DRAFT FOR PUBLIC COMMENT

Public Health Assessment

Evaluation of Residential Soils in the Newhall Street Neighborhood of Hamden

Hamden, New Haven County, Connecticut

February 2004

Prepared by
The Connecticut Department of Public Health
under cooperative agreement with
The Agency for Toxic Substances and Disease Registry

CT DPH will accept comments on this document until May 3, 2004

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The conclusions and recommendations in this Public Health Assessment are based on the data and information made available to the Connecticut Department of Public Health and the Agency for Toxic Substances and Disease Registry. The Connecticut Department of Public Health and the Agency for Toxic Substances and Disease Registry will review additional information when received. The review of additional data could change the conclusions and recommendations listed in this document.

SUMMARY

The Newhall Street neighborhood is located in the southern portion of the town of Hamden, Connecticut. It is an approximately 11-block area comprised of residences, as well as the nearby Hamden Middle School and two town parks (Rochford Field and Mill Rock Park). The area was used for disposal of domestic and industrial waste during the 1930s, 1940s and 1950s. Many of the homes in the Newhall Street neighborhood were built on top of landfill waste.

The purpose of this Public Health Assessment is to evaluate environmental sampling data from residential yards in the Newhall Street neighborhood, in Hamden, Connecticut, to determine whether landfill waste materials present a public health hazard. This Public Health Assessment builds upon results of several health consultations and a Public Health Assessment previously prepared by the Connecticut Department of Public Health (CT DPH) (under a cooperative agreement with the Agency for Toxic Substances and Disease Registry [ATSDR]). These previously prepared documents address the public health significance of landfill waste materials at the Hamden Middle School, two town parks and the Newhall Street School, all located in the Newhall Street neighborhood. This Public Health Assessment builds upon information contained in the prior evaluations but data analyzed in this document have not been evaluated previously.

Environmental investigations in the Newhall Street neighborhood have focused on surface and subsurface soils from residential yards. Investigations have found elevated levels of lead, polycyclic aromatic hydrocarbons (PAHs), and arsenic in both surface and subsurface soils. These results are consistent with sampling data from other areas in the neighborhood where landfill waste was disposed (for example, Hamden Middle School, Rochford Field, Mill Rock Park). In 2001 and 2002, the Environmental Protection Agency (EPA) removed contaminated soils at 13 residential properties because surface soil contamination was so high that immediate action was needed to reduce exposure.

To evaluate public health implications from contaminants in soil in the Newhall Street neighborhood, CT DPH first considered the available environmental data and how people might become exposed to contaminants. If there is no exposure, there is no threat to public health. In cases where exposure is possible, CT DPH compared maximum concentrations of contaminants with health-protective comparison values. This screening step rules out exposures that have little likelihood of causing adverse health impacts. When contaminant concentration exceeded comparison values, CT DPH further evaluated the exposures to determine the likelihood that such exposures would result in adverse health impacts.

People could be exposed to landfill contaminants in the Newhall Street neighborhood through direct contact with contaminated soil (ingestion of soil, skin contact, inhaling soil particles). CT

DPH evaluated exposures to lead in soil using a screening model which relates soil lead levels to blood lead levels. This model indicates that at properties with the highest concentrations of lead in surface soil, there is the potential for increases in blood lead levels in children above levels of concern for adverse health impacts. Fortunately, these homes have been already cleaned up by EPA so exposures are no longer occurring. However, there are still many other homes with elevated lead in soil and if they are left unremediated, future exposures could result in elevations in blood lead among children. Files on blood lead levels were reviewed to identify any children in the Newhall Street neighborhood who had elevated blood lead levels. No elevations were found that could be related to lead exposure from landfill waste. Regarding elevated levels of arsenic and PAHs in soil, CT DPH's evaluation of cancer and noncancer risks shows that adverse health impacts from exposure to these contaminants are unlikely.

ATSDR has a categorization scheme whereby the level of public health hazard at a site is assigned to one of five conclusion categories. Based on a review of the available environmental data, CT DPH has determined that the properties with the highest lead levels posed a "Public Health Hazard" in the past (that is, before EPA performed soil cleanup activities). Based on current conditions and available data, "No Apparent Public Health Hazard" currently exists. However, this hazard category will be re-evaluated once the full nature and extent of landfill waste contamination of the Newhall Street neighborhood is determined.

This Public Health Assessment also contains an evaluation of health outcome data. CT DPH evaluated the health survey information collected by the Quinnipiack Valley Health District (QVHD), which included reported cases of cancer. CT DPH verified reported cancer cases in the Tumor Registry records. Based on CT DPH's qualitative review, the number and types of cancer that were reported in the health survey conducted by QVHD do not appear to be in excess of what would be expected to occur. With regard to illnesses other than cancer, it was not possible to scientifically evaluate whether the reported illnesses are in excess of what would be expected to occur because there are no data on background rates of these illnesses. However, based on the number of dwellings surveyed, CT DPH believes the number and type of reported illnesses do not look unusual. CT DPH also evaluated the most recent published cancer incidence data for the town of Hamden and found no statistically meaningful elevations in cancer incidence for Hamden.

CT DPH received community health concerns during numerous public and private meetings with area residents. Their concerns have been identified and addressed in this Public Health Assessment document.

Based on its evaluation of the environmental data, CT DPH's recommended actions include the following: digging or other activities that disturb soils beneath the ground surface should be avoided; the CT Department of Environmental Protection (CT DEP) should continue in its role overseeing the process of further investigation of landfill waste in the neighborhood and this investigation should proceed as quickly as possible; QVHD should offer free blood lead screening in the Newhall Street neighborhood; and, QVHD should expand the health concerns survey originally conducted in 2001 to areas known to have landfill waste that were not included in the previous survey.

