of about 80% of initial nitrobenzene in 6 days. In a stabilization pond study, the half-life for volatilization was about 20 hours, with approximately 3% adsorbed to sediments (Davis et al. 1983).

A study investigating the use of the solar thermal electrochemical photo (STEP) concept to degrade nitrobenzene in wastewater demonstrated the experimental ease of solar-driven thermo- and electrochemical degradation of nitrobenzene in wastewater (Gu et al. 2017). The electrode reaction yields CO_2, nitric acid, and hydrogen. A study examining the use of zero-valent iron (ZVI) to reduce nitrobenzene found ZVI to be another feasible way to reduce nitrobenzene in groundwater (Dong et al. 2010). Dong et al. (2010) found that ZVI could be used to reduce nitrobenzene to aniline, resulting in an observed nitrobenzene reduction rate constant of 0.0006 minute^{-1} and a half-life of 115.5 minutes. The final removal efficiency using ZVI was 80.98% (Dong et al. 2010).

Under laboratory conditions, direct photolysis of nitrobenzene in solvents such as isopropanol yields phenylhydroxylamine, which can be oxidized to nitrobenzene by oxygen (Hurley and Testa 1966, 1967). Phenylhydroxylamine and nitrobenzene can then combine to form azoxybenzene. However, these reactions may not be important under natural conditions in the absence of hydrogen donors (i.e., under environmental conditions) (EPA 1982b). Zepp et al. (1987) reported that hydrated electrons from dissolved organic matter could significantly increase photoreduction of compounds such as nitrobenzene, and that photolysis of nitrate ions to hydroxyl radicals increased nitrobenzene photodegradation (Zepp et al. 1987). Algae do not enhance photolysis of nitrobenzene (Zepp and Schlotzhauer 1983). Photolysis may be an important pathway in natural waters (EPA 1985), but probably only under conditions where biodegradation is poor or absent and where both UV irradiance and appropriate facilitating molecules occur in relatively clear waters.

Sediment and Soil. Nitrobenzene biodegrades under both aerobic and anaerobic conditions in soil. When a solution of nitrobenzene and other pollutants was passed through a column packed with Lincoln fine sand in a 45-day soil column transport experiment, 20–40% of the nitrobenzene was degraded

(Wilson et al. 1981). More than 99.9% of nitrobenzene added to an aerobic oil microcosm was removed during passage; the experiment, which was set up to mimic the fate of nitrobenzene in municipal wastewater applied to soil, suggests that the compound is degraded in treatment facilities (Piwoni et al. 1986). Under aerobic conditions, nitrobenzene had a half-life of 13.4–56 days in two different waste sludges mixed with a Derby soil in batch reactor experiments (Kincannon and Lin 1985). Nitrobenzene was transformed or removed with a half-life of 56 minutes in sediments from ponds and streams that had a sediment:water ratio of 0.13 (Wolfe 1992). Nitrobenzene was reduced in soils containing sulfide minerals. Nitrobenzene was typically reduced to aniline, and the rate of reaction was determined by dissolution rate and mineral solubility (Yu and Bailey 1992).

Other Media. Nitrobenzene may be almost completely removed by activated sludge treatment (EPA 1983; Gomółka and Gomółka 1979). Gomółka and Gomółka (1979) experimented with a 45-day soil column transport containing a solution of nitrobenzene and other pollutants that were passed through a column packed with Lincoln fine stand; 20–40% of the chemical was degraded with a half-life of 56 days. Similarly, anaerobic soil microcosm containing reed canary glass was created to understand the effect of nitrobenzene in municipal wastewater applied to soil; 99.9% of the added nitrobenzene was removed demonstrating the compound was biodegraded (Wilson et al. 1981). Pitter (1976) obtained 98% removal of chemical oxygen demand (COD) at a rate of 14 mg COD/hour/g dry weight of activated sludge with nitrobenzene as the sole carbon source. Tabak et al. (1981) obtained 100% biodegradation in settled domestic wastewater in 7 days. Hallas and Alexander (1983) reported 100% degradation in 10 days after a 6-day lag under aerobic conditions with municipal sewage effluent. Similar results have been reported by a number of researchers (Davis et al. 1981, 1983; Kincannon et al. 1983; Patil and Shinde 1988; Stover and Kincannon 1983) using a variety of model sewage treatment reactors and wastewater sources, including adapted industrial sludges.

