Public Health Assessment

Final Release

Public Health Implications of Exposures to Site Contaminants

FORMER KIL-TONE COMPANY

VINELAND, NEW JERSEY

EPA FACILITY ID: NJN000200874

Prepared by
New Jersey Department of Health

FEBRUARY 27, 2023

Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Office of Capacity Development and Applied
Prevention Science
Atlanta, Georgia 30333

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment was prepared by ATSDR's cooperative Agreement Partner pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6), and in accordance with our implementing regulations (42 C.F.R. Part 90). In preparing this document, ATSDR's Cooperative Agreement Partner has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate. In addition, this document has previously been provided to EPA and the affected states in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review.

The New Jersey Department of Health (NJDOH) prepared this Public Health Assessment for the Former Kil-Tone Site, located in Vineland, Cumberland County, New Jersey. This publication was made possible by a cooperative agreement (program#TS20-2001) with the federal Agency for Toxic Substances and Disease Registry (ATSDR).

The revised document was released for a 63-day public comment period. Subsequent to the public comment period, ATSDR's Cooperative Agreement Partner (the NJDOH) addressed all public comments and revised or appended the document as appropriate. The public health assessment has now been reissued. This concludes the public health assessment process for this site, unless additional information is obtained by ATSDR's Cooperative Agreement Partner which, in the agency's opinion, indicates a need to revise or append the conclusions previously issued.

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PUBLIC HEALTH ASSESSMENT

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Environmental and Occupational Health Surveillance Program
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Summary

Introduction

On September 30, 2015, the United States Environmental Protection Agency (USEPA) proposed the former Kil-Tone Company site (Kil-Tone), Cumberland County, New Jersey, to the National Priorities List (NPL). The site was added to the NPL on April 5, 2016. This public health assessment was prepared by the New Jersey Department of Health (NJDOH) under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). This document evaluates environmental data collected from the site to assess the potential for human health impacts from exposures to site contaminants. The top priority of NJDOH and ATSDR is to ensure that the community around the site has the best information possible to safeguard its health by reducing or eliminating exposure to site-related contaminants.

Kil-Tone manufactured arsenic-based pesticides from the late 1910s until the late 1930s. Contaminated soil has been identified on the former facility property and in the surrounding area. The primary contaminants related to Kil-Tone's former operations are arsenic and lead. Elevated levels of these contaminants have been found in on-site soil, in residential and non- residential soil surrounding the site, and in groundwater. Elevated levels of arsenic and lead have also been found in surface water and sediment in the Tarkiln Branch, an intermittent stream that receives runoff from the site. The former Kil-Tone facility property is currently owned by a sign manufacturing company. The current site operations are not related to the past Kil-Tone operations.

The site contamination is being addressed by the USEPA in multiple phases, or Operable Units (OUs). OU-1: Contaminated soil at residential properties in the vicinity of the site. OU-2: Contaminated soil at the site and other non- residential properties in the vicinity. OU-3: Groundwater at and in the vicinity of the site. OU-4: Surface water and sediment of the Tarkiln Branch and associated floodplain soil.

This public health assessment evaluates the potential public health implications from exposures to site contaminants from data collected during the initial USEPA removal investigations and actions. This includes data for the former Kil-Tone property and 89 residential properties potentially impacted by site contaminants. It should be noted that since the initial removal investigations and actions, USEPA has conducted further remedial investigations (RIs) which have identified more OU-1 and OU-2 properties that are impacted than those evaluated in this public health assessment. The NJDOH will evaluate additional data collected during the remedial investigations in future documents.

Conclusions	The NJDOH and ATSDR have reached the following conclusions for the former Kil-Tone site:
Conclusion 1	*The NJDOH and ATSDR conclude that past, current, and future exposures to surface soil contaminants for residents at 49 of the 89 properties may harm people's health.*

Basis for Conclusion

Forty properties are located near the Kil-Tone site, and nine properties are along the Tarkiln Branch.

For five properties, calculated doses for chronic exposures to arsenic were above levels where certain skin conditions (darkening and thickening of skin) were observed in human studies. For 15 properties, the arsenic levels in surface soil may result in an increased theoretical cancer risk from exposure.

For two properties, calculated doses for short-term (acute) exposure to copper were above levels where gastrointestinal effects (nausea, stomach pain, and vomiting) may be experienced by children. These effects may occur in children up to age 11 at the first property and up to age 2 at the second property.

For 20 properties, if children exhibit pica behavior (ingesting unusually high amounts of soil), the calculated doses for copper were above levels where gastrointestinal effects could occur based on human studies.

For three properties, if children exhibit pica behavior, the calculated doses for arsenic were approaching levels where facial swelling and gastrointestinal effects were observed in human studies.

Thirty-seven properties had average soil lead levels above 200 mg/kg. This is the level that the USEPA's lead model predicts children's blood lead levels may exceed 5 µg/dL, which is used to determine if subsequent remediation is necessary. Even remediated properties may have some lead in soil presenting a completed exposure pathway. Exposures to lead should be minimized as much as possible. Elevated blood lead levels in children may lead to attention, learning, and behavioral problems. They may also cause decreased hearing and slower growth and development.

Tables 31 and 32 in this document summarize the properties with current and past exposure concerns. Twenty-four properties have been remediated, thus eliminating current and future exposures. Nineteen are located near the Kil-Tone site, and five are located near the Tarkiln Branch. Remedial actions include the installation of fencing to prevent access along the Tarkiln Branch near two apartment complexes.

Next Steps	The USEPA's remediation activities are ongoing. Eight properties near the site with elevated soil lead will not be remediated because the USEPA determined that the lead was not site related. The NJDOH provided the Vineland Health Department with fact sheets on reducing exposures to lead and arsenic in soil, and on safe gardening which were distributed to all properties evaluated in this health assessment regardless of remediation status. This outreach ensures that all residents understand the measures they can take to reduce exposures and protect their health and the health of their family.
Conclusion 2	*The NJDOH and ATSDR conclude that past, current, and future exposures to lead in the Tarkiln Branch sediment may harm people's health.*
Basis for Conclusion	For accessible areas of the Tarkiln Branch, the average lead concentration in sediment was above 200 mg/kg, indicating the potential for exposure to lead resulting in blood lead levels above 5 µg/dL, which is used to determine if subsequent remediation is necessary. Lead levels in surface water were below the New Jersey Department of Environmental Protection (NJDEP) drinking water standard of 15 µg/L and are not likely to contribute to adverse health effects. However, exposures to lead should be minimized as much as possible.
Next Steps	The NJDOH and ATSDR recommend that the USEPA ensure that accessible areas of the Tarkiln Branch are fenced or otherwise protected from being accessed by residents until remediation is complete.
Conclusion 3	*The NJDOH and ATSDR conclude that past, current, and future exposures to soil contaminants for residents at the 40 remaining properties are not likely to harm people's health. Harmful health effects are also not expected for workers at the former Kil-Tone site.*
Basis for Conclusion	Calculated exposure doses for 21 residential properties near the Kil-Tone site and 19 residential properties along the Tarkiln Branch were below noncancer health guidelines for arsenic and copper. In addition, soil lead levels at these 40 properties were at or below 200 mg/kg. The USEPA's Adult Lead Methodology (ALM) model predicted that the blood lead levels of unborn children of pregnant workers would not exceed the CDC reference level of 3.5 µg/dL. The site is currently capped, preventing current and future exposures of site workers. Theoretical cancer risks for site workers and these residents were also determined to be low.

Conclusion 4	*The NJDOH and ATSDR conclude that past, current, and future exposures to arsenic in the Tarkiln Branch surface water and sediment are not likely to harm people's health.*
Basis for Conclusion	For arsenic in surface water and sediment, calculated exposure doses for noncancer health effects were below health guidelines. In addition, theoretical cancer risks were low for people wading or swimming in the Tarkiln Branch.
For More Information	Copies of this report will be provided to concerned residents in the vicinity of the site via the township libraries and the Internet. NJDOH will notify area residents that this report is available for their review and provide a copy upon request. Questions about this public health assessment should be directed to the NJDOH at (609) 826-4984.

Statement of Issues

On September 30, 2015, the United States Environmental Protection Agency (USEPA) proposed to add the former Kil-Tone Company site (Kil-Tone), Cumberland County, New Jersey, to the National Priorities List (NPL). The site was added to the NPL on April 5, 2016. Pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and the Superfund Amendments and Reauthorization Act (SARA) of 1986, the federal Agency for Toxic Substances and Disease Registry (ATSDR) is required to conduct public health assessment activities for sites listed or proposed to the NPL.

This public health assessment was prepared by the New Jersey Department of Health (NJDOH) under a cooperative agreement with ATSDR. This assessment evaluates environmental data collected from the site to assess the potential for human health impacts from exposures to site contaminants. The top priority of NJDOH and ATSDR at this site is to ensure that the community around the site has the best information possible to safeguard its health.

This public health assessment evaluates the residential properties sampled during the initial USEPA removal investigations and actions. This document also evaluates on-site soil and Tarkiln Branch surface water and sediment data collected during the USEPA's 2015 removal assessments.

Background

Site Description and Operational History

Kil-Tone is located at 527 East Chestnut Avenue in a residential/commercial/light industrial neighborhood of Vineland, Cumberland County, New Jersey (**See Figure 1**). The site is bounded to the north by East Cherry Street, to the south by Paul Street, to the east by South Sixth Street, and to the west by South East Boulevard (**See Figure 2**). The residences surrounding the site are mostly older structures constructed in the early 1900s. Most the properties are single-family homes or duplexes that have been converted into tenant-occupied apartment buildings. The oldest homes were built in 1890. The newest homes were constructed as recently as 1999.

The residential yards have lawns, landscaping, and impervious surfaces that include driveways, sidewalks, and patios. Residents at properties with more impervious surfaces would be less likely to come in contact with potentially contaminated soil. Commercial properties surrounding the site include a fuel distribution facility, a transmission service company, a salon, a restaurant, and a market. There are vacant lots and uninhabited properties in the area as well.

A storm sewer catch basin located in the northwestern corner of the Kil-Tone site receives storm water from the property and discharges into the Tarkiln Branch located across South East Boulevard about 400 feet west of the property (**See Figure 2**). The Tarkiln Branch is an intermittent surface water body. It is a tributary of the Parvin Branch which flows into the Maurice River located approximately 3.5 miles from the site [USEPA 2015]. The Maurice River eventually flows into Union Lake six miles downstream of the entrance of Parvin Branch.

Kil-Tone manufactured arsenic-based pesticides from the late 1910s until the late 1930s. The primary contaminants related to Kil-Tone's operations are arsenic and lead. Elevated levels of these contaminants have been found in on-site soil, groundwater, and surface water and in residential soil surrounding the site. Contamination has also been found in soil, sediment, surface water and groundwater downgradient of the property along the Tarkiln Branch.

The site was occupied by several food product and building supply businesses after Kil-Tone ceased operations [USEPA 2015a]. The site has been occupied by a sign manufacturing company since 2007. Operations are conducted within the building, with vehicles and equipment stored outside. The majority of the property was unpaved until the winter of 2016-2017 when the USEPA capped the site with pavement. The current business operations do not use lead or arsenic and are not related to Kil-Tone's past operations.

Regulatory and Remedial History

Contamination related to Kil-Tone was first discovered during remedial activities at a former fuel distribution facility called LERCO located across Chestnut Avenue from the former Kil-Tone property (**See Figure 2**). Soil samples collected at the LERCO property identified elevated arsenic and lead levels on the property. LERCO attributed this contamination to former pesticide manufacturing operations at Kil-Tone.

In August 2014, the NJDEP conducted a site investigation at the former Kil-Tone property and the surrounding residential properties. The purpose of this investigation was to determine if these properties were impacted by historic operations from Kil-Tone. Samples were collected from soil, groundwater, surface water and sediment on the former Kil-Tone site. Samples were also collected on residential, commercial, and vacant lots in the area of the site. Surface water and sediment from the Tarkiln Branch were also sampled during this investigation.

Samples were analyzed for the following metals: antimony, arsenic, barium, copper, and lead. Groundwater samples were collected from temporary well points installed on the properties sampled. Arsenic was detected in groundwater at both the LERCO property and the former Kil-Tone site. These findings prompted the NJDEP to refer the site to the USEPA on November 14, 2014, for a removal action under CERCLA. The site was proposed to the NPL on September 30, 2015 and was added to the NPL on April 5, 2016.

The USEPA conducted three phases of soil sampling investigations to determine if arsenic and lead levels in residential soil near the Kil-Tone site were present at concentrations that could pose a threat to public health and the environment. Samples were analyzed for metals, excluding mercury and cyanide. Soil samples on the Kil-Tone property and at 15 nearby residential properties were also analyzed for semi-volatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), and pesticides. **Table 1** summarizes the history of remedial investigations at the Kil-Tone site.

Phase I Investigation and Removal Assessment: In January 2015, the USEPA collected soil samples at 27 residential properties located closest to the former Kil-Tone property. Surface and subsurface soil samples were collected at multiple locations throughout each property at multiple depth intervals. Surface soil depths were defined by the USEPA as 0-6 inches below ground surface (bgs).

Concentrations of arsenic and lead exceeding the USEPA Residential Removal Management Levels of 67 milligrams/kilogram (mg/kg) for arsenic and 400 mg/kg for lead were found in the top two feet of soil at 19 of the 27 properties sampled.

In April 2015, the USEPA collected samples of sediment and surface water from the flood plain along the Tarkiln Branch and portions of the Parvin Branch to determine if there have been any site impacts. Soil samples were also collected from the floodplain of eight residential properties. Elevated concentrations of arsenic and lead are present in the sediments and flood plain areas along the entire stretch of the Tarkiln Branch to the confluence of the Maurice River.

Phase II Investigation and Removal Assessment: In June 2015, the USEPA expanded the soil sampling to further delineate the extent of contamination. This was done based on the elevated arsenic and lead concentrations in the soil at properties closest to the former Kil-Tone property. Soil sampling was completed on-site and at an additional 36 homes nearby. Surface soil samples for six homes exceeded the NJDEP arsenic residential soil remediation standard of 19 mg/kg, and 24 homes exceeded the lead residential soil remediation standard of 400 mg/kg.

In October 2015, the USEPA collected soil samples from 28 residential properties located within the flood plain of the Tarkiln Branch southwest of the site. Both arsenic and lead exceeded the USEPA residential removal managements levels. Samples were collected at multiple depths, with the shallowest depth at 0-2 inches below ground surface (bgs). This sample depth would be the most accessible to residents and was used by the NJDOH and ATSDR to evaluate exposures and potential health effects.

Phase III Investigation and Removal Assessment: In February and April 2016, the USEPA collected soil samples from 27 previously sampled residences to refine the horizontal and vertical extent of soil contamination related to Kil-Tone.

Table 1. Summary of Previous Investigations

Agency	Sampling Investigation Activity	Timeframe	Contaminants Analyzed	Surface Soil Depth Used in NJDOH/ATSDR Evaluation (inches bgs) *
NJDEP	Site Investigation	August 2014 - Surface soil samples - nine on-site and 12 residences	Metals **	0-6
USEPA	Removal Assessment Phase I Residential Soil	January 2015 (27 residences) – 20 homes have surface soil data	Metals **	0-2
USEPA	Removal Assessment Tarkiln Branch Sediment	April 2015 - Included surface soil samples in floodplain/wetland/creek bank areas for eight residential properties	Metals **	0-6 - sediment 0-2 - residential soil

Table 1 (Continued)

Agency	Sampling Investigation Activity	Timeframe	Contaminants Analyzed	Surface Soil Depth Used in NJDOH/ATSDR Evaluation (inches bgs) *
USEPA	Removal Assessment Tarkiln Branch Surface Water	April 2015 – 3 on-site and 12 off-site samples (including one duplicate sample) from Tarkiln Branch	Metals **	Not Applicable
USEPA	Removal Assessment Phase II Residential Soil	June 2015 (on-site and 36 additional residences not sampled during Phase I)	Metals, SVOCs, pesticides, PCBs**	0-2
USEPA	Removal Assessment Phase II Tarkiln Branch Residential Soil	October 2015 (28 residences)	Metals **	0-2
USEPA	Removal Assessment Phase III Residential Soil	February 2016; April 2016 (27 residences repeated from prior sampling) 18 have surface soil data	Metals, SVOCs, pesticides, PCBs **	0-2

*Soil sample depth units are in inches below ground surface (bgs); ** Metals analyzed by NJDEP: arsenic, lead, copper, antimony and barium; Metals analyzed by USEPA: arsenic, lead, copper and zinc; SVOCs (Semi-Volatile Organic Compounds), pesticides, and PCBs (polychlorinated biphenyls) were sampled on-site and for 15 homes during Phases II and III. NJDEP = New Jersey Department of Environmental Protection; USEPA = United States Environmental Protection Agency.

In the spring and summer of 2016, the USEPA completed interim removal actions on 26 residential properties with the highest concentrations of arsenic and lead in surface soil until a more permanent remedy can be implemented. These interim actions consisted of the installation of landscaping barriers (including stone, gravel, mulch, sod, raised garden beds, etc.) to prevent direct contact with contaminated soils. Six inches of topsoil and a layer of sod were also part of the interim removal actions on these properties. Property owners and/or residents were instructed to not disturb this layer. Interim removal actions were taken at 18 residential properties near the Kil-Tone site and at eight residences adjacent to the Tarkiln Branch with similarly high levels of arsenic and/or lead in soil.

The USEPA is currently addressing the Site in four phases or operable units (OUs). OU-1 addresses the contaminated soil on residential properties. EPA selected a remedy for OU-1 and the OU-1 Record of Decision (ROD) was signed on September 12, 2016. The OU-1 remedy includes excavation of soil contaminated primarily with arsenic and lead; off-site disposal of contaminated soil; backfilling of excavated areas with clean fill; and restoration of the affected properties. Remedial Action for the cleanup of impacted OU-1 residential properties was initiated in 2017. As of April 2020, 32 impacted OU-1 residential properties have been cleaned up. Cleanup of the remaining impacted OU-1 residential properties is expected to be completed by Fall 2023.

OU-2 addresses contaminated soil on commercial or non-residential properties in the vicinity of the former Kil-Tone facility. The OU-2 ROD was signed on September 30, 2019, and the selected remedy includes excavation of soil primarily contaminated with arsenic and lead from the former Kil-Tone facility and other impacted commercial or non-residential properties in the vicinity; off-site disposal of contaminated soil that exceeds the appropriate property-specific soil remediation standard, backfilling of excavated areas with clean fill; and restoration of the affected properties. Remedial Design for the OU-2 is expected to be ready by Spring 2023, and the Remedial Action is expected to be completed by 2027.

OU-3 addresses the groundwater contamination. The OU-3 Remedial Investigation/Feasibility Study (RI/FS) was initiated in 2019 and is currently in progress. Most residents in the area use public water, and the nearest supply well is 15 miles away. Therefore, public water supplies were not sampled. The USEPA has identified 13 residences with private wells in the area of the site. Eleven of these wells were sampled by the USEPA in November 2019. The results indicated that lead, aluminum, and manganese exceeded federal or state drinking water standards in three of the eleven wells sampled. The USEPA determined that these contaminants are not likely related to the former Kil-Tone site and provided the sampling results to the residents. The USEPA provided the residents with the NJDOH private well fact sheet which has information on private well issues and maintenance. The Vineland Health Department was also notified of the private well sampling results.

OU-4 will address sediment and surface water contamination in the Tarkiln Branch and associated floodplain soil, and further downstream as needed, based on the findings of ongoing investigations. There are some residential properties in the floodplain; these will be fully addressed as part of OU-4, after an ROD is signed and the remedy is designed (removal actions were taken on some of them). The OU-4 RI/FS was initiated in 2020.

Site Geology and Hydrogeology

The topography of the Kil-Tone property and the surrounding area is generally flat. The site is located on Downer and Auro loamy sands, according to the US Department of Agriculture, Soil Conservation Service, Soil Survey of Cumberland County [Tetra Tech 2016a]. The Downer loamy sands are formed from fluviomarine deposits, located on river basins or hills. The Auro loamy sands occur with low hills and ancient stream terraces. The permeability is moderately slow to moderate for these soil associations. Parent material is described as loamy and gravelly alluvium.

Demographics

According to the 2010 U.S. Census, 17,477 people live within one mile of the site. The population in this area increased 4% since the 2000 census. Of these, approximately 2,200 (13%) are ages six and under. Additionally, approximately 4,000 (23%) women of child-bearing age live within one mile of the site. This is important because one of the primary contaminants at this site is lead, which can cause serious health effects in young children, especially those under the age of six. There are several factors associated with increased blood lead levels in children.

These include:

- living in homes built before 1978, and especially before 1950,
- age of infrastructure (i.e., plumbing),
- living in rental housing,
- poverty,
- minority groups,
- living in urban areas,
- living in the Northeast region of the United States, and

- immigrant and refugee populations

More detailed demographic information about the people in the area can be found in **Appendix B.**

Vineland is an overburdened community as defined by New Jersey's Environmental Justice Law of September 2020. An overburdened community is one in which:

- at least 35 percent of the households qualify as low-income households (at or below twice the poverty threshold as determined by the United States Census Bureau);
- at least 40 percent of the residents identify as minority or as members of a State-recognized tribal community; or
- at least 40 percent of the households have limited English proficiency (without an adult that speaks English "very well" according to the United States Census Bureau).

For more information and resources for overburdened communities, please visit dep.nj.gov/ej/communities/.

Healthy Community Planning Reports: A snapshot of a Municipality's Health

These reports were developed by NJDOH and NJDEP as part of New Jersey's Environmental Public Health Tracking project. They provide municipal-level health and environmental data and resources for communities to take actions to promote a healthy and safe environment.