A. PURPOSE

The purpose of this Public Health Assessment is to evaluate environmental sampling data from residential yards in the Newhall Street neighborhood, in Hamden, Connecticut, to determine whether landfill waste materials present a public health hazard. This Public Health Assessment builds upon results of several health consultations and a Public Health Assessment previously prepared by the Connecticut Department of Public Health (CT DPH) (under a cooperative agreement with the Agency for Toxic Substances and Disease Registry [ATSDR]). These previously prepared documents address the public health significance of landfill waste materials at the Hamden Middle School, two town parks and the Newhall Street School, all located in the Newhall Street neighborhood (ATSDR 2003, ATSDR 2003a ATSDR 2001, ATSDR 2001a).

This Public Health Assessment focuses on environmental investigations in residential yards. The document begins with a general summary of the history of the site and actions that have already been taken to protect people from exposure to contamination. This is followed by a presentation of the results of soil sampling in the neighborhood and an explanation of how people could be exposed to contamination in the soil. The public health implications section which follows the exposure section describes the likely health impacts from exposure to residents of the neighborhood. Finally, community health questions and concerns are identified and answered, conclusions and recommendations are presented and a public health action plan is proposed. In preparing this Public Health Assessment, CT DPH relied on all currently available data. It should be noted that additional environmental sampling is planned for the neighborhood. CT DPH will evaluate the new data as it becomes available. It is possible that the conclusions and recommendations presented in this Public Health Assessment could change based on the new sampling results.

B. BACKGROUND

This Public Health Assessment evaluates soil data collected by the U.S. Environmental Protection Agency (EPA), the Connecticut Department of Environmental Protection (CT DEP) and Olin Corporation from a residential area encompassing approximately 11 blocks in the Newhall Street neighborhood of the town of Hamden, Connecticut. This neighborhood is in the southern part of Hamden and includes Bryden Terrace, Remington Street, Newbury Street, Edwards Street, St. Mary Street and parts of Newhall Street, Morse Street, Marlboro Street, Winchester Avenue, Wadsworth Street, Shelton Avenue, Augur Street and Butler Street. The land that is now occupied by residences, as well as the nearby Hamden Middle School and two town parks (Rochford Field and Mill Rock Park), were used for disposal of domestic and industrial waste during the 1930s, 1940s and 1950s (EPA 2001). Many of the homes in the Newhall Street neighborhood were built on top of landfill waste.

The portions of the neighborhood that are the focus of this Public Health Assessment are delineated in an attached map (Figure 1, Attachment A). It is important to note that the lines on the map do not necessarily represent the limits of the landfill, but rather the lateral extent of soil sampling that has been conducted thus far. The landfill limits are still being investigated. Sampling in the residential neighborhood to determine the extent of landfill materials is ongoing.

In January 2001, CT DEP began investigating soils in the neighborhood to identify where landfill materials were present and whether there were elevated levels of contaminants. This investigation was initiated after environmental studies at the nearby Hamden Middle School, Rochford Field and Mill Rock Park indicated the presence of elevated levels of metals and polycyclic aromatic hydrocarbons (PAHs) in soils. PAHs is the name for a group of chemicals that are formed during the incomplete burning of organic substances. In the Environmental Data Section, individual PAH compounds are identified and quantified. More about PAH toxicity is provided in Attachment F.

CT DEP's initial investigation in January 2001 focused on surface and subsurface soils from public right-of-way grass strips between the sidewalk and road in areas that may have been filled in the past (based on CT DEP's review of historical aerial photographs). CT DEP's investigation indicated the presence of elevated levels of contaminants including lead, arsenic and PAHs in accessible surface soils and in soils at depth (up to 8 feet below ground surface) in many locations throughout the Newhall Street neighborhood. CT DEP observed non-native material such as ash, cinders, slag and other debris in the soil samples they collected. The results of this sampling helped CT DEP identify initial boundaries of the landfill and areas on which to focus subsequent investigations.

Subsequent investigations in the neighborhood focused on defining the nature and extent of contamination in surface soils of residential yards. Surface soils are the most accessible soils and children and adults could be exposed to contaminants on a daily basis in surface soils in their yards, especially if contaminants are present in areas that are not covered (i.e., bare earth not covered with grass, asphalt or other barriers). For this portion of the investigation, CT DEP received assistance from EPA. In April 2001, EPA sampled surface soils (0-6 inches below ground surface) on approximately 76 residential properties. The purpose of EPA's investigation was to identify properties with surface soil contaminant levels so high that immediate action was needed to reduce potential exposure.

After EPA had completed its activities in the neighborhood, a number of residents whose properties had not been sampled by EPA, expressed a desire to receive sampling on their properties. To respond to these requests, CT DEP initiated a supplemental soil sampling program. So far, CT DEP has sampled surficial soil at over 20 additional residences in the neighborhood. In order to be sampled, a resident must have observed waste materials in his yard or have a reasonable suspicion of waste materials being present.

In August 2002, additional soil sampling in the neighborhood was performed by the Olin Corporation, one of the parties identified by CT DEP as being potentially responsible for the landfill waste material. Olin's primary focus was to better define the extent of fill material at depth in the neighborhood and to define the limits of landfill waste materials (Olin 2002). Although their focus was soils at depth, they collected approximately 75 surface soil samples (0-3 inches below ground surface) in addition to the 139 depth samples. Depth samples were collected as deep as 20 feet below ground surface. Surface soils were analyzed only for lead and arsenic. Elevated levels of lead and/or arsenic were found in 23% of the surface soil samples taken by Olin.

In April 2003, a consent order was finalized between CT DEP and the entities who are potentially responsible for placing contaminated landfill waste in the neighborhood and other adjacent areas (Hamden Middle School, Rochford Field, Mill Rock Park). The consent order allocates responsibility among the parties for investigation and remediation of the contamination. It also sets out a framework for further investigation and remediation of the site and provides a plan for public involvement.

1. Public Health Actions Taken

Since the time contamination was first discovered in the Newhall Street neighborhood in early 2001, a number of activities have taken place to protect the public from exposure to contamination, assess health concerns in the community and communicate potential health risks to the public.