Nitrobenzene was either highly resistant to degradation or inhibited biodegradation of other components of the waste in several biodegradation studies (EPA 1979b; Davis et al. 1981; Korte and Klein 1982; Lutin et al. 1965; Marion and Malaney 1963). However, these effects were observed at concentrations (≥50 mg/L) of nitrobenzene much higher than those detected in ambient waters (see Section 5.5.2).

Nitrobenzene is also degradable by anaerobic processes, but more slowly than described above. Chou et al. (1978) reported that nitrobenzene was 81% removed in 110 days by acclimated domestic sludge in an anaerobic reactor, and Hallas and Alexander (1983) found that 50% was degraded in 12 days under similar conditions. Canton et al. (1985) measured an 8% decrease in nitrobenzene after 8 days in unadapted media but reported a half-life of <2 weeks in adapted media. As soon as degradation began, aniline was detected (Hallas and Alexander 1983).

5.5 LEVELS IN THE ENVIRONMENT

Reliable evaluation of the potential for human exposure to nitrobenzene depends, in part, on the reliability of supporting analytical data from environmental samples and biological specimens. Concentrations of nitrobenzene in unpolluted atmospheres and in pristine surface waters are often so low as to be near the limits of current analytical methods. In reviewing data on nitrobenzene levels monitored or estimated in the environment, it should also be noted that the amount of chemical identified analytically is not necessarily equivalent to the amount that is bioavailable.

Table 5-4 shows the lowest limit of detections that are achieved by analytical analysis in environmental media. An overview summary of the range of concentrations detected in environmental media is presented in Table 5-5.

Table 5-4. Lowest Limit of Detection for Nitrobenzene Based on Standards[a]

Media	Detection limit	Reference
Air at landfill sites	0.05 ppb	Harkov et al. 1985
Air	0.02 mg/sample	NIOSH 1984
Air	0.5 mg/m^3	NIOSH 1977
Air	130 pptv	Francis et al. 2009
Wastewater	3.6 μg/L (FID); 13.7 μg/L (ECD)	EPA 1982c
Wastewater	5.42 μg/L	Zhang et al. 2007
Water	1.9 μg/L	EPA 1982c
Surface water	0.1 ng/L	Gatermann et al. 1995
Groundwater	10 μg/L	EPA 1986a
Soil and solid waste	137 mg/kg[a]	EPA 1986b
Soil and solid waste	19 mg/kg[a]	EPA 1986c
Soil and solid waste	660 μg/kg[b]	EPA 1986a
Soil and solid waste	12.5 μg/L[d]	EPA 2014
Blood	0.32 ng/mL	CDC 2021a

Table 5-4. Lowest Limit of Detection for Nitrobenzene Based on Standards[a]

Media	Detection limit	Reference
Urine	0.8 mg/L	Dangwal and Jethani 1980
Honey	<2 µg/kg	Castle et al. 2004

[a]Detection limits based on using appropriate preparation and analytics. These limits may not be possible in all situations.
[b]Approximate detection limit in high-level soil and sludges.
[c]Approximate detection limit in low-level soil and sediments.
[d]Detection limit in water. Detection limit in solids and wastes is several orders of magnitude higher.

ECD = electron capture detector; FID = flame ionization detector

Table 5-5. Summary of Environmental Levels of Nitrobenzene

Media	Low	High	For more information
Outdoor air (ppbv)	0.020	5.7	Section 5.5.1
Surface water (ppb)	0.0005	115	Section 5.5.2
Groundwater (ppb)	0.05	139	Section 5.5.2
Drinking water (ppb)	0.7	100	Section 5.5.2
Soil and sediment (ppb)	2	8,000	Section 5.5.3

Detections of nitrobenzene in air, water, and soil at NPL sites are summarized in Table 5-6.

Table 5-6. Nitrobenzene Levels in Water, Soil, and Air of National Priorities List (NPL) Sites

Medium	Median[a]	Geometric mean[a]	Geometric standard deviation[a]	Number of quantitative measurements	NPL sites
Water (ppb)	21.5	74.9	37.4	24	12
Soil (ppb)	5,550	13,900	30.0	14	10
Air (ppbv)			No data		

[a]Concentrations found in ATSDR site documents from 1981 to 2022 for 1,868 NPL sites (ATSDR 2022a). Maximum concentrations were abstracted for types of environmental media for which exposure is likely. Pathways do not necessarily involve exposure or levels of concern.