These reports can be found at nj.gov/health/hcpnj. Vineland's specific report can be viewed at: nj.gov/health/hcpnj/documents/county-reports/HCPNJ_fullreports/CUMBERLAND_VINELAND%20CITY.pdf

Site Visit

In October 2016, ATSDR, USEPA, and NJDOH staff conducted a site visit to determine potential human exposure pathways for site contaminants. Areas inspected during the site visit included the site itself, surrounding residences, and the Tarkiln Branch. The Tarkiln Branch is an intermittent stream. No water was observed in the stream during the site visit, but the stream runs behind homes and is accessible to residents.

Most residents in the area use public water, and the nearest supply well is 15 miles away. Therefore, public water supplies were not sampled. The USEPA has identified 13 residences with private wells in the area of the site. Eleven of these wells were sampled by the USEPA. The USEPA has provided the sampling results to the residents and to the Vineland Health Department. The NJDOH will evaluate potable well data in a separate document.

Interim remedial actions had been taken at residences immediately surrounding the site. These include the placement of a six-inch soil cap and providing raised beds to residents for gardening. Since the site visit, 32 properties in the area of the site have been permanently remediated, and the site itself has been capped with pavement. Site visit photos can be found in **Appendix C**.

Community Concerns

The NJDOH and ATSDR participated in two USEPA hosted availability sessions in July 2015 to address community concerns. The main health concerns expressed by residents included child blood lead testing and gardening in contaminated soil. Residents also expressed concern about children in the community with learning disabilities.

The NJDOH and ATSDR provided fact sheets on reducing exposures to lead in soil and safe gardening in contaminated soil. These fact sheets were tailored specifically for the Kil-Tone Site and were provided in both English and Spanish. The NJDOH and ATSDR also advised residents on ways to reduce exposures to lead and arsenic in soil at the availability sessions and by going door-to-door speaking directly with residents. Contact information was provided for the Region 2 Pediatric Environmental Health Specialty Unit (PEHSU) and to the Rutgers Environmental and Occupational Health Sciences Institute (EOHSI). Residents can have their child's pediatrician contact these specialists to discuss exposures and provide further testing guidance. The Vineland Health Department also offered guidance on blood lead testing for concerned parents.

The NJDOH and ATSDR hosted a community meeting on June 29, 2022, to solicit public comments for this public health assessment. No formal comments were provided. However, some residents expressed concerns over future well water contamination and soil testing on their properties. These concerns were brought to the USEPA's attention for follow-up.

Environmental Contamination

An evaluation of site-related environmental contamination consists of a two-tiered approach: 1) a screening analysis, and 2) a more in-depth analysis to determine public health implications of site-specific exposures. First, maximum concentrations of detected substances are compared to media-specific screening levels called comparison values. If concentrations exceed the media-specific (e.g., soil, water) comparison value, these substances are referred to as Contaminants of Potential Concern (COPCs) and are selected for further evaluation. If media-specific comparison values are unavailable, contaminants are selected for further evaluation.

Contaminant levels above media-specific comparison values do not mean that adverse health effects are likely, but that further evaluation is necessary. An exposure point concentration (EPC) is derived for COPCs. The EPC is either the maximum concentration or the 95% upper confidence limit of the mean of the environmental data. The EPC determines the concentration of the contaminant used to calculate exposure doses. Once exposure doses are estimated, they are further evaluated to determine the likelihood of adverse health effects.

Environmental Guideline Comparison

There are a number of media-specific comparison values available for screening environmental contaminants to identify contaminants of concern. These include ATSDR Environmental Media Evaluation Guides (EMEGs) and Reference Media Evaluation Guides (RMEGs). EMEGs are estimated contaminant concentrations that are not expected to result in adverse non-carcinogenic health effects. RMEGs represent the concentration in water or soil at which daily human exposure is unlikely to result in adverse non-carcinogenic effects. If the substance is a known or a probable carcinogen, ATSDR's Cancer Risk Evaluation Guides (CREGs) are also considered as comparison values. CREGs are estimated contaminant concentrations that would be expected to cause no more than one excess cancer in a million (expressed exponentially as 10^{-6}) persons exposed over their lifetime (78 years).

In the absence of an ATSDR media-specific comparison value, other screening levels may be used to evaluate contaminant levels in environmental media. These include the USEPA Regional Screening Levels and the NJDEP Soil Remediation Standards. For surface water contaminants, the NJDEP drinking water maximum contaminant levels (MCLs) are used.

Soil – On-site and Off-site

During the August 2014 NJDEP site investigation, discrete soil samples were collected from 12 residential properties, three vacant properties, and three commercial properties, including the former Kil-Tone site itself. The northwestern portion of the Kil-Tone site had the highest concentrations of arsenic and lead in surface soil samples (0-2 feet bgs) with arsenic at 3,000 mg/kg and lead at 3,100 mg/kg. Both exceed the NJDEP non-residential soil remediation standards. A subsurface soil sample collected in the western portion of the former Kil-Tone property at four feet bgs contained arsenic at 5,800 mg/kg and lead at 3,600 mg/kg [USEPA 2015]. Arsenic and lead were detected in the top six inches of soil at the residential properties at concentrations as high as 83 mg/kg and 1,100 mg/kg, respectively.

During the USEPA's Phase I removal assessment in January 2015, the highest concentration of arsenic in residential soil was 1,000 mg/kg at a depth of 2-6 inches bgs. The highest concentration of lead was 2,500 mg/kg at 6-12 inches bgs. In surface soil (0-2 inches bgs), arsenic was found at concentrations as high as 240 mg/kg, and lead was found at concentrations as high as 1,800 mg/kg. These concentrations were not found on the same property. Surface soil samples collected on the Kil-Tone site itself showed maximum arsenic and lead concentrations at 2,300 mg/kg and 380 mg/kg, respectively.

During the USEPA's Phase II removal assessment at residences near the site in June 2015, the highest concentration of arsenic was detected at 380 mg/kg at a sample depth of 2-6 inches bgs. The highest lead concentration was detected at 5,700 mg/kg at a sample depth of 0-2 inches bgs. These concentrations were not found on the same property. Residential properties along the Tarkiln Branch were sampled in October 2015. Soil samples collected at 0-2 inches bgs at these properties had arsenic and lead levels as high as 610 mg/kg and 820 mg/kg, respectively.

The USEPA conducted a Phase III removal assessment in February 2016 for previously sampled homes. Maximum arsenic and lead concentrations at the shallowest sample depth of 0-2 inches bgs were 129 mg/kg and 4,160 mg/kg, respectively.

For surface soil, ATSDR considers the top three inches of soil the layer for incidental soil ingestion and dermal contact exposures. For this public health assessment, surface soil samples collected at a depth of 0-2 inches bgs for the residential properties and sediment samples at depths of 0-6 inches bgs were used to evaluate the potential for health effects. This is because sub-surface soils and sediments are not considered accessible.

Table A-1 in Appendix A summarizes the contaminants found in surface soil on the Kil-Tone site. **Tables A-2 and A-3** summarize contaminants found in surface soils at the residential properties closest to the site and adjacent to the Tarkiln Branch. As shown in these tables, lead, arsenic, and copper exceeded applicable comparison values in surface soil. Low levels of some polycyclic aromatic hydrocarbons (PAHs) and pesticides also exceeded applicable comparison values. These contaminants will be evaluated for potential human health effects.

Surface Water and Sediment – Kil-Tone Site and Tarkiln Branch

Tables B-1 and B-2 in Appendix A summarize contaminants found in surface water samples collected on the site and in the Tarkiln Branch. Three surface water samples were collected on the Kil-Tone property itself in April 2015. The samples were collected in the northwest corner of the site where the storm water catch basin leading to the Tarkiln Branch is located. Samples were analyzed for arsenic and lead. Maximum arsenic and lead concentrations were 13,000 micrograms per liter (µg/L) and 39,000 µg/L, respectively. The residential water supply was not sampled because the area is served by public water and the nearest drinking water supply well is located 15 miles from the site.

Surface water samples collected by the USEPA from the Tarkiln Branch in April 2015 contained arsenic up to 360 µg/L and lead at 16 µg/L. Sediment samples collected by the USEPA in April 2015 from the Tarkiln Branch contained arsenic up to 1,400 mg/kg and lead up to 2,200 mg/kg. Sediment samples were collected at a depth of 0-6 inches bgs. **Table B-3 in Appendix A** summarizes the contaminants found in Tarkiln Branch sediment.

Discussion

The method for assessing whether a health hazard exists to a community is to determine whether there is a completed exposure pathway from a contaminant source to an exposed population and whether exposures to contamination are high enough to be of health concern [ATSDR 2005]. Site-specific exposure doses can be calculated and compared with health guidelines, such as ATSDR's minimal risk level (MRL). If site doses exceed the health guideline, those doses can be compared with levels determined to cause harmful effects in animal and human studies.

Assessment Methodology – Identifying Exposure Pathways

An exposure pathway is a series of steps starting with the release of a contaminant in environmental media and ending at the interface with the human body. A completed exposure pathway consists of five elements:

1. source of contamination;
2. environmental media and transport mechanisms;
3. point of exposure;
4. route of exposure; and
5. receptor population.

Generally, the ATSDR considers three exposure pathway categories:

1) completed exposure pathways - all five elements of a pathway are present;
2) potential exposure pathways - one or more of the elements may not be present, but information is insufficient to eliminate or exclude the element; and
3) eliminated exposure pathways - one or more of the elements is absent.

Exposure pathways are used to evaluate specific ways in which people were, are, or will be exposed to environmental contamination in the past, present, and future **(See Table 2**).

Table 2. Exposure Pathways

Pathway	Environmental Medium	Exposure Route	Location	Exposed Population	Pathway Classification
Surface Soil	Soil	Ingestion/Dermal Contact	Site Property/ Area Properties	Workers/ Children/Adults	Past, Current, and Future – Complete for some residents, Eliminated for site workers*
Sub-Surface Soil	Soil	Ingestion/Dermal Contact	Site Property/ Area Properties	Workers	Past, Current, and Future - Eliminated
Sediment	Soil	Ingestion/Dermal Contact	Tarkiln Branch	Children/Adults	Past, Current, and Future - Complete
Surface Water	Water	Ingestion/Dermal Contact	Site Property/ Tarkiln Branch	Workers/ Children/Adults	Past, Current, and Future – Complete for residents, Eliminated for site workers
Drinking Water	Water	Ingestion/Dermal Contact	Water Supply Wells	Children/Adults	Potential **
Biota	Food	Ingestion	Tarkiln Branch	Children/Adults	Eliminated

*Current and future exposures for site workers and some residents have been eliminated due to remediation activities. Past exposures are complete for site workers and all residents exposed prior to remediation; ** NJDOH recently learned there are potable wells at some residences in the area of the site.

Completed Exposure Pathways

Ingestion of and dermal contact with contaminated surface soil (past, current and future).
There is a completed exposure pathway for area residents and workers who contact contaminated surface soil. Residents, especially children, may come into contact with contaminated soil while playing in their yards, particularly in areas with bare soil. Based on information collected during the site visit and availability sessions, residents in the area also garden. Prior to the site being capped, workers may have come into contact with contaminated surface soil/dust while eating or smoking outdoors.

The USEPA has provided residents with raised garden beds as part of remedial activities. Additionally, information about safe gardening in contaminated soil has been provided to residents by the USEPA, NJDOH, and ATSDR (See **Appendix D**). The site property was capped with pavement in the winter of 2016-2017.

Ingestion of and dermal contact with surface water and sediment from Tarkiln Branch (past, current, and future). The Tarkiln Branch runs through residential neighborhoods and is accessible from the backyards of several homes. Some homes have also experienced flooding from the Tarkiln, which may deposit contaminants into their yards. Therefore, there is a completed exposure pathway for residents, particularly children, who come into contact with contaminated surface water and sediments in the Tarkiln Branch. It is unlikely that the Tarkiln Branch is used for swimming; however, residents may wade in the shallow water when water is present.

The USEPA has interrupted these pathways with fencing to prevent access to the Tarkiln Branch in some areas and through the removal of contaminated soil from impacted properties. This work is ongoing, so completed exposure pathways may still exist at some properties, particularly those along the Tarkiln

Branch. The USEPA has provided information on reducing exposures to lead and arsenic to residents along the Tarkiln Branch. This information is consistent with fact sheets previously distributed to residents near the Kil-Tone site by the NJDOH and ATSDR (See **Appendix D**).

Potential Exposure Pathways

Ingestion of Drinking Water. Although there are no public drinking water supply intakes within 15 miles of the site [USEPA 2015], the NJDOH has learned that there are potable wells for some residences in the area of the site. In November 2019, the USEPA collected potable well samples from 11 residences.

Eliminated Exposure Pathways

Ingestion of and Dermal Contact with Sub-Surface Soil. Sub-surface soil is not considered accessible to residents or workers. Most of the contamination on the residential properties is within the top two feet of soil. Due to the nature of the businesses on the site and in the area, it is unlikely that workers will be digging into contaminated soil. The former Kil-Tone site itself has been paved (capped), eliminating exposures to contaminated soil on the site.

Ingestion of and Dermal Contact with On-site Surface Water. The three on-site surface water samples collected by the USEPA were located in two storm drains and one puddled area leading to a storm drain on the site. It is not likely that site workers would come into contact with this surface water because it drains quickly. Therefore, this pathway is eliminated.

Ingestion of Biota. Based on information provided in USEPA reports and the site visit conducted by the NJDOH and ATSDR, it is unlikely that the Tarkiln Branch is used for fishing. Therefore, this pathway is eliminated.

Public Health Implications of Completed Exposure Pathways

Once it has been determined that individuals have or are likely to come in contact with site-related contaminants (i.e., a completed exposure pathway), the next step in the public health assessment process is the calculation of site-specific exposure doses. This is called a health guideline comparison that involves looking more closely at site-specific exposure conditions, the estimation of exposure doses, and the evaluation with health guidelines. Health guidelines are based on data drawn from the epidemiologic and toxicologic literature and often include uncertainty or safety factors to ensure that they are amply protective of human health. When doses are below health guidelines like ATSDR's MRL, then noncancerous effects are not likely.

There is no health guideline for lead, and exposure doses are not calculated. The Centers for Disease Control and Prevention (CDC) currently uses a blood lead reference value of 3.5 micrograms of lead per deciliter of blood (µg/dL) to identify children with higher levels of lead in their blood compared to most children. Residential child lead exposures are evaluated using the USEPA's integrated exposure uptake biokinetic (IEUBK) model [USEPA 1994, 2021]. Lead exposures associated with children's use of lead contaminated areas were evaluated using the USEPA's IEUBK model.

This model is designed to predict the probability that children ages one to five years who regularly play in areas with soil lead contamination could be exposed to lead at levels high enough to raise their blood lead levels above 5 µg/dL, which was previously CDC's blood lead reference value. This value is also the lowest blood lead level verified for the model. This probability estimate should be at or below a protection level of five percent, i.e., P5 ≤ 5 percent, as recommended by the USEPA Office of Solid Waste and Emergency Response (USEPA 1994). Because no threshold for adverse health effects has been identified for blood lead levels, the public health goal of the NJDOH and ATSDR is to reduce blood lead levels in children as much as possible.

USEPA guidance states that average soil lead concentrations should be used when running the model [USEPA 1994]. The USEPA's Adult Lead Methodology (ALM) model was used to estimate blood lead levels in pregnant women who may have worked on the site prior to it being capped. This model is designed to predict the blood lead levels of fetuses that are exposed to lead [USEPA 2003]. Because there is no safe blood lead level, it is important to reduce lead exposure as much as possible.

Determining the Exposure Concentration for Contaminants of Concern

When estimating exposure to a contaminant of concern, the ATSDR recommends using the 95 percent upper confidence limit (95% UCL) of the arithmetic mean when data are sufficient to determine the exposure point concentrations (EPC) for site-related contaminants [ATSDR 2019]. The 95% UCL is considered a "conservative estimate" of average contaminant concentrations in an environmental medium.

EPCs were calculated for each contaminant at each property for all contaminants of concern. Using ATSDR guidance [ATSDR 2019], the 95% UCL of the mean was used for soil contaminants with eight or more samples and for samples with 20% or more detections. Maximum concentrations were used as the EPCs for contaminants with seven or fewer samples or less than 20% of detections. Duplicate samples were averaged and counted as one sample. The IEUBK model requires the use of the average soil concentration as the EPC for lead.

Noncancer Health Effects

To assess noncancer health effects, ATSDR has developed MRLs for contaminants that are commonly found at hazardous waste sites. An MRL is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse, noncancer health effects. MRLs are developed for a route of exposure, such as swallowing or breathing, over a specified time period. Exposure periods are classified as:

- acute (less than 14 days),
- intermediate (15 - 364 days), or
- chronic (365 days or more).

MRLs are based largely on toxicological studies in animals and sometimes on reports of human occupational (workplace) exposures. MRLs are usually extrapolated doses from observed effect levels in animal toxicological studies or occupational studies and are adjusted by a series of uncertainty (or safety) factors or through the use of statistical models. In toxicological literature, effect levels are categorized as

- no-observed-adverse-effect level (NOAEL); and
- lowest-observed-adverse-effect level (LOAEL).

A NOAEL is the highest tested dose of a substance that has been reported to have no harmful health effects on people or animals. A LOAEL is the lowest tested dose of a substance that has been reported to cause harmful health effects in people or animals. Based on current ATSDR guidance, calculated exposure doses are compared to effect levels (LOAEL) rather than no effect levels (NOAEL). As the exposure dose increases beyond the MRL to the level of the LOAEL, the likelihood of adverse health effects increases.

To ensure that MRLs are sufficiently protective, the extrapolated values can be several hundred times lower than the observed effect levels in experimental studies. When MRLs for specific contaminants are unavailable, other health guidelines, such as the USEPA reference dose (RfD), are used. The RfD is an estimate of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of harmful effects during a lifetime.

Ingestion – Residential Soil/Sediment and On-Site Soil

Exposures to off-site residents and on-site workers are based on incidental ingestion of contaminated surface soil for children and adults. Noncancer exposure doses were calculated using the following formula for contaminants other than lead:

$$\textit{Exposure Dose (mg/kg/day)} = \frac{C \times IR \times EF \times CF}{BW}$$

where,
mg/kg/day = milligrams of contaminant per kilogram of body weight per day;
C = concentration of contaminant in surface soil (mg/kg);
IR = soil ingestion rate (mg/day);
EF = exposure factor representing the site-specific exposure scenario;
CF = conversion factor (10^{-6} kg/mg) and,
BW = body weight (kg).

Noncancer health effects are assessed by comparing the exposure dose to health guidelines like ATSDR's MRL or EPA's RfD via a ratio known as the "hazard quotient" or "HQ". The hazard quotient is defined as follows:

$$\textit{Hazard Quotient (HQ)} = \frac{\textit{Exposure Dose}}{\textit{MRL or RfD}}$$

A hazard quotient above one means that the health guideline is exceeded. Contaminants of concern with a hazard quotient exceeding a value of one were evaluated further to determine whether these contaminants pose a health threat to exposed or potentially exposed populations.

Exposure Dose Assumptions and Scenarios for Contaminants Other than Lead

ATSDR's exposure dose guidance for soil and sediment ingestion and USEPA's Exposure Factor Handbook were used to calculate exposure doses (ATSDR 2018, USEPA 2011). Exposure doses were calculated for adults and children ingesting contaminated soil on each property. Exposure doses were calculated for three soil ingestion scenarios using the ATSDR Public Health Assessment Tool (PHAST). For people with typical, or average soil ingestion rates, we used a "central tendency exposure" (CTE) scenario. For people with above average ingestion rates, a "reasonable maximum exposure" (RME) scenario was used. The RME refers to people with above average exposures but still within a realistic exposure range.

For both CTE and RME scenarios, the age range for children is from infant through less than 21years. The adult scenario is for people 21 years of age and over. **Tables 3 and 4** show the exposure parameters and assumptions used to calculate exposure doses for both scenarios. For the Tarkiln Branch, exposure scenarios included wading, swimming, and incidental ingestion of sediment during summer months for adults and for children ages 6 to less than 21 years.

Table 3. Exposure Parameters Used in Dose Calculations

Age Group	CTE Scenario - Average Soil Ingestion Rate (mg/day)	RME Scenario - Above Average Soil Ingestion Rate (mg/day)	Body Weight (kg)
Child - Birth to < 1 year	55	150	7.8
Child - 1 to < 2 years	90	200	11.4
Child - 2 to < 6 years	60	200	17.4
Child - 6 to < 11 years	60	200	31.8
Child - 11 to < 16 years	30	100	56.8
Child - 16 to < 21 years	30	100	71.6
Adult ≥ 21 years	30	100	80

CTE = Central Tendency Exposure; RME = Reasonable Maximum Exposure; mg/day = milligrams of soil ingested per day; kg = kilograms.

Table 4. Exposure Assumptions Used in Dose Calculations

Exposed Population	Soil Ingestion Rate (mg/day)	Body Weight (kg)	Exposure Frequency	Exposure Frequency for Tarkiln Branch
Child Resident	Age Specific *	Age Specific *	365 days/year	Children ages 6 to < 21 years of age: 5 days/week, 12 weeks/year
Adult Resident	30 (CTE); 100 (RME) *	80	365 days/year	Adults ≥ 21 years of age: 5 days/week, 12 weeks/year
Adult Site Worker	100 (low soil contact)	80	250 days/year for 10 years ^	Not Applicable

*= See parameters in **Table 3**; ^ = 10-year duration for site workers represents the length of time that the sign company was operating prior to the site being capped; CTE = Central Tendency Exposure; RME = Reasonable Maximum Exposure; mg/day = milligrams of soil ingested per day; kg = kilograms.

The third soil ingestion scenario is for children with soil-pica behaviors. Pica is defined as the consumption of nonfood items and is well documented in children [ATSDR 2018]. Soil-pica is the consumption of large amounts of soil. Within any population of children, particularly those of preschool age, some could exhibit soil-pica behavior.

