

Health Consultation

US OIL RECOVERY

PASADENA, HARRIS COUNTY, TEXAS

EPA FACILITY ID: TXN000607093

Prepared by the
Texas Department of State Health Services

May 20, 2020

Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Community Health Investigations
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

A health consultation is a verbal or written response from ATSDR or ATSDR's Cooperative Agreement Partners to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR or ATSDR's Cooperative Agreement Partner which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

The Texas Department of State Health Services (DSHS) prepared this health consultation for the US Oil Recovery site, located in Pasadena, Harris County, Texas. This publication was made possible by Grant Number NU61TS000284-02-01 under a cooperative agreement with the federal ATSDR. DSHS evaluated data of known quality using approved methods, policies, and procedures existing at the date of publication. ATSDR reviewed this document and concurs with its findings based on the information presented by DSHS.

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US Oil Recovery

Final Release

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Summary

Introduction

The US Oil Recovery (USOR) Superfund site is an abandoned used oil processor and wastewater treatment facility located in Pasadena, Harris County, Texas. The site consists of two separate properties, known as USOR and MCC Recycling (MCC). USOR began operations in 2002 and MCC began operating in 2008. Both were abandoned between January and July 2010. While in operation, USOR and MCC were investigated in response to resident complaints filed with multiple environmental government agencies regarding odor emissions and improper handling of hazardous wastes.

In 2011, the United States Environmental Protection Agency (EPA) conducted an environmental investigation to determine if hazardous wastes stored at the site had migrated off site and contaminated the surrounding area, which includes non-residential sections of the Vince and Little Vince Bayous. Sediment, surface soil, and surface water samples were collected from runoff pathways within the impacted area. Surface water from the Vince and Little Vince Bayous is not used for drinking water purposes. Residences near the site get drinking water from the City of Pasadena, which is monitored for compliance with state and federal drinking standards. The city's water supply has not been impacted by this site. EPA proposed the USOR site to the National Priorities List (NPL) on September 16, 2011 and listed the site as final on the NPL on September 18, 2012.

Under a cooperative agreement with ATSDR, the Texas Department of State Health Services (DSHS) prepared this health consultation (HC) to evaluate chemicals that people may come into contact with near the USOR site and provide recommendations to protect the health of the community. The top priority of DSHS and ATSDR at this site is to ensure that people living around the site have the best information possible to protect their health.

Conclusions

Based on the available information, DSHS and ATSDR reached three conclusions about the site:

Conclusion 1

DSHS and ATSDR conclude that past, present, and future exposures (from incidental ingestion and skin contact) to arsenic and polycyclic aromatic hydrocarbons (PAHs) found in off-site surface soil and sediment are not expected to harm people's health.

Basis for Conclusion

Nearby residents and visitors, including adults and children older than six years of age, may have come into contact with the contaminants in the surface soil and sediment through incidental ingestion and skin contact while participating in outdoor activities such as playing or fishing along the bank of Vince Bayou. However, the calculated exposure doses for short-term (up to 14 days) arsenic and long-term (more than 1 year) PAH exposures among recreational users did not exceed health-based guidelines for non-cancer health effects.

To evaluate the potential for cancer effects, DSHS used conservative site-specific exposure assumptions. Given the vegetated, difficult terrain off-site, these assumptions likely overestimate exposure frequency and excess cancer risk. When considering both average (central tendency) exposure and higher-than-average (reasonable maximum) exposure scenarios, DSHS concluded there is a low increased risk of cancer for arsenic and PAHs in soil and sediment.

Conclusion 2

DSHS and ATSDR cannot currently conclude whether eating fish caught from Vince and Little Vince Bayous could harm people's health.

Basis for Conclusion

This exposure pathway could not be evaluated because no fish samples were collected. However, the DSHS Seafood and Aquatic Life Group (SALG) issued a fish and shellfish consumption advisory (Advisory 49) for individuals to limit their

consumption of all species of fish and blue crabs from the Houston Ship Channel and the San Jacinto River, and all adjoining waters, which includes Vince and Little Vince Bayous (DSHS 2013a, 2013b). Specifically, women who are nursing, pregnant, or who may become pregnant, and children under 12 should not consume any fish or crab from this area. Women past child bearing age and males ages 12 and older should limit consumption of all species of fish and crab from this area to no more than one (1) eight-ounce (8 oz) meal per month. There are numerous sources of contaminant discharge in the area, and the contaminants of concern [polychlorinated biphenyls (PCBs), polychlorinated dibenzo-p-dioxins (PCDDs), and dibenzofurans (PCDFs)] for the consumption advisory are not attributable to the USOR site.

Conclusion 3

DSHS and ATSDR cannot conclude whether breathing ambient (outside) air in the past at the nearby residential area could harm people's health.

Basis for Conclusion

Community members reported smelling odors coming from the site in the past. However, this exposure pathway could not be evaluated because no ambient air samples were collected.

Recommendations

- People that are playing in the area may have an increased chance of contacting the contaminated soil through incidental ingestion and skin contact. Practice good personal hygiene habits (such as washing hands after playing in the area, and before eating) can reduce or prevent the exposure to contaminants in soil.
- Individuals concerned about their past exposures to contaminants during the USOR site operations are advised to speak with their personal physician about their health concerns.
- ATSDR and DSHS recommend that EPA, in consultation with Texas Commission on Environmental Quality (TCEQ), continue efforts to remediate the site.

- ATSDR and DSHS recommend that EPA, in consultation with TCEQ, continue to monitor the perimeter fence surrounding the USOR site to reduce trespassing at these locations.
- Individuals are encouraged to follow the DSHS SALG fish consumption advisory recommendations for Advisory 49, which can be found at:
<https://www.dshs.texas.gov/seafood/advisories-bans.aspx>.

Next Steps

The final version of this document will be made available to community members, city officials, the Texas Commission on Environmental Quality (TCEQ), the EPA, and other interested parties.

For More Information

For more information about this health consultation, contact the Texas Department of State Health Services, Environmental Surveillance and Toxicology Branch at (800) 588-1248.

Purpose and Statement of Issues

This health consultation (HC) was prepared for the US Oil Recovery (USOR) site in accordance with the interagency cooperative agreement between the Agency for Toxic Substances and Disease Registry (ATSDR) and the Texas Department of State Health Services (DSHS). Located in Pasadena, Harris County, Texas, the site was a used oil processor and wastewater treatment facility until it was abandoned in 2010. While in operation, nearby residents complained about the odor emissions and improper handling of hazardous wastes. In 2011, the United States Environmental Protection Agency (EPA) conducted an environmental investigation and proposed the USOR site to the National Priorities List (NPL) on September 16, 2011. EPA listed the site as final on the NPL on September 18, 2012.

During the investigation in 2011, EPA collected off-site sediment, surface soil, and surface water samples from runoff pathways and areas within Vince and Little Vince Bayous. The samples were analyzed for metals, semi-volatile organic compounds (SVOCs), and volatile organic compounds (VOCs) (USEPA 2011a). DSHS reviewed environmental data obtained by EPA to evaluate potential human exposures to the contaminants and to determine whether the exposures are of public health concern.

Background

Site Description

The USOR Superfund site is located in a mixed industrial and residential area close to the Houston Ship Channel in Pasadena, Harris County, Texas. The site consists of two separate properties, USOR and MCC Recycling (MCC), located north of Texas State Highway 225 (SH 225). USOR is located at 400 North Richey Street and MCC is located at 200 North Richey Street (Figure 1). The USOR property consists of one land tract that is approximately 13 acres and the MCC property consists of two adjacent land tracts totaling approximately 5 acres. The MCC property is bisected by Vince Bayou and each tract is connected by a foot bridge and an aboveground pipeline. The USOR and MCC properties are connected by an underground pipeline along North Richey Street (USEPA 2011a).



Figure 1. US Oil Recovery Superfund site map (USEPA 2011b).

The USOR property consists of an office building, a large warehouse, and a security guard shed. The perimeter of the property is surrounded by a chain link security fence. The large warehouse building is centrally located on the property and includes a containment storage area, oil processing equipment, a laboratory, a machine shop, and a parts warehouse. A secondary containment area with additional aboveground storage tanks (ASTs) is located on the north end of the warehouse. A large, steel reinforced concrete walled structure known as the bioreactor¹ was located in the northwest corner of the property. A poly-lined containment pond is located on the west side of the warehouse building, and numerous types of roll-off containers² are stored throughout the property (USEPA 2011a, TCEQ 2011).

The MCC property is located about one-quarter of a mile to the southeast of the USOR property. This property was a former City of Pasadena wastewater treatment facility. The west plant contains the headworks, a trickling filter, a primary clarifier, an aeration basin, and multiple lift stations for pumping wastewater to the east plant. The east plant contains the gravity thickener, the pump room, an aerobic digester tank, the belt filter press building, a chlorine contact tank, a sludge tank, the remnants of a sand filter, and two final clarifiers (USEPA 2011a). Both MCC properties are secured with a perimeter chain link security fence.

Site History

USOR facility began operations in 2002 as a used oil processor and water treatment facility. The MCC property was acquired by USOR in 2008 and began treating the facility's wastewater. The properties were abandoned between January and July 2010.

During its operation, USOR received and treated oily waste, sludge, and organic chemical-bearing wastes that were divided according to their percentage of solids. Once the wastes were accepted, they were treated through treatment practices such as de-watering, screening, clarification, and biological processes. Wastewater containing less than five percent solids was pumped into treatment containers; however, wastewater containing more than five percent solids was pumped to concrete holding tanks to be de-watered and solidified. Solids were separated using lime and cement kiln dust, sawdust, or by filter press operation. After treatment, the wastewater effluent was pumped to MCC for storage, additional treatment, and discharge through the City of Pasadena wastewater treatment plant (USEPA 2011a, 2018).