5.5.1 Air

Most of the information on nitrobenzene levels in air is derived from reports from New Jersey, in which ambient air in urban, rural, and waste disposal areas were monitored extensively. In 1978, nitrobenzene levels averaged 0.40 ppbv in industrial areas, and 0.02 and 0.09 ppbv in two residential areas, but in 1982, levels in residential areas were approximately ≤0.3 ppbv, while levels in industrial areas were ≥0.9 ppbv (Bozzelli and Kebbekus 1982). Again, most of the samples were negative for nitrobenzene. The highest values were 3.5–5.7 ppbv.

Harkov et al. (1983) reported low levels of nitrobenzene (0.07–0.1 ppbv) in approximately 85% of air samples of nitrobenzene in their study of airborne toxic chemicals in summer. Nitrobenzene was not detected during the winter (Harkov et al. 1984; Lioy et al. 1983).

Studies of air over waste disposal sites (Harkov et al. 1985) are confounded by weather and timing. Air at one landfill showed a mean nitrobenzene concentration of 1.32 ppbv and another of 0.3 ppbv; but at two other sites (measured during snow and/or rain), nitrobenzene was not detected. LaRegina et al. (1986) summarized these studies by noting that the highest value for nitrobenzene was 14.48 ppbv at a hazardous waste site, whereas nitrobenzene was often undetectable elsewhere (especially in rural areas or at sanitary landfills) or anywhere in the air during the winter.

Very little information is available for other areas of the United States. EPA (1978) found only one positive value of 107 ng/m^3 (0.020 ppbv) at a plant site in Louisiana. EPA (1985) data showed <25% of United States air samples positive, with a median concentration of approximately 0.01 ppbv.

5.5.2 Water

Nitrobenzene concentrations in the effluent of a Los Angeles County municipal wastewater treatment plant was about 200 ppb in 1978 and <10 ppb in 1980 (Young et al. 1983). Nitrobenzene was not reported in runoff samples in 1982 in a nationwide project (Cole et al. 1984). Kopfler et al. (1977) list nitrobenzene as one of the chemicals found in finished tap water in the United States, but do not report its concentrations or locations. EPA (1979c) reported only one positive sample (total sample number not stated) in Hartford, Connecticut sewage treatment plant influents, and no nitrobenzene was detected in samples taken from three other major metropolitan areas. Nitrobenzene was detected in only 0.4% of the 836 ambient surface water stations involved in EPA's STORET database (Staples et al. 1985).

Data from EPA's Water Quality Portal from 2000 to 2022 is presented in Tables 5-7 and 5-8 for both surface water and groundwater.

Table 5-7. Annual mean Nitrobenzene Concentrations (ppb) Measured in Surface Water at Locations Across the United States[a]

Year	Number of samples	Average of the arithmetic mean at all locations	Maximum concentration	Percent detected
2000–2004	137	84.8	115	43.8%
2005–2009	98	0.095	0.47	38.8%
2010–2014	490	0.093	0.26	3.49%
2015–2019	298	2.37	3.2	3.02%
2022	109	0.046	0.07	11.9%

[a] As of October 20, 2022.

Source: EPA 2022

Table 5-8. Annual mean Nitrobenzene Concentrations (ppb) Measured in Groundwater at Locations Across the United States[a]

Year	Number of samples	Average of the arithmetic mean at all locations	Maximum concentration	Percent detected
2000–2004	139	20.8	139	3.59%
2005–2009	252	7.08	40	54.4%
2010–2014	75	4.89	5	49.3%
2015–2019	14	ND	ND	ND
2022	1	0.37	0.37	100%

[a] As of October 20, 2022.

ND = not detected

Source: EPA 2022

Many studies have examined the concentration and distribution of nitrobenzene in surface water in China after a spill containing nitrobenzene occurred following a plant explosion. Nitrobenzene has been detected in rivers, especially in North China, at a mean concentration of 18.1 ng/L (Li et al. 2010). Fu et al. (2008) found that the peak concentration measured at Harbin, the capital of Hoeilongjiang Province located approximately 500 km downstream of the spill, 10 days after the spill was 0.58 mg/L; the guideline for nitrobenzene in China for drinking water is 0.017 mg/L. Another study, conducted at the Songhua River years after the spill, resulted in detections of nitrobenzene in all water and ice samples at concentrations between 0 and 0.65 µg/L (Dai et al. 2010b). In a study of the Yellow river, concentrations of nitrobenzene ranged from 0.128 to 8.427 µg/L, and nitrobenzene was the predominant contaminant in all locations sampled (He et al. 2006).