EPA "Time Critical" Soil Removal Action

EPA completed soil removal activities on 13 residential properties during the period October 2001 to January 2002 (EPA 2001, EPA 2003). Contaminated soil was removed by EPA to a depth of approximately 18 inches. The soil removal action served to eliminate the potential for adults and children to come into contact with very high levels of contaminants in accessible surface soils of these yards. The soil removal action by EPA is not a permanent remedy because in most cases, contaminants remain in soils deeper than 18 inches.

Properties were selected for soil removal based upon whether contaminant levels in surface soil exceeded immediate action trigger values[1] established by CT DPH in collaboration with EPA and others. At all 13 properties, lead levels exceeded the immediate action trigger level. At some of the 13 properties, arsenic and/or PAHs exceeded trigger levels as well.

Home Visits with Residents

During May and June 2001, CT DPH and EPA met with most of the residents of the approximately 76 properties that were sampled by EPA. Soil results were provided to each resident and next steps were discussed. CT DPH answered questions about exposure and health impacts. A fact sheet prepared jointly by EPA and CT DPH about ways to reduce exposure to soil was distributed to residents (the fact sheet is included as Attachment B). At properties where EPA removal actions were planned, EPA and CT DPH met with residents on multiple occasions.

Voluntary Blood Lead Screening

Because lead is a primary contaminant in the landfill waste, the Quinnipiack Valley Health District (QVHD) offered free blood lead screening to neighborhood residents on August 1, 2001. The screening was open to anyone interested, but residents were specifically targeted who had elevated lead in soil with children residing in the home. The purpose of the screening was to identify cases of lead poisoning among neighborhood residents so that further investigation could

[1]The immediate action trigger levels used in Hamden are 1200 mg/kg for lead, 150 mg/kg for arsenic, and 10 mg/kg for benzo(a)pyrene. These levels are risk based and are intended to trigger action to reduce exposure within 6 months.

occur to identify possible sources of lead exposure. There were no individuals who came to the screening.

QVHD Lead Exposure Follow Up Activities

CT DEP referred a number of homes to the QVHD for lead exposure follow-up activities. The homes referred for follow up were those homes with elevated lead in surface soil, where young children reside (or visit often), that were *not* scheduled to receive an EPA immediate soil removal action. In some cases, an EPA soil removal action was not possible because the elevated lead in soil was from lead paint, not landfill waste materials. In other cases, the lead elevation was not high enough to trigger immediate EPA action. Lastly, some homes were discovered through the CT DEP supplemental soil sampling program after EPA had already completed its soil removal activities in Hamden.

QVHD follow-up actions for elevated lead in soil varied depending on the specifics of the situation. Activities they conducted included the following.

- Providing educational materials to residents about reducing exposure to lead paint in soil.
- Providing educational materials to residents about health impacts to adults and children from exposure to lead.
- Conducting home visits to observe the condition of the backyard and suggesting ways to reduce soil exposure (such as mulching bare soil).

QVHD database search for elevated blood lead levels in children

To learn about potential elevated blood lead levels in children residing in the Newhall Street neighborhood, the QVHD performed a manual search of all QVHD files in the Newhall Street area for elevated blood lead levels. The QVHD found three children with elevated blood lead who resided in the Newhall Street neighborhood since 1978 (when record-keeping began). Two of these children had been relocated from another town into the Newhall Street neighborhood because of elevated blood lead levels they had received while living in another town. These two children had continual decreases in their blood lead levels while in residence in the Newhall Street neighborhood. Peeling paint with toxic levels of lead was the known risk factor for the third child. CT DPH recognizes that this search would not identify a child with elevated blood lead who may frequently visit a grandparent or other relative but not reside in the neighborhood.

QVHD Community Health Concerns Survey

During May and June 2001, staff from the QVHD collected health information from the neighborhood using a community concerns interview form (see Attachment C). QVHD staff visited 125 homes in the Newhall Street neighborhood. In some homes, information was collected through a personal interview with the resident. In other cases, the resident completed the survey form themselves. Each of the 125 targeted homes were visited as many as three different occasions if an occupant was not found at home. After the third attempt, an interview form was left at the residence. The survey was intended to collect information (for qualitative evaluation) about health symptoms and health concerns among residents living in the area known to have landfill waste present. Completed survey forms were received from 55 of the 125 targeted homes.

Public Meetings and Public Availability Session

CT DPH staff participated in four public meetings and hosted one public availability session to present health and exposure information to residents and respond to residents' questions and concerns. In addition, CT DPH staff have provided health and exposure information and answered questions at citizen advisory group meetings.

Methane Screening in Homes

Beginning in April 2001, the Town of Hamden Fire Marshall's office sponsored a methane screening program in the neighborhood. The program was initiated in response to residents' concerns about methane after elevated levels of methane were found beneath the boiler room floor in the adjacent Hamden Middle School. Although the source of the methane in the school was never definitively linked to the presence of landfill waste, residents wanted assurance that dangerous levels of methane were not present in their homes. The methane screening program was voluntary. There were 12 homes that requested and received methane screening. Methane was not detected in any homes.

Residential Structural Evaluations

Many of the residents have concerns about settling problems in their homes and possible structural damage and safety issues. Beginning in late 2001, CT DEP hired structural and geotechnical engineering consultants to assess the issue of excessive settlement of foundations due to the loose fill over which many houses were built. Engineers identified 42 homes with possible settlement problems and at 34 of these homes, evidence of building cracks and settlement was observed during field visits. At four homes, crack gauges were installed across cracks in interior walls and exterior foundations to monitor any further movement. Detailed field visits were conducted at four homes with the most severe settlement. It was noted that at all four homes, settlement has occurred to the extent that structural damage to beams and columns may have occurred. However, further investigation by structural engineers determined that none of the homes have damage so severe that occupants are in imminent danger. Engineering contractors made recommendations regarding repairs that could be done to stabilize the homes. In 2004, CT DEP plans to further evaluate the structural condition of homes built on top of fill material. CT DEP intends to include structural repairs with remediation of the site, where warranted.

2. Demographics

The portions of the neighborhood that are the focus of this health consultation are delineated by the red lines in the map included in Attachment A. Within this area, there are approximately 238 homes with approximately 600 residents.