¹ The bioreactor consisted of two adjoining rectangular, open-topped tanks which were originally used to treat wastewater by bacteria processes and had a liquid holding capacity of 330,000 gallons each.

² Roll-off containers are rectangular, open-topped metal structures that vary in size and are used to store loose material and debris. They vary in size, but the containers on site were 20-25 cubic yard containers.

Due to odor complaints from area residents, environmental investigations began in December 2003 by the EPA, the Texas Commission on Environmental Quality (TCEQ), and the Harris County Public Health and Environmental Services (HCPHES). During these investigations, USOR was found to have violated numerous environmental regulations, such as unpermitted transport of hazardous wastes, unauthorized discharges of hazardous wastes to Vince Bayou, odor emissions, and the improper storage of wastes at the facilities (USEPA 2011b).

On May 20, 2009, a 600-gallon wastewater release into Vince Bayou occurred from the MCC facility (ATSDR 2009). In order to determine if the release contaminated soil and sediment, EPA collected samples near the discharge locations along Vince Bayou. Based on their evaluation of the environmental data, EPA requested assistance from ATSDR to determine if contamination following the release would pose a public health concern. ATSDR released a health consultation on October 27, 2009, and concluded that exposure to arsenic, polycyclic aromatic hydrocarbons (PAHs), total petroleum hydrocarbons (TPHs), and other contaminants in soil and sediment along Vince Bayou did not pose a public health hazard to people frequenting the area recreationally. To prevent any additional exposure risks to the public utilizing the Vince Bayou for recreational activities, ATSDR recommended the USOR facility owners abide by the required actions established by the environmental regulatory agencies (ATSDR 2009).

In July 2010, Hurricane Alex brought heavy rainfall to the area. TCEQ and HCPHES notified the National Response Center of the presence of hazardous substances stored at the USOR facility and the potential for these substances to be released into Vince Bayou. As a result, EPA activated an emergency response and removal action to prevent hazardous wastes from flowing into Vince Bayou. It was at this time EPA discovered the site had been abandoned (USEPA 2011b).

In March 2011, EPA collected sediment and surface water samples from locations throughout Vince Bayou and Little Vince Bayou³ to further determine the extent of contamination. EPA collected soil samples from locations of water runoff from the site into Vince Bayou (USEPA 2011a).

On September 16, 2011, EPA proposed the USOR site to the National Priorities List (NPL). On September 18, 2012, EPA listed the site as final on the NPL. EPA and the Potentially Responsible Parties (PRP) group⁴ removed materials and took actions to prevent the liquids stored in the various containments from overflowing into Vince Bayou. Stabilization efforts have included bi-weekly site inspections, controlling

³ Little Vince Bayou is a tributary to Vince Bayou located north of the MCC property and east of the US Oil Recovery property.

⁴ Potentially Responsible Parties are the parties responsible for, in whole or in part, the presence of hazardous substances at a site.

container leaks, removal of various storage containers and liquids, video surveillance, and security throughout the site (USEPA 2014).

On February 23, 2016, EPA approved the Remedial Investigation/Feasibility Study (RI/FS) work plan and associated plans for the 400 N. Richey Street property. The field activities started in May 2016 and are currently ongoing (USEPA 2014).

Site Visits

On January 24, 2012, the DSHS, TCEQ, and EPA's contractor conducted a site visit of the facilities and the surrounding area. The USOR property is secured by a six-foot tall chain link security fence and multiple locked gates. The main access onto the site was through the entrance gate located on North Richey Street. Secondary walk-through access gates were located on the south and west perimeter fence adjacent to the Union Pacific Railroad and a pipeline right-of-way, respectively.

Due to rainfall in the area, standing water had pooled in the parking areas, on roll-off box coverings, and inside buildings throughout the property. The main warehouse building was being used for staging 55-gallon drums, overpacks and salvage drums, and intermediate bulk containers (IBCs)⁵. The tank farm had 24 ASTs_ that were used to store oily waste. Obvious signs of overflowing and corrosion were present on the exterior surfaces of the tanks. During the site visit, DSHS observed the bulging walls of the bioreactor had been temporarily stabilized with steel rebar and select hardware. The containment pond was filled with water likely from rainwater run-off from the warehouse rooftop. There was no visible sheen present on the water surface.

The MCC properties are also secured by a six-foot tall chain link security fence and multiple locked access gates throughout the east and west plant facilities. The main access onto the site was through the east plant entrance gate located on South Richey Street. Both MCC properties had the remnants of old wastewater treatment facility structures that had been used to store oily liquid and solids.

From September 18 to 20, 2012, DSHS and ATSDR staff conducted community outreach activities in two neighborhoods located between the USOR facilities and Texas State Highway 225. Staff performed a door-to-door survey to provide residents information regarding the site and to gather any community health concerns. The residents expressed concerns about odors, drinking tap water, as well as eating crops from home gardens and fish caught from the Bayous. These concerns are addressed in the Community Health Concerns section of this report.

⁵ An intermediate bulk container (IBC) is a plastic container made from polyethylene and surrounded by a galvanized tubular steel cage that is attached to a pallet which is used to store liquids and solids.

On June 5, 2014, DSHS staff, in conjunction with TCEQ and the PRP group's contractor, conducted a follow-up site visit to observe the progress of the removal activities at the USOR and MCC facilities. This inspection consisted of touring the warehouse building and the outdoor hazardous waste storage and staging facilities. DSHS staff also toured both the east and west MCC properties.

On July 16, 2015, DSHS staff and the PRP group's contractor conducted a site visit to verify the removal activities were completed at the USOR facilities. The most significant removal activities completed at the USOR facility include: removal of the bioreactor, drums, and intermediate bulk containers; routine pump down of the containment pond, truck bays and sumps, and the containment areas surrounding the north tank farm; and removal of liquids, sludge, and debris stored in the north tank farm, roll-off boxes, and frac-tanks. All 861 drums and 246 totes were removed from October 30, 2014 to January 16, 2015 (USEPA 2015). Current activities at the MCC facility include: maintaining security; maintaining liquid levels in containment structures; repairing containment structure leaks and the perimeter fence; and, basic grounds keeping and security activities. During this visit, DSHS noticed that recent underground utility work was completed along the right-of-way between Vince Bayou and the USOR property line.

Demographics

The 2010 United States Census Bureau reported the total population for Harris County and the City of Pasadena as 4,092,459 and 149,043, respectively (USCB 2010). The Census Bureau reported 5,475 people residing in 2,042 housing units within a 1-mile radius of the site. At the time of the census, 819 children under the age of six and 1,171 women of child-bearing age (15-44 years old) resided in this area (Figure 2).

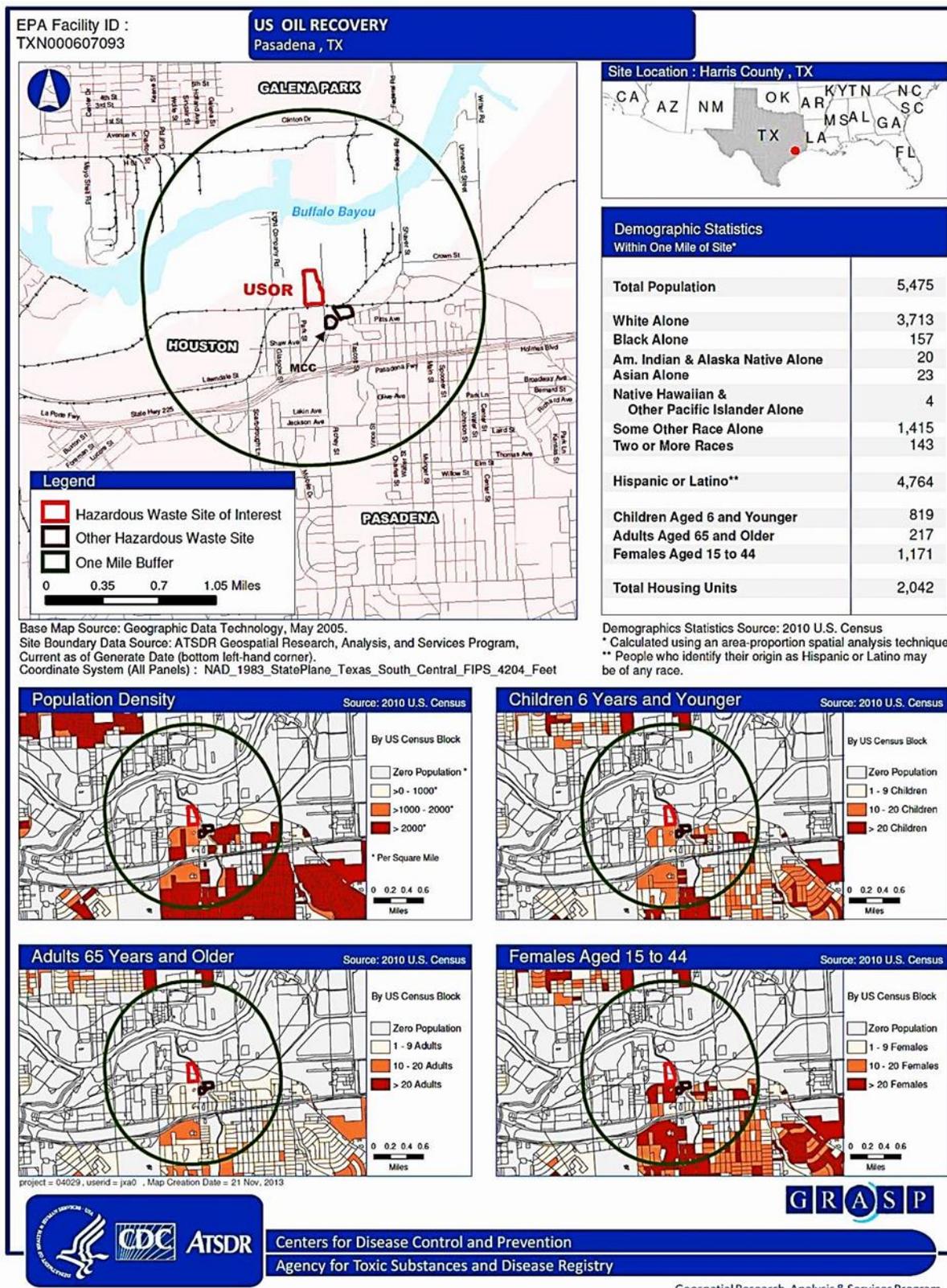


Figure 2. Demographic information for the US Oil Recovery Site.