Nitrobenzene was a contaminant that was monitored for during the EPA's first unregulated Contaminant Monitoring Rule (UCMR). UCMR 1 required monitoring for 26 contaminants including nitrobenzene between 2001 and 2003 using analytical methods developed by EPA, consensus organizations, or both. Nitrobenzene was detected in 2 of the 3,867 public water systems tested (33,937 total samples analyzed) at concentrations of 21.6 and 100 μg/L (EPA 2003). Data from other nations indicate that nitrobenzene is occasionally detected in drinking water at low levels. It was detected in 1 of 14 samples of treated water in the United Kingdom and was detected in potable water from the Netherlands at a maximum value of 0.7 μg/L (WHO 2009).

Nitrobenzene was found in all 33 water samples taken from the eastern part of the North Sea at concentrations from 0.5 to 2.5 ng/L (Gatermann et al. 1995). The highest concentrations were found in the open sea and concentrations increased in a north-west direction.

5.5.3 Sediment and Soil

With the exception of the data shown in Table 5-6 regarding levels of nitrobenzene at NPL sites, there a few data regarding nitrobenzene levels in soil. Nitrobenzene was detected at a level of 8 ppm (mg/kg) in soil at one of two sampling sites along the bank of the industrially polluted Buffalo River in New York (Nelson and Hites 1980). Nitrobenzene was not detected at any of three sediment sampling sites in this study. Nitrobenzene was detected in 1 of 10 soil samples collected from the Gas Works Park in Seattle, Washington, at a concentration of 0.79 mg/kg (Turney and Goerlitz 1990). Nitrobenzene was detected in the sediment of the River Havel, Gmund Germany in March of 1993 at 4 ng/g dry weight (Lopes and Furlong 2001), and in the Spree River at Dahme and at Spandau shipping canal at 2 and 10 ng/g dry weight, in March 1993 and July 1994, respectively (Ricking et al. 2003).

5.5.4 Other Media

Nitrobenzene has not been found in other environmental media. It has not been detected as a bioaccumulated material in fish samples (Staples et al. 1985). No monitoring of plant tissues has been reported, even though uptake of nitrobenzene by plants has been observed (McFarlane et al. 1987a, 198b).

Nitrobenzene is a component of Frow mixture occasionally used to control Acarine, a parasite infestation, in honeybees, and nitrobenzene residues may be found in honey as a result (Castle et al. 2004). However, of 49 samples of honey tested at a detection limit of 2 μg/kg, none contained a detectable level of nitrobenzene residue (Castle et al. 2004).

5.6 GENERAL POPULATION EXPOSURE

General exposure of the population to nitrobenzene is limited to variable concentrations in air and possibly drinking water (WHO 2009). Its occurrence in public water systems was low in the Unregulated Contaminant Monitoring Rule (UCMR) 1 testing results but has been detected in groundwater (see Section 5.5.2). Air levels can be high in the vicinity of manufacturing or production facilities (especially petroleum refining, leather finishing and some chemical manufacturers). Urban areas have much higher levels in the summer than winter due to both the formation of nitrobenzene by nitration of benzene (from motor vehicle fuels) and the higher volatility of nitrobenzene during the warmer months. Table 5-9 summarizes the geometric mean and percentiles of nitrobenzene in the blood of the U.S. general population from the National Health and Nutrition Examination Survey (NHANES) survey years 2013–2016. In each age and demographic group, the number of detections were too low to calculate the geometric means and representative percentiles.

Table 5-9. Geometric Mean and Selected Percentiles of Blood Nitrobenzene (in ng/mL) for the U.S. Population from the National Health and Nutrition Examination Survey (NHANES)

	Survey years	Geometric mean (95% CI)	Selected percentiles (95% CI)[a]				Sample size
			50th	75th	90th	95th	
Total	2013–2014	Not calculated	<LOD	<LOD	<LOD	<LOD	3,180
	2015–2016	Not calculated	<LOD	<LOD	<LOD	<LOD	3,037
Age group							
12–19 years	2013–2014	Not calculated	<LOD	<LOD	<LOD	<LOD	593
	2015–2016	Not calculated	<LOD	<LOD	<LOD	<LOD	537
20 years and older	2013–2014	Not calculated	<LOD	<LOD	<LOD	<LOD	2,587
	2015–2016	Not calculated	<LOD	<LOD	<LOD	<LOD	2,500
Sex							
Females	2013–2014	Not calculated	<LOD	<LOD	<LOD	<LOD	1,649
	2015–2016	Not calculated	<LOD	<LOD	<LOD	<LOD	1,534
Males	2013–2014	Not calculated	<LOD	<LOD	<LOD	<LOD	1,531
	2015–2016	Not calculated	<LOD	<LOD	<LOD	<LOD	1,503
Race/ethnicity							
Mexican American	2013–2014	Not calculated	<LOD	<LOD	<LOD	<LOD	505
	2015–2016	Not calculated	<LOD	<LOD	<LOD	<LOD	542