C. DISCUSSION

In this Section, results from environmental sampling are presented. Environmental data are presented and discussed along with relevant health-based comparison values. Comparison values are screening levels, below which, there is little likelihood of adverse health effects from exposure. When contaminant concentrations are below comparison values, no further evaluation for human health is necessary and it can be concluded that adverse health impacts are not likely. When contaminant concentrations exceed comparison values, it indicates that further evaluation of exposures and health impacts is needed. Comparison values used in this Public Health Assessment are Connecticut Residential Direct Exposure Criteria for soil from the Remediation Standard Regulations (CT RSRs). Comparison values are presented in the data tables which are included in the Environmental Data section.

There is another set of values (trigger concentrations) that were used to evaluate soil data from the Newhall Street neighborhood. Trigger concentrations are not the same as comparison values. Trigger concentrations are levels that indicate the need for immediate action by EPA to reduce exposure. Trigger concentrations used for the Newhall Street neighborhood soil data were developed by CT DPH and EPA for this project. They are higher than CT RSRs because they indicate where contaminant levels are so high that immediate action is needed. As discussed in greater detail in the following section, EPA used the trigger concentrations to identify which properties needed immediate soil removal actions.

Exposure pathways (i.e., ways people could come into contact with contamination) and the public health significance of these exposures, along with an evaluation of available health outcome data, are also discussed in this Section.

1. Environmental Data

As mentioned in the Background Section, there have been several soil sampling efforts in the Newhall Street neighborhood, beginning in 2001. The initial sampling effort was conducted by CT DEP in January 2001 and focused on public right-of-way grass strips between the sidewalk and road in locations believed to have received fill. This was followed by EPA sampling of surface soils to identify properties where immediate action was necessary. After EPA completed its surface soil sampling effort, CT DEP continued to sample soil at properties who requested soil sampling. The final dataset evaluated in this Health Assessment consists of soil samples collected by the Olin Corporation in August 2002. Each of these soil datasets will be presented and summarized in more detail in the following paragraphs.

<u>CT DEP Right-Of-Way Soil Sampling</u>

Beginning in January 2001, CT DEP collected surface soil samples (0-6 inches below ground surface) from 65 locations in right-of-way grass strips. At eight of these locations, soils at depth were collected as well. Depth samples were collected as much as 12 feet below ground surface. Samples were analyzed for total metals, pesticides, semi-volatile organic chemicals (SVOCs) and volatile organic chemicals (VOCs).

In the right-of-way samples, polycyclic aromatic hydrocarbons (PAHs) were the contaminants found most often at levels exceeding health-based comparison values (15 out of 65 samples). PAHs were more often elevated in surface soil than at soil at depth. Maximum concentrations of PAHs in surface soils are from 2 to 5 times above comparison values. Lead, arsenic, total extractable petroleum hydrocarbons (ETPH) and pesticides were also found at levels exceeding comparison values. However, pesticides were elevated only in surface samples and were infrequently detected at elevated levels. Field observations during sampling noted the presence of non-native materials such as ash and cinders. The right-of-way sampling effort is significant because it was the first data to show that landfill waste extends into residential areas beyond the Hamden Middle School[2].

The right-of-way sample results for surface soils are summarized in Table 1. Table 1 includes maximum concentrations for those contaminants detected above health-based comparison values. Results from soils at depth are summarized in Table 2.

Table 1. Summary of Surface Soil Samples (0-6 inches) Collected by DEP from Right-Of-Way Areas, Newhall Street Neighborhood, Hamden, CT, January 2001.

Chemical	Maximum Concentration (mg/kg)	# samples above Comparison Value/Total # samples	Comparison Value[2] (mg/kg)
Lead	4173	3/65	400^
Arsenic	98	5/65	10
ETPH[1]	716	2/65	500
Chromium	104*	1/65	3900/100*
PAHs			
Benzo(b)fluoranthene	5	15/81	1
Benzo(a)pyrene	2.5	5/65	1
Benzo(a)anthracene	2.6	6/65	1
Benzo(k)fluoranthene	2.3	0/65	8.4
Dibenzo(ah)anthracene	0.59	0/65	1
Indeno(1,2,3-cd)pyrene	2	3/65	1
Pesticides			
Chlordane (total)	17	3/65	0.49
Heptachlor	0.4	1/65	0.14
beta-BHC	1.6	1/65	0.34
Dieldrin	0.05	1/65	0.038

[1] ETPH = Total Extractable Petroleum Hydrocarbons
[2] The source for all Comparison Values used in this Health Assessment (unless otherwise noted) is the CT Remediation Standard Regulations Residential Direct Exposure Criteria for soil (CT RSR). These soil standards are developed to be protective of a child who contacts soil on a daily basis for many years (30 years).
^CT DEP site-specific cleanup criterion at the Hamden Landfill sites. This criterion will eventually become part of the CT Remediation Standard Regulations and will be used statewide.
*The CT RSR for trivalent chromium is 3900 mg/kg, the CT RSR for hexavalent chromium is 100 mg/kg. The sample was not speciated so it is unknown how much of the chromium is hexavalent.

[2]The Hamden Middle School and the athletic field behind it are the primary areas where dumping of domestic and industrial waste occurred during the 1940s and 1950s.

Table 2. Summary of Subsurface Soil Samples Collected by CT DEP and EPA, Hamden, CT, 2001-2002.