Soil-pica behavior is most likely to occur in preschool children as part of their normal exploratory behavior, with somewhere from 4% to 20% of preschool children exhibiting soil-pica. Children between the ages of 1 and 2 have the greatest tendency for soil-pica behavior, which diminishes as they age [ATSDR 2018]. For the purposes of this health consultation, soil-pica behavior was assessed for two preschool aged groups: ages 1 to < 2 years, and 2 to < 6 years.

Table 5 summarizes the parameters used to evaluate soil-pica behavior in children. These parameters represent a weekly dose for acute exposures or a monthly dose for intermediate durations. The soil ingestion rate for pica behavior in children represents the average (CTE) intake rate, as there is no reliable upper percentile intake rate available for soil-pica [ATSDR 2018].

Table 5. Soil-pica Exposure Parameters

Exposed Population	Soil Ingestion Rate Pica Child (mg/event)	Body Weight (kg)	Exposure Frequency
Child (1 to < 2 years)	5,000 *	11.4	3 days/7days = 0.43
Child (2 to < 6 years)	5,000 *	17.4	3 days/7days = 0.43

*Represents average (CTE) intake rate; CTE = Central Tendency Exposure; mg/event = milligrams of soil ingested per event; kg = kilograms.

Dermal exposure doses were also calculated using PHAST and added to the ingestion doses to create a combined dose. The dermal dose was minimal compared to the ingestion exposure pathway. Dermal exposures doses were calculated using the following formula:

$$\text{Dermal Absorbed Dose (mg/kg/day)} = \frac{C \times AF \times EF \times CF \times ABS_d \times SA}{BW \times ABS_{GI}}$$

where,
mg/kg/day = milligrams of contaminant per kilogram of body weight per day;
C = concentration of contaminant in surface soil (mg/kg);
AF = Adherence Factor to skin (mg/cm^2-event);
EF = Exposure Factor representing the site-specific exposure scenario (unitless);
CF = Conversion Factor (10^{-6} kg/mg);
ABS_d = Dermal Absorption Fraction to skin (unitless);
SA = Skin surface area available for contact (cm^2);
BW = Body Weight (kg); and
ABS_{GI} = Gastrointestinal Absorption Factor (unitless).

Toxicological information for the contaminants of concern can be found in **Appendix E**. The information and health effects presented in **Appendix E** summarize what we know about the toxicology of a chemical. The potential health effects from site-specific exposures are discussed below. An example PHAST spreadsheet and dose calculation for noncancer health effects is shown in **Appendix F**.

Exposure doses were calculated for children and adults using both average (CTE) and above average (RME) soil ingestion rates. The ratio of these doses to the MRL or RfD results in the hazard quotient. A hazard quotient is calculated for each age group and exposure duration (acute, intermediate, chronic) for each contaminant of concern. Contaminants with hazard quotients above one were compared to the corresponding effect level (e.g., a LOAEL) to determine the likelihood of adverse health effects. For simplicity, only the results of the maximum RME dose are presented, which reflects the worst-case scenario.

Table 6 summarizes the health effect levels for the metals which had elevated hazard quotients for at least one age group. Lead is evaluated separately, as there is no LOAEL available.

Table 6. Summary of Health Guidelines and Noncancer Health Effects

Contaminant	Chronic Health Guidelines (mg/kg/day)	Intermediate Health Guidelines (mg/kg/day)	Acute Health Guidelines (mg/kg/day)	Chronic Health Effect	Intermediate Health Effect	Acute Health Effect
Arsenic [+]	MRL = 0.0003 NOAEL = 0.0008 LOAEL = 0.002	NA	MRL = 0.005 LOAEL = 0.05	Skin conditions in humans*	NA	Facial swelling/ GI effects in humans**
Copper	NA	MRL = 0.01 NOAEL = 0.042 LOAEL = 0.09	MRL = 0.01 NOAEL = 0.027 LOAEL = 0.01-0.07	NA	GI effects in humans**	GI effects in humans**

[+]ATSDR assumes 60% bioavailability when calculating arsenic doses; *specific skin conditions based on human studies include hyperpigmentation and hyperkeratosis; MRL = ATSDR Minimal Risk Level; NOAEL = No Observed Adverse Effect Level; LOAEL = Lowest Observed Adverse Effect Level; **Gastrointestinal (GI) effects include nausea, vomiting, diarrhea; NA = Not Available; mg/kg/day = milligrams of contaminant per kilogram body weight per day.

Soil Ingestion – Residential Exposures

Arsenic and copper had elevated hazard quotients for at least one exposure duration (acute, intermediate, or chronic) and age group. The "Margin of Exposure" evaluates the likelihood of harmful health effects based on the ratio of the calculated exposure dose to the health guideline (LOAEL).

<u>Arsenic:</u> Of the 89 residential properties evaluated in this health assessment, 62 properties had hazard quotients below one. Therefore, noncancer health effects are not expected at these properties. Twenty-seven properties had elevated hazard quotients for arsenic, which required further evaluation. Sixteen of these properties are located near the former Kil-Tone site (**See Table 7**). The remaining 11 properties are located near the Tarkiln Branch (**See Table 8**). Calculated exposure doses at 22 of these 27 properties were well below the chronic LOAEL of 0.002 mg/kg/day for certain skin conditions (hyperpigmentation, hyperkeratosis) reported in human studies. Therefore, noncancer adverse health effects are not expected at these 22 properties.

Estimated doses in children at five properties approached or exceeded the chronic LOAEL of 0.002 mg/kg/day where adverse health effects were observed in human studies. These studies reported adverse effects to the skin, along with gastrointestinal, cardiovascular, liver, blood, and respiratory system effects at or near this skin LOAEL. [ATSDR 2007a]. Because the risk of skin effects at low doses requires about 10 years of exposure, weighted averages of the highest exposure doses for children up to age 11 were calculated and compared to the LOAEL to decide whether residents were at risk of harmful effects involving the skin (See **Tables 7 and 8**).

Table 7. Chronic Exposures to Arsenic – Properties Near Kil-Tone Site

Property ID	Arsenic EPC (mg/kg)[a]	RME Dose (mg/kg/day)[b]	Chronic MRL (mg/kg/day)[c]	Hazard Quotient [d]	Chronic LOAEL (mg/kg/day)[e]	Margin of Exposure [f]	RME Weighted Average Dose [g] (mg/kg/day)	Potential for Non-Cancer Health Effects
7	220	0.0028	0.0003	9.5	0.002	0.71	**0.0016**	**Yes**
6	150	0.0019	0.0003	6.5	0.002	1.05	**0.0011**	**Yes**
19	100	0.0013	0.0003	4.3	0.002	1.54	0.0007	No
68	66	0.00085	0.0003	2.8	0.002	2.35	NC	No
21	61	0.00079	0.0003	2.6	0.002	2.53	NC	No
1	59	0.00076	0.0003	2.5	0.002	2.63	NC	No
5	59	0.00076	0.0003	2.5	0.002	2.63	NC	No
20	50	0.00065	0.0003	2.2	0.002	3.08	NC	No
26	48	0.00062	0.0003	2.1	0.002	3.23	NC	No
4	40	0.00052	0.0003	1.7	0.002	3.85	NC	No
8	32	0.00041	0.0003	1.4	0.002	4.88	NC	No
2	29	0.00037	0.0003	1.2	0.002	5.41	NC	No
35	29	0.00037	0.0003	1.2	0.002	5.41	NC	No
29	27	0.00035	0.0003	1.2	0.002	5.71	NC	No
25	25	0.00032	0.0003	1.1	0.002	6.25	NC	No
27	24	0.00031	0.0003	1.0	0.002	6.45	NC	No

[a] Exposure point concentration derived using 95% UCL of the mean for properties with $\geq$ 8 samples (Properties 1 and 26),or the maximum concentration for properties with < 8 samples; [b] Reasonable Maximum Exposure Dose representing above average ingestion rates for children ages birth to < 1 year; [c] MRL = Chronic Minimal Risk Level; [d] Hazard Quotient = RME Dose/ Chronic MRL; [e] LOAEL = Lowest Observed Adverse Effect Level; [f] Margin of Exposure = Chronic LOAEL / RME Dose; [g] Weighted average RME dose represents children ages birth to <11 years; mg/kg/day = milligrams of contaminant per kilogram body weight per day; mg/kg = milligrams of contaminant per kilogram of soil; NC = Not Calculated.

Table 8. Chronic Exposures to Arsenic – Tarkiln Branch Properties

Property ID	Arsenic EPC (mg/kg)[a]	RME Dose (mg/kg/day) [b]	Chronic MRL (mg/kg/day) [c]	Hazard Quotient [d]	Chronic LOAEL (mg/kg/day)[e]	Margin of Exposure [f]	RME Weighted Average Dose (mg/kg/day) [g]	Potential for Non-Cancer Health Effects
93	210	0.0027	0.0003	9.0	0.002	0.74	**0.0015**	**Yes**
86	190	0.0025	0.0003	8.2	0.002	0.80	**0.0014**	**Yes**
102	150	0.0019	0.0003	6.5	0.002	1.05	**0.0011**	**Yes**
113	120	0.0015	0.0003	5.2	0.002	1.33	0.0008	No
92	72	0.00092	0.0003	3.1	0.002	2.17	NC	No
111	30	0.00039	0.0003	1.3	0.002	5.13	NC	No
100	54	0.0007	0.0003	2.3	0.002	2.86	NC	No
99	44	0.00057	0.0003	1.9	0.002	3.51	NC	No
95	45	0.00058	0.0003	1.9	0.002	3.45	NC	No
101	30	0.00039	0.0003	1.3	0.002	5.13	NC	No
98	25	0.00032	0.0003	1.1	0.002	6.25	NC	No

[a] Exposure point concentration derived using 95% UCL of the mean for properties with $\geq$ 8 samples (Properties 99 and111), or the maximum concentration for properties with < 8 samples; [b] Reasonable Maximum Exposure Dose representing above average ingestion rates for children ages birth to < 1 year; [c] MRL = Minimal Risk Level; [d] Hazard Quotient = RME Dose/ Chronic MRL; [e] LOAEL = Lowest Observed Adverse Effect Level; [f] Margin of Exposure = Chronic LOAEL /RME Dose; [g] Weighted average RME dose represents children ages birth to <11 years; mg/kg/day = milligrams of contaminant per kilogram body weight per day; mg/kg = milligrams of contaminant per kilogram of soil; NC = Not Calculated.

Copper: Because too few studies have been conducted, there is no chronic MRL for copper. However, sufficient studies exist for deriving acute and intermediate MRLs (0.01 mg/kg/day.) The acute MRL is based on a NOAEL of 0.027 mg/kg/day and the intermediate MRL is based on a NOAEL of 0.042 mg/kg/day. Many studies exist showing that a one-time (acute) exposure to copper ranging from 0.011 to 0.0966 mg/kg/day resulted in gastrointestinal distress, such as abdominal pain, nausea, and vomiting [ATSDR 2004]. Because of this, the lowest LOAEL of 0.01 mg/kg/day was used to determine the likelihood of harmful health effects for acute exposures to copper. In addition, since the LOAEL (0.01 mg/kg/day) for acute exposures is lower and more protective than the intermediate LOAEL (0.09 mg/kg/day), the decisions about harmful effects from acute exposures also apply to intermediate duration exposures.

Two properties had elevated hazard quotients for copper, which means that estimated exposures in some age groups exceeded the acute oral MRL. These properties are located near the former Kil-Tone site. At property 56, children up to 11 years old may experience transitory GI effects from acute exposures to copper in soil. At property 74, only children up to 2 years old may experience transitory GI effects, such as nausea and vomiting [ATSDR 2004] **(See Table 9)**.

Table 9. Acute Exposures to Copper for Two Properties Near Kil-Tone Site

Property ID	Copper EPC (mg/kg) [a]	RME Dose (mg/kg-day) [b]	Acute MRL (mg/kg/day) [c]	Hazard Quotient [d]	Acute LOAEL (mg/kg/day) [e]	Margin of Exposure [f]	Potential for Noncancer Health Effects
56	2800	0.056	0.01	5.6	0.01	0.18	**Yes**
74	540	0.011	0.01	1.1	0.01	0.91	**Yes**

[a] Exposure point concentration derived using 95% UCL of the mean for ≥ 8 samples (Property 74) or the maximum concentration for < 8 samples; [b] Reasonable Maximum Exposure Dose representing above average ingestion rates for children ages birth to < 1 year; [c] MRL = Minimal Risk Level; [d] Hazard Quotient = RME Dose/ Acute MRL; [e] LOAEL = Lowest Observed Adverse Effect Level; [f] Margin of Exposure = Acute LOAEL / RME Dose; mg/kg/day = milligrams of contaminant per kilogram body weight per day; mg/kg = milligrams of contaminant per kilogram of soil.

Soil-pica - Residential Soil Ingestion

Properties mentioned in the following tables had elevated hazard quotients for arsenic and copper. These properties were further evaluated for possible adverse health effects for children with soil-pica behaviors. The maximum concentration was used as the EPC to evaluate soil-pica in children. The potential for health effects from soil-pica behavior was based on the maximum pica doses which were calculated using the exposure parameters from **Table 5.** These doses were compared to the applicable health guideline for acute and intermediate exposures. A “Margin of Exposure” was then calculated to determine the likelihood of adverse health effects.

As stated previously, children between the ages of 1 and 2 have the greatest tendency for soil-pica behavior, which diminishes as they age [ATSDR 2018]. For the purposes of this health assessment, soil-pica behavior was assessed for two preschool aged groups: ages 1 to < 2 years, and 2 to < 6 years.

Arsenic: Of the 89 residential properties evaluated in this health assessment,18 had elevated hazard quotients for arsenic soil-pica for at least one age group. Nine of these properties are located near the site (**See Table 10**), and nine are located along the Tarkiln Branch (**See Table 11**).

As shown in the tables, the calculated exposure doses for three properties (one near the site and two near the Tarkiln Branch) were approaching the LOAEL of 0.05 mg/kg/day where facial swelling and gastrointestinal effects were observed in human studies [ATSDR 2007a]. Therefore, adverse health effects may occur in children with soil-pica behavior exposed to arsenic in soil at these three properties. Adverse health effects would not be expected for children with soil-pica behavior at the remaining 15 properties with elevated hazard quotients. The remaining 71 properties did not have elevated soil-pica hazard quotients for arsenic. Therefore, noncancer health effects at these properties are also not likely.

Table 10. Soil-pica – Acute Exposures to Arsenic for Properties Near Kil-Tone Site

Property ID	Arsenic EPC (mg/kg) [a]	Maximum Pica Dose (mg/kg/day) [b]	Acute MRL (mg/kg/day) [c]	Maximum Hazard Quotient [d]	Acute LOAEL (mg/kg/day) [e]	Margin of Exposure [f]	Potential for Noncancer Health Effects
7	220	0.025	0.005	5.0	0.05	2.0	**Yes**
6	150	0.017	0.005	3.4	0.05	2.9	No
19	100	0.011	0.005	2.3	0.05	4.6	No
68	66	0.008	0.005	1.5	0.05	6.7	No
21	61	0.007	0.005	1.4	0.05	7.1	No
1	69	0.008	0.005	1.6	0.05	6.3	No
5	59	0.007	0.005	1.3	0.05	7.5	No
20	50	0.006	0.005	1.1	0.05	8.8	No
26	48	0.006	0.005	1.1	0.05	9.1	No

[a] Exposure point concentration derived using maximum concentration found at each property; [b] Maximum pica dose represents children ages 1 to < 2 years; [c] Minimal Risk Level; [d] Hazard Quotient = Maximum Pica Dose/Acute MRL; [e] LOAEL = Lowest Observed Adverse Effect Level; [f] Margin of Exposure = Acute LOAEL / Maximum Pica Dose; mg/kg/day = milligrams of contaminant per kilogram body weight per day; mg/kg = milligrams of contaminant per kilogram of soil.

Table 11. Soil-pica – Acute Exposures to Arsenic for Tarkiln Branch Properties

Property ID	Arsenic EPC (mg/kg) [a]	Maximum Pica Dose (mg/kg/day) [b]	Acute MRL (mg/kg/day) [c]	Maximum Hazard Quotient [d]	Acute LOAEL (mg/kg/day) [e]	Margin of Exposure [f]	Potential for Noncancer Health Effects
93	210	0.024	0.005	4.8	0.05	2.1	**Yes**
86	190	0.022	0.005	4.3	0.05	2.2	**Yes**
102	150	0.017	0.005	3.4	0.05	2.9	No
113	120	0.014	0.005	2.7	0.05	3.6	No
92	72	0.0082	0.005	1.6	0.05	6.1	No
111	61	0.007	0.005	1.4	0.05	7.1	No
100	54	0.0062	0.005	1.2	0.05	8.1	No
99	92	0.01	0.005	2.1	0.05	5.0	No
95	45	0.0051	0.005	1.0	0.05	9.8	No

[a] Exposure point concentration derived using maximum concentration found at each property; [b] Maximum pica dose represents children ages 1 to < 2 years; [c] Minimal Risk Level; [d] Hazard Quotient = Maximum Pica Dose/Acute MRL; [e] LOAEL = Lowest Observed Adverse Effect Level; [f] Margin of Exposure = Acute LOAEL / Maximum Pica Dose; mg/kg/day = milligrams of contaminant per kilogram body weight per day; mg/kg = milligrams of contaminant per kilogram of soil.

Copper: Similar to the acute arsenic exposure analysis above, we compared soil-pica doses for copper to the lowest LOAEL (0.01 mg/kg/day) from human studies to determine the likelihood of harmful health effects. Twenty properties had elevated hazard quotients for soil-pica for at least one age group. Thirteen of these properties are located near the former Kil-Tone site. The remaining seven properties are located along the Tarkiln Branch.

Properties near the former Kil-Tone site: Children with soil-pica behavior living at the 13 properties located near the site may experience gastrointestinal distress from acute exposures to copper in soil **(See Table 12)**. This is because the calculated exposure doses exceed the acute LOAEL for gastrointestinal effects, such as nausea and vomiting, that were observed in human studies [ATSDR 2004].

Table 12. Soil-pica – Acute Exposures to Copper for Properties Near the Kil-Tone Site

Property ID	Copper EPC (mg/kg) [a]	Maximum Pica Dose (mg/kg/day) [b]	Acute MRL (mg/kg/day) [c]	Maximum Hazard Quotient [d]	Acute LOAEL (mg/kg/day) [e]	Margin of Exposure [f]	Potential for Noncancer Health Effects
56	2800	0.53	0.01	53	0.01	0.02	**Yes**
74	540	0.10	0.01	10	0.01	0.10	**Yes**
65	190	0.036	0.01	3.6	0.01	0.28	**Yes**
49	180	0.034	0.01	3.4	0.01	0.29	**Yes**
39	170	0.032	0.01	3.2	0.01	0.31	**Yes**
62	150	0.028	0.01	2.8	0.01	0.36	**Yes**
6	110	0.021	0.01	2.1	0.01	0.48	**Yes**
2	100	0.019	0.01	1.9	0.01	0.53	**Yes**
7	90	0.017	0.01	1.7	0.01	0.59	**Yes**
8	84	0.016	0.01	1.6	0.01	0.63	**Yes**
75	77	0.015	0.01	1.5	0.01	0.67	**Yes**
5	63	0.012	0.01	1.2	0.01	0.83	**Yes**
21	62	0.012	0.01	1.2	0.01	0.83	**Yes**

[a] Exposure point concentration derived using maximum concentration found at each property; [b] Maximum pica dose represents children ages 1 to < 2 years; [c] Minimal Risk Level; [d] Hazard Quotient = Maximum Pica Dose/Acute MRL; [e] LOAEL = Lowest Observed Adverse Effect Level; [f] Margin of Exposure = Acute LOAEL / Maximum Pica Dose; mg/kg/day = milligrams of contaminant per kilogram body weight per day; mg/kg = milligrams of contaminant per kilogram of soil.

Adverse health effects from exposure to copper would not be expected for children with soil-pica behavior at the remaining properties.

Tarkiln Branch Properties: Children with soil-pica behavior living at seven properties located near the Tarkiln Branch may experience gastrointestinal distress from acute exposures to copper in soil **(See Table 13)**. This is because the calculated exposure doses exceed the acute LOAEL for gastrointestinal effects, such as nausea and vomiting, that were observed in human studies [ATSDR 2004].

Table 13. Soil-pica – Acute Exposures to Copper for Tarkiln Branch Properties

Property ID	Copper EPC (mg/kg) [a]	Maximum Pica Dose (mg/kg/day) [b]	Acute MRL (mg/kg/day) [c]	Maximum Hazard Quotient [d]	Acute LOAEL (mg/kg/day)[e]	Margin of Exposure [f]	Potential for Noncancer Health Effects
86	140	0.026	0.01	2.6	0.01	0.38	**Yes**
92	135	0.025	0.01	2.5	0.01	0.40	**Yes**
99	100	0.019	0.01	1.9	0.01	0.53	**Yes**
113	89	0.017	0.01	1.7	0.01	0.59	**Yes**
111	82	0.015	0.01	1.5	0.01	0.67	**Yes**
100	76	0.014	0.01	1.4	0.01	0.71	**Yes**
95	69	0.013	0.01	1.3	0.01	0.77	**Yes**

[a] Exposure point concentration derived using maximum concentration found at each property; [b] Maximum pica dose represents children ages 1 to < 2 years; [c] Minimal Risk Level; [d] Hazard Quotient = Maximum Pica Dose/Acute MRL; [e] LOAEL = Lowest Observed Adverse Effect Level; [f] Margin of Exposure = Acute LOAEL / Maximum Pica Dose; mg/kg/day = milligrams of contaminant per kilogram body weight per day; mg/kg = milligrams of contaminant per kilogram of soil.