Land and Natural Resource Use

The Vince Bayou watershed is located in southeast Harris County and has a drainage area of 16 square miles while traveling northwest through residential and industrialized areas before its confluence with the Houston Ship Channel (HCFCFCD 2018). The watershed consists of two tidally-influenced streams, Vince Bayou and Little Vince Bayou. Shoreline access for outdoor recreational activities, such as fishing and swimming, is available along the bayou at bridge crossings, throughout residential neighborhoods, and public parks.

On June 26, 2013, the DSHS Seafood and Aquatic Life Group (SALG) issued a revised fish and shellfish consumption advisory, Advisory 49 (ADV-49), for individuals to limit their consumption of all species of fish and blue crabs from the Houston Ship Channel and the San Jacinto River, and all adjoining waters, which includes Vince and Little Vince Bayous (DSHS 2013a, DSHS 2013b). Specifically, women who are nursing, pregnant, or who may become pregnant, and children under 12 are advised not consume any fish or crab from this area. Women past child bearing age and males ages 12 and older should limit consumption of all species of fish and crab from this area to no more than one (1) eight-ounce (8 oz) meal per month. Although the contaminants of concern listed in ADV-49 are not attributable to the USOR site, individuals are encouraged to follow the DSHS SALG meal consumption recommendations.

The topographical slope on the USOR property is predominantly flat, although storm water runoff flows to the north and east towards Vince Bayou. The southern portion of the property drains storm water south and east into a storm drainage channel paralleling the west side of N. Richey Street before entering Vince Bayou north of the property. During heavy rainfall or flood events, surface runoff flows directly across N. Richey Street into the bayou (Figure 3) (USEPA 2011a, TCEQ2011).

On the MCC property, surface water runoff is collected in storm drains that discharge into Vince Bayou. Storm water runoff from the east and west plants flows in the direction of the bayou (Figure 4) (USEPA 2011a).



Figure 3. Drainage pathway for the US Oil Recovery facility (USEPA 2011a).



Figure 4. Drainage pathway for the MCC Recycling facility (USEPA 2011a).

Discussion

Environmental Data Used

Data evaluated in this health consultation include off-site sediment, surface soil, and surface water sampling results collected by EPA. The samples were collected and analyzed following EPA's standard protocols and quality assurance/quality control guidelines. Thus, DSHS and ATSDR assumed adequate quality assurance/quality control procedures were followed regarding data collection, chain of custody, laboratory procedures, and data reporting.

In March 2011, EPA collected 19 sediment and 19 surface water samples, plus two duplicates for each sampling media, from 19 locations within Vince and Little Vince Bayous (Figure 5). Sediment and surface water samples were collected from Vince and Little Vince Bayous beginning upstream of the MCC property and continuing downstream past the last known probable point of exposure from the USOR site. Seven surface soil samples and one duplicate sample were collected from seven locations of potential water run-off pathways from the site(s) into Vince Bayou.

Samples were analyzed for various metals, SVOCs, and VOCs (USEPA 2011a). Duplicate samples were collected for quality control purposes. DSHS used the average of the duplicate samples as the exposure point concentration in this health consultation.

Process to Evaluate Environmental Contamination

DSHS conducted a three-step process to evaluate the public health implications using available environmental data. First, DSHS conducted an exposure pathway analysis to identify how people may be exposed. Second, DSHS conducted a screening analysis by comparing the sampling data to health-based guidelines. Third, DSHS conducted a more detailed public health evaluation of contaminants of concern identified in the screening analysis (ATSDR 2005).

Exposure Pathways Analysis

An exposure pathway describes how a chemical moves from its source and comes into physical contact with people. Identifying exposure pathways is important in a health consultation because adverse health impacts from contaminants can only happen if people are exposed to them. The presence of a contaminant in the environment does not necessarily mean that people are coming into contact with it. DSHS divided exposure pathways into three categories: completed, potential, and eliminated.

There are five elements considered in the evaluation of exposure pathways:

1. a source of contamination,
2. an environmental media that could absorb or transport the contamination,
3. a point of exposure where people could contact the contaminated media,
4. a route of exposure, such as inhalation, ingestion, or dermal contact, and
5. an identifiable exposed population.

A completed exposure pathway occurs when all five elements are present, and exposure has occurred, is occurring, or will occur in the future. A potential exposure pathway occurs when one or more of the five elements cannot be identified but may be present at some point in the future. Eliminated exposure pathways are missing one or more elements and exposure cannot occur.

DSHS identified the following off-site exposure pathways for people living near the site based on available environmental data and knowledge of accessibility to contaminated areas. On-site exposure pathways were not evaluated because no environmental samples (i.e., soil, air, and water) were collected. In addition, the USOR properties have restricted access with fences and video surveillance (Pastor 2014). Therefore, the general public is not likely to have direct contact with the on-site contaminants.

Surface soil/Sediment - Completed Exposure Pathway for past, current, and future.

Nearby residents and visitors may have come into contact with the contaminants in the surface soil and sediments through incidental ingestion and skin contact while participating in outdoor activities such as playing or fishing along the bank of Vince Bayou.

The site is located at a highly industrialized area and the shoreline vegetation along the bayou is overgrown acting as a natural contact barrier. Erosion from heavy rainfall has scoured some area along storm drainage channels. There is a residential area south of the facility. The surface soil and sediment samples were collected from locations where children could potentially walk the shoreline between MCC properties or walk and ride a bicycle on the street. Older children (greater than six years old) and adults could potentially be exposed to contaminants in these areas through incidental ingestion and skin contact. However, no children less than six years old were observed in the bayous or surrounding areas during the site visits.

Surface water - Eliminated Exposure Pathway for past, current, and future.

Vince Bayou and the Houston Ship Channel are not used as a source of public drinking water. In addition, the chance of uptake of contaminants through

incidental ingestion of surface water is minimal because swimming in the bayou is not expected to occur.

Surface water from the site enters the bayou and continues downstream before entering the Houston Ship Channel. Nearby residents and visitors are not likely to have frequent or prolonged contact with the contaminants in the surface water through incidental ingestion and skin contact while fishing. Based on observations during site visits, the only water-related recreational activity in the area is fishing from the bank and/or bridge crossings.

Residential drinking water - Eliminated Exposure Pathway for past, current, and future.

Water from the Vince and Little Vince Bayous is not used for drinking water purposes. Residences near the site get drinking water from the City of Pasadena, which is monitored for compliance with state and federal drinking standards. The city's water supply has not been impacted by this site.

Fish - Potential Exposure Pathway for past, current, and future.

People may have come in contact with the contaminants while eating fish caught from Bayous Vince and Little Vince. Although no fish were analyzed for target compounds, some of the contaminants released into the bayous have potential for bioaccumulation, and people eat fish from these water bodies. This exposure pathway could not be evaluated as a part of this health consultation because no fish data are available.

Ambient Air - Potential Exposure Pathway for past, current, and future.

Nearby residents may have come in contact with the contaminants in ambient air through breathing.

When the site was operating, numerous complaints from area residents were filed with environmental government agencies for noxious chemical odors (USEPA 2011a). Although no air samples were collected, strong foul odors associated with the emission of hydrocarbons, benzene, and acetone have been detected during site investigations in 2004 and 2009. The PRP group and EPA have removed most on-site contaminants to reduce potential contaminated air exposures (CDC 2018). Upon the completion of removal activities, this exposure pathway would be eliminated. This exposure pathway could not be evaluated as a part of this health consultation because no air data are available.

Table 1. Off-site Exposure Pathway Evaluation

Source	Medium	Point of Exposure	Route of Exposure	Potentially Exposed Population	Time Frame & Type of Exposure Pathway
USOR and USOR and MCC (e.g., drums, poly totes, ASTs, bioreactors)	Surface water	Vince and Little Vince Bayous	None	None	Past: Eliminated Current: Eliminated Future: Eliminated
	Sediment	Vince and Little Vince Bayous	incidental ingestion, dermal contact	Recreational users	Past: Completed Current: Completed Future: Completed
	Surface soil	Vicinity of USOR properties	incidental ingestion, dermal contact	Recreational users	Past: Completed Current: Completed Future: Completed
	Biota (i.e. fish)	Food	Ingestion	Recreational users	Past: Potential Current: Potential Future: Potential
City of Pasadena's public water system	Residential Drinking Water	Residential tap	Ingestion	Residents	Past: eliminated Current: eliminated Future: eliminated



Figure 5. Map shows soil and sediment sampling locations (US EPA 2011a)

Screening Analysis: Comparison to Health-Based Comparison Values

Following identification of a completed/potential exposure pathway, DSHS conducted a screening analysis to identify contaminants of concern. The analytical results for each contaminant were compared to health-based comparison values (CVs) published by ATSDR. When CVs were not available from ATSDR, regional screening levels (RSLs) published by the EPA were used. The ATSDR CVs and EPA RSLs are media-specific (e.g., air, food, soil, and water) levels below which no adverse health effects are expected to occur. It is important to note that if a chemical concentration exceeds a CV, it does not necessarily mean there is a health concern. It means the chemical- and site-specific exposure scenario warrants further public health evaluation based on site-specific exposure conditions.