Chemical	Maximum Concentration (mg/kg)	Sample Depth (feet)	# samples above Comp. Value/Total # samples	Comparison Value[2] (mg/kg)
Lead	39,400	5.5-6	89/166	400^
Arsenic	347	3-3.5	55/157	10
Mercury	70	1.5	1/145	20
Chromium*	114	2-7	1/145	3900/100*
ETPH[1]	15,450	1-4	2/129	500
PAHs				
Benzo(b)fluoranthene	350	3-4.5	61 /142	1
Benzo(a)pyrene	240	3-4.5	60/142	1
Benzo(a)anthracene	230	3-4.5	56/142	1
Benzo(k)fluoranthene	250	3-4.5	50/142	8.4
Dibenzo(ah)anthracene	18	1-4	6/142	1
Indeno(1,2,3-cd)pyrene	52	3-4.5	17/142	1

[1]ETPH = Total Extractable Petroleum Hydrocarbons.
[2] The source for all Comparison Values used in this Health Assessment (unless otherwise noted) is the CT Remediation Standard Regulations Residential Direct Exposure Criteria for soil (CT RSR). These soil standards are developed to be protective of a child who contacts soil on a daily basis for many years (30 years).
^CT DEP site-specific cleanup criterion at the Hamden Landfill sites. This criterion will eventually become part of the CT Remediation Standard Regulations and will be used statewide.
*The CT RSR for trivalent chromium is 3900 mg/kg, the CT RSR for hexavalent chromium is 100 mg/kg. The sample was not speciated so it is unknown how much of the chromium is hexavalent.

EPA Residential Soil Sampling

Based on the results of the CT DEP right-of-way sampling, CT DEP asked EPA to conduct a residential soil sampling program to determine if contaminant levels were high enough that immediate action was needed to reduce exposure. In April 2001, EPA sampled surface soils (0-6 inches) at 76 properties. Sampling focused on accessible surface soils in yards where people work and play. In each yard, EPA targeted its sampling on children's play areas, bare soil areas, gardens and any other areas likely to receive high use. In addition, EPA sampled areas where homeowners had observed non-native soil material (e.g., ash, glass, cinders, slag or other debris). Four or five locations on each property were sampled and were field analyzed for lead, arsenic and mercury using x-ray fluorescence (XRF). Approximately 40% of the XRF samples were sent to EPA's laboratory for confirmatory analysis. At the single location on each property with the highest lead level, a soil sample was laboratory analyzed for semi-volatile organic compounds (SVOCs), including PAHs.

EPA's sampling indicated that there were properties which had contaminant levels high enough that immediate action was needed to reduce exposure. The immediate action implemented by EPA was removal of contaminated soil to a depth of 18 inches below ground surface and disposal at an offsite location. Properties were considered for immediate action by EPA if contaminants in surface soil exceeded trigger levels[3] developed by CT DPH in collaboration with EPA, CT DEP and the QVHD. At properties where surface soil concentrations exceeded trigger levels, EPA collected additional surface soil samples and at least one depth sample. The purpose of the additional sampling was to confirm the presence of contaminants above trigger levels and rule out lead paint as the source of elevated lead in surface soil. If, based on the additional sampling, a property was identified to receive an immediate action, EPA conducted a third round of sampling. This round of sampling provided a more complete characterization of the extent of contamination. It involved sampling surface soil at 10-foot grid intervals and field screening the samples for lead using XRF. This more detailed characterization allowed EPA to more precisely define the horizontal extent of contamination across the yard and develop work plans for where and how much soil removal would occur. Because sampling data indicated that high arsenic and PAHs almost always occurred with high lead levels, EPA made decisions about soil removal based only on lead results.

EPA conducted soil removal actions on 13 properties during the period October 2001 to January 2002. CT DPH reviewed and concurred with EPA's actions and assured that it was health protective (see letter in Attachment D). As mentioned previously, EPA removed soils to a depth of approximately 18 inches and then backfilled the excavation with clean fill. To gain a better understanding of contaminant concentrations at depth at the 13 properties, CT DEP collected soil samples at the base of the excavation prior to backfilling by EPA.

All of EPA's residential surface soil sampling results are summarized in Table 3 below. Depth samples collected by EPA and CT DEP are summarized in Table 2 on the previous page. Table 2 includes depth samples collected by EPA from residential yards, depth samples collected by CT DEP at the base of excavations and depth samples from right-of-way areas.

[3]Trigger concentrations used to indicate further sampling and the possible need for immediate action by EPA were lead concentrations in surface soil exceeding1,200 mg/kg, arsenic exceeding 150 mg/kg or benzo(a)pyrene exceeding 10 mg/kg. Immediate actions consisted of removal of soil to a depth of approximately 18 inches and replacement with clean soil.

Table 3. Summary of Surface Soil Samples (0-6") Collected by EPA from Residential Yards in the Newhall Street Neighborhood, Hamden, CT, April 2001.

Chemical	Maximum Concentration (mg/kg)	# samples above Comp. Value/ Total # samples	Comparison Value[2] (mg/kg)	# samples above Trigger Concentration	Trigger Concentration[@] (mg/kg)
Lead	43,900	476/884	400[^]	91/884	1200
Arsenic[1]	155	15/85	10	1/85	150
PAHs					
Benzo(b)-fluoranthene	50	41/69	1	---	----
Benzo(a)-pyrene	54	41/69	1	2/69	10
Benzo(a)-anthracene	48	30/69	1	---	----
Benzo(k)-fluoranthene	46	3/69	8.4	---	----
Dibenzo(ah)-anthracene	12	6/69	1	---	----
Indeno(1,2,3-cd)pyrene	30	25/69	1	---	----

[1] Results presented for arsenic are laboratory results, not the field screening (XRF) results. Laboratory results are presented because the arsenic detection limit for XRF was 60 mg/kg, which is higher than the comparison value for arsenic of 10 mg/kg.
[2] The source for all Comparison Values used in this Health Assessment (unless otherwise noted) is the CT Remediation Standard Regulations Residential Direct Exposure Criteria for soil (CT RSR). These soil standards are developed to be protective of a child who contacts soil on a daily basis for many years (30 years).
[^]CT DEP site-specific cleanup criterion at the Hamden Landfill sites. This criterion will eventually become part of the CT Remediation Standard Regulations and will be used statewide.
[@]The trigger concentrations were developed jointly by CT DEP, EPA and CT DPH for this project. Trigger concentrations indicate the need for immediate soil removal actions.