Lead – Evaluating Health Effects

Accumulation of lead in the body can cause damage to the nervous or gastrointestinal system, kidneys, or red blood cells. Children, infants, and fetuses are the most sensitive populations. Lead may cause learning difficulties and stunted growth and may also harm fetal development. Health effects associated with lead exposure, particularly changes in children's neurobehavioral development, may occur at blood lead levels so low as to be essentially without a threshold (i.e., no NOAEL or LOAEL is available) [ATSDR 2007b].

Lead exposures were evaluated using the USEPA’s IEUBK model. This model estimates a plausible distribution of blood lead levels centered on the geometric mean blood lead levels from available exposure information. Blood lead levels are indicators of exposure and are the most widely used index of internal lead body burdens associated with potential health effects. The CDC uses a blood lead reference value of 3.5 µg/dL to identify children with blood lead levels higher than most children in the U.S[1].

The USEPA screens lead at an average concentration of 200 mg/kg. This level represents a screening level used by the USEPA to evaluate soil lead levels for further actions. If the maximum or the average lead levels exceed 200 mg/kg, individual samples are identified to determine if they exceed the current NJDEP Residential Soil Remediation Standard of 400 mg/kg. The USEPA used soil depths of 0-2 feet bgs to determine the need for residential soil remediation. The NJDOH used surface soil depths of 0-2 inches bgs to evaluate the potential for health effects.

We evaluated the broad scope of lead exposures in this community, looking at the potential contribution of lead at this site on children’s blood lead levels. We also evaluated this community and their

[1] In October 2021, CDC updated the blood lead reference value (BLRV) from 5 µg/dL to 3.5 µg/dL. However, lead models are not currently validated for levels below 5 µg/dL. Therefore, ATSDR uses 5 µg/dL in the models in our health evaluations until the updated BLRV of 3.5 µg/dL can be verified by EPA in their models.

CDC’s BLRV (Blood Lead Reference Value) is a screening tool to identify children who have higher levels of lead in their blood compared with most children. The reference value is not health-based and is not a regulatory standard. States independently determine action thresholds based on state laws, regulations, and resource availability. CDC encourages healthcare providers and public health professionals to follow the recommended follow-up actions based on confirmed blood lead levels.

potential for increased child blood lead levels based on several risk factors. Factors associated with the increased risk of higher blood lead levels include:

- living in homes built before 1978, and especially before 1950,
- age of infrastructure (i.e., plumbing),
- living in rental housing,
- poverty,
- minority groups,
- children younger than six,
- living in urban areas,
- living in the Northeast region of the United States, and
- immigrant and refugee populations.

This community has many of these factors that make it a higher risk for elevated blood lead levels in children. We continue to work collaboratively with the USEPA to stop, reduce, and prevent exposure to lead.

Lead exposures associated with children's use of lead contaminated areas were evaluated using the USEPA's IEUBK model. This model is designed to predict the probability that children ages one to 5 years who regularly play in areas with soil lead contamination could be exposed to lead at levels high enough to raise their blood lead levels above CDC's reference level of 5 µg/dL. As mentioned previously, this reference level is the lowest blood lead level verified for the model and CDC recently lowered the reference level to 3.5 µg/dL. Therefore, the public health goal of NJDOH and ATSDR is to reduce exposures to lead as much as possible since there is no safe level for blood lead in children.

Many factors influence lead exposure and uptake, which limits the accuracy of the IEUBK model to predict individual blood lead levels. These limitations include lead bioavailability and individual nutritional status, model limitations, lead exposure risk factors, seasonality, exposure age, and multiple sources of lead exposure.

Average lead levels in surface soils (0-2 inches bgs) were used as an input value to calculate the distribution of expected children's blood lead levels from incidental ingestion. The assumptions for the residential exposure scenario for children are as follows:

- Exposure every day to the same soil concentrations.
- Exposure to the average soil lead concentration in the area of interest.
- Exposure to other sources of lead (air, water, dust, diet, paint, etc.) is consistent with default (or typical) values identified by USEPA [USEPA 2002].

Lead in Residential Surface Soil

Lead was evaluated at 89 residential properties. Sixty-one properties are located near the former Kil-Tone site. The remaining 28 properties are located along the Tarkiln Branch. **Tables A-4 and A-5 in Appendix A** summarize the lead concentrations in surface soil (0-2 inches bgs) at the residential properties near the Kil-Tone site and along the Tarkiln Branch.

Table 14 below shows the number of properties where the probability of children ages 1- 5 years having a blood lead level exceeding 5 µg/dL may occur based on average surface soil lead concentrations. The higher the probability of exceeding CDC's reference level (currently 3.5 µg/dL) means the greater the concern for harmful effects in children from soil lead exposure. The NJDOH provided the Vineland Health Department with fact sheets which were distributed to all properties where lead was detected in surface soil, regardless of the concentration, to minimize exposures to lead in soil for residents.

This table includes the 61 properties near the former Kil-Tone site and the 28 properties along the Tarkiln Branch. **Tables 15 and 16** summarize properties near the Kil-Tone site and the Tarkiln Branch with average lead concentrations in surface soil above 200 mg/kg.

Table 14. Surface Soil Lead Concentrations and Modeled Blood Lead Levels in Children

Average Lead Concentration Range in Soil (mg/kg)	Estimated Probability (%) of exceeding a Blood Lead Level of 5 µg/dL *	Estimated Geometric Mean Blood Lead Level (µg/dL) **	Number of Properties
ND-99	NA-1.29	NA-1.76	26
100-199	1.32-5.94	1.76-2.40	25
200-399	6.01-24.9	2.41-3.64	30
400-799	25.1-63.9	3.65-5.91	6
800-1,199	64.0-83.9	5.92-7.96	1
>1200	> 83.9	> 7.97	1

NA = Not applicable; µg/dL = micrograms of lead per deciliter of blood; *The IEUBK model is validated using the previous CDC Reference Level of 5 µg/dL; **Blood lead levels were calculated using the USEPA Integrated Exposure Uptake Biokinetic (IEUBK) model (Windows Version 2.0) with default assumptions with the exception of blood lead levels set to 5 µg/dL. The model was run with results displayed as a density curve for ages 12-60 months (1-5 years), with a bioavailability of 0.3 and geometric standard deviation (GSD) of 1.6.

Table 15. Remediation Status of Properties Near the Site with Average Soil Lead Levels Above 200 mg/kg

Property ID	Average Surface Soil Lead Concentration (mg/kg) *	Remediation Status
66	1288	Planned by Fall 2023 (Phase 3 of OU1)
6	1010	Complete
30	727	Planned by Fall 2023 (Phase 3 of OU1)
7	724	Complete
10	724	Complete
61	568	Planned by Fall 2023 (Phase 3 of OU1)
5	544	Complete
8	508	Complete
58	396	Planned by Fall 2023 (Phase 3 of OU1)
76	393	Planned by Fall 2023 (Phase 3 of OU1)
59	391	Planned by Fall 2023 (Phase 3 of OU1)
71	375	**Not Planned – Lead Not Site Related**
65	373	Planned by Fall 2023 (Phase 3 of OU1)

Property ID	Average Surface Soil Lead Concentration (mg/kg)*	Remediation Status
22	369	Complete
56	355	**Not Planned – Lead Not Site Related**
49	345	**Not Planned – Lead Not Site Related**
34	342	Complete
75	327	Planned by Fall 2023 (Phase 3 of OU1)
44	326	Planned by Fall 2023 (Phase 3 of OU1)
78	323	Planned by Fall 2023 (Phase 3 of OU1)
62	316	**Not Planned – Lead Not Site Related**
39	300	Planned by Fall 2023 (Phase 3 of OU1)
12	271	Complete
70	266	**Not Planned – Lead Not Site Related**
15	257	Complete
9	251	Complete
55	242	**Not Planned – Lead Not Site Related**
57	240	Planned by Fall 2023 (Phase 3 of OU1)
3	237	Complete
20	235	Complete
73	226	Complete
63	214	**Not Planned – Lead Not Site Related**
47	213	**Not Planned – Lead Not Site Related**
74	206	Complete

*Surface soil depth is 0-2 inches below ground surface (bgs); mg/kg = milligrams of contaminant per kilogram of soil.

Table 16. Properties Near Tarkiln Branch with Average Lead Levels Above 200 mg/kg

Property ID	Average Surface Soil Lead Concentration (mg/kg) *	Remediation Status
86	333	Complete
113	218	Complete
92	217	Part of OU4

*Surface soil depth is 0-2 inches below ground surface (bgs); mg/kg = milligrams of contaminant per kilogram of soil.

As shown in the above tables, 16 properties with average lead levels above 200 mg/kg have been remediated. This minimizes current and future exposures to lead in soil at these properties. Twelve properties near the Kil-Tone site will be remediated in the Fall of 2022. One property near the Tarkiln Branch will be remediated as part of the USEPA's OU4.

Eight properties near the Kil-Tone site will not be remediated because the USEPA has determined that the lead in soil on these properties is not site related. Therefore, it is especially important for these residents to be aware of ways to reduce exposures to soil contaminants on their properties. The NJDOH provided the Vineland Health Department with fact sheets on reducing exposures to soil contaminants to all properties regardless of remediation status. These fact sheets have been distributed to all properties evaluated in this health assessment.

Outreach activities have been conducted by the NJDOH and the USEPA to educate residents about the site and how to reduce exposures to soil contaminants, including lead (See **Appendix D**). The USEPA also has information on the Kil-Tone website on ways to reduce exposures until properties can be remediated.

Lead in Surface Water and Sediment – Tarkiln Branch

Eleven surface water samples were collected from the Tarkiln Branch and analyzed for lead by the USEPA in April 2015. Two samples were background samples and not accessible to residents living along the Tarkiln Branch. The average lead concentration for the remaining nine samples was 9 µg/L. This level is below the NJDEP drinking water standard of 15 µg/L. This evaluation conservatively assumes that the Tarkiln Branch is a drinking water source when in fact, it is an intermittent stream. Therefore, adverse health effects from ingesting lead in the Tarkiln Branch surface water are not likely.

There were 123 sediment samples collected along the Tarkiln Branch by the USEPA in April 2015. Sixty-five of these samples are in locations accessible to residents living along the Tarkiln Branch. Lead levels in accessible surface sediment (0-6 inches bgs) ranged from 15 mg/kg to 2,200 mg/kg.

The average lead concentration was 416 mg/kg, indicating the potential for exposure to lead resulting in blood lead levels above 5 µg/dL. As mentioned earlier, the Vineland Health Department has distributed NJDOH's fact sheets on reducing exposures to lead in soil regardless of remediation status in order to minimize exposures as much as possible.

Table 17 summarizes the lead levels in surface sediment at each accessible location along the Tarkiln Branch and the probability of children's blood lead levels exceeding 5 µg/dL. The higher the probability of exceeding CDC's reference level (currently 3.5 µg/dL) means the greater the concern for harmful effects in children from soil lead exposure.

Table 17. Sediment Lead Concentrations and Modeled Blood Lead Levels in Children

Average Lead Concentration Range in Soil (mg/kg)	Estimated Probability (%) of exceeding a Blood Lead Level of 5 µg/dL *	Estimated Geometric Mean Blood Lead Level (µg/dL) **	Number of Properties
ND-99	NA-1.29	NA-1.76	18
100-199	1.32-5.94	1.76-2.40	5
200-399	6.01-24.9	2.41-3.64	15
400-799	25.1-63.9	3.65-5.91	17
800-1,199	64.0-83.9	5.92-7.96	7
>1200	> 83.9	> 7.97	3

NA = Not applicable; µg/dL = micrograms of lead per deciliter of blood; *The IEUBK model is validated using the previous CDC Reference Level of 5 µg/dL; **Blood lead levels were calculated using the USEPA Integrated Exposure Uptake Biokinetic (IEUBK) model (Windows Version 2.0) with default assumptions with the exception of blood lead levels set to 5 µg/dL. The model was run with results displayed as a density curve for ages 12-60 months (1-5 years), with a bioavailability of 0.3 and geometric standard deviation (GSD) of 1.6.

Childhood Blood Lead Data

The NJDOH requires every physician, professional registered nurse, and health care facility to screen for lead exposure in all children under 6 years of age who come to them for care (Public Law 1995, chapter 328). Specifically, the New Jersey testing law requires the following (N.J.A.C. 8:51):

- All children should be tested at both 12 and 24 months of age.
- All children 25 to 72 months (less than 6 years) of age who has never previously been tested should be tested.
- All children up to 72 months of age who has been exposed to a known or suspected source of lead should be tested.

Since July 1999, NJDOH has required clinical laboratories to report all blood lead test results to the State. The NJDOH Childhood Lead Poisoning Prevention (CLPP) program maintains a central surveillance database and patient tracking system called LeadTrax. Using LeadTrax, CLPP coordinates with local health departments to document, share and track case management data and environmental intervention activities. The LeadTrax database includes the following information on each laboratory report: patient's identifying information, patient's address, patient's age at time of blood specimen collection, type of screening specimen (venous or capillary), and blood lead result in micrograms of lead per deciliter of blood (µg/dL).

Multiple lead test reports may be received on the same patient. For the purpose of this analysis, each child was counted only once per calendar year. For each child, the highest result among all venous specimens during a calendar year was selected. If no venous sample is available for a child in a calendar year, the lowest result among capillary specimens (finger sticks) was selected, since a blood lead test done on a capillary specimen is susceptible to falsely high results.

Recently, the CDC updated its blood lead reference value to 3.5 µg/dL in response to the Lead Exposure Prevention and Advisory Committee's recommendation made on May 14, 2021 [CDC 2021]. Prior to this, the CDC used a reference level of 5 µg/dL [CDC 2021]. The new reference value places an emphasis on primary prevention–controlling or eliminating sources of lead in children's environments so that they are not exposed—and triggering targeted public health actions to lower blood lead levels.

On September 18, 2017, New Jersey amended its rules (N.J.A.C. 8:51) to require nurse case management at a single, venous blood lead level of 5 µg/dL or higher. The rule amendment also requires an environmental inspection whenever a child has two venous blood lead levels of 5 to 9 µg/dL one to four months apart, or a single venous blood lead level of 10 µg/dL or higher. Both actions are performed by a local health department and require a home visit.

Nurse case management includes education, counseling, health and social services assessments, referrals, and monitoring of retesting. Environmental inspections identify lead hazards, order abatement, and ensure the removal of occupants while abatement work is being performed. Blood lead levels of 45 µg/dL or higher require medical evaluation and treatment.

N.J.A.C. 8:51A continues to require that children be screened at both ages 1 and 2 years. Risk assessments determine if a child should be screened before the age of 1 year, or more frequently. While it is ideal for all children to be tested at both 1 and 2 years of age, at a minimum all children should have at least one blood lead test done before their third birthday. NJDOH's CLPP uses the age span of 6 to 29 months to capture data on tests that are performed either earlier than the age of 12 months or later than the age of 24 months. This is because not all children are tested exactly at the age of 1 and 2 years.

Blood lead test results in the period January 1, 2000 through December 31, 2016 were extracted from LeadTrax for children up to the age of 35 months at the time that blood was collected for lead analysis. Results were summarized for the impacted area around the Kil-Tone site, Vineland, and the State of New Jersey. In each of these areas, the percent of children tested whose blood lead test reached or exceeded five, 10, and 20 µg/dL was computed for the entire year period and for each year.

NJDOH's CLPP also examined childhood lead screening data for all children under the age of 18 for the same time period and geographic areas. Results showed similar patterns and trends to the data for children up to age 3, so only the data for this age group are presented below.

Table 18 presents the percent of tested children less than age 3 with blood lead levels equal to or exceeding five, 10 or 20 µg/dL, in the impacted area, Vineland, and the State of New Jersey, during the 17-year period 2000-2016. A Chi-Square test of proportions showed there are no statistically significant differences among the proportion of children less than age 3 by blood lead level across the three geographic areas (p-value = 0.28). Based on the information presented below reflecting percentages of children among those tested with elevated blood levels, the proportion is not different among the three geographic areas (alpha= 0.05).

Table 18. Percent of children under 3 years exceeding key blood lead levels (2000 through 2016)

Population	% > 5 µg/dL	% >10 µg/dL	% > 20 µg/dL
Impacted area	10.1%	1.8%	0.5%
Vineland	9.1%	1.0%	0.2%
State of New Jersey	9.3 %	1.1%	0.2%

µg/dL = micrograms of lead per deciliter of blood.

Polycyclic Aromatic Hydrocarbons (PAHs)

PAHs are a class of over 100 different compounds that are found in and formed during incomplete combustion of coal, oil, wood, or other organic substances [ATSDR 1995]. More commonly they are found in petroleum-based products such as coal tar, asphalt, creosote, and roofing tar. In the environment, PAHs are found as complex mixtures of compounds, and many have similar toxicological effects. Because combustion processes produce them, PAHs are widespread in the environment.

Noncancer adverse health effects associated with PAH exposures have been observed in animals but generally not in humans [ATSDR 1995]. Noncancer effects are usually seen at much higher levels than found in the environment. The main potential concern for PAH exposures is for cancer effects. As summarized in **Appendix A, Tables A-1 and A-2**, the following PAHs and one phthalate (substances used to make plastics more flexible), were determined to be COPCs for the Kil-Tone site and the residential properties:

- Acenaphthylene (PAH)
- Benzo(a)pyrene (PAH)
- Benzo(b)fluoranthene (PAH)

- Benzo(g,h,i)perylene (PAH)
- Carbazole
- Dibenzofuran (PAH)
- Phenanthrene (PAH)
- Di-methyl-phthalate (Phthalate)

Di-methyl-phthalate was found in one surface soil sample at a concentration of 0.086 mg/kg on one residential property. There is no comparison value available for di-methyl- phthalate. Therefore, this contaminant could not be evaluated for possible health effects.

Benzo(a)pyrene is the only detected PAH with a health guideline for noncancer health effects. The other PAHs were evaluated relative to benzo(a)pyrene. The maximum concentration for benzo(a)pyrene detected in surface soil was used to determine the potential for noncancer health effects from PAH exposures for residents and site workers.

The maximum concentration of benzo(a)pyrene was found on a residential property at 3.3mg/kg (Property 4). As shown in **Table 19,** the hazard quotient is below one for benzo(a)pyrene using the maximum RME dose. Therefore, noncancer health effects are not likely from ingesting soil containing PAHs on the former Kil-Tone site and on the residential properties. This is because all of the other detections for benzo(a)pyrene were lower both on the site property and on the other residential properties evaluated in this document.

Table 19. Chronic Exposures - Polycyclic Aromatic Hydrocarbons – Residential Properties

Contaminant (PAH)	EPC (mg/kg) [a]	RME Dose (mg/kg/day) [b]	Reference Dose (mg/kg/day)	Hazard Quotient [c]	Potential for Non-Cancer Health Effects
Benzo(a)pyrene	3.3	8.3E-05	3.0E-04	0.28	No

[a] Exposure Point concentration derived using the maximum concentration; [b] Reasonable Maximum Exposure Dose representing above average ingestion rates for children ages birth to < 1 year; [c] Hazard Quotient = RME Dose/Reference Dose; mg/kg = milligrams of contaminant per kilogram of soil; mg/kg/day = milligrams of contaminant per kilogram body weight per day; PAH = Polycyclic aromatic hydrocarbons.

Pesticides and PCBs

PCBs were not detected at the residential properties or on the site above applicable comparison values. Three pesticides exceeded comparison values on one property (Property 21). Using the maximum value as the EPC, all hazard quotients were below one as shown in **Table 20.** Therefore, noncancer health effects from pesticide exposures at this property are not likely.

Table 20. Chronic Exposures to Pesticides – Property 21

Contaminant	EPC (mg/kg) [a]	RME Dose (mg/kg/day) [b]	Chronic RfD or MRL (mg/kg/day) [c]	Hazard Quotient [d]	Potential for Non-Cancer Health Effects
Heptachlor epoxide	0.38	7.3E-06	1.3E-05 (RfD)	0.56	No
Aldrin	0.046	1.1E-06	3.0E-05 (MRL)	0.04	No
Dieldrin	0.49	1.2E-05	5.0E-05 (MRL)	0.23	No

[a] Exposure Point concentration derived using the maximum detected concentration in surface soil (0-2 inches bgs); [b] Reasonable

Maximum Exposure Dose representing above average soil ingestion rates for children ages birth to < 1year; [c] RfD = USEPA Reference Dose, MRL = ATSDR Minimal Risk Level; [d] Hazard Quotient = RME Dose/RfD or MRL; mg/kg = milligrams of contaminant per kilogram of soil; mg/kg/day = milligrams of contaminant per kilogram body weight per day.

Surface Water and Sediment Ingestion of Arsenic – Tarkiln Branch

As mentioned previously, nine surface water samples and 65 sediment samples were collected from accessible areas of the Tarkiln Branch in April 2015 and analyzed for arsenic and lead. This section pertains to arsenic exposures since lead was evaluated separately above.

Tables B-2 and B-3 in Appendix A summarize contaminants in surface water and sediment for the Tarkiln Branch. Exposures to arsenic in the Tarkiln Branch were evaluated for adults and children ages 6 to < 21 years accessing the Tarkiln Branch 5 days/week for 12 weeks during the summer. This is a very conservative scenario as it is unlikely that the Tarkiln Branch is used for swimming. However, residents may wade in the shallow water when water is present and water levels may occasionally be deep enough for younger children to swim. The surface water scenario includes an above average ingestion rate of 0.12 Liters/hour and an additional exposure parameter of 2 hours/day spent swimming and wading in the Tarkiln Branch.

The doses shown in the tables below represent the youngest child age group of 6 < 11 years as this is the most sensitive exposed age group in this scenario (**See Tables 21 and 22**). As shown in these tables, the calculated hazard quotients are below one. Therefore, harmful noncancer health effects are not likely from exposures to arsenic in Tarkiln Branch surface water and sediment.