Arsenic and PAHs were identified as contaminants of concern (Tables 2 and 3) and selected for further evaluation because their detected levels exceeded relevant CVs or the substance had no available comparison value. Soil arsenic concentrations ranged from 2.1 to 335 milligrams per kilogram (mg/kg). One soil sample (SS-03) had a much higher concentration of arsenic (335 mg/kg) than all other samples collected. All other samples were around background levels. Soil sample SS-03 was collected near an AST in a heavily vegetated area, and its arsenic concentration exceeded ATSDR's acute and chronic environmental media evaluation guides (EMEGs) for children. Sediment samples collected from downstream of Vince Bayou had high concentrations of arsenic ranging from 5.9 to 19.3 mg/kg (Figure 5). One sediment sample (SW-04) had an arsenic concentration exceeded the ATSDR's chronic EMEG for children.

PAHs are a group of over 100 different chemicals that are formed through the incomplete burning of coal, garbage, gas, oil, tobacco, wood, and charbroiled meat (DSHS 2013b, ATSDR 1995). PAHs are typically analyzed as mixtures because they are rarely found in the environment as individual compounds. Benzo(a)pyrene (BaP) was used as a surrogate to assess the relative toxicity of PAHs in soil and sediment. To determine the toxicity of a mixture of PAHs, the concentration of each PAH was multiplied by its Toxic Equivalency Factor (TEF), which results in its BaP toxic equivalency concentration (BaP TE; Appendix B). The toxic equivalency concentrations for each sample were then added together to determine the total B(a)P toxic equivalency concentration for the mixture. Total B(a)P toxic equivalency concentrations ranged from 0.83 to 2.26 mg/kg for soil samples, and 0.78 to 3.77 mg/kg for sediment samples (USEPA 2011a, ATSDR 1995, Nisbet and LaGoy 1992). The PAH dibenz(a,h)anthracene was evaluated separately because its chemical-specific cancer potency value is available. No spatial trends were noted in PAHs.

Table 2. Selected contaminants of concern for off-site surface soil samples (0 to 1 inch below ground surface). Soil samples were collected in March 2011 by the Environmental Protection Agency (EPA) from drainage pathways surrounding US Oil Recovery, MCC Recycling, and the Vince Bayou. Only contaminants exceeding screening values are included.

Contaminant	Concentration Range (mg/kg) ^a	Comparison Value ^{bc} (mg/kg)	Number of Samples with Levels that Exceed Comparison Values / Total Number of Samples
Arsenic	2.10- 335	16 – child chronic EMEG ^d 260 – child acute EMEG	1/7; 1/7
BaP Toxic Equivalency Concentration ^e	0.83-2.26	0.11 – CREG	7/7

^a mg/kg – milligrams per kilogram are equivalent to parts per million (ppm).

^b Comparison values (CVs) are media-specific (e.g. air, soil, and water) levels below which no adverse health effects are expected to occur. The Agency for Toxic Substances and Disease Registry (ATSDR) CVs include cancer risk evaluation guides (CREGs) and the environmental media evaluation guides (EMEGs).

^c Bold values indicate the concentrations of a contaminant exceeded the ATSDR CV(s).

^d The CREG for arsenic in soil is below background levels, so the recommended screening CV is the EMEG.

^e Polycyclic aromatic hydrocarbon (PAHs) data were analyzed as a mixture in relation to the relative toxicity of each individual compound compared to benzo(a)pyrene (BaP). The CREG for BaP was used to compare the results of BaP Equivalency Concentration.

Table 3. Selected contaminants of concern for off-site sediment samples. Sediment samples were collected in March 2011 by the Environmental Protection Agency (EPA) from Vince and Little Vince Bayous.

Contaminant	Concentration Range (mg/kg) ^a	Comparison Value ^{b, c} (mg/kg)	Number of Samples with Levels that Exceed Comparison Values / Total Number of Samples
Arsenic	1.30- 19.3	16 – child chronic EMEG ^d	1/19
BaP Toxic Equivalency Concentration ^e	0.78-3.77	0.11 – CREG	19/19
Dibenz(a,h)anthracene	0.55-1.01	None	—

^a a. mg/kg – milligrams per kilogram are equivalent to parts per million (ppm).

^b Comparison values (CVs) are media-specific (e.g. air, soil, and water) levels below which no adverse health effects are expected to occur. The Agency for Toxic Substances and Disease Registry (ATSDR) CVs include cancer risk evaluation guides (CREGs) and the environmental media evaluation guides (EMEGs).

^c Bold values indicate the concentrations of a contaminant exceeded the ATSDR CV(s).

^d The CREG for arsenic in soil is below background levels, so the recommended screening CV is the EMEG.

^e Polycyclic aromatic hydrocarbon (PAHs) data were analyzed as a mixture in relation to the relative toxicity of each individual compound compared to benzo(a)pyrene (BaP). The CREG for BaP was used to compare the results of BaP Equivalency Concentration.

Public Health Implications

The selected contaminants of concern were further evaluated based on site-specific exposure conditions. Site-specific exposure doses were calculated and compared to levels at which adverse health effects have been observed in critical animal, clinical, and/or epidemiological studies. The evaluation considered the potential health impacts to the general public and sensitive groups. Cancer risks are also discussed in this section.

Estimation of Site-Specific Exposure Doses

An exposure dose is an estimate of the amount of a contaminant that gets into a person's body over a specific period of time. DSHS used EPA's ProUCL to calculate the 95% Upper Confidence Limit (UCL) of the arithmetic mean as the exposure point concentration if more than eight samples were collected (e.g., sediment samples). The maximum concentration was used as the exposure point concentration if less than eight samples were collected (e.g., soil samples). DSHS assumed that recreational users visit the area 2 days per week for 52 weeks (i.e., 104 days per year) (ATSDR 2009). No site-specific soil intake rates were available. DSHS used ATSDR's recommended two exposure scenarios: an average, or Central Tendency Exposure (CTE), scenario and a higher-than-average, or Reasonable Maximum Exposure (RME), scenario (Appendix C).

Combined ingestion and dermal exposure doses were calculated for children greater than six years old and adults because no children less than six years old were observed in the bayous or surrounding areas during the site visits. Standard body weight, exposure duration, and EPA's default arsenic bioavailability were used to calculate the daily exposure doses (Appendix C). Bioavailability refers to how much of a contaminant is absorbed into the body after ingestion (swallowing) of soil. If a contaminant is not absorbed (i.e., not bioavailable), it will leave the body.

Non-Cancer Health Effects Evaluation

To evaluate possible non-cancer health effects, the estimated exposure dose was compared to an appropriate health guideline, such as ATSDR's minimal risk level (MRL) or EPA's reference dose (RfD). A health guideline is an estimate of daily exposure to a substance over a specified duration that is unlikely to cause harmful, non-cancer health effects in humans. If an estimated exposure dose is lower than the health-based guideline, adverse non-cancer health effects are not expected to occur. If an estimated dose is higher than the MRL, it does not necessarily mean it will harm people's health; it means that DSHS must conduct an in-depth evaluation to determine if adverse health effects are possible and if the exposure poses a health hazard. This is done by comparing the dose to known non-carcinogenic health effect levels found in the scientific literature.

Cancer Health Effects Evaluation

To estimate cancer risk for cancer-causing contaminants, such as arsenic, the estimated exposure dose was multiplied by the contaminant's cancer slope factor (CSF). The calculated cancer risk is called an excess lifetime cancer risk, which estimates the proportion of a population that may be affected by a carcinogen during a lifetime exposure (24 hours/day, 365 days/year, for 78 years) (Appendix C). An excess lifetime cancer risk represents the additional risk above the existing background cancer risk. For example, an estimated cancer risk of 2 per million (or 2.0×10^{-6}) represents potentially two excess cancer cases in a population of one million over a lifetime of continuous exposure. In the United States, the background cancer risk (or the probability of developing cancer at some point during a person's lifetime) is about 2 in 5 for men (39.66%) and women (37.65%) (ACS 2018). Note, cancer risk estimates are not a measure of the actual cancer cases in a community; rather, they are a tool used by ATSDR for making public health recommendations.

Arsenic

Arsenic is a naturally-occurring element widely distributed in the earth's crust and found in air, water, and soil. In Texas, the median background concentration for arsenic is 5.9 mg/kg (TCEQ 2007). Arsenic exists as inorganic arsenic, organic arsenic, and arsine. In general, organic arsenic is less toxic than inorganic arsenic (ATSDR 2007). In humans, skin is the most sensitive target organ after ingesting arsenic for a long period of time. Typical effects include hyperkeratosis (patches of hardened skin, especially on the palms of the hands and soles of the feet), hyperpigmentation of the skin, and changes in the blood vessels of the skin. These symptoms typically begin to manifest at exposure levels of about 0.002–0.02 mg/kg/day. Ingestion of arsenic can also result in effects on other organ systems such as cardiovascular and respiratory organ systems. Nausea, vomiting, and diarrhea are also common symptoms in humans after repeated exposure to low doses of arsenic; these effects are due to a direct irritation of the gastrointestinal mucosa (ATSDR 2007).

Non-Cancer Health Effects

Acute Exposure (short-term; up to 14 days): ATSDR's MRL of 0.005 mg/kg/day was used as the health guideline. The short-term MRL is based on swelling (edema) of the face and gastrointestinal and upper respiratory symptoms in people exposed to arsenic contaminated soy sauce for 2-3 weeks (ATSDR 2007). The specific health effects include nausea, vomiting, headaches, stomach cramps, diarrhea, fatigue, chills, sore throat, and nasal discharge. These effects typically stop once the exposure to arsenic is stopped.