Table 5-9. Geometric Mean and Selected Percentiles of Blood Nitrobenzene (in ng/mL) for the U.S. Population from the National Health and Nutrition Examination Survey (NHANES)

	Survey years	Geometric mean (95% CI)	Selected percentiles (95% CI)[a]				Sample size
			50th	75th	90th	95th	
All Hispanics	2013–2014	Not calculated	<LOD	<LOD	<LOD	<LOD	810
	2015–2016	Not calculated	<LOD	<LOD	<LOD	<LOD	947
Non-Hispanic White	2013–2014	Not calculated	<LOD	<LOD	<LOD	<LOD	1,283
	2015–2016	Not calculated	<LOD	<LOD	<LOD	<LOD	986
Non-Hispanic Black	2013–2014	Not calculated	<LOD	<LOD	<LOD	<LOD	615
	2015–2016	Not calculated	<LOD	<LOD	<LOD	<LOD	634
Asians	2013–2014	Not calculated	<LOD	<LOD	<LOD	<LOD	363
	2015–2016	Not calculated	<LOD	<LOD	<LOD	<LOD	345

[a] The lowest limit of detection (LLOD) for nitrobenzene in blood in both NHANES 2013–2014 and 2015–2016 is 0.3200 ng/mL. All values that fell below the LLOD were recorded as the LLOD divided by the square root of 2. All of the measured values for nitrobenzene in blood were below the LLOD and were assigned the same value below the LLOD, resulting in a standard deviation of 1 for all groups.

CI = confidence interval; LOD = limit of detection

Source: CDC 2021b

Nitrobenzene is absorbed after dermal, inhalational, or oral exposure and then metabolized to various intermediates as discussed in Chapter 3. About 10–20% of a dose is eliminated in the urine as p-nitrophenol, which is used in biological monitoring of occupational exposures. Table 5-10 summarizes urinary levels of p-nitrophenol in the U.S. general population for NHANES survey years 2011–2014. As mentioned in Chapter 3, this metabolite is not specific to nitrobenzene; it is also a metabolite of organophosphate insecticides like parathion.

Table 5-10. Geometric Mean and Selected Percentiles of Urinary Nitrobenzene (in μg/L) for the U.S. Population from the National Health and Nutrition Examination Survey (NHANES)

	Survey years	Geometric mean (95% CI)	Selected percentiles				Sample size
			50th	75th	90th	95th	
Total	2011–2012	0.64 (0.57–0.71)	0.63	1.17	2.17	3.31	2,350
	2013–2014	0.64 (0.60–0.69)	0.61	1.18	2.17	3.21	2,584
Age group							
6-11 years	2011–2012	0.61 (0.50–0.75)	0.60	1.21	2.08	2.78	394
	2013–2014	0.84 (0.72-0.98)	0.68	1.66	3.11	4.09	411

Table 5-10. Geometric Mean and Selected Percentiles of Urinary Nitrobenzene (in µg/L) for the U.S. Population from the National Health and Nutrition Examination Survey (NHANES)