Table 21. Arsenic in Surface Water of Tarkiln Branch

Contaminant	EPC (mg/L) [a]	RME Dose (mg/kg/day) [b]	Chronic MRL (mg/kg/day) [c]	Hazard Quotient [d]	Potential for Non-Cancer Health Effects
Arsenic	0.212	0.00029	0.0003	0.96	No

[a] Exposure Point Concentration represents the 95% UCL of the mean; [b] Reasonable Maximum Exposure Dose representing above average soil ingestion rates for children ages 6 to < 11 years; [c] ATSDR Chronic Minimal Risk Level; [d] Hazard Quotient = RME Dose / Chronic MRL; mg/L = milligrams of contaminant per liter of water; mg/kg/day = milligrams of contaminant per kilogram body weight per day.

Table 22. Arsenic in Sediment of Tarkiln Branch

Contaminant	EPC (mg/kg) [a]	RME Dose (mg/kg/day) [b]	Chronic MRL (mg/kg/day) [c]	Hazard Quotient [d]	Potential for Non-Cancer Health Effects
Arsenic	166	0.00012	0.0003	0.41	No

[a] Exposure Point Concentration represents the 95% UCL of the mean; [b] Reasonable Maximum Exposure Dose representing above average soil ingestion rates for children ages 6 to < 11 years; [c] ATSDR Chronic Minimal Risk Level; [d] Hazard Quotient = RME Dose / Chronic MRL; mg/kg = milligrams of contaminant per kilogram of sediment; mg/kg/day = milligrams of contaminant per kilogram body weight per day.

Soil Ingestion - On-site Workers

The former Kil-Tone property is currently occupied by a sign manufacturing company. The business operations are not related to past operations from Kil-Tone. Business activities are conducted inside the building, with minimal contact to on-site soil. Therefore, a low soil contact exposure scenario was used to calculate exposure doses for current employees.

Using the same formulas used for residential exposures, PHAST calculated exposure doses for site workers for exposures to arsenic and PAHs. No other contaminants (except for lead which was evaluated separately below) exceeded their respective comparison values. For PAHs, the maximum EPC was found on a residential property as described in **Table 19**. Based on these residential results, noncancer health effects from exposures to PAHs on the former Kil- Tone site are not likely.

Arsenic was detected in all five surface soil samples (including one duplicate sample) collected at the former Kil-Tone site by the USEPA in October 2015. The PHAST calculated exposure doses for acute, intermediate, and chronic exposures to arsenic using the maximum concentration detected were less than the chronic MRL (i.e., an HQ < 1.0). Therefore, as shown in **Table 23**, adverse noncancer health effects to workers from exposures to arsenic are not likely.

Table 23. Arsenic – Noncancer Health Effects – Chronic Exposures - Site Workers

Contaminant	EPC (mg/kg) [a]	Exposure Dose (mg/kg/day) [b]	Chronic MRL (mg/kg/day) [c]	Hazard Quotient [d]	Potential for Noncancer Health Effects
Arsenic	140	0.000081	0.0003	0.27	No

[a] Exposure point concentration derived using the maximum concentration in surface soil (0-2 inches bgs); [b] Exposure dose representing adult site workers with low soil contact; [c] ATSDR Chronic Minimal Risk Level; [d] Hazard Quotient = Exposure Dose/Chronic Minimal Risk Level; mg/kg = milligrams of contaminant per kilogram of soil; mg/kg/day = milligrams of contaminant per kilogram body weight per day.

Lead in Pregnant Women - Site Workers

As mentioned previously, the USEPA's ALM model was used to estimate blood lead levels in pregnant women who may have worked on the site prior to it being capped. This model is designed to predict the blood lead levels of fetuses that are exposed to lead [USEPA 2003]. The scenario used in the model was for pregnant women working at the sign company (former Kil-Tone property) with minimal surface soil contact. The mean soil lead concentration detected on the site of 282 mg/kg was used in the model to predict adult blood lead levels.

Using the ALM model, pregnant women exposed to an average soil lead concentration of 282 mg/kg from the Kil-Tone site have a 1.4% risk that their unborn child's blood lead levels could exceed the CDC blood lead reference level of 3.5 µg/dL. The 95th percentile fetal blood lead level is predicted to be 3.6 µg/dL which is similar to CDCs' reference level of 3.5 µg/dL. Since there is no safe level of lead in blood, the NJDOH and ATSDR recommend reducing exposures to lead as much as possible.

Cancer Health Effects

NJDOH evaluates the potential for cancer health effects by assessing the excess cancer risk relating to exposure over the background cancer risk. In New Jersey, approximately 45% of women and 49% of men (about 47% overall), will be diagnosed with cancer in their lifetime [NJDOH 2016]. This is referred to as the “background cancer risk.” The term “excess cancer risk” represents the risk on top of the background cancer risk and is referred to as the Lifetime Excess Cancer Risk, or LECR. An LECR of “one-in-a-million” (1/1,000,000 or 10^{-6} cancer risk) means that if 1,000,000 people are exposed to a cancer-causing substance at a certain level for a period of time, then one cancer above the background number of cancers may develop in those one million people over the course of their lifetime (considered to be 78 years).

To put the LECR of 10^{-6} in context of New Jersey’s background cancer risk, the number of cancers expected in one million people over their lifetime is 470,000 (47%) in New Jersey. If these one million people are all exposed to a cancer-causing substance for a specific duration, then 470,001 people may develop cancer instead of the expected 470,000 over the course of their lifetime (78 years). Note that this is a theoretical estimate of cancer risk that ATSDR uses as a tool for deciding whether public health actions are needed to protect health. It is not an actual estimate of cancer cases in a community. This theoretical cancer risk is not a prediction that cancer will occur.

The NJDOH considers estimated cancer risks of less than one additional cancer case among one million (1,000,000) persons exposed as an unlikely increased cancer risk (expressed exponentially as 10^{-6}). Health guidelines are typically developed for carcinogens based on one excess cancer case per 1,000,000 individuals exposed. According to the U.S. Department of Health and Human Services, possible cancer classes of contaminants detected at a site are as follows:

- Known human carcinogen
- Reasonably anticipated to be a carcinogen
- Not classified

LECRs were calculated for the following contaminants: arsenic, PAHs, and these pesticides: dieldrin, aldrin and heptachlor epoxide. Cancer exposure doses were calculated using the following formula:

$$\textit{Cancer Exposure Dose (mg/kg/day)} = \frac{C \times IR \times EF \times CF}{BW} \times \frac{ED}{AT}$$

where,
mg/kg/day = milligrams of contaminant per kilogram of body weight per day;
C = exposure point concentration of contaminant in soil (mg/kg);
IR = soil ingestion rate (mg/day);
EF = exposure factor representing the site-specific exposure scenario;
CF = conversion factor (10^{-6} kg/mg);
ED = exposure duration (scenario specific);
AT = averaging time of 78 years; and
BW = body weight (kg).

The site-specific assumptions and exposure factors used to calculate the LECR are the same as those used to assess noncancer health effects. The LECR was calculated by multiplying the cancer exposure dose by the EPA’s cancer slope factor (CSF). The CSF is defined as the slope of the dose-response curve obtained from animal and/or human cancer studies and is expressed as the inverse of the daily exposure dose, i.e., $(mg/kg/day)^{-1}$. LECRs for soil exposures were calculated using the following formula [USEPA 2009]:

LECR = Cancer Exposure Dose x CSF

where,

CSF = Cancer Slope Factor $(mg/kg/day)^{-1}$

Evaluating Cancer for PAHs – Site Workers and Residents

A relative potency estimate approach was developed [USEPA 2020] to assess the cancer risks associated with PAHs. Using this approach, the cancer potency of carcinogenic PAHs can be estimated based on their relative potency with reference to benzo[a]pyrene. For each of the carcinogenic PAHs, the benzo[a]pyrene equivalence was calculated by multiplying the concentration with the cancer potency factor. The total benzo(a)pyrene equivalence was then obtained by summing each of the individual benzo(a)pyrene equivalences.

Based on previously described exposure assumptions, LECRs were calculated by multiplying the exposure dose by the cancer slope factor. The exposure dose was calculated using the ATSDR PHAST and accounts for dermal and ingestion exposures and a 10-year exposure duration for workers with low soil contact.

Table 24 summarizes the cancer potency factors and LECR for site workers. Arsenic was included in this table and added to the PAH LECR to give the total LECR for the site workers. As shown in the table, the total LECR for site workers exposed to PAHs and arsenic in surface soil before the site was capped is approximately two in 100,000 individuals. Most of the cancer risk comes from exposure to arsenic in soil. This is considered to be a low theoretical cancer risk.

Table 24. LECR - Site Workers

Contaminant	EPC (mg/kg) [a]	Potency Factor [b]	BaP Equiv. (mg/kg) [c]	Total BaP Equiv. (mg/kg)	Exposure Dose (mg/kg/day)	CSF $(mg/kg/d)^{-1}$ [d]	LECR [e]
Benzo(a)pyrene	0.31	1	0.31	0.31	3.5E-07	1.0	4.5E-08
Benzo(g,h,i)perylene	0.089	0.01	0.00089	---------	-----------	-----------	---------
Phenanthrene	0.27	0.001	0.00027	----------	------------	------------	---------
Arsenic	140	NA	NA	NA	8.1E-05	1.5	1.6E-05
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[a] Exposure Point concentration derived using the maximum concentration; [b] Cancer potency factor relative to benzo[a]pyrene (BaP); [c] Benzo(a)pyrene Equivalence Concentration = EPC x Potency Factor (example BaP Equivalent Concentration for Phenanthrene = 0.27 x 0.001 = 0.00027); [d] Cancer Slope Factor; [e] Lifetime Excess Cancer Risk = Exposure Dose x 10 years/78 years (worker scenario) x CSF; NA = Not Applicable; mg/kg = milligrams of contaminant per kilogram of soil; mg/kg/day = milligrams of contaminant per kilogram body weight per day.

For residential exposures, the maximum LECRs were calculated using the ATSDR PHAST. We don’t have information on resident duration. Therefore, we used the most conservative residential exposure scenario. This scenario accounts for children and adults with above average soil ingestion rates where children live as adults in the same house (21 years as a child plus 12 years as an adult). Dermal exposure dose was also included. An example PHAST spreadsheet is included in **Appendix E**.

One residence had PAHs above applicable comparison values. **Table 25** summarizes the LECR for PAHs at this residence. One residence had pesticides detected above applicable comparison values (See

Table 26). Arsenic was found at these properties as well and was added to both residences to give the total LECR for these properties.

The total LECRs for residential properties 4 and 21 range from one to two in 10,000 individuals. This is considered to be an increased theoretical cancer risk. These properties have been remediated, minimizing current and future exposures to these contaminants.

Table 25. LECR – Residential Exposures - Property 4

Contaminant	EPC (mg/kg) [a]	Potency Factor [b]	BaP Equiv. (mg/kg) [c]	Total BaP Equiv. (mg/kg)	RME Dose (mg/kg/day) [d]	CSF $(mg/kg/d)^{-1}$ [e]	LECR [f]
Benzo[a]pyrene	3.3	1	3.3	3.9	9.8E-05	1.0	4.6E-05
Benzo[b]fluoranthene	6	0.1	0.6	-----------	----------	---------	---------
Benzo(g,h,i)perylene	0.53	0.01	0.0053	-----------	----------	---------	---------
Phenanthrene	2	0.001	0.002	------------	----------	----------	---------
Arsenic	40	NA	NA	NA	5.2E-04	1.5	8.0E-05
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[a] Exposure Point concentration derived using the maximum concentration; [b] Cancer potency factor relative to benzo[a]pyrene (BaP); [c] Benzo(a)pyrene Equivalence Factor = EPC x Potency Factor; [d] Reasonable Maximum Exposure Dose representing above average ingestion rates for children ages birth to <1 year; [e] Cancer Slope Factor; [f] Lifetime Excess Cancer Risk using 33 year exposure duration over 78 year lifetime; NA = Not Applicable; mg/kg = milligrams of contaminant per kilogram of soil; mg/kg/day = milligrams of contaminant per kilogram body weight per day.

Table 26. LECR – Residential Exposures - Property 21

Contaminant	EPC (mg/kg) [a]	RME Dose (mg/kg/day) [b]	CSF $(mg/kg/d)^{-1}$ [c]	LECR [d]
Heptachlor epoxide	0.38	7.3E-06	9.1	6.4E-06
Aldrin	0.046	1.1E-06	17	2.0E-06
Dieldrin	0.49	1.2E-05	16	2.0E-05
Arsenic	61	7.9E-04	1.5	1.2E-04
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[a] Exposure point concentration derived using the maximum concentration; [b] Reasonable Maximum Exposure Dose representing above average ingestion rates for children ages birth to <1 year; [c] Cancer Slope Factor; [d] Lifetime Excess Cancer Risk using 33 year exposure duration over 78 year lifetime; mg/kg = milligrams of contaminant per kilogram of soil; mg/kg/day = milligrams of contaminant per kilogram body weight per day.

For the remaining residential properties near the site and along the Tarkiln Branch, arsenic was the only contaminant contributing to the cancer risk for surface soil exposures. The LECRs for 15 properties range from approximately one to four in 10,000 individuals, representing an increased theoretical cancer risk (See **Table 27**).

Table 27. LECRs for properties with Increased Cancer Risks

Property ID	Arsenic EPC (mg/kg) [a]	LECR [b]	Property Location	Remediated
7	220	4.4E-04	Near Site	Yes
6	150	3.0E-04	Near Site	Yes
19	100	2.0E-04	Near Site	Yes
68	66	1.3E-04	Near Site	**No**
21*	61	1.5E-04	Near Site	Yes
1	59	1.2E-04	Near Site	Yes
5	59	1.2E-04	Near Site	Yes
20	50	1.0E-04	Near Site	Yes
4**	40	1.3E-04	Near Site	Yes
93	210	4.2E-04	Tarkiln Branch	**No**
86	190	3.80-04	Tarkiln Branch	Yes
102	150	3.0E-04	Tarkiln Branch	**No**
113	120	2.4E-04	Tarkiln Branch	Yes
92	72	1.4E-04	Tarkiln Branch	**No**
100	54	1.1E-04	Tarkiln Branch	**Actions taken to prevent access**

[a] Exposure point concentration derived based on maximum concentration or 95% UCL of the mean; [b] Lifetime Excess Cancer Risk representing 33 year exposure duration over 78 year lifetime; *The LECR for Property 21 represents the total cancer risk from arsenic and pesticide exposures as shown in Table 26 above; **The LECR for Property 4 represents the total cancer risk from arsenic and PAH exposures as shown in Table 25 above; mg/kg = milligrams of contaminant per kilogram of soil.

Ten of these properties have been remediated, eliminating current and future exposures. Property 100 is an apartment complex where fencing was installed to prevent access to Tarkiln Branch contamination. The remaining four properties are planned for remediation in the future. Property 68 will be remediated as part of Phase 3 of OU1 which is planned to begin in the Fall of 2022.

The three properties near the Tarkiln Branch will be remediated as part of OU4.Until these properties can be remediated, the USEPA's website for Kil-Tone has information for residents on ways to reduce exposures to contaminated soil on their properties. Additionally, the NJDOH has provided the USEPA with fact sheets to share with residents on reducing exposures to lead and arsenic in soil and on safe gardening practices. The Vineland Health Department has also distributed these fact sheets to all residents evaluated in this health assessment. The LECRs for the remaining properties evaluated in this public health assessment are below one in 10,000 individuals and represent a low theoretical cancer risk.

Cancer Risks – Sediment and Surface Water – Tarkiln Branch

The same exposure assumptions previously described to calculate hazard quotients for noncancer health effects were used to calculate cancer risks for exposures to arsenic in surface water and sediment of the Tarkiln Branch. **Table 28** shows the LECRs for arsenic in surface water. **Table 29** shows the LECR for arsenic in sediment. These LECRs represent adults and children with above average ingestion rates.

As shown in these tables, the LECRs for both sediment and surface water exposures to arsenic range from approximately seven in 1,000,000 to two in 100,000 individuals for adults and children. The combined maximum LECR for both surface water and sediment exposures to adults and children is approximately three to eight in 100,000 individuals, respectively. All of these LECRs represent low theoretical cancer risks.

Table 28. LECR – Arsenic in Surface Water – Tarkiln Branch

Exposure Group	EPC (mg/L) [a]	ED (years) [b]	CSF $(mg/kg/day)^{-1}$ [c]	LECR [d]
Child (6 to < 21 years)	0.212	15	1.5	5.7E-05
Adult (≥ 21 years)	0.212	15	1.5	2.3E-05

[a] Exposure Point Concentration represents 95% UCL of the mean; [b] Exposure Duration; [c] Cancer Slope Factor; [d] Lifetime Excess Cancer Risk; Child LECR represents the total LECR for children ages 6 to < 21 years; mg/L = milligrams of contaminant per liter of water; mg/kg/day = milligrams of contaminant per kilogram body weight per day.

Table 29. LECR – Arsenic in Sediment – Tarkiln Branch

Exposure Group	EPC (mg/kg) [a]	ED (years) [b]	CSF $(mg/kg/day)^{-1}$ [c]	LECR [d]
Child (6 to < 21 years)	166	15	1.5	2.0E-05
Adult (≥ 21 years)	166	15	1.5	7.1E-06

[a] Exposure Point Concentration represents 95% UCL of the mean; [b] Exposure Duration; [c] Cancer Slope Factor; [d] Lifetime Excess Cancer Risk; Child LECR represents the total LECR for children ages 6 to < 21 years; mg/kg = milligrams of contaminant per kilogram of soil; mg/kg/day = milligrams of contaminant per kilogram body weight per day.

Child Health Considerations

ATSDR recognizes that the unique vulnerabilities of infants and children demand special emphasis in communities faced with contamination in their environment. Children are at greater risk than adults from certain kinds of exposures to hazardous substances because they eat and breathe more than adults. They also play outdoors and often bring food into contaminated areas. Children are also smaller, resulting in higher doses of chemical exposure per body weight. The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages. Most importantly, children depend completely on adults for risk identification and management decisions, housing decisions, and access to medical care**.**

Soil-pica – Copper

The NJDOH and ATSDR evaluated the potential risk for children living in the residential area near the site or along the Tarkiln Branch where they may have been exposed to metals in surface soil. Specifically, soil-pica behaviors among children ages one to five years may experience gastrointestinal health effects from exposures to copper.

Table 30 shows 20 properties that have elevated levels of copper in surface soil which may contribute to health effects in children with soil-pica behaviors. Copper was present in the lead arsenate used to make pesticides at the former Kil-Tone site [USEPA 2016b].

Twelve properties have been remediated, or actions have been taken to prevent access to contaminated areas. Remediation for three properties near the Kil-Tone site is planned by the Fall of 2023 as part of USEPA's Phase 3 of OU1. The remaining three properties near the site are not planned for remediation because there were no site related contaminants found on these properties.

The USEPA has provided property 62 with a "No Further Action" letter and the NJDOH fact sheet on reducing exposures to soil contaminants. The two properties near the Tarkiln Branch will be remediated as part of USEPA's OU4. As mentioned previously, the NJDOH provided the Vineland Health Department with NJDOH's fact sheets (**Appendix D**) which were distributed to all properties regardless of remediation status. These fact sheets are also posted on the USEPA's website for Kil-Tone to inform residents on ways to reduce exposures to contaminated soils on their properties.

Table 30. Properties with Elevated Soil-pica for Copper

Property ID	Property Location	Copper – Soil-pica Potential for Health Effects	Property Remediated
2	Near Kil-Tone Site	Yes	Yes
5	Near Kil-Tone Site	Yes	Yes
6	Near Kil-Tone Site	Yes	Yes
7	Near Kil-Tone Site	Yes	Yes
8	Near Kil-Tone Site	Yes	Yes
21	Near Kil-Tone Site	Yes	Yes
39	Near Kil-Tone Site	Yes	**No (Planned by Fall 2023)**
49	Near Kil-Tone Site	Yes	**No (Remediation Not Planned)**
56	Near Kil-Tone Site	Yes	**No (Remediation Not Planned)**
62	Near Kil-Tone Site	Yes	**No (Remediation Not Planned)**
65	Near Kil-Tone Site	Yes	**No (Planned by Fall 2023)**
74	Near Kil-Tone Site	Yes	Yes
75	Near Kil-Tone Site	Yes	**No (Planned by Fall 2023)**
86	Tarkiln Branch	Yes	Yes
92	Tarkiln Branch	Yes	**No (Planned as part of OU-4)**
95	Tarkiln Branch	Yes	**No (Planned as part of OU-4)**
99	Tarkiln Branch	Yes	Actions taken to prevent access
100	Tarkiln Branch	Yes	Actions taken to prevent access
111	Tarkiln Branch	Yes	Actions taken to prevent access
113	Tarkiln Branch	Yes	Yes

Property Status Summary

Tables 31 and 32 summarize all properties with current and past exposure issues to contaminants of concern. Properties not listed in these tables had no elevated levels of contaminants of concern or had no elevated hazard quotients or cancer risks. Properties not listed in these tables also had average lead levels below 200 mg/kg. It is important to note that lead is a concern in soil regardless of the concentration detected on each property. Properties with higher levels of lead in surface soil are of greater concern. The NJDOH has provided educational materials to inform residents on how to minimize exposures.