Chronic Exposure (Long-term; more than 1 year): ATSDR's MRL of 0.0003 mg/kg/day was used as the health guideline. The MRL is based on a study where no observable adverse effects were noted in humans when exposed to 0.0008 mg/kg/day arsenic in drinking water. Skin darkening (hyperpigmentation) and localized overgrowth of skin (keratosis) were observed when humans were exposed to 0.014 mg/kg/day arsenic in drinking water (ATSDR 2007). The no observable adverse effects level (NOAEL) identified was limited given that dermal lesions increased with age and the majority of the study population was younger than 20 years old, and because estimates of dietary arsenic intake rates were highly variable (USEPA 2011c).

The results of estimated age-specific combined ingestion and dermal exposure doses indicated that children aged 6 to less than 11 years have the greatest exposures for the age groups evaluated. DSHS calculated the Hazard Quotients (HQs) to compare estimated exposure doses to health guidelines, which are considered to be safe doses at which adverse health effects are not expected. The HQs were calculated by dividing the estimated exposure doses by the health guideline, such as the MRL. If the HQ is less than 1, then adverse health effects are not likely. If the HQ is greater than 1, DSHS further evaluated the margin of exposure (MOE). The MOE is a measure of how many times lower the actual soil/sediment arsenic exposure is when compared to the arsenic exposure that has been shown to cause non-cancer health effects. Complete results are presented in Tables 4 (acute exposure for soil), 5 (chronic exposure for soil), and 6 (chronic exposure for sediment).

Acute Exposure: the estimated risk is associated with one exposure event. All the resulting HQs for combined ingestion of and dermal exposure to soil were less than 1.

Chronic Exposure: all the resulting HQs for combined ingestion of and dermal exposure to soil and sediments were less than 1 except for the 6 to less than 11 years old age group. The HQs for this age group was 1.436 (1.4 from soil + 0.036 from sediment) at the high end of exposure (RME), and 0.605 (0.59 from soil + 0.015 from sediment) for a typical level of exposure (CTE). The highest combined RME dose was 0.000441 mg/kg/day (4.3×10^{-4} from soil + 1.1×10^{-5} from sediment) for the 6 to less than 11 years old age group. This value is above ATSDR's MRL. DSHS further evaluated MOE, which is 32. This means that the estimated exposure dose is 32 times below the human health effect level.

Based on the available information, DSHS determined that both acute and chronic non-cancer health effects are not likely to occur because the estimated exposure doses did not exceed the health guideline (short-term) or are more than 30 times lower than the human health effect level (long-term). In addition, the exposure

doses are likely to be overestimated because the maximum soil concentration was used. Additionally, this soil sample had a much higher concentration of arsenic (335 mg/kg) than all other samples collected (all the other samples were around background levels). This sample was collected near an AST in a heavily vegetated area.

Cancer Health Effects: DSHS calculated age-specific exposure doses and corresponding cancer risks for both CTE and RME exposure scenarios, as presented in Tables 5 and 6. The estimated cancer risks ranged from 2.3×10^{-5} to 6.9×10^{-5} due to exposures to arsenic in soil, and from 5.9×10^{-7} to 1.7×10^{-6} due to exposures to arsenic in sediments

Cancer risks were summed across environmental media (soil and sediments), and age groups (children ages 6-21 year and adults) and exposure routes (ingestion and dermal) to produce a total arsenic cancer risk due to different exposure scenarios, as presented in Table 7. For incidental ingestion of and dermal exposure to arsenic in soil and sediment, DSHS estimated excess lifetime cancer risk to be 3.3×10^{-5} to 7.1×10^{-5} among children (15 years of exposure) and 2.4×10^{-5} to 5.6×10^{-5} among adults (33 years of exposure). This indicates chronic uptake of arsenic, through incidental ingestion and dermal contact, from off-site soil and sediment may result in a low increased risk of cancer; that is, the chance of getting cancer from this exposure is low. This is likely an overestimate of excess cancer risk. Given that the off-site terrain is vegetated and difficult to access, people are probably exposed less frequently than twice a week.

Table 4. Acute exposure dose, non-cancer hazard quotient, and cancer risk estimations for Central Tendency Exposure (CTE) and Reasonable Maximum Exposure (RME) for arsenic in off-site surface soil.

Exposure Group	Estimated CTE Exposure (mg/kg/day)	Estimated RME Exposure (mg/kg/day)	Hazard Quotient for CTE Exposure	Hazard Quotient for RME Exposure
6 to < 11 years	6.2×10^{-4}	1.5×10^{-3}	0.12	0.30
11 to < 16 years	3.0×10^{-4}	5.5×10^{-4}	0.06	0.11
16 to < 21 years	2.5×10^{-4}	4.5×10^{-4}	0.05	0.09
Adult	1.3×10^{-4}	3.0×10^{-4}	0.03	0.06

Table 5. Chronic exposure dose, non-cancer hazard quotient, and cancer risk estimations for Central Tendency Exposure (CTE) and Reasonable Maximum Exposure (RME) for arsenic in off-site surface soil.

Exposure Group	Estimated CTE Exposure (mg/kg/day)	Estimated RME Exposure (mg/kg/day)	Hazard Quotient for CTE Exposure	Hazard Quotient for RME Exposure	Estimated Lifetime Cancer Risk for CTE Exposure	Estimated Lifetime Cancer Risk for RME Exposure
6 to < 11 years	1.8×10^{-4}	4.3×10^{-4}	0.59	1.4	3.2×10^{-5}	6.9×10^{-5}
11 to < 16 years	8.5×10^{-5}	1.6×10^{-4}	0.28	0.52	3.2×10^{-5}	6.9×10^{-5}
16 to < 21 years	7.3×10^{-5}	1.3×10^{-4}	0.24	0.43	3.2×10^{-5}	6.9×10^{-5}
Adult	3.7×10^{-5}	8.7×10^{-5}	0.12	0.29	2.3×10^{-5}	5.5×10^{-5}

Table 6. Chronic exposure dose, non-cancer hazardous quotient, and cancer risk estimations for Central Tendency Exposure (CTE) and Reasonable Maximum Exposure (RME) for arsenic in off-site sediment.

Exposure Group	Estimated CTE Exposure (mg/kg/day)	Estimated RME Exposure (mg/kg/day)	Hazard Quotient for CTE Exposure	Hazard Quotient for RME Exposure	Estimated Lifetime Cancer Risk for CTE Exposure	Estimated Lifetime Cancer Risk for RME Exposure
6 to < 11 years	4.5×10^{-6}	1.1×10^{-5}	0.015	0.036	8.2×10^{-7}	1.7×10^{-6}
11 to < 16 years	2.2×10^{-6}	4.0×10^{-6}	0.007	0.013	8.2×10^{-7}	1.7×10^{-6}
16 to < 21 years	1.8×10^{-6}	3.3×10^{-6}	0.006	0.011	8.2×10^{-7}	1.7×10^{-6}
Adult	9.3×10^{-7}	2.2×10^{-6}	0.0031	0.0074	5.9×10^{-7}	1.4×10^{-6}

Table 7. Combined lifetime cancer risk estimations for Central Tendency Exposure (CTE) and Reasonable Maximum Exposure (RME) for arsenic in off-site surface soil and sediment.

Exposure Group	Estimated Lifetime Cancer Risk for CTE Exposure from Soil & Sediments	Estimated Lifetime Cancer Risk for RME Exposure from Soil & Sediments
Child (from 6 to < 21 years old)	3.3×10^{-5}	7.1×10^{-5}
Adult	2.4×10^{-5}	5.6×10^{-5}

Polycyclic Aromatic Hydrocarbons (PAHs)

Most people are exposed to PAHs by breathing the compounds in tobacco smoke, wood smoke, and ambient air, and eating food containing PAHs. PAHs tend to be stored mostly in the kidneys, liver, and fat. Most PAHs that enter the body leave within a few days, primarily in the feces and urine (ATSDR 1995). Several PAHs, including benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(j)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-c,d)pyrene, have been found to cause cancers in laboratory animals when they breathed, ate or had long periods of skin exposure to PAHs (ATSDR 1995).

Non-Cancer Health Effects: Similar to arsenic, DSHS calculated combined ingestion and dermal exposure doses for CTE and RME for BaP TE and dibenz(a,h)anthracene concentration ranges. As stated, DSHS used the BaP TE value to evaluate six of the PAHs detected in samples collected for USOR, including benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, and indeno(1,2,3-c,d)pyrene. Dibenz(a,h)anthracene was evaluated separately.

EPA's RfD of 0.0003 mg/kg/day was used as the referenced health guideline for BaP. The RfD is determined based on a neurodevelopmental study which showed abnormal behavioral effects in rats from Morris water maze⁶, elevated plus maze⁷, and open field tests in the exposed groups. The benchmark dose of 0.092 mg/kg/day was used to derive the RfD and an uncertainty factor was applied to account for using an animal study, individual variability, and deficiencies in the toxicity database.

⁶ Morris water maze: a circular pool filled with milky water.

⁷ Elevated plus maze: it includes four narrow platforms of equal length that are oriented along a single plane and elevated a certain distance above the floor.

The results of estimated age-specific combined ingestion and dermal exposures doses for BaP TE in soil and sediment indicated that children aged 6 to less than 11 years have the greatest exposures. Complete results are presented in Tables 8 and 9. The resulting HQs for combined ingestion of and dermal exposure to soil and sediments this age group were 0.04 (i.e. 0.02 from soil ingestion + 0.02 from sediment ingestion) at the high end of exposure (RME), and 0.021 (i.e. 0.011 from soil ingestion + 0.01 from sediment ingestion) for a typical level of exposure (CTE).

The highest combined RME dose was 0.000012 mg/kg/day (6.1×10^{-6} from soil ingestion + 5.9×10^{-6} from sediment ingestion) for the 6 to less than 11 years old group, which is lower than EPA's reference dose of 0.0003 mg/kg/day.