Table 3 shows that lead was found in surface soil at extremely high levels (up to 43,900 milligrams per kilogram [mg/kg]). This is over 100 times greater than the comparison value of 400 mg/kg. The comparison value of 400 is a screening level below which there is little likelihood of adverse health effects. Arsenic was found in surface soil at levels as high as 155 mg/kg (15 times greater than the comparison value). However, arsenic was not detected above the comparison value as frequently as lead. Virtually all of the samples with elevated arsenic also had elevated lead. With regard to PAHs, there were numerous properties with concentrations of PAHs above comparison values. In virtually all cases, properties with elevated PAHs also had elevated lead. The highest levels of PAHs found on a property were as much as 50 times greater than comparison values.

During soil removal activities, EPA conducted perimeter air monitoring using two personal data Real-time Aerosol Monitors (RAMs) which were placed upwind and down wind of the work area. The RAMs monitored dust levels in real time and ensured that dust suppression measures were performing within established guidelines. In addition, four low flow air sampling pumps were placed along the perimeter of the work zone to verify that airborne lead in dust, if present, was not migrating beyond the work areas. Personal air monitoring for airborne lead was conducted during the first three days of excavation work. Personal monitoring was discontinued because analytical results indicated no elevated levels of lead in the air.

CT DEP Supplemental Soil Sampling

As mentioned previously, soil data were also collected by CT DEP as part of its supplemental soil sampling program. CT DEP's supplemental soil sampling program included residences who were not included in EPA's sampling program but had reason to suspect that landfill waste materials were present in soil on their property. Beginning in December 2001, CT DEP collected surface soil samples at approximately 21 residences that had not been sampled by EPA. CT DEP followed essentially the same sampling procedure as EPA had followed for its April 2001 sampling effort. CT DEP's sampling identified the presence of lead in surface soil at levels up to 5010 mg/kg (more than 12 times greater than the comparison value). There were four properties found with lead levels greater than the immediate action trigger level of 1200 mg/kg. At these properties, exposure reduction measures such as covering bare soil were performed. Arsenic was also found at levels greater than the comparison value of 10 mg/kg. Several PAHs were found at levels significantly above comparison values in one surface soil location at one property. EPA did not conduct soil removal actions at these properties because they were discovered after EPA had already completed its activities in the neighborhood. CT DEP's supplemental soil sampling results are not included in the summary data tables.

Olin Soil Sampling

The final soil data that exists for the Newhall Street neighborhood consists of samples collected and analyzed by Olin Corporation in August 2002. As mentioned earlier, the focus of Olin's sampling was to better define the extent of fill material at depth in the neighborhood and to define the limits of landfill waste materials. Although their focus was soils at depth, they collected approximately 75 surface soil samples (0-3 inches below ground surface) as part of their investigation. Some samples were collected from public right-of-way areas and other samples were collected from private yards. Surface soils were analyzed for lead and arsenic. The maximum lead concentration in surface soil was 738 mg/kg and the maximum arsenic concentration was 35 mg/kg. These concentrations are above comparison values but do not exceed the immediate action trigger value. Regarding contaminant concentrations at depth, Olin's results were generally consistent with what previous subsurface investigations have found. That is, lead, arsenic and PAHs were found at elevated levels. Maximum lead found in soils at depth was 10,100 mg/kg and maximum arsenic was 303 mg/kg. A new finding was that at one property, PAHs were found at depth (2-4 feet below ground surface) at levels much higher than any previous sampling had found. Several PAH compounds were found at 96 to 3,100 times greater than comparison values. Olin's dataset is not included in the summary data tables.

2. Exposure Pathways

To evaluate potential exposures in the Newhall Street neighborhood, CT DPH considered the available environmental data and how people might come into contact with contaminants. In order for exposure to occur, there must be a source of hazardous contaminants, a way for people to come into direct contact with the contaminants and a way for the contaminants to enter the body. It is important to emphasize that if there is no exposure to a hazardous contaminant, there is no risk of adverse health effects.

In the Newhall Street neighborhood, contaminants have been detected in surface soil and subsurface soil.

<u>Surface soil</u>
For surface soil, possible ways people could be exposed to contamination is by ingestion (eating soil particles adhered to fingers or food items), dermal contact (skin contact with soil during activities such as gardening or other yard work, children playing in the soil) and inhalation (inhaling soil particles). In yard areas that are grassed or have other barriers to direct soil contact such as asphalt, exposure potential to surface soils will be greatly diminished. For the purposes of this Public Health Assessment, exposure to contaminants in surface soils is considered to be a *complete exposure pathway* and is evaluated in more detail in the Public Health Implications Section.

<u>Subsurface soil</u>
Subsurface soils in the neighborhood were also found to have contaminants. However, provided that excavation, digging or other activities that penetrate into deep soils do not occur, there will be *no* exposure to subsurface soils. For the purposes of this Public Health Assessment, exposure to contaminants in subsurface soils is considered a *potential exposure pathway* and is not evaluated further in this Public Health Assessment.

With regard to exposure pathways other than soil, air monitoring conducted during EPA's soil excavation work showed no airborne lead and the methane screening program found no evidence of methane in the basements of homes in the neighborhood that were tested. Therefore, exposure to landfill waste materials through the air pathway (indoor air and outdoor air) is not likely.

Contaminants have been detected in groundwater in the neighborhood, however, groundwater is *not* used for drinking water or other non-potable uses so there is no exposure to groundwater from drinking[5].

If there is no potential for exposure to contaminants, then it can be concluded that there is no possibility of adverse health effects from the contaminants. However, if there is an actual

[5] Another way for exposure to occur from groundwater is through the volatilization pathway. If volatile chemicals are present in shallow groundwater at high enough levels, vapors can move from the groundwater and can enter basements through cracks and other openings in the foundation. Limited groundwater sampling in the neighborhood does not show the presence of volatile chemicals. More groundwater sampling is planned that should provide information needed to rule out this exposure pathway as one of concern.

(completed) or potential exposure pathway, contaminant concentrations are compared to health-protective comparison values. As stated previously, comparison values are screening levels, below which, there is little likelihood of adverse health effects from exposure. When contaminant concentrations exceed comparison values, exposures are evaluated further. In this Public Health Assessment, CT DPH used the Connecticut residential criteria for direct exposure to soil (CT RSRs) as comparison values. These values assume that contact with soil occurs every day over the long term (30 years).