Table 31. Properties with Current Exposure Concerns

Property ID	Property Location	Elevated LECR	Potential for Non-Cancer Health Effects (Pica Scenario)	Potential for Non-Cancer Health Effects (RME Scenario)	USEPA Remediation Status
30	Near Site	No	No	No	Planned by Fall 2023
39	Near Site	No	**Yes (copper)**	No	Planned by Fall 2023
44	Near Site	No	No	No	Planned by Fall 2023
47	Near Site	No	No	No	**No Further Action – Lead not site related**
49	Near Site	No	**Yes (copper)**	No	**No Further Action – Lead not site related**
55	Near Site	No	No	No	**No Further Action – Lead not site related**
56	Near Site	No	**Yes (copper)**	**Yes (copper)**	**No Further Action – Lead not site related**
57	Near Site	No	No	No	Planned by Fall 2023
58	Near Site	No	No	No	Planned by Fall 2023
59	Near Site	No	No	No	Planned by Fall 2023
61	Near Site	No	No	No	Planned by Fall 2023
62	Near Site	No	**Yes (copper)**	No	**No Further Action – Lead not site related**
63	Near Site	No	No	No	**No Further Action – Lead not site related**
65	Near Site	No	**Yes (copper)**	No	Planned by Fall 2023
66	Near Site	No	No	No	Planned by Fall 2023
68	Near Site	**Yes**	No	No	Planned by Fall 2023
70	Near Site	No	No	No	**No Further Action – Lead not site related**
71	Near Site	No	No	No	**No Further Action – Lead not site related**
75	Near Site	No	**Yes (copper)**	No	Planned by Fall 2023
76	Near Site	No	No	No	Planned by Fall 2023
78	Near Site	No	No	No	Planned by Fall 2023
92	Near Tarkiln Branch	**Yes**	**Yes (copper)**	**No**	Planned during OU-4
93	Near Tarkiln Branch	**Yes**	**Yes (arsenic)**	**Yes (arsenic)**	Planned during OU-4
95	Near Tarkiln Branch	No	**Yes (copper)**	No	Planned during OU-4
102	Near Tarkiln Branch	**Yes**	**Yes (arsenic)**	**Yes (arsenic)**	Planned during OU-4

Table 32. Properties with Past Exposure Concerns

Property ID	Property Location	Elevated LECR	Potential for Non-Cancer Health Effects (Pica Scenario)	Potential for Non-Cancer Health Effects (RME Scenario)	USEPA Remediation Status
1	Near Site	**Yes**	No	No	Complete
2	Near Site	No	**Yes (copper)**	No	Complete
3	Near Site	No	No	No	Complete
4	Near Site	**Yes**	No	No	Complete
5	Near Site	**Yes**	**Yes (copper)**	No	Complete
6	Near Site	**Yes**	**Yes (arsenic, copper)**	**Yes (arsenic)**	Complete
7	Near Site	**Yes**	**Yes (arsenic, copper)**	**Yes (arsenic)**	Complete
8	Near Site	No	**Yes (copper)**	No	Complete
9	Near Site	No	No	No	Complete
10	Near Site	No	No	No	Complete
12	Near Site	No	No	No	Complete
15	Near Site	No	No	No	Complete
19	Near Site	**Yes**	No	No	Complete
20	Near Site	**Yes**	No	No	Complete
21	Near Site	**Yes**	**Yes (copper)**	No	Complete
22	Near Site	No	No	No	Complete
34	Near Site	No	No	No	Complete
73	Near Site	No	No	No	Complete
74	Near Site	No	**Yes (copper)**	**Yes (copper)**	Complete
86	Near Tarkiln Branch	**Yes**	**Yes (arsenic, copper)**	**Yes (arsenic)**	Complete
99	Near Tarkiln Branch	No	**Yes (copper)**	No	Fence installed to prevent access
100	Near Tarkiln Branch	**Yes**	**Yes (copper)**	No	Fence installed to prevent access
111	Near Tarkiln Branch	No	**Yes (copper)**	No	Fence installed to prevent access
113	Near Tarkiln Branch	**Yes**	**Yes (copper)**	No	Complete

Public Comment

The public comment period for this public health assessment was from May 9, 2022 to July 12, 2022. A community meeting was held in Vineland on June 29, 2022, to solicit public comments. This document was also shared with the Vineland City Health Department, the NJDEP, the USEPA, and was sent to the Vineland public library. No comments were received.

Conclusions

The NJDOH and ATSDR have reached the following conclusions for the former Kil-Tone site:

1. *Past, current, and future exposures to surface soil contaminants for residents at 49 of the 89 properties may harm people's health.* Forty properties are located near the Kil-Tone site and nine properties are along the Tarkiln Branch. For five properties, calculated doses for chronic exposures to arsenic were above levels where certain skin conditions (darkening and thickening of skin) were observed in human studies. For 15 properties, the arsenic levels in surface soil may result in an increased theoretical cancer risk from exposure. For two properties, calculated doses for short-term (acute) exposure to copper were above levels where gastrointestinal effects (nausea, stomach pain, vomiting) may be experienced by children. These effects may occur in children up to age 11 at the first property and up to age 2 at the second property. For 20 properties, if children exhibit pica behavior (ingesting unusually high amounts of soil), the calculated doses for copper were above levels where gastrointestinal effects could occur based on human studies. For three properties, if children exhibit pica behavior, the calculated doses for arsenic were approaching levels where facial swelling and gastrointestinal effects were observed in human studies. Thirty-seven properties had average soil lead levels above 200 mg/kg. This is the level that the USEPA's lead model predicts children's blood lead levels may exceed 5 µg/dL, which is used to determine if subsequent remediation is necessary. Even remediated properties may have some lead in soil presenting a completed exposure pathway. Exposures to lead should be minimized as much as possible. Elevated blood lead levels in children may lead to attention, learning and behavioral problems. It may also cause decreased hearing and slower growth and development.

2. *Past, current, and future exposures to lead in the Tarkiln Branch sediment may harm people's health.* For accessible areas of the Tarkiln Branch, the average lead concentration in sediment was above 200 mg/kg, indicating the potential for exposure to lead resulting in blood lead levels above 5 µg/dL, which is used to determine if subsequent remediation is necessary. Lead levels in surface water were below the NJDEP drinking water standard of 15 µg/L and are not likely to contribute to adverse health effects. However, exposures to lead should be minimized as much as possible.

3. *Past, current, and future exposures to soil contaminants for residents at the 40 remaining properties are not likely to harm people's health. Harmful health effects are also not expected for workers at the former Kil-Tone site.* Calculated exposure doses for noncancer health effects for 21 residential properties near the Kil-Tone site and 19 residential properties along the Tarkiln Branch were below noncancer health guidelines for arsenic and copper. In addition, soil lead levels at these 40 properties were at or below 200 mg/kg. The USEPA's Adult Lead Methodology (ALM) model predicted that the blood lead levels of unborn children of pregnant workers would not exceed the CDC reference level of 3.5 µg/dL. The site is currently capped, preventing current and future exposures to site workers. Theoretical cancer risks for site workers and these residents were also determined to be low.

4. *Past, current, and future exposures to arsenic in the Tarkiln Branch surface water and sediment are not likely to harm people's health.* For arsenic in surface water and sediment, calculated

exposure doses for noncancer health effects were below health guidelines. In addition, theoretical cancer risks were low for people wading or swimming in the Tarkiln Branch.

Recommendations

The NJDOH and ATSDR recommend:

- The USEPA continue to remediate the site in accordance with the September 2016 Record of Decision for Operable Unit 1 (OU-1).

- The USEPA continue to provide outreach on reducing exposures to contaminated soil for residents whose properties have not yet been remediated.

- The USEPA ensure that accessible areas of the Tarkiln Branch are fenced or otherwise protected from being accessed by residents until remediation is complete.

- Residents tell a healthcare provider if they have been exposed to contaminants under the conditions described in this report. A healthcare provider can help determine whether special medical evaluation or increased frequency of tests are needed.

Public Health Action Plan

The purpose of a Public Health Action Plan is to ensure that this PHA not only identifies public health hazards, but also provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. Included is a commitment on the part of the NJDOH to follow-up on this plan to ensure that it is implemented. The public health actions to be implemented by the NJDOH are as follows:

Public Health Actions Taken

The NJDOH and ATSDR:

- Attended two availability sessions hosted by the USEPA to address community health concerns.

- Provided residents with fact sheets on safe gardening in contaminated soil and on reducing exposures to lead in soil so that residents can take actions to protect their health. These fact sheets were provided to residents in both English and Spanish.

- Visited homes of several residents to gather information on demographics and discuss ways to reduce exposures to lead and arsenic contaminated soil. A bilingual representative from ATSDR was present to communicate these public health messages.

- Released this document for public comment. Copies of this health assessment were provided to the USEPA, the NJDEP, the Vineland City Health Department, the Vineland public library and is posted on the NJDOH website.

- Hosted a community meeting on June 29, 2022, to solicit public comments.

- Provided the Vineland Health Department with fact sheets on reducing exposures to lead and arsenic in soil, and on safe gardening which were distributed to all properties evaluated in this health assessment regardless of remediation status. This outreach ensures that residents understand the measures they can take to reduce exposures and protect their health and the health of their family.

Public Health Actions Planned

NJDOH will:

- Assist community members who contact the NJDOH with questions about the findings of this report.

- Continue to review and evaluate data as they are made available.

- Assist community members with outreach between their physician and trained experts specializing in occupational and environmental exposures to hazardous substances.

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Report Preparation

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FIGURES

Figure 1: Location of the Former Kil-Tone Company

Figure 2. Former Kil-Tone Area Map

Figure 3. Former Kil-Tone Area Map Including Tarkiln Branch

APPENDICES

Appendix A – Tables

Table A-1. On-Site Soil Contaminants of Concern - Former Kil-Tone Property

Contaminant	Number of Samples	Maximum Concentration (mg/kg) [a]	Comparison Value (mg/kg) [b]	Selected for Further Evaluation
Metals				
ARSENIC	6	140	0.26 (CREG)	**Yes**
LEAD	6	450	800 (NJDEP)*	**Yes**
COPPER	6	94	520 (Intermediate EMEG Child)	No
ZINC	6	440	16,000 (EMEG Child)	No
Polycyclic Aromatic Hydrocarbons (PAHs)				
CAPROLACTAM	7	0.27	26,000 (RMEG Child)	No
ANTHRACENE	7	0.064	16,000 (RMEG Child)	No
PYRENE	7	0.81	1,600 (RMEG Child)	No
BENZO(GHI)PERYLENE	7	0.089	NA	**Yes**
INDENO(1,2,3-CD) PYRENE	7	0.14	23 (NJDEP)	No
BENZO(B)FLUORANTHENE	7	0.62	23 (NJDEP)	No
FLUORANTHENE	7	0.65	2,100 (RMEG Child)	No
BENZO(K)FLUORANTHENE	7	0.17	230 (NJDEP)	No
ACENAPHTHENE	7	0.049	3,100 (RMEG Child)	No
CHRYSENE	7	0.35	2,300 (NJDEP)	No
BENZO(A)PYRENE	7	0.31	0.11 (CREG)	**Yes**
DIBENZO(A,H)ANTHRACENE	7	0.031	2.3 (NJDEP)	No
BENZO(A)ANTHRACENE	7	0.3	23 (NJDEP)	No
PHENANTHRENE	7	0.27	NA	**Yes**
CARBAZOLE	7	0.031	NA	**Yes**
ACETOPHENONE	7	0.037	5,200 (RMEG Child)	No
Phthalates				
DI (2-ETHYLHEXYL) PHTHALATE	7	0.36	28 (CREG)	No
DI-N-BUTYL PHTHALATE	7	0.036	5,200 (RMEG Child)	No
BUTYL BENZYL PHTHALATE	7	0.087	10,000 (RMEG Child)	No
Polychlorinated Biphenyls (PCBs)				
AROCLOR 1254	6	0.18	1.0 (EMEG Child)	No
Pesticides				
HEPTACHLOR EPOXIDE	7	0.0025	0.043 (CREG)	No
HEXACHLOROCYCLOHEXANE, ALPHA-	7	0.000051	0.062 (CREG)	No

Table A-1 (Continued)

Pesticides	Number of Samples	Maximum Concentration (mg/kg) [a]	Comparison Value (mg/kg) [b]	Selected for Further Evaluation
HEXACHLOROCYCLOHEXANE, BETA-	7	0.0024	0.22 (CREG)	No
CHLORDANE (CIS)	7	0.00055	1.4 (NJDEP)	No
CHLORDANE (TRANS)	7	0.0026	1.4 (NJDEP)	No
DIELDRIN	7	0.00047	0.024 (CREG)	No
ENDRIN	7	0.005	16 (EMEG Child)	No
DDD, P,P'-	7	0.007	1.6 (CREG)	No
DDE, P,P'-	7	0.00077	1.1 (CREG)	No
DDT, P,P'-	7	0.02	1.1 (CREG)	No

[a] Maximum concentration in surface soil (0-2 inches bgs); NA = Not Available; CREG = ATSDR Cancer Risk Evaluation Guide; EMEG = ATSDR Environmental Media Evaluation Guide; RMEG = ATSDR Reference Media Evaluation Guide; NJDEP = NJDEP Non-Residential Soil Remediation Standard; [b] Comparison values are for chronic exposures unless otherwise noted; mg/kg = milligrams of contaminant per kilogram of soil;*Lead was evaluated regardless of whether it exceeded its comparison value.

Table A-2. Soil Contaminants of Concern– Residential Properties Near Kil-Tone Site

Contaminant	Number of Samples [a]	Maximum Concentration (mg/kg) [b]	Comparison Value (mg/kg) [c]	Selected for Further Evaluation
Metals				
ARSENIC	340	240	0.26 (CREG); 27 (Pica)	**Yes**
LEAD	340	5700	400 (NJDEP)	**Yes**
COPPER	340	2800	520 (Child Intermediate EMEG); 53 (Pica)	**Yes**
ZINC	340	720	16,000 (Child Intermediate EMEG); 1,600 (Pica)	No
Polycyclic Aromatic Hydrocarbons (PAHs)				
ANTHRACENE	24	0.28	16,000 (RMEG Child); 53,000 (Pica)	No
PYRENE	24	5.6	1,600 (RMEG Child)	No
BENZO(GHI)PERYLENE	24	0.53	NA	**Yes**
INDENO(1,2,3-CD) PYRENE	24	0.73	5.1 (NJDEP)	No
BENZO(B)FLUORANTHENE	24	6	5.1 (NJDEP)	**Yes**
FLUORANTHENE	24	5.4	2,100 (RMEG Child/Pica)	No

Table A-2 (Continued)

PAHs	Number of Samples [a]	Maximum Concentration (mg/kg) [b]	Comparison Value (mg/kg) [c]	Selected for Further Evaluation
FLUORENE	24	0.067	2,100 (RMEG Child/Pica)	No
BENZO(K)FLUORANTHENE	24	2.8	51 (NJDEP)	No
ACENAPHTHENE	24	0.064	3,100 (RMEG Child); 3,200 (Pica)	No
ACENAPHTHYLENE	24	0.11	NA	**Yes**
2-METHYL-NAPHTHALENE	24	0.024	210 (RMEG Child)	No
CHRYSENE	24	4.3	510 (NJDEP)	No
BENZO(A)PYRENE	24	3.3	0.11 (CREG)	**Yes**
DIBENZO(A,H)ANTHRACENE	24	0.12	0.51 (NJDEP)	No
DIBENZOFURAN	24	0.033	NA	**Yes**
BENZO(A)ANTHRACENE	24	2.7	5.1 (NJDEP)	No
PHENANTHRENE	24	2	NA	**Yes**
CARBAZOLE	24	0.44	NA	**Yes**
Phthalates				
DI(2-ETHYLHEXYL) PHTHALATE	24	1.5	28 (CREG); 530 (Pica)	No
DI-N-BUTYL PHTHALATE	24	0.17	5,200 (RMEG Child); 2,700 (Pica)	No
DI-N-OCTYL PHTHALATE	24	0.1	21,000 (EMEG Intermediate Child); 2,100 (Pica)	No
DI-METHYL-PHTHALATE	24	0.086	NA	**Yes**
BUTYL BENZYL PHTHALATE	24	0.54	10,000 (RMEG Child)	No
Polychlorinated Biphenyls (PCBs)				
AROCLOR 1248	24	0.034	0.25 (NJDEP)	No
AROCLOR 1260	24	0.093	0.25 (NJDEP)	No
Pesticides				
HEPTACHLOR EPOXIDE	24	0.38	0.043 (CREG)	**Yes**
HEPTACHLOR	24	0.021	0.086 (CREG); 0.53 (Pica)	No
CHLORDANE (CIS)	24	0.038	0.27 (NJDEP)	No
CHLORDANE (TRANS)	24	0.033	0.27 (NJDEP)	No

Table A-2 (Continued)

Pesticides	**Number of Samples [a]**	**Maximum Concentration (mg/kg) [b]**	**Comparison Value (mg/kg) [c]**	**Selected for Further Evaluation**
ALDRIN	24	0.046	0.023 (CREG); 11(Pica)	**Yes**
DIELDRIN	24	0.49	0.024 (CREG); 0.53(Pica)	**Yes**
ENDRIN	24	0.014	16 (EMEG Child); 3.2 (Pica)	No
ENDRIN ALDEHYDE ^	24	0.003	16 (EMEG Child); 3.2 (Pica)	No
ENDRIN KETONE ^	24	0.025	16 (EMEG Child); 3.2 (Pica)	No
ENDOSULFAN I ^^	24	0.0032	260 (EMEG Child); 27 (Pica)	No
ENDOSULFAN SULFATE	24	0.00042	380 (USEPA)	No
GAMMA BHC (Lindane)	24	0.0038	16 (RMEG Child); 0.053 (Pica)	No
METHOXYCHLOR	24	0.032	260 (RMEG Child); 27 (Pica)	No
DDD, P,P'-	24	0.14	1.6 (CREG)	No
DDE, P,P'-	24	0.039	1.1 (CREG)	No
DDT, P,P'-	24	0.059	1.1 (CREG); 2.7(Pica)	No

[a] Number of samples for metals includes all 61 properties evaluated in the area of the site. For other contaminants, the number of samples is for subset of properties selected by the USEPA to evaluate these contaminants; [b] Maximum concentration in surface soil (0-2 inches bgs); ^ Used comparison value for Endrin; ^^ Used comparison value for Endosulfan; NA = Not Available; CREG = ATSDR Cancer Risk Evaluation Guide; EMEG = ATSDR Environmental Media Evaluation Guide; RMEG = ATSDR Reference Media Evaluation Guide; NJDEP = NJDEP Residential Soil Remediation Standard; USEPA = USEPA Regional Screening Level; [c] Comparison values are for chronic exposures unless otherwise noted; Pica represents acute and/or intermediate exposures; bgs = below ground surface; mg/kg = milligrams of contaminant per kilogram of soil.

Table A-3. Soil Contaminants of Concern – Tarkiln Branch Residential Properties

Contaminant	**Number of Samples [a]**	**Maximum Concentration (mg/kg) [b]**	**Comparison Value (mg/kg) [c]**	**Selected for Further Evaluation**
ARSENIC	189	210	0.26 (CREG)/27 (EMEG Child/Pica)	**Yes**
LEAD	189	760	400 (NJDEP)	**Yes**
COPPER	180	140	520/53 (Child Intermediate EMEG/Pica)	**Yes**
ZINC	180	360	16,000/1,600 (Child Pica)	No

[a] Number of samples includes all 28 properties evaluated near the Tarkiln Branch; [b] Maximum concentration in surface soil (0-2 inches bgs); CREG = ATSDR Cancer Risk Evaluation Guide; EMEG = ATSDR Environmental Media Evaluation Guide; NJDEP = NJDEP Residential Soil Remediation Standard; [c] Comparison values are for chronic exposures unless otherwise noted; Pica represents acute and/or intermediate exposures; mg/kg = milligrams of contaminant per kilogram of soil.

Table A-4. Surface Soil Lead Levels at Residential Properties Near the Kil-Tone Site

Property ID	Number of Samples	Number of Detections	Maximum Lead Concentration (mg/kg) [a]	Average Lead Concentration (mg/kg) [b]
1	12	12	500	196
2	7	7	430	132
3	3	3	400	**237**
4	5	5	191	118
5	5	5	1300	**544**
6	9	9	4160	**1206**
7	7	7	1050	**709**
8	6	6	660	**508**
9	4	4	515	**237**
10	2	2	778	**724**
12	6	6	987	**271**
13	4	4	168	96
14	6	6	159	128
15	4	4	290	**258**
16	3	3	320	**200**
19	7	7	290	163
20	8	8	500	**219**
21	7	7	340	129
22	7	7	640	**336**
23	4	4	200	144
25	6	6	430	169
26	9	9	135	86
27	6	6	210	148
28	9	9	290	161
29	7	7	200	108
30	4	4	1800	**727**
34	4	4	459	**370**
35	7	7	290	174
39	5	5	550	**300**
44	8	8	520	**325**
47	6	6	410	**213**
49	7	7	490	**339**
50	6	6	56	34
51	6	6	110	74
53	6	6	180	129
54	8	8	140	97
55	8	8	640	**242**
56	4	4	720	**355**
57	4	4	280	**240**
58	5	5	490	**366**
59	5	5	870	**360**
61	5	5	950	**498**
62	10	10	400	**316**
63	8	8	480	**214**
64	6	6	290	195

Table A-4 (Continued)

Property ID	Number of Samples	Number of Detections	Maximum Lead Concentration (mg/kg) [a]	Average Lead Concentration (mg/kg) [b]
65	4	4	500	**310**
66	5	5	5700	**1288**
67	5	5	240	136
68	7	7	300	95
69	8	8	240	105
70	5	5	450	**278**
71	4	4	560	**415**
72	7	7	210	134
73	9	9	360	**226**
74	8	8	460	**206**
75	7	7	930	**286**
76	6	6	530	**393**
77	3	3	160	100
78	3	3	380	**323**
82	12	12	160	48
83	6	6	260	175

[a] Maximum concentration in surface soil (0-2 inches bgs); [b] The USEPA screens lead at an average concentration of 200 mg/kg. This level represents a screening level used by the USEPA to evaluate soil lead levels for further actions. If the maximum or the average lead levels exceed 200 mg/kg, individual samples are identified to determine if they exceed the current NJDEP Residential Soil Remediation Standard of 400 mg/kg. Properties with average lead levels at or above 200 mg/kg are presented in **Bold**; mg/kg = milligrams of contaminant per kilogram of soil.