ATSDR has not derived oral MRLs for dibenz(a,h)anthracene because there are no adequate human or animal dose response data available. However, the PAH doses at which non-cancer health effects occurred in mice were many orders of magnitude higher than the estimated PAH doses from soil/sediment exposures at this site (ATSDR 1995). Therefore, it is unlikely that any non-cancerous harmful health effects from PAH soil and sediment exposures would occur in children or adults.

Cancer Health Effects: DSHS calculated cancer risks using the EPA CSF of 1 (mg/kg/day)⁻¹ for BaP TE and the California EPA (CalEPA) CSF of 4.1 (mg/kg/day)⁻¹ for dibenz(a,h)anthracene. DSHS calculated age-specific exposure doses and corresponding cancer risks for both CTE and RME exposure scenarios as presented in Table 8 and 9. Cancer risks were summed across environmental media (soil and sediments), age groups (children ages 6-21 years and adults), and exposure routes (ingestion and dermal) to produce a total cancer risk due to different PAH exposure scenarios (Table 10).

DSHS estimated excess cancer risk due to exposure to BaP TE in sediment and soil (Table 10) to be 2.2×10^{-6} to 3.6×10^{-6} among children (15 years of exposure), and 5.8×10^{-7} to 1.1×10^{-6} among adults (33 years of exposure). No dibenz(a,h)anthracene soil sample data were available. For dibenz(a,h)anthracene in sediment, excess cancer risk was estimated to be 1.1×10^{-6} to 1.8×10^{-6} among children and 2.9×10^{-7} to 5.4×10^{-7} among adults (Table 10).

This indicates a low risk among children and adults following chronic exposure to the levels of PAHs measured in the soil and sediment samples. However, based on DSHS's observations, it does not seem likely that children or adults would have regular contact with off-site soil and sediment. Therefore, this is likely an overestimation of excess cancer risk.

Table 8. Chronic exposure dose, non-cancer hazard quotient, and cancer risk* estimations for Central Tendency Exposure (CTE) and Reasonable Maximum Exposure (RME) for Benzo(a)pyrene (BaP) toxic equivalency concentrations (TE) in off-site surface soil.

Exposure Group	Estimated CTE Exposure (mg/kg/day)	Estimated RME Exposure (mg/kg/day)	Hazard Quotient for CTE Exposure	Hazard Quotient for RME Exposure	Estimated Lifetime Cancer Risk for CTE Exposure	Estimated Lifetime Cancer Risk for RME Exposure
6 to < 11 years	3.2×10^{-6}	6.1×10^{-6}	0.011	0.020	1.1×10^{-6}	1.8×10^{-6}
11 to < 16 years	1.9×10^{-6}	2.7×10^{-6}	0.007	0.009	1.1×10^{-6}	1.8×10^{-6}
16 to < 21 years	1.7×10^{-6}	2.3×10^{-6}	0.006	0.008	1.1×10^{-6}	1.8×10^{-6}
Adult	7.0×10^{-7}	1.3×10^{-6}	0.002	0.004	2.9×10^{-7}	5.4×10^{-7}

* Age-dependent adjustment factors (3 for age 6 to < 11 years old and age 11 to < 16 years old; 1 for age 16 to < 21 years old and adult) were used to estimate cancer risks because PAHs are mutagens.

Table 9. Chronic exposure dose, non-cancer hazard quotient, and cancer risk* estimations for Central Tendency Exposure (CTE) and Reasonable Maximum Exposure (RME) for PAHs in off-site sediment.

Contaminant	Exposure Group	Estimated CTE Exposure (mg/kg/day)	Estimated RME Exposure (mg/kg/day)	Hazard Quotient for CTE Exposure	Hazard Quotient for RME Exposure	Estimated Lifetime Cancer Risk for CTE Exposure	Estimated Lifetime Cancer Risk for RME Exposure
Benzo(a)pyrene Toxic Equivalency	6 to < 11 years	3.2×10^{-6}	6.1×10^{-6}	0.011	0.020	1.1×10^{-6}	1.8×10^{-6}
	11 to < 16 years	1.9×10^{-6}	2.7×10^{-6}	0.007	0.009	1.1×10^{-6}	1.8×10^{-6}
	16 to < 21 years	1.7×10^{-6}	2.3×10^{-6}	0.006	0.008	1.1×10^{-6}	1.8×10^{-6}
	Adult	7.0×10^{-7}	1.3×10^{-6}	0.002	0.004	2.9×10^{-7}	5.4×10^{-7}
Dibenz(a,h)-anthracene	6 to < 11 years	3.2×10^{-6}	6.1×10^{-6}	0.011	0.020	1.1×10^{-6}	1.8×10^{-6}
	11 to < 16 years	1.9×10^{-6}	2.7×10^{-6}	0.007	0.009	1.1×10^{-6}	1.8×10^{-6}
	16 to < 21 years	1.7×10^{-6}	2.3×10^{-6}	0.006	0.008	1.1×10^{-6}	1.8×10^{-6}
	Adult	7.0×10^{-7}	1.3×10^{-6}	0.002	0.004	2.9×10^{-7}	5.4×10^{-7}

*Age-dependent adjustment factors (3 for age 6 to < 11 years old and age 11 to < 16 years old; 1 for age 16 to < 21 years old and adult) were used to estimate cancer risks because PAHs are mutagenic.

Table 10. Combined chronic exposure dose and cancer risk estimations for Central Tendency Exposure (CTE) and Reasonable Maximum Exposure (RME) for Benzo(a)pyrene (BaP) toxic equivalency concentrations (TE) in off-site surface soil and sediment.

Exposure Group	Estimated Lifetime Cancer Risk for CTE Exposure from Soil & Sediment	Estimated Lifetime Cancer Risk for RME Exposure from Soil & Sediment
Child (from 6 to < 21 years old)	2.2×10^{-6}	3.6×10^{-6}
Adult	5.8×10^{-7}	1.1×10^{-6}

Cumulative Exposures

This section provides an evaluation of the combined risks due to exposure to arsenic and PAHs in soil and sediment. DSHS used the default assumption of additivity for evaluating health effects of simultaneous exposure to multiple chemicals (i.e., the combined toxic effect of multiple chemicals is the same as the sum of the individual toxic effects).

DSHS calculated the total cancer risk for CTE and RME scenarios. The total excess lifetime cancer risks were estimated to be 3.6×10^{-5} to 7.6×10^{-5} for children (15 years of exposure) and 2.5×10^{-5} to 5.8×10^{-5} for adults (33 years of exposure), which indicates a low increased risk of cancer among children and adults following chronic exposure to arsenic and PAHs at levels measured in offsite soil and sediment samples.

As mentioned above, this is likely an overestimation of excess cancer risk because the off-site terrain is vegetated and difficult to access, and people are probably exposed less frequently than twice a week.

Table 11. Estimated Cumulative Excess Lifetime cancer risks from combined soil and sediment ingestion of arsenic and PAHs.

Exposure Scenario	Central Tendency Exposure	Reasonable Maximum Exposure
Child only (15 years of exposure)	3.6×10^{-5}	7.6×10^{-5}
Adult only (33 years of exposure)	2.5×10^{-5}	5.8×10^{-5}

Community Health Concerns

As part of the public health evaluation process, DSHS and ATSDR try to learn what health-related concerns people in the area might have about this site. Consequently, health agency personnel actively gathered information and comments from people who live near the site during site visits and door-to-door surveys. The following are community health concerns received and responses to those concerns from door-to-door outreach activities completed in September 2012.

Are the noxious odors in the neighborhood related to the site?

The Harris County Pollution Control Services Department (HCPCS) received numerous complaints from residents regarding odors emanating from the vicinity of the USOR site from 2005-2011. Although DSHS did not review any air sampling results, because this is a highly industrialized area, odors could be coming from multiple facilities. Once the site was listed on the NPL, EPA and the PRP group began on-site contaminant stabilization and removal efforts to reduce noxious odors potentially originating from the USOR site.

For odor complaints or concerns, please contact the HCPCS at 713-920-2831.

Is the tap water contaminated?

Water from the Vince and Little Vince Bayous is not used for drinking water purposes. Residences near the site get drinking water from the City of Pasadena's public water system, which is monitored for compliance with state and federal drinking water standards. The city's water supply has not been impacted by this site. Drinking water sampling reports for the City of Pasadena are on file with TCEQ (TCEQ 2018) and publicly available online⁸.

For additional drinking water information, residents can contact the City of Pasadena, Public Works Department at 713-475-5566, or review drinking water quality reports online⁹.

Are fish caught in Vince and Little Vince Bayous safe to eat?

On June 26, 2013, the DSHS Seafood and Aquatic Life Group (SALG) issued a revised fish consumption advisory for individuals to limit their consumption of all species of fish and blue crabs harvested from the Houston Ship Channel, San Jacinto River, and Upper Galveston Bay and all adjoining waters, which includes Vince and Little Vince Bayous (HCFCD 2018). Residents should follow DSHS SALG meal consumption recommendations to prevent increased exposure to contaminants. Women past childbearing age and adult men should limit

⁸<https://dww2.tceq.texas.gov/DWW/>

⁹<https://www.pasadenatx.gov/397/Water-Quality-Reports>

consumption of all species of fish and blue crabs harvested from these waters to one eight-ounce meal per month. Women of childbearing age and children less than 12 years old are advised not to consume any species of fish and blue crab harvested from these waters (HCFCF 2018).

For additional information about consuming fish harvested in Texas water bodies, contact the DSHS Seafood and Aquatic Life Group at 512-834-6757 or visit <http://www.dshs.state.tx.us/seafood/>.

Are fruits and vegetables grown in our yards safe to eat?