	Survey years	Geometric mean (95% CI)	Selected percentiles				Sample size
			50th	75th	90th	95th	
12–19 years	2011-2012	0.62 (0.51-0.74)	0.64	1.15	1.85	2.51	376
	2013–2014	0.66 (0.57–0.77)	0.68	1.23	1.82	2.71	415
20+ years	2011–2012	0.64 (0.57–0.72)	0.63	1.18	2.23	3.48	1,580
	2013–2014	0.62 (0.58–0.67)	0.57	1.14	2.07	3.21	1,758
Sex							
Male	2011–2012	0.67 (0.61–0.74)	0.70	1.24	2.21	3.19	1,190
	2013–2014	0.67 (0.62–0.73)	0.65	1.17	2.02	3.03	1,306
Female	2011–2012	0.60 (0.52–0.70)	0.58	1.13	2.14	3.48	1,160
	2013–2014	0.62 (0.56–0.68)	0.58	1.19	2.32	3.40	1,278
Race/ethnicity							
Mexican American	2011–2012	0.62 (0.52–0.73)	0.68	1.18	1.84	2.51	285
	2013–2014	0.68 (0.58–0.80)	0.67	1.30	2.07	2.64	403
Non-Hispanic Black	2011–2012	0.70 (0.55–0.87)	0.72	1.37	2.34	3.47	642
	2013–2014	0.76 (0.69–0.84)	0.78	1.37	2.49	3.59	576
Non-Hispanic White	2011–2012	0.62 (0.54–0.71)	0.60	1.15	2.13	3.31	752
	2013–2014	0.60 (0.56–0.64)	0.57	1.10	2.03	3.16	986
All Hispanic	2011–2012	0.64 (0.58–0.72)	0.68	1.16	1.98	2.98	546
	2013–2014	0.69 (0.60–0.79)	0.67	1.29	2.17	2.82	637
Asians	2011–2012	0.72 (0.63–0.81)	0.62	1.54	2.84	3.87	325
	2013–2014	0.74 (0.62–0.89)	0.63	1.39	3.16	4.90	284

CI = confidence interval

Source: CDC 2021b

Nitrobenzene in water is expected to be semi-volatile; thus, there is potential for inhalation exposure during showering and bathing. ATSDR’s three-compartment Shower and Household-Use Exposure (SHOWER) model predicts air concentrations in the shower stall, bathroom, and main house throughout the day by estimating the contribution from showering or bathing and the contribution from other water sources in the house, such as the dishwasher, clothes washer, and faucets (ATSDR 2022b). This information, along with human activity patterns, is used to calculate a daily time-weighted average (TWA) exposure concentration via inhalation exposure and from dermal uptake from skin contact. ATSDR’s SHOWER model is available by sending a request to showermodel@cdc.gov. Using maximum potable water levels from Section 5.5.2 and representative outdoor air levels discussed in

Section 5.5.1, Reasonable Maximum Exposure (RME) levels are estimated. Table 5-11 presents estimated intakes of nitrobenzene from such activities for various demographic groups.

Table 5-11. Reasonable Maximum Exposure for Daily Inhalation Dose and Administered Dermal Dose in μg/kg/day for the Target Person

Exposure group	Inhalation	Dermal
Birth–<1 year	5.4	0.36
1–<2 years	5.8	0.33
2–<6 years	3.9	0.29
6–<11 years	2.3	0.23
11–<16 years	1.5	0.19
16–<21 years	1.2	0.18
Adult	1.1	0.17
Pregnant and breastfeeding women	1.6	0.17

Source: ATSDR 2022b

5.7 POPULATIONS WITH POTENTIALLY HIGH EXPOSURES

Occupational exposure can be significantly higher than the exposure of the general population. NIOSH (1988) identified about 10,600 workers (mainly chemists, equipment servicers, and janitorial staff) as potentially exposed workers in facilities where nitrobenzene is used. Additionally, Hanley et al. (2012) found that workers at a rubber chemical manufacturing plant in New York were occupationally exposed to nitrobenzene, ortho toluidine, and aniline. At an industrial exposure level of 5 mg/m^3 (1 ppmv), which is the Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL), a worker would receive about 25 mg of nitrobenzene during an 8-hour day (Dunlap 1981). Additional information on regulations regarding occupational exposure is found in Chapter 7. Nitrobenzene is readily absorbed through the skin, as well as taken up by inhalation and ingestion; the need for worker protection is dependent on the scenario and may include the use of respirators and gloves, among other protections.

Based on the New Jersey air studies and on estimates of releases during manufacture, only populations in the vicinity of manufacturing activities (i.e., producers and industrial consumers of nitrobenzene for subsequent synthesis) and petroleum refining plants are likely to have any significant exposure to anthropogenic nitrobenzene. However, consideration of possible groundwater and soil contamination and uptake of nitrobenzene by plants expands the potentially high exposure group to include people living in and around abandoned hazardous waste sites. Children may be exposed to nitrobenzene if they play in dirt that has been contaminated with nitrobenzene.

Residents of cities getting drinking water from the Songhua River, which was contaminated by a spill of nitrobenzene after an explosion at a petrochemical plant in Jilin, Jilin Province, China, were at high risk of exposure after the spill.