Table A-5. Surface Soil Lead Levels at Residential Properties Near the Tarkiln Branch

Property ID	Number of Samples	Number of Detections	Maximum Lead Concentration (mg/kg) [a]	Average Lead Concentration (mg/kg) [b]
86	8	8	760	**302**
87	8	8	25	11
88	3	3	180	101
89	6	6	360	165
91	7	7	22	19
92	7	7	360	**234**
93	7	7	560	112
94	6	6	29	16
95	7	7	230	148
97	13	13	100	47
98	7	7	130	89
99	12	12	230	48
100	8	8	200	87
101	6	6	230	95
102	7	7	360	149
103	5	5	120	76
104	6	6	86	55

Table A-5 (Continued)

Property ID	Number of Samples	Number of Detections	Maximum Lead Concentration (mg/kg) [a]	Average Lead Concentration (mg/kg) [b]
106	12	12	88	26
111	9	9	310	61
113	7	7	480	**219**
114	10	10	42	22
115	7	7	24	16
116	10	10	22	15
117	6	6	34	24
118	5	5	25	19
119	5	5	31	21
121	6	6	76	37
122	5	5	87	61

[a] Maximum concentration in surface soil (0-2 inches bgs); [b] The USEPA screens lead at an average concentration of 200 mg/kg. This level represents a screening level used by the USEPA to evaluate soil lead levels for further actions. If the maximum or the average lead levels exceed 200 mg/kg, individual samples are identified to determine if they exceed the current NJDEP Residential Soil Remediation Standard of 400 mg/kg; Properties with average lead levels at or above 200 mg/kg are presented in **Bold**; mg/kg = milligrams of contaminant per kilogram of soil.

Table B-1. Surface Water Contaminants – On-Site – April 2015

Contaminant	Number of Samples [a]	Maximum Detected Concentration (µg/L) [b]	Comparison Value (µg/L) [c]	Selected for Further Evaluation
Arsenic	3	13,000	0.016 (CREG)	**Yes**
Lead	3	39,000	15 (MCL)	**Yes**

[a] Samples were collected in northwest corner of property; [b] µg/L = micrograms of contaminant per liter of water; [c] Comparison values represent ATSDR Cancer Risk Evaluation Guide (CREG) for arsenic and NJDEP Maximum Contaminant Level (MCL) for lead; µg/L = micrograms of contaminant per liter of water.

Table B-2. Surface Water Contaminants – Tarkiln Branch – April 2015

Contaminant	Number of Samples [a]	Maximum Detected Concentration (µg/L) [b]	Comparison Value (µg/L) [c]	Selected for Further Evaluation
Arsenic	9	360	0.016 (CREG)	**Yes**
Lead	9	16	15 (MCL)	**Yes**

[a] Number of samples excludes one duplicate sample and two background samples; [b] µg/L = micrograms of contaminant per liter of water; [c] Comparison values represent ATSDR Cancer Risk Evaluation Guide (CREG) for arsenic and NJDEP Maximum Contaminant Level (MCL) for lead; µg/L = micrograms of contaminant per liter of water.

Table B-3. Sediment Contaminants – Tarkiln Branch – April 2015

Contaminant	Number of Samples [a]	Maximum Detected Concentration (mg/kg) [b]	Comparison Value (mg/kg) [c]	Selected for Further Evaluation
Arsenic	65	1400	0.26 (CREG)	**Yes**
Lead	65	2200	400 (NJDEP)	**Yes**

[a] Number of samples (0-6 inches bgs) excludes four duplicate samples and 61 background samples; [b] mg/kg = milligrams of contaminant per kilogram of sediment; [c] Comparison values represent ATSDR Cancer Risk Evaluation Guide (CREG) for arsenic and NJDEP Residential Soil Remediation Standard for lead; mg/kg = milligrams of contaminant per kilogram of soil.

Appendix B – Demographic Maps

Former Kil-Tone Company

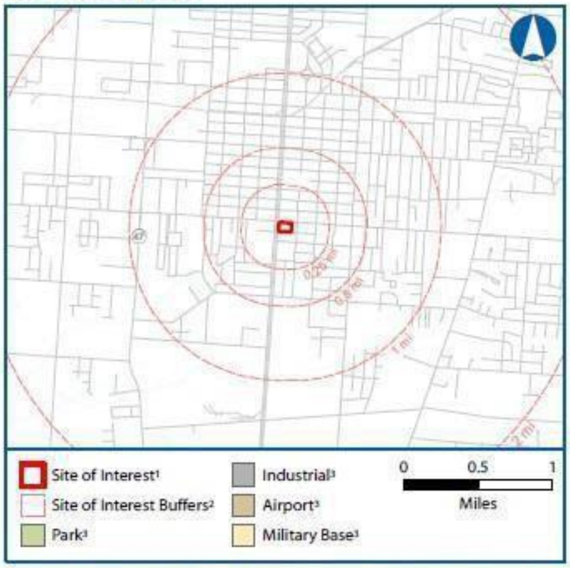
Vineland, Cumberland County, NJ

GENERAL SITE PROFILE

EPA FACILITY ID NJN000200874

INTRODUCTORY MAP SERIES

Site Vicinity Map



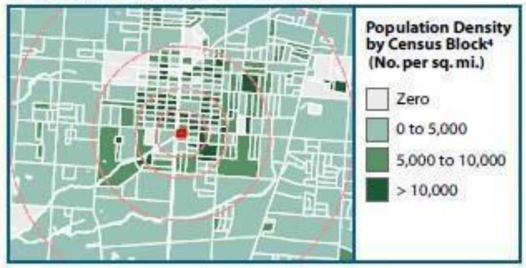
The **General Site Profile Map** depicts the hazardous waste site of interest, along with any airport, industrial, military, or park land uses. It also provides community demographic and housing statistics.

Demographic Statistics[4,5]

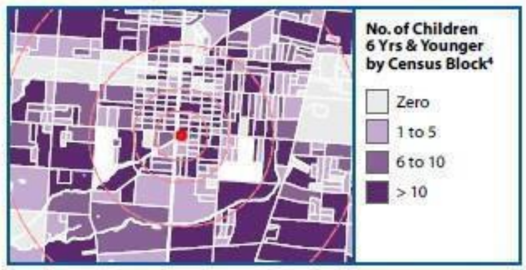
Within 1 mile buffer of site boundary

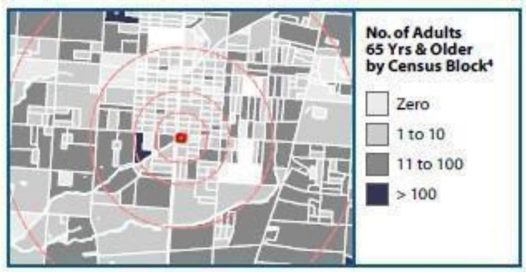
Measure	2000	2010	Change
Total Population	16,800	17,477	+4%
White Alone	7,413	8,915	+20%
Black Alone	3,383	3,524	+4%
Am. Indian & Alaska Native Alone	165	184	+11%
Asian Alone	152	165	+8%
Native Hawaiian & Other Pacific Islander Alone	16	7	-56%
Some Other Race Alone	4,802	3,898	-18%
Two or More Races	874	789	-9%
Hispanic or Latino[6]	9,805	11,825	+20%
Children Aged 6 and Younger	1,985	2,233	+12%
Adults Aged 65 and Older	1,895	1,717	-9%
Females Aged 15 to 44	3,846	3,977	+3%
Housing Units	6,088	6,012	-1%
Housing Units Pre 1950	1,883	1,577	-16%

General Population Density



Sensitive Populations





Data Sources: [1]ATSDR GRASP Hazardous Waste Site Boundary Database. [2]ATSDR GRASP. [3]TomTom International BV (2012). [4]US Census 2010. **Notes:** [5]Calculated using area-proportion spatial analysis method. [6]Individuals identifying origin as Hispanic or Latino may be of any race.
Projection: Projection used for all map panels is NAD 1983 StatePlane New Jersey FIPS 2900 Feet.

PRJ 04739 JXA0 11/3/15

GRASP

Agency for Toxic Substances and Disease Registry

Division of Toxicology and Human Health Sciences

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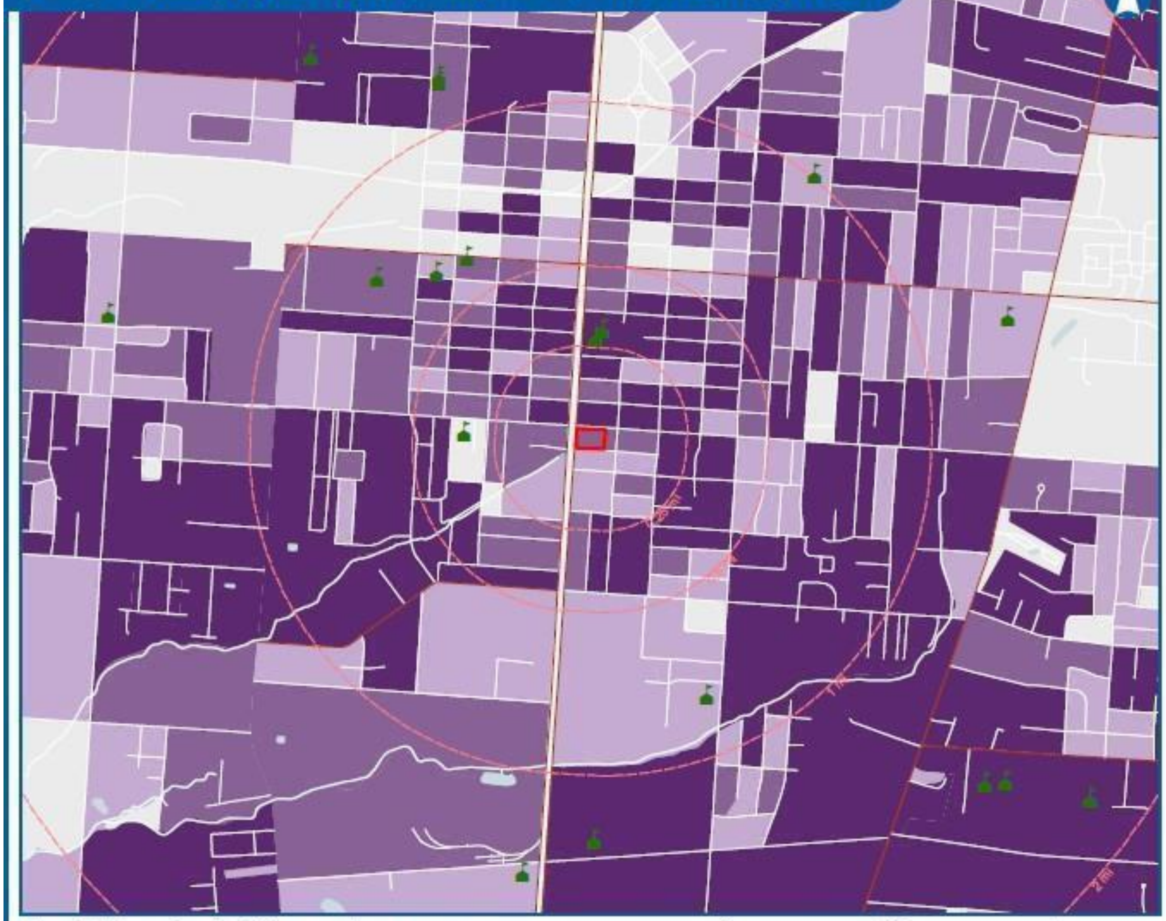
INTRODUCTORY MAP SERIES

Former Kil-Tone Company

Vineland, Cumberland County, NJ

SENSITIVE POPULATION: CHILDREN 6 YRS AND YOUNGER



The **Children Aged 6 Years and Younger Map** depicts the site of interest and the distribution and number of children residing in the surrounding community. The distribution of sensitive populations in and around a site is critical to understanding a community's potential for exposure to hazardous substances.

Within a **5-mile buffer** of this site are located **6,416** children 6 years and younger.

Site of Interest

- Site of Interest[1]
- Site of Interest Buffers[2]

Number of Children 6 Yrs & Younger by Census Block[3]

- Zero
- 1 to 5
- 6 to 10
- > 10

Community Resources

- Hospitals[4]
- Day Care Centers[5]

0 0.5 1

Miles

Children 6 Years and Younger[3,6]

Within specified distance of site boundary

Distance	2000	2010	Change
0.25 mile	235	255	+8%
0.50 mile	832	942	+13%
1 mile	1,985	2,233	+12%
3 miles[7]	4,212	4,875	+15%
5 miles[7]	5,607	6,416	+14%

Data Sources: [1]ATSDR GRASP Hazardous Waste Site Boundary Database. [2]ATSDR GRASP. [3]US Census 2010. [4]Oak Ridge National Laboratory (2013). [5]Homeland Security Infrastructure Program 2011.
Notes: [6]Calculated using area-proportion spatial analysis method. [7]Buffer not shown.
Projection: NAD 1983 StatePlane New Jersey FIPS 2900 Feet.

GRASP PRJ ID 04739, 11/3/15

GRASP

Agency for Toxic Substances and Disease Registry

Division of Toxicology and Human Health Sciences

ATSDR

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EPA FACILITY ID NJN000200874

INTRODUCTORY MAP SERIES

Former Kil-Tone Company

Vineland, Cumberland County, NJ

SENSITIVE POPULATION: FEMALES 15 YRS TO 44 YRS

The **Females Aged 15 to 44 Years Map** depicts the site of interest and the distribution and number of females residing in the surrounding community. The distribution of population in and around a site is critical to understanding a community's potential for exposure to hazardous substances.

Within a **5-mile buffer** of this site are located **13,548** females aged 15 to 44 years.

Site of Interest

- Site of Interest[1]
- Site of Interest Buffers[2]

Number of Females 15 to 44 Yrs by Census Block[3]

- Zero
- 1 to 20
- 21 to 100
- > 100

Healthcare Facilities

- Hospitals[4]
- Pharmacies[5]

0 0.5 1

Miles

Females 15 to 44 Years[3,6]

Within specified distance of site boundary

Distance	2000	2010	Change
0.25 mile	387	440	+13%
0.50 mile	1,511	1,581	+4%
1 mile	3,846	3,977	+3%
3 miles[7]	9,738	10,036	+3%
5 miles[7]	13,120	13,548	+3%

Data Sources: [1]ATSDR GRASP Hazardous Waste Site Boundary Database. [2]ATSDR GRASP. [3]US Census 2010. [4]Oak Ridge National Laboratory (2013).[5] TomTom International BV (2012).
Notes: [6]Calculated using area-proportion spatial analysis method. [7]Buffer not shown.
Projection: NAD 1983 StatePlane New Jersey FIPS 2900 Feet.

GRASP PRJ ID 04739, 11/3/15

GRASP

Agency for Toxic Substances and Disease Registry

Division of Toxicology and Human Health Sciences

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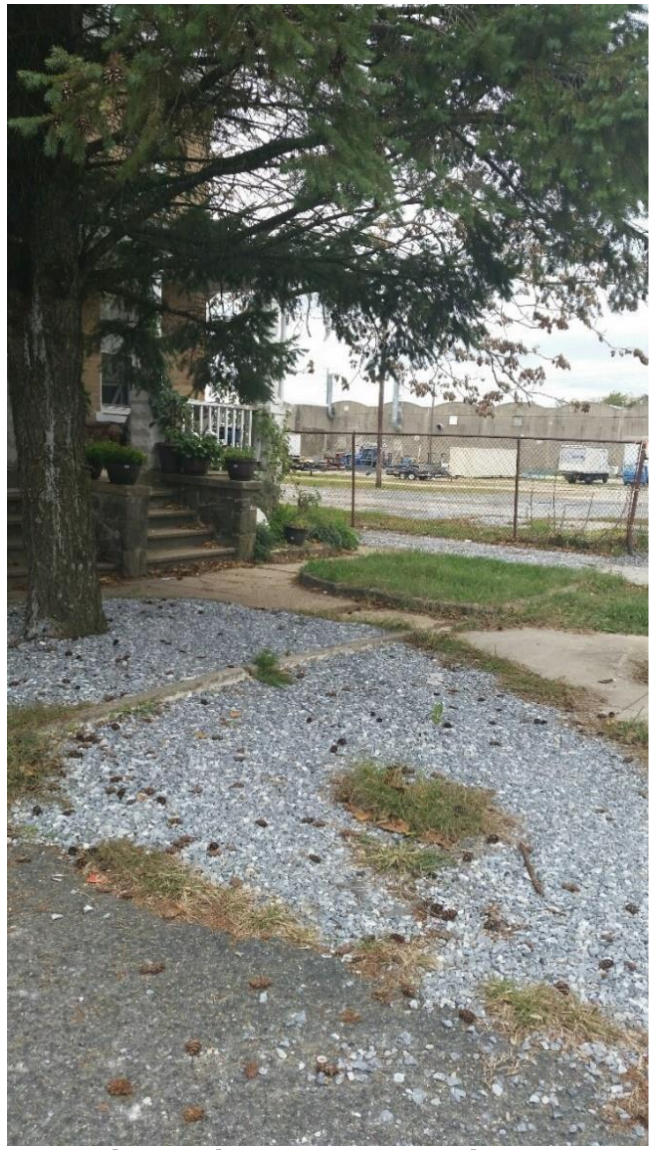
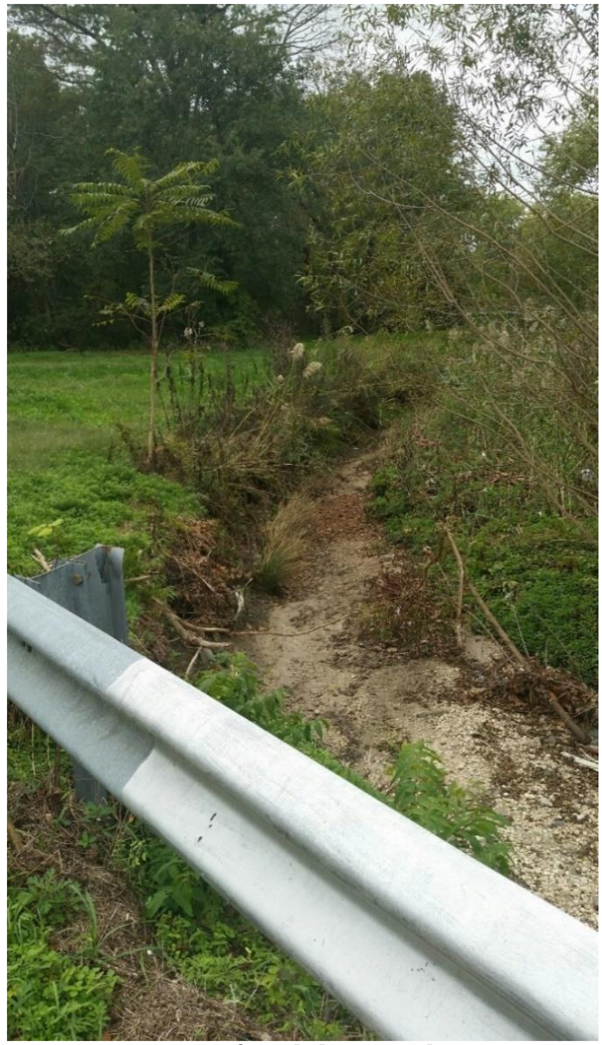
Appendix C – Site Visit Photos



Former Kil-Tone Site

Residence Adjacent to Former Kil-Tone Site


Residence with raised bed garden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Appendix D – Fact Sheets (English and Spanish)

Consumer, Environmental & Occupational Health Services

Public Health Services Branch
PO Box 369
Trenton, NJ 08625-0369

Former Kil-Tone Company Site, Vineland, New Jersey

Safe Gardening Fact Sheet

Lead and Arsenic are the two chemicals of concern at the former Kil-Tone Company Site. Therefore, the NJDOH recommends the following:

- Avoid eating root vegetables and green, leafy vegetables that have been grown in direct contact with contaminated soil.
  - Examples of root vegetables are carrots, beets, turnips and onions
  - Examples of green leafy vegetables are herbs, lettuce, cabbage and spinach
- Before eating other types of vegetables or fruits that have been grown in direct contact with contaminated soil, ensure that they have been thoroughly washed and peel them if possible.
  - Examples include tomatoes, squash, peppers, cucumbers, peas, beans and eggplant

Preparing Fruits and Vegetables

- When washing vegetables, use running water and scrub vegetables well before eating.
- Clean your hands, cutting boards, and kitchen tools with hot, soapy water and rinse well before and after handling your fruits and vegetables.
- Soak garden produce in cool water and rinse thoroughly until the water runs clear.
- Scrub garden produce with a vegetable-cleaning brush to remove dust and dirt before peeling or eating.
- Wash berry fruits like strawberries and blackberries, and remove the "caps" (the tops of the berries where the stem and leaves attach).

Consumer, Environmental & Occupational Health Services

Sucursal de Servicios de Salud Pública
Aptdo. Postal 369
Tenton, NJ 08625-0369

Sitio Antiguo de la Compañía Kil-Tone, Vineland, Nueva Jersey

Hoja Informativa para la Jardinería Segura

Plomo y arsénico son los dos químicos de preocupación en el sitio antiguo de la compañía Kil-Tone. Por lo tanto, el Departamento de Salud de Nueva Jersey hace las siguientes recomendaciones:

- Evite comer vegetales de raíz y vegetales de hoja que han crecido en tierra contaminada.
  - Ejemplos de vegetales de raíz son, zanahorias, cebollas, remolacha, y nabos.
  - Ejemplos de vegetales de hoja son hierbas, lechuga, repollo y espinaca.
- Antes de comer otros tipos de vegetales o frutas que han crecido en tierra contaminada, asegúrese que se hayan lavado a fondo y si es posible pelarlos.
  - Ejemplos incluyen tomates, calabazas, pimientos, pepinos, chicharos, frijoles y berenjena.