This exposure pathway could not be evaluated in this health consultation because no residential soil samples were collected. However, contaminant migration from the site occurred mainly during times of heavy rainfall. Although residential soil data were not collected, these soils are not likely contaminated because contaminants from USOR site would most likely be carried downstream and away from residential neighborhoods during these events.

Residents concerned about exposure to contaminants are recommended to follow urban gardening practices by using raised beds or container gardens for growing fruits and vegetables. More information on these practices can be found at the Texas A&M Agrilife Extension Service website (<http://agriflifeextension.tamu.edu/>).

Limitations

This health consultation has several limitations, some of which are listed below.

Data limitations:

- A small number of soil samples were collected, which may not adequately represent the off-site exposure pathway. One soil sample had a much higher concentration of arsenic than all other samples collected.
- Laboratory documentation indicates that some sample results were estimated because serial dilution differences did not meet technical quality control criteria. Therefore, some sample results may not represent the true concentrations of contaminants present in off-site soil and sediment.

Exposure assumptions:

- Estimating exposure dose needs to identify how much, how often, and how long a person may come in to contact with the contaminants. DSHS made assumptions for site-specific exposure scenarios. Although DSHS' assumptions were conservative, each individual's exposure could be higher or lower depending on his/her lifestyle.

Chemical bioavailability in soil and sediment:

- Bioavailability refers to how much of a contaminant is absorbed into the body after ingestion (swallowing) of soil. If a contaminant is not absorbed (i.e. not bioavailable), it will leave the body. There is no site-specific bioavailability for arsenic or PAHs. DSHS used EPA default bioavailability for arsenic (60%) and assumed 100% bioavailability for PAHs.

Cumulative Exposure assumptions:

- There is no information about the combined toxic effects due to exposures to arsenic and PAHs. DSHS used the default assumption of additivity to evaluate health effects from simultaneous exposure to multiple chemicals. However, sometimes the combined toxic effect can be greater than the sum of the individual toxic effects. For example, the joint toxic effects on the neurological system due to exposure to a lead and arsenic mixture are greater than the additive for the effect of arsenic and lead.

Conclusions

Based on the available information, DSHS and ATSDR reached three conclusions about the USOR site:

Conclusion 1: Past, present, and future exposures (from incidental ingestion and skin contact) to arsenic and polycyclic aromatic hydrocarbons (PAHs) found in off-site surface soil and sediment are not expected to harm people's health.

Basis for Conclusion: Nearby residents and visitors, including adults and children older than six years of age, may have come into contact with the contaminants in the surface soil and sediment through incidental ingestion and skin contact while participating in outdoor activities such as playing or fishing along the bank of Vince Bayou. However, the calculated exposure doses for short-term (up to 14 days) arsenic and long-term (more than 1 year) PAH exposures among recreational users did not exceed health-based guidelines for non-cancer health effects.

To evaluate the potential for cancer effects, DSHS used conservative site-specific exposure assumptions. Given the vegetated, difficult terrain off-site, these assumptions likely overestimate exposure frequency and excess cancer risk. When considering both average (central tendency) exposure and higher-than-average (reasonable maximum) exposure scenarios, DSHS concluded there is a low increased risk of cancer for arsenic and PAHs in soil and sediment.

Conclusion 2: DSHS and ATSDR cannot currently conclude whether eating fish caught from Vince and Little Vince Bayous could harm people's health.

Basis for Conclusion: This exposure pathway could not be evaluated because no fish samples were collected. However, the DSHS Seafood and Aquatic Life Group (SALG) issued a fish and shellfish consumption advisory (Advisory 49) for individuals to limit their consumption of all species of fish and blue crabs from the Houston Ship Channel and the San Jacinto River, and all adjoining waters, which includes Vince and Little Vince Bayous (DSHS 2013a, DSHS 2013b). Specifically, women who are nursing, pregnant, or who may become pregnant, and children under 12 should not consume any fish or crab from this area. Women past child bearing age and males ages 12 and older should limit consumption of all species of fish and crab from this area to no more than one (1) eight-ounce (8 oz) meal per month. There are numerous sources of contaminant discharge in the area, and the contaminants of concern [polychlorinated biphenyls (PCBs), polychlorinated dibenzo-p-dioxins (PCDDs), and dibenzofurans (PCDFs)] for the consumption advisory are not attributable to the USOR site.

Conclusion 3: DSHS and ATSDR cannot conclude whether breathing ambient (outside) air in the past at the nearby residential area could harm people's health.

Basis for Conclusion: Community members reported smelling odors coming from the site in the past. However, this exposure pathway could not be evaluated because no ambient air samples were collected.

Recommendations

Based upon DSHS and ATSDR's review of the USOR data and the concerns expressed by community members, the following recommendations are appropriate and protective of public health:

1. People that play, fish, or wade in the area may have an increased chance of contacting the contaminated soil through incidental ingestion and skin contact. Practicing good personal hygiene habits (such as washing hands after playing in the area, and before eating) can reduce or prevent the exposure to contaminants in soil.
2. Individuals concerned about their past exposures to contaminants during the USOR site operations are advised to speak with their personal physician about their health concerns.
3. ATSDR and DSHS recommend that EPA, in consultation with Texas Commission on Environmental Quality (TCEQ), continue efforts to remediate the site.

4. ATSDR and DSHS recommend that EPA, in consultation with TCEQ, continue to monitor the perimeter fence surrounding the USOR site to reduce trespassing at these locations.
5. Individuals are encouraged to follow the DSHS SALG fish consumption advisory recommendations, for Advisory 49, which can be found at: <https://www.dshs.texas.gov/seafood/advisories-bans.aspx>.

Public Health Action Plan

The public health action plan for the site contains a description of actions that have been or will be taken by DSHS, ATSDR, and other government agencies at the site. The purpose of the public health action plan is to ensure that this health consultation both identifies public health hazards and provides a plan of action designed to mitigate and prevent harmful human health effects resulting from breathing, ingesting, or skin contact with hazardous substances found in the environment. Included is a commitment on the part of DSHS and ATSDR to follow up on this plan to ensure that it is implemented.

Actions Completed

1. In July 2010, as a result of Hurricane Alex, EPA initiated an emergency response and removal action to prevent hazardous wastes from flowing off site into Vince Bayou.
2. EPA collected sediment, surface soil, and surface water samples from drainage pathways and Vince and Little Vince Bayous in March 2011.
3. The USOR site was proposed to the NPL in September 2011 and listed as final on the NPL in September 2012.
4. DSHS, TCEQ, and the EPA contractor conducted a site visit of the facilities and the surrounding area in January 2012.
5. DSHS and ATSDR conducted a follow-up site visit and door-to-door community outreach activities in September 2012.
6. DSHS, TCEQ, EPA, and the PRP group's contractor conducted a follow-up site visit in June 2014 and July 2015 to observe the progress of removal activities.

Actions Planned

- This document will be made available to community members, city officials, the Texas Commission on Environmental Quality (TCEQ), the EPA, and other interested parties.

Preparers of Report

The Texas Department of State Health Services (DSHS) prepared this health consultation for the US Oil Recovery site, located in Pasadena, Harris County, Texas. This publication was made possible by Grant Number NU61TS000284-02-01 under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). DSHS evaluated data of known quality using approved methods, policies, and procedures existing at the date of publication. ATSDR reviewed this document and concurs with its findings based on the information presented by DSHS.

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APPENDIX A: Conversion of Detected PAH Soil and Sediment Concentrations to Toxic Equivalency Concentrations (TE) of Benzo[a]pyrene

Table A1. BaP Toxic Equivalency Concentration (mg/kg) in soil samples collected from various locations (see Figure 5)

Polycyclic Aromatic Hydrocarbon Fraction	TEF ¹	BaP ² TE ³ at SS 01	BaP TE at SS 02	BaP TE at SS 03	BaP TE at SS 04	BaP TE at SS 05	BaP TE at SS 06	BaP TE at SS 07
Benzo(a)anthracene	0.1	0.08	0.07	0.07	0.08	0.12	0.06	0.06
Benzo(a)pyrene	1	1.32	0.66	0.65	0.78	1.68	0.59	0.60
Benzo(b)fluoranthene	0.1	0.17	0.07	0.07	0.08	0.20	0.06	0.06
Benzo(k)fluoranthene	0.1	0.10	0.07	0.07	0.08	0.13	0.06	0.06
Chrysene	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01
Indeno(1,2,3-cd)pyrene	0.1	0.12	0.07	0.07	0.08	0.12	0.06	0.06
Total BaP Equivalency Concentration (mg/kg)		1.79	0.93	0.92	1.11	2.26	0.83	0.85

1. ¹ TEF: Toxic Equivalency Factor. The Cal EPA BaP potency equivalency factors were used to calculate BaP equivalents. http://www.oehha.ca.gov/air/hot_spots/hotspots2015.html (Table G-2).
2. ² BaP: benzo(a)pyrene
3. ³ mg/kg: milligram/kilogram

Table A2. BaP Toxic Equivalency Concentration (mg/kg) in sediment samples collected from various locations (see Figure 5)