3. Public Health Implications for Adults and Children

This section presents the likely health impacts to Newhall Street neighborhood residents from hazardous contaminants in landfill waste. Whether a person becomes sick from exposure to hazardous contamination depends on the following factors:

- the concentration of the chemical someone is exposed to (how much),
- the duration and frequency of exposure (how long, how many times),
- the route of exposure (breathing, eating/drinking, skin contact), and
- the person's individual characteristics (age, diet, lifestyle, genetics).

To evaluate public health implications to adults and children from contaminants in residential yards in the Newhall Street neighborhood, CT DPH first compared maximum concentrations of contaminants with comparison values. When concentrations exceeded comparison values, they were evaluated further to determine the likelihood that the exposures would be significant enough to cause health effects. For contaminants that exceeded comparison values (lead, arsenic, PAHs, pesticides, TPH), CT DPH evaluated cancer and noncancer health impacts. For lead, CT DPH evaluated the predicted increase in blood lead level.

For a summary of the general toxicological and epidemiological information for the three primary contaminants found in the Newhall Street neighborhood (lead, arsenic and PAHs), please refer to Attachment F. The information in Attachment F is included for the purpose of providing general background information. It is not intended to imply that these health effects would be expected or are likely to occur among residents in the neighborhood. More toxicological information can also be found on the ATSDR website (www.atsdr.cdc.gov).

Public Health Implications of Lead in Surface Soil

There has been a large amount of environmental sampling in the Newhall Street neighborhood over the past three years. Surface soil samples collected from neighborhood yards (Table 3) indicate that lead was frequently found above its comparison value of 400 mg/kg. Lead is the contaminant found at the highest concentration in surface soil, relative to its comparison value. Lead was detected at one property at concentrations over 100 times above its comparison value. The maximum lead level found in surface soil in a residential yard is 43,900 mg/kg. Lead was found at levels above 400 mg/kg in approximately 50% of samples.

Adults and children in the Newhall Street neighborhood could come into direct contact with contaminated surface soil while working or playing in their yards. Exposure could occur through direct skin contact (dermal), eating soil particles adhered to fingers or food items (ingestion) or breathing soil particles in the air (inhalation). Children have a greater potential for exposure to soil than do adults. Children have more opportunities for contact with soil because they play on the ground and in bare soil. Children also have greater hand-mouth activity, which leads to more soil ingestion than adults. In addition, children have a greater sensitivity than adults to the harmful health effects from lead exposure.

The high levels of lead found in the Newhall Street neighborhood were present in surface soils where children currently reside or resided in the past. As discussed previously, lead in soil can be an important route of exposure to lead.

ATSDR has developed a screening procedure for evaluating exposures to lead (ATSDR 1999). ATSDR's screening procedure uses a blood lead slope factor which predicts the increase in blood lead per unit lead concentration in soil. The slope factor assumes continuous exposure. The screening procedure involves multiplying the lead level in soil by the percentage of outside time that is spent in one's yard. This is then multiplied by the blood lead-to-soil lead slope factor. CT DPH used a blood lead slope factor for U.S. children of 0.0068, which is based on a study of U.S. children from 1-18 years of age. For adults, CT DPH used a slope factor of 0.001, which is based on a study of U.S. males aged 18-65 years. For the percentage of outside time spent in one's yard, CT DPH made two alternative assumptions, shown in Table 4 below.

The relationship between soil lead and blood lead depends on many factors including the bioavailability[6] of lead in the soil, the chemical form of lead, the age of the exposed person and their work or play habits. Using the ATSDR screening procedure, CT DPH estimated the incremental blood lead level for children and adults working and playing in soil in the yard with the highest *average* lead level (which was calculated to be 11,800 mg/kg). Lead levels were not averaged across multiple yards because exposure occurs mostly in one's own yard rather than in other yards in the neighborhood. The average lead concentration (11,800 mg/kg) was conservatively estimated as the 95% Upper Confidence Limit (UCL) of the mean, using EPA's Pro UCL program (Pro UCL, version 2.0). The results of the blood lead estimates are presented below in Table 4.

Table 4. Estimated Blood Lead Increment from Exposure to Lead in Residential Soil, Newhall Street Neighborhood, Hamden, CT (based on ATSDR Screening Procedure, July 1999).

Exposed Person	Soil Lead Concentration[1] (mg/kg)	Soil Slope Factor (ug/dL blood lead per mg/kg soil lead)	Fraction of play or work time spent in one's own yard	Estimated Incremental Blood Lead Burden (ug/dL)
Child	11,800	0.0068	1.0 (100%)	80
Child	11,800	0.0068	0.5 (50%)	40
Adult	11,800	0.001	0.5 (50%)	6

[1]The soil lead concentration of 11,800 mg/kg is the average concentration in the most contaminated yard. The average was conservatively estimated as the 95% Upper Confidence Limit of the average. It is unlikely to underestimate the true average.

[6] Bioavailability refers to the degree to which lead is available to the body. Bioavailability is influenced by how easily the lead is absorbed from the soil into the body.

Assuming that a child spends 100% of their play time in their yard (as opposed to play time spent elsewhere, such as at a park) , an incremental blood lead of 80 ug/dL was estimated based on the average (11,800 mg/kg) lead concentration in soil. CT DPH also estimated the incremental blood lead level using a different assumption about the portion of time spent playing in one's yard. If it is assumed that children spend only 50% of their play time in their yard, an incremental blood lead of 40 ug/dL is estimated using the average concentration in the most contaminated yard. CT DPH believes it is reasonable to assume that children would not spend less than 50% of their play time in their yards.