Preparando Frutas y Verduras

- Cuando lave vegetales, use agua corriente y limpie los vegetales antes de comer.
- Lave sus manos, tablas de cortar, y utensilios de la cocina con agua caliente y con jabón y enjuague bien antes y después del manejo de frutas y vegetales.
- Moje productos del jardín en agua fría y enjuague hasta que el agua salga transparente.
- Limpie productos del jardín con un cepillo de limpieza para verduras para remover polvo y tierra antes de pelarlos o comerlos.
- Lave frutas de tipo baya como fresas y frambuesas, y remueva el rabito (la parte de arriba donde se encuentran las hojas).

Consumer, Environmental & Occupational Health Services

Public Health Services Branch
PO Box 369
Trenton, NJ 08625-0369

Former Kil-Tone Company Site, Vineland, New Jersey

Fact Sheet
Reducing Exposure to Lead and Arsenic in Soil

How to reduce exposure to lead and arsenic in your home

- Limit the amount of soil you bring into your home by taking off coats, outerwear and shoes when entering your home. Place washable rugs at all entries to home.
- Clean your home weekly to keep it dust free as possible. Clean floors, window sills, doorframes, and baseboards with soap and water. Use a wet mop on hard floors, and clean window sills with wet rags.
- Vacuum carpets and rugs before mopping non-carpeted areas. If possible, use a vacuum with a high-efficiency particulate air (HEPA) filter.
- Wash children's hands frequently, and especially after playing outside, before they eat, and before bedtime. Adults should also wash hands frequently.
- Wash your hands after gardening and before eating or drinking.
- Bathe your pets frequently.

How to reduce exposure to lead and arsenic when doing outdoor activities

- Avoid eating or drinking while working in the yard or garden.
- Dampen soils with water before you garden to limit the amount of dust you inhale.
- Avoid working or playing in the yard on windy days, when dust can be stirred up.
- Keep children and pets away from bare soil areas.
- Have children play in grassy areas or a sandbox that can be covered.

Consumer, Environmental & Occupational Health Services

Sucursal de Servicios de Salud Pública
Aptdo. Postal 369
Trenton, NJ 08625-0369

Sitio Antiguo de la Compañía Kil-Tone , Vineland, Nueva Jersey

Hoja Informativa
Reduciendo la exposición al plomo y arsénico en la tierra

Como reducir la exposición al plomo y arsénico en su hogar

- Limite la cantidad de tierra que mete a su hogar con quitarse abrigos, zapatos, y otro tipo de vestimenta exterior antes de entrar a su hogar. Posicione tapetes lavables en cada entrada del hogar.
- Limpie su hogar cada semana para mantenerlo libre de tierra. Lave pisos, repisas de las ventanas, marcos de las puertas y rodapiés con agua y con jabón. Use un trapeador mojado para los pisos, y limpie las repisas con trapos mojados.
- Aspire alfombras y tapetes antes de trapear otras superficies. Si es posible, use una aspiradora con un filtro "high-efficiency particulate air" (HEPA).
- Lave las manos de los niños frecuentemente, y especialmente después de que jugar afuera, antes de comer, y antes de ir a dormir. Los adultos también deberían lavarse las manos frecuentemente.
- Lave sus manos después de jardinear y antes de comer o beber.
- Bañe a sus mascotas frecuentemente.

Como reducir la exposición al plomo y arsénico cuando haciendo actividades al aire libre

- Evite comer o beber mientras trabaja en el patio o jardín.
- Moje la tierra con agua antes de jardinear para limitar la cantidad de tierra que pueda inhalar.
- Evite trabajar o jugar en el patio en días ventosos, cuando la tierra se puede agitar.
- Mantenga niños y mascotas fuera de áreas con tierra descubierta.

Appendix E – Toxicological Summaries

The toxicological summaries provided in this Appendix are based on ATSDR's ToxFAQs (https://www.atsdr.cdc.gov/toxfaqs/index.asp). The health effects described in this section are typically known to occur at levels of exposure much higher than those that occur from environmental contamination. The chance that a health effect will occur is dependent on the amount, frequency and duration of exposure, and the individual susceptibility of exposed persons. The main text provides our opinion about which health effects might occur in residents and workers living at properties with contaminated soil and sediment.

Arsenic. Arsenic is a naturally occurring element widely distributed in the earth's crust. In the environment, arsenic is combined with oxygen, chlorine, and sulfur to form inorganic arsenic compounds. Arsenic in animals and plants combines with carbon and hydrogen to form organic arsenic compounds.

Inorganic arsenic compounds are mainly used to preserve wood. Copper chromated arsenate (CCA) is used to make "pressure-treated" lumber. CCA is no longer used in the U.S. for residential uses; it is still used in industrial applications. Organic arsenic compounds are used as pesticides, primarily on cotton fields and orchards.

Breathing high levels of inorganic arsenic can give you a sore throat or irritated lungs. Ingesting very high levels of arsenic can result in death. Exposure to lower levels can cause nausea and vomiting, decreased production of red and white blood cells, abnormal heart rhythm, damage to blood vessels, and a sensation of "pins and needles" in hands and feet.

Ingesting or breathing low levels of inorganic arsenic for a long time can cause a darkening of the skin and the appearance of small "corns" or "warts" on the palms, soles, and torso. Skin contact with inorganic arsenic may cause redness and swelling.

Almost nothing is known regarding health effects of organic arsenic compounds in humans. Studies in animals show that some simple organic arsenic compounds are much less toxic than inorganic forms. For example, the ingestion of arsenobetaine found in seafood is not harmful. Ingestion of methyl and dimethyl arsenical compounds can cause diarrhea and damage to the kidneys.

Several studies have shown that ingestion of inorganic arsenic can increase the risk of skin cancer and cancer in the liver, bladder, and lungs. Inhalation of inorganic arsenic can cause increased risk of lung cancer. The Department of Health and Human Services (DHHS) and the USEPA have determined that inorganic arsenic is a known human carcinogen. The International Agency for Research on Cancer (IARC) has determined that inorganic arsenic is carcinogenic to humans.

Lead. Lead is a naturally occurring bluish-gray metal found in small amounts in the earth's crust. Lead can be found in all parts of our environment. Much of it comes from human activities including burning fossil fuels, mining, and manufacturing.

Lead has many different uses. It is used in the production of batteries, ammunition, metal products (solder and pipes), and devices to shield X-rays. Because of health concerns, lead from paints and ceramic products, caulking, and pipe solder has been dramatically reduced in recent years. The use of lead as an additive to gasoline was banned in 1996 in the United States. The effects of lead are the same whether it enters the body through breathing or swallowing. Lead can affect almost every organ and system in your body. The main target for lead toxicity is the nervous system, both in adults and children. Long-term exposure of adults can result in decreased performance in some tests that measure functions of the nervous system. It may also cause weakness in fingers, wrists, or ankles.

Lead exposure also causes small increases in blood pressure, particularly in middle-aged and older people and can cause anemia. Exposure to high lead levels can severely damage the brain and kidneys in adults or children and ultimately cause death. In pregnant women, high levels of exposure to lead may cause miscarriage. High level exposure in men can damage the organs responsible for sperm production.

Children are more vulnerable to lead poisoning than adults. A child who swallows large amounts of lead may develop blood anemia, severe stomachache, muscle weakness, and brain damage. If a child swallows smaller amounts of lead, much less severe effects on blood and brain function may occur. Even at much lower levels of exposure, lead can affect a child's mental and physical growth.

Exposure to lead is more dangerous for young and unborn children. Unborn children can be exposed to lead through their mothers. Harmful effects include premature births, smaller babies, decreased mental ability in the infant, learning difficulties, and reduced growth in young children. These effects are more common if the mother or baby was exposed to high levels of lead. Some of these effects may persist beyond childhood.

We have no conclusive proof that lead causes cancer in humans. Kidney tumors have developed in rats and mice that had been given large doses of lead compounds. DHHS has determined that lead and lead compounds are reasonably anticipated to be human carcinogens and the USEPA has determined that lead is a probable human carcinogen. IARC has determined that inorganic lead is probably carcinogenic to humans and that there is insufficient information to determine whether organic lead compounds will cause cancer in humans.

Polycyclic Aromatic Hydrocarbons (PAHs). Polycyclic aromatic hydrocarbons (PAHs) are a group of over 100 different chemicals that are formed during the incomplete burning of coal, oil and gas, garbage, or other organic substances like tobacco or charbroiled meat. PAHs are usually found as a mixture containing two or more of these compounds, such as soot.

Some PAHs are manufactured. These pure PAHs usually exist as colorless, white, or pale yellow-green solids. PAHs are found in coal tar, crude oil, creosote, and roofing tar, but a few are used in medicines or to make dyes, plastics, and pesticides.

Mice that were fed high levels of one PAH during pregnancy had difficulty reproducing and so did their offspring. These offspring also had higher rates of birth defects and lower body weights. It is not known whether these effects occur in people. Animal studies have also shown that PAHs can cause harmful effects on the skin, body fluids, and ability to fight disease after both short- and long-term exposure. But these effects have not been seen in people.

The Department of Health and Human Services (DHHS) has determined that some PAHs may reasonably be expected to be carcinogens. Some people who have breathed or touched mixtures of PAHs and other chemicals for long periods of time have developed cancer. Some PAHs have caused cancer in laboratory animals when they breathed air containing them (lung cancer), ingested them in food (stomach cancer), or had them applied to their skin (skin cancer).

Appendix F – PHAST Dose Calculations

The following example dose calculations and PHAST spreadsheets were all from one property (Property ID 6). This property was selected to demonstrate how the risks were calculated for each property evaluated in this health consultation. The PHAST spreadsheet calculates doses for all age groups for all contaminants of concern. PHAST also calculates the doses for all exposure durations (chronic, intermediate, and acute). It then compares those doses to the appropriate health guideline if available:

MRL = ATSDR Minimal Risk Level

RfD = USEPA Reference Dose

CSF = USEPA Cancer Slope Factor

Further evaluation was conducted for contaminants with Hazard Quotients (HQs) above 1.0 for noncancer health effects. The highest cancer risks for each contaminant at each property were added together to determine the total LECR for each property.

EXAMPLE DOSE CALCULATIONS FROM PHAST: Property ID 6

Contaminant of concern = Arsenic

Exposure Group = Children ages 1 to < 2 years

Contaminant of Concern	EPC (RME) mg/kg	EPC (Pica) mg/kg	Intake Rate (RME) mg/day	Intake Rate (Pica) mg/day	ATSDR Minimal Risk Level (MRL) mg/kg/day	Cancer Slope Factor (CSF) mg/kg/day $^{-1}$
Arsenic	150	150	200	5,000	Chronic = 0.0003 Intermediate = Not Available Acute = 0.005	1.5

Exposure Dose Calculations - Arsenic:

RME Dose (Above average soil ingestion rates)

Calculations represent children ages 1 to < 2 years

<u>Note:</u> The ingestion dose for arsenic includes a bioavailability factor (BF) of 60% or 0.6. The bioavailability factor for the other contaminants is 100% or 1.0.

Ingestion Dose

$$\text{Exposure Dose (mg/kg/day)} = \frac{C \times IR \times EF \times CF \times BF}{BW}$$

where, mg/kg/day = milligrams of contaminant per kilogram of body weight per day;

C = concentration of contaminant in surface soil = 150 mg/kg

IR = Ingestion rate for children ages 1 to < 2 years = 200 mg/day

EF = Exposure factor = 1.0

CF = Conversion factor (10^{-6} kg/mg)

BW = Body weight = 11.4 kg

BF = Bioavailability factor = 60% or 0.6 (only used when calculating arsenic doses)

Substituting values (Ingestion dose):

Exposure Dose =

$$\frac{150 \text{ mg/kg} \times 200 \text{ mg/day} \times 0.6 \times 1 \times 10^{-6} \text{ (kg/mg)}}{11.4 \text{ kg}} = \mathbf{0.0016\ mg/kg/day}$$

Dermal Dose

$$\text{Dermal Exposure Dose (mg/kg/day)} = \frac{C \times AF \times EF \times CF \times ABS_d \times SA}{BW \times ABS_{GI}}$$

where, mg/kg/day = milligrams of contaminant per kilogram of body weight per day

C = concentration of contaminant in surface soil = 150 mg/kg

AF = Adherence Factor to skin (mg/cm^2-event) = 0.2

EF = Exposure Factor = 1.0

CF = Conversion Factor (10^{-6} kg/mg)

ABS_d = Dermal Absorption Fraction to skin = 0.03

SA = Skin surface are available for contact = 2,299 cm^2

BW = Body Weight = 11.4 kg

ABS_{GI} = Gastrointestinal Absorption Factor = 1.0

Substituting values (Dermal dose):

Dermal Exposure dose =

$$\frac{150 \text{ mg/kg} \times 0.2\text{mg/cm}^2 \times 1.0 \times 10^{-6} \text{ (kg/mg)} \times 0.03 \times 2{,}299 \text{ cm}^2}{11.4 \text{ kg} \times 1.0} = \mathbf{0.00018 \text{ mg/kg/day}}$$

Total RME Dose = Ingestion dose + Dermal dose =

0.0016 mg/kg/day+ 0.00018 mg/kg/day = 0.0018 mg/kg/day

Chronic Hazard Quotient (HQ) = $\frac{\text{Total RME Dose} = 0.0018 \text{ mg/kg/day}}{\text{Chronic MRL} = 0.0003 \text{ (mg/kg/day)}}$ = **5.9 (RME HQ)**

Note: Calculations may vary slightly due to rounding

Soil-Pica Dose (applies only to children between ages 1 to < 6 years); used maximum concentration detected on each property as the EPC.

Following the same formulas as above for ingestion and dermal. *The only exception is the pica exposure factor (EF) is 3days/7days = 0.429 and the ingestion rate for pica is 5,000 mg/day.*

The following calculation is for pica children ages 1 to < 2 years.

Substituting values for the Pica Ingestion and Dermal doses:

Pica Ingestion Dose =

$$\frac{150 \text{ mg/kg} \times 5{,}000 \text{ mg/day} \times 0.6 \times 0.429 \times 10^{-6}}{11.4 \text{ (kg)}} \text{ (kg/mg)} = \mathbf{0.017 \text{ mg/kg/day}}$$

Pica Dermal Dose =

$$\frac{150 \text{ mg/kg} \times 0.2 \times 1.0 \times 10^{-6} \text{ (kg/mg)} \times 0.03 \times 2{,}299 \text{ cm}^2}{11.4 \times 1.0} = \mathbf{0.00018 \text{ mg/kg/day}}$$

Total Pica dose = Pica Ingestion Dose + Pica Dermal Dose =

0.017 mg/kg/day + 0.00018 mg/kg/day = 0.017 mg/kg/day

Acute Hazard Quotient (HQ) **=** $\frac{\text{Pica Dose} = 0.017 \text{ mg/kg/day}}{\text{Acute MRL} = 0.005 \text{ mg/kg/day}}$ **= 3.4 (Pica HQ)**

Lifetime Excess Cancer Risk (LECR) –

Cancer risks are calculated for all age groups and added to get the total LECR.

RME Cancer Risk (LECR) = Total RME Dose x $\frac{ED}{AT}$ x CSF

Age-Specific Dose x Cancer Slope Factor x Exposure Duration / Averaging Time

Where, LECR = Lifetime Excess Cancer Risk for RME scenario

Total RME Dose (see formula for RME dose above) = 0.0018 mg/kg/day

ED = Exposure Duration = 1 year (for children ages 1 to < 2 in this example)

AT = Averaging Time = 78 years (lifetime)

CSF = Cancer slope factor = 1.5 mg/kg-day^{-1} for Arsenic

Substituting values for a child ages 1 to < 2 years (RME scenario) as noted in Table below:

RME Cancer Exposure Dose (mg/kg/day) = 0.0018 mg/kg/day x $\frac{\text{1 year}}{\text{78 years}}$ = 0.000023 mg/kg/day

LECR = 0.000023 mg/kg/day x 1.5 mg/kg-day $^{-1}$ = 3.5E-05

Cancer Risk by Age Group	RME Dose (mg/kg/day)	Exposure Duration for Cancer Dose (ED)	RME Cancer Exposure Dose (mg/kg/day)	Cancer Slope Factor for Arsenic (mg/kg/day) $^{-1}$	RME Lifetime Excess Cancer Risk (LECR) for Arsenic *
Child Birth to < 1 year	0.0019	1	0.000024	1.5	3.6E -05
Child 1 to < 2 years	0.0018	1	0.000023	1.5	3.5E -05
Child 2 to < 6 years	0.0012	4	0.000062	1.5	9.2E -05
Child 6 to < 11 years	0.00067	5	0.000043	1.5	6.4E -05
Child 11 to <16 years	0.00024	5	0.000015	1.5	2.3E -05
Child 16 to <21 years	0.00020	5	0.000013	1.5	1.9E -05
Combined cancer risk for children exposed for 21 years	---------------	21	---------------	---------------	2.7E-4

Cancer Risk by Age Group	RME Dose (mg/kg/day)	Exposure Duration for Cancer Dose (ED)	RME Cancer Exposure Dose (mg/kg/day)	Cancer Slope Factor for Arsenic $(mg/kg/day)^{-1}$	RME Lifetime Excess Cancer Risk (LECR) for Arsenic *
Adult	0.00014	33	0.000059	1.5	8.6E-5
Birth to < 21 years + 12 years as an adult **	This scenario represents children who live in the same house as adults	------------	--------------	----------------	3.0E-4

*LECR results may vary slightly due to rounding; **This LECR is calculated using the following formula: Total LECR = RME Adult Dose x 12 years/78-year lifetime x Cancer Slope Factor + Combined RME LECR for children. This maximum LECR was used to evaluate the cancer risks for each contaminant on each property.

PHAST TABLES - Soil - Combined Chronic Exposures

Table 1. Residential: Default combined ingestion and dermal exposure doses for chronic exposure to ARSENIC in soil at 150 mg/kg along with noncancer hazard quotients and cancer risk estimates*

PHAST Public Health Assessment Site Tool Exposure Group	CTE Dose (mg/kg/day)	CTE Noncancer Hazard Quotient	CTE Cancer Risk	CTE Exposure Duration for Cancer (yrs.)	RME Dose (mg/kg/day)	RME Noncancer Hazard Quotient	RME Cancer Risk	RME Exposure Duration for Cancer (yrs.)
Birth to < 1 year	0.00084	2.8†	-	1	0.0019	6.5†	-	1
1 to < 2 years	0.00089	3.0†	-	1	0.0018	5.9†	-	1
2 to < 6 years	0.00044	1.5†	-	4	0.0012	3.9†	-	4
6 to < 11 years	0.00028	0.93	-	5	0.00067	2.2†	-	5
11 to < 16 years	0.00013	0.45	-	1	0.00024	0.82	-	5
16 to < 21 years	0.00011	0.38	-	0	0.00020	0.67	-	5
Total Child	-	-	9.7E-5‡	12	-	-	2.7E-4‡	21
Adult	5.7E-05	0.19	1.3E-5‡	12	0.00014	0.45	8.6E-5‡	33
Birth to < 21 years plus 12 years during adulthood§	-	-	-	-	-	-	3.0E-4‡	33

Source: [Tetra Tech, 2015a]; Abbreviations: CTE = central tendency exposure (typical); mg/kg/day = milligram chemical per kilogram body weight per day; mg/kg = milligram chemical per kilogram soil; RME = reasonable maximum exposure (higher); yrs. = years; * The calculations in this table were generated using ATSDR's PHAST v1.6.0.0. The noncancer hazard quotients were calculated using the chronic (greater than 1 year) minimal risk level of 0.0003 mg/kg/day and the cancer risks were calculated using the cancer slope factor of 1.5 $(mg/kg/day)^{-1}$; † A shaded cell indicates the hazard quotient exceeds the noncancer health guideline, which ATSDR evaluates further; ‡ A shaded cell indicates that the cancer risk exceeds one extra case in a million people similarly exposed, which ATSDR evaluates further; § This cancer risk represents a scenario where children are likely to continue to live in their childhood home as adults.

PHAST TABLES - Soil - Combined Acute Exposures

Table 2. Residential: Default combined ingestion and dermal exposure doses for acute exposure to ARSENIC in soil at 150 mg/kg along with noncancer hazard quotients *

PHAST PUBLIC HEALTH ASSESSMENT SITE TOOL Exposure Group	CTE Dose (mg/kg/day)	CTE Noncancer Hazard Quotient	RME Dose (mg/kg/day)	RME Noncancer Hazard Quotient	Soil-Pica Dose (mg/kg/day)	Soil-Pica Noncancer Hazard Quotient
Birth to < 1 year	0.00084	0.17	0.0019	0.39	-	-
1 to < 2 years	0.00089	0.18	0.0018	0.35	0.017	3.4†
2 to < 6 years	0.00044	0.089	0.0012	0.23	0.011	2.2†
6 to < 11 years	0.00028	0.056	0.00067	0.13	-	-
11 to < 16 years	0.00013	0.027	0.00024	0.049	-	-
16 to < 21 years	0.00011	0.023	0.00020	0.040	-	-
Adult	5.7E-05	0.011	0.00014	0.027	-	-

Source: [Tetra Tech, 2015a]; Abbreviations: CTE = central tendency exposure (typical); mg/kg/day = milligram chemical per kilogram body weight per day; mg/kg = milligram chemical per kilogram soil; RME = reasonable maximum exposure (higher);* The calculations in this table were generated using ATSDR's PHAST v1.6.0.0. The noncancer hazard quotients were calculated using the acute (less than two weeks) minimal risk level of 0.005 mg/kg/day; † A shaded cell indicates the hazard quotient exceeds the noncancer health guideline, which ATSDR evaluates further.