Polycyclic Aromatic Hydrocarbon Fraction	TEF ¹	BaP ² TE ³ at PPE 01	BaP TE at PPE 02	BaP TE at PPE 03	BaP TE at PPE 04	BaP TE at PPE 05	BaP TE at PPE 06	BaP TE at SED 01	BaP TE at SED 02	BaP TE at SW 01	BaP TE at SW 02	BaP TE at SW 03	BaP TE at SW 04	BaP TE at SW 05	BaP TE at SW 06	BaP TE at SW 07	BaP TE at SW 08	BaP TE at SW 09	BaP TE at SW 10	BaP TE at SW 11
Benzo(a)anthracene	0.1	0.07	0.08	0.09	0.09	0.14	0.13	0.06	0.12	0.21	0.07	0.12	0.07	0.16	0.06	0.09	0.08	0.08	0.06	0.06
Benzo(a)pyrene	1	0.72	1.26	1.24	1.40	2.16	2.01	0.63	1.74	2.82	0.67	1.69	0.67	2.50	1.00	1.50	1.00	1.28	0.63	0.55
Benzo(b)fluoranthene	0.1	0.07	0.16	0.15	0.18	0.26	0.24	0.06	0.19	0.30	0.07	0.19	0.07	0.29	0.11	0.19	0.12	0.13	0.06	0.06
Benzo(k)fluoranthene	0.1	0.07	0.10	0.10	0.11	0.17	0.16	0.06	0.14	0.20	0.07	0.16	0.07	0.19	0.07	0.13	0.08	0.11	0.06	0.06
Chrysene	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.02	0.03	0.01	0.02	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01
Indeno(1,2,3-cd)pyrene	0.1	0.07	0.11	0.08	0.08	0.16	0.14	0.06	0.12	0.21	0.07	0.13	0.07	0.20	0.07	0.14	0.08	0.11	0.06	0.06
Total BaP Equivalency Concentration		1.02	1.72	1.67	1.88	2.90	2.71	0.89	2.32	3.77	0.94	2.31	0.94	3.36	1.31	2.06	1.36	1.72	0.89	0.78

- ¹ TEF: Toxic Equivalency Factor. The Cal EPA BaP potency equivalency factors were used to calculate BaP equivalents. http://www.oehha.ca.gov/air/hot_spots/hotspots2015.html (Table G-2).
- ² BaP: benzo(a)pyrene
- ³ mg/kg: milligram/kilogram

APPENDIX B: Exposure Dose Estimates and Parameters

Estimated exposure doses were used to determine the amount of chemical that could get into the body for each of the chemicals that exceeded their respective health-based guidelines. Exposures through incidental ingestion were calculated using the following formula and assumptions.

The 95% upper confidence limit (sediment) and maximum (soil) concentration of each chemical in milligrams per kilogram (mg/kg) was used to calculate age-specific estimated exposure doses in milligrams per kilogram per day (mg/kg/day) using the following formula:

$$\text{Dose (mg/kg/day)} = (\text{concentration (mg/kg)} \times \text{bioavailability factor} \times \text{intake rate (mg/day)} \times \text{exposure factor} \times \text{conversion factor (10}^{-6} \text{ kg/mg)}) / \text{body weight (kg)}$$

Bioavailability refers to how much of a contaminant is absorbed into the body after ingestion (swallowing) of soil. A contaminant is not absorbed (i.e. not bioavailable) will leave the body. EPA's default bioavailability for arsenic is 60%. It is assumed that recreational receptors visit the area 2 days per week for 52 weeks (i.e. 104 days per year) (ATSDR 2009). Therefore, the exposure factor is 0.28. Age-specific ingestion rates in milligrams per day (mg/day) for Reasonable Maximum Exposure (RME) and Central Tendency Exposure (CTE), and body weights in kilograms (kg) are based on data presented in the Environmental Protection Agency (EPA) 2011 Exposure Factors Handbook (USEPA 2011c).

- RME: referring to persons who are at the upper end of the exposure distribution (about the 95%). The RME assesses exposures that are higher than average but still within a realistic exposure range. In this case, this would refer to individuals who have a very high soil intake rate.
- CTE: referring to individuals who have an average or typical soil intake rate.

Table B1. Age groups, ingestion rates, and body weights used for the reasonable maximum exposure (RME) evaluation.

Age Groups (years)	RME Soil Intake Rate (mg/day)	Mean Body Weight (kg)	(Exposure Factor)
6 to < 11	200	31.8	0.28
11 to < 16	100	56.8	0.28
16 to <21	100	71.6	0.28
Adults ≥ 21	100	80.0	0.28

Table B2. Age groups, ingestion rates, and body weights used for the central tendency exposure (CTE) evaluation.

Age Groups (years)	CTE Soil Intake Rate (mg/day)	Mean Body Weight (kg)	Exposure Factor
6 to < 11	60	31.8	0.28
11 to < 16	30	56.8	0.28
16 to < 21	30	71.6	0.28
Adults ≥ 21	30	80.0	0.28

For example, the estimated RME exposure dose for children (6 year to less than 11 years old) exposed to arsenic in soil (mg/kg) by ingestion was calculated as follows:

$$\text{Dose (mg/kg/day)} = (205 \text{ (mg/kg)} \times 0.6 \times 200 \text{ (mg/day)} \times 0.28 \times 10^{-6} \text{ (kg/mg)}) / 31.8 \text{ kg} = 0.00022$$

Hazard quotients (HQs) were calculated to compare estimated exposure doses to health guidelines, which are considered to be safe doses at which adverse health effects are not expected. The hazard quotient is calculated by dividing the estimated exposure dose by the health guideline, such as the minimal risk level (MRL) or reference dose (RfD).

$$\text{HQ} = \text{Exposure Dose} / \text{Health Guideline}$$

The arsenic HQ for children 6 years old to less than 11 years old is:

$$\text{HQ} = 0.00022 / 0.0003 = 0.73$$

For contaminants considered to be carcinogens, the estimated cancer risk was calculated using the following formula:

$$\text{Risk} = (\text{Dose (mg/kg/day)} \times \text{cancer slope factor (mg/kg/day)}^{-1} \times \text{exposure duration (years)}) / \text{Lifetime (years)}$$

DSHS used ATSDR's default assumption for exposure duration to calculate the cancer risks. These exposures were averaged over a lifetime of 78 years.

For example, the estimated RME cancer risks for adults and children (6 years old to less than 21 years old) exposed to arsenic in soil (mg/kg) by ingestion was calculated as:

Adults:

$$\text{Risk} = (3.7 \times 10^{-5} \text{ (mg/kg/day)} \times 1.5 \text{ (mg/kg/day)}^{-1} \times 33 \text{ years}) / 78 \text{ years} = 1.4 \times 10^{-5}$$

Children:

6 years to less than 11 years

$$\text{Risk} = (2.6 \times 10^{-4} \text{ (mg/kg/day)} \times 1.5 \text{ (mg/kg/day)}^{-1} \times 5 \text{ years}) / 78 \text{ years} = 2.5 \times 10^{-5}$$

11 years to less than 16 years

$$\text{Risk} = (9.5 \times 10^{-5} \text{ (mg/kg/day)} \times 1.5 \text{ (mg/kg/day)}^{-1} \times 5 \text{ years}) / 78 \text{ years} = 9.1 \times 10^{-6}$$

16 years to 21 years

$$\text{Risk} = (7.9 \times 10^{-5} \text{ (mg/kg/day)} \times 1.5 \text{ (mg/kg/day)}^{-1} \times 5 \text{ years}) / 78 \text{ years} = 7.6 \times 10^{-6}$$

The cancer risks for each age group from 6 years old to less than 21 years old were then summed to obtain the cumulative cancer risk estimate for children.

$$\text{Total Cancer Risk} = (2.5 \times 10^{-5}) + (9.1 \times 10^{-6}) + (7.6 \times 10^{-6}) = 4.2 \times 10^{-5}$$

For contaminants such as PAHs that have a mutagenic mode of action, age-dependent adjustment factors (ADAF) are applied to the cancer risk to account for early life exposures. Therefore, the estimated cancer risk for PAHs was calculated using the following formula:

$$\text{Risk} = (\text{Dose (mg/kg/day)} \times \text{cancer slope factor (mg/kg/day)}^{-1} \times \text{exposure (years)} \times \text{ADAF}) / \text{Lifetime (years)}$$

For example, the estimated RME cancer risk for children (6 to less than 11 years old) exposed to BaP in soil (2.26 mg/kg) was calculated as:

$$\text{Risk} = (6.1 \times 10^{-6} \text{ (mg/kg/day)} \times 1 \text{ (mg/kg/day)}^{-1} \times 5 \text{ years} \times 3) / 78 \text{ years} = 1.2 \times 10^{-6}$$

This value (1.2×10^{-6}) represents the cancer risk from 6 to less than 11 years old age group. The process was repeated for each of the age groups listed above. The cancer risks for each age group were then summed to obtain the cumulative cancer risk estimate for children ages from 6 to less than 21 years. ADAF of 3 was used for children 6 to 16 years old. ADAF of 1 was used for children greater than 16 years old and adults. The same calculation was used to determine the cancer risk for adults exposed to PAHs for 33 years. These exposures were averaged over a lifetime of 78 years.

Using a similar approach, exposure doses for dermal contact were calculated using the following equations and assumptions.

Soil Dermal Absorbed Dose Equation

$$DAD = (C \times EF \times CF \times AF \times ABSd \times SA) / BW$$

- DAD = Dermal Absorbed Dose (mg/kg-day)
- C = Contaminant Concentration (mg/kg)
- EF = Exposure Factor (unitless) = 0.28 (see above section)
- CF = Conversion Factor (10^{-6} kg/mg)
- AF = Adherence Factor to Skin (mg/cm²-event)
- ABSd = Dermal Absorption Fraction to Skin (unitless) (DSHS used ATSDR's default values of 0.03 for arsenic and 0.13 for PAHs)
- SA = Skin Surface Area Available for Contact (cm²)
- BW = Body Weight (kg)

Table B3. Exposure factor variable values used for dermal dose estimation

Exposure Group	Body Weight (kg)	Age Specific Exposure Duration (years)	Adherence Factor to Skin (mg/cm² event)	Combined Skin Surface Area (cm²)
6 to < 11 years	31.8	5	0.2	3,824
11 to < 16 years	56.8	5	0.2	5,454
16 to < 21 years	71.6	5	0.2	6,083
Adult	80	33	0.07	6,030