These blood lead estimates are greater than the level of concern for potential adverse health impacts in children (greater than 10 ug/dL). It is important to note that 11,800 mg/kg is the average lead level in the *most contaminated yard*.[7] Estimated blood lead levels would be lower in yards with lower lead levels in soil. For example, using the ATSDR screening procedure, any yard with an average soil lead concentration above 1500 mg/kg has the potential to result in blood lead levels greater than the level of concern for children (>10 ug/dL). This assumes that the child spends 100% of his/her play time in their yard There are several yards with average lead levels greater than 1500 mg/kg but they have already been cleaned up by EPA (as has the yard with an average lead level of 11,800 mg/kg) . Therefore, under *current conditions*, there is no opportunity for exposure to lead at levels of public health concern.

CT DPH's blood lead calculations show that estimates of incremental blood lead levels in children are above levels of concern for potential adverse health impacts (>10 ug/dL). However, it is important to realize that there is no indication that children living in the neighborhood actually have these levels of lead in their blood. *The model used by CT DPH is a screening procedure that cannot predict the true blood lead level in any given person because of the many uncertainties inherent in the relationship between soil lead and blood lead.*[8] At best, the model results indicate that at the most contaminated properties, there is the potential for increases in blood lead levels in children. At properties with lower lead levels in soil, the potential for exposure would be less. Fortunately, the homes with the highest levels of lead in surface soil that we know about, received immediate soil removal actions by EPA in 2001. Therefore, CT DPH believes that exposures at levels of public health concern are no longer occurring in the neighborhood. CT DPH has concluded that under current conditions in the neighborhood, lead does not pose a public health threat. However, past exposures to lead in soil could have caused elevations in childrens' blood lead above levels of concern for possible adverse health impacts. Elevations in children's blood lead could occur in the future if the remaining properties with elevated lead in soil are not cleaned up. As shown in Table 4, CT DPH also estimated incremental blood lead levels in adults and found the estimated increase to be small and not above a levels of concern for adults (>20 ug/L).

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[7] This yard (as well as other yards with very high lead levels) has already been cleaned up.
[8] If someone is concerned that they might have elevated lead levels in their blood, they should contact their physician to get a blood test for lead.

Public Health Implications of Other Contaminants in Surface Soil

Arsenic and PAHs

As shown in Table 3, arsenic was found in surface soil at levels above comparison values. The maximum arsenic concentration was 155 mg/kg (15 times higher than the comparison value). Several PAHs were also found at elevated levels (as much as 54 times above comparison values). Only a single surface soil sample from each yard was analyzed for PAHs. For arsenic, most properties only have two or three laboratory confirmed samples[9]. The small number of samples are not enough to calculate averages on a property-by-property basis for arsenic and PAHs. Therefore, to estimate concentrations of arsenic and PAHs that residents could be exposed to, CT DPH calculated average concentrations of arsenic and PAHs using data from multiple properties. Properties in the neighborhood were separated into two groups according to the spatial distribution of landfill waste.

Morse Street Property Group

The first group of properties (Morse Street Group), consists of six different properties. In this property group, six PAH samples and 13 arsenic samples were available to calculate average concentrations. The average concentration (95% UCL) for each PAH was below comparison values (CT RSRs). Therefore, PAH exposure in this group of properties is unlikely to present a cancer or noncancer health threat. The average concentration (95% UCL) of arsenic in the Morse Street group of properties was 54 mg/kg. This average concentration exceeds the comparison value for arsenic of 10 mg/kg, so exposures to arsenic in the Morse Street group of properties were evaluated further.

CT DPH calculated exposure doses and theoretical risks from exposure to arsenic in the Morse Street group of properties, assuming that soil exposure occurs 7 days per week for 9 months of the year, for 30 years. Nine months rather than 12 months was used in the calculations because it is assumed that contact with soil would not occur during the winter, when the ground is frozen and possibly snow-covered. CT DPH believes these are realistic, yet still health protective assumptions given the specifics of the site. Arsenic doses to children and adults were calculated. As previously stated, CT DPH assumed people would be exposed to 54 mg/kg arsenic in soil. This is the 95% UCL of the average. A 95% UCL accounts for variability in the data and ensures that the average is not underestimated. Given these assumptions, the average daily dose from ingestion and dermal exposure to arsenic was estimated to be 0.00026 mg/kg/day. This dose is below the Agency for Toxic Substances and Disease Registry's (ATSDR's) Minimum Risk Level (MRL) for chronic oral arsenic exposure of 0.00034 mg/kg/day. MRLs are estimates of daily exposure to humans that are likely to be without harmful noncancer effects. Because the dose from the site is less than the MRL, harmful noncancer effects from arsenic in soil are unlikely. See Attachment G for the detailed calculations.

Because arsenic can be an acute (short-term) toxin, CT DPH also calculated an acute ingestion dose for a 2 year-old child assuming a larger soil ingestion rate over a 7-day period. The acute calculation focused on a young child because younger children are more likely to ingest soil than

[9] There are many more field screening results for arsenic but the detection limit is higher than the comparison value so the results are not meaningful for evaluating public health impacts.

older children. The acute dose from the site is three times less than ATSDR's Acute MRL. Thus, adverse health effects from acute oral exposure to arsenic in the soil are unlikely. See Attachment G for the detailed calculations.

CT DPH also calculated theoretical cancer risks from long-term exposure to arsenic (assuming exposure from age one to age 30 years). The theoretical cancer risk from arsenic exposure of 5×10^{-5} (five excess cancer cases per 100,000 exposed people) represents a non-meaningful incremental cancer risk above the background cancer level of approximately one in three (NCI 2001). Another way to describe the background cancer rate of one in three is that in a population of 100,000 people, roughly 33,000 of them would be expected to get cancer at some point in their lifetime. If that same population of 100,000 people were exposed to arsenic in soil at 54 mg/kg (the average level in the Morse Street group of properties), five extra cancers (above the 33,000 cancer cases from all other causes) would be expected. This is not a meaningful increase in cancer risk. Readers should refer to the Americal Cancer Society website (www.cancer.org) or the National Cancer Institute (www.nci.nih.gov) for more information about cancer and its risk factors.

Moreover, the estimated arsenic dose that people would receive over 30 years is lower than the cancer effect level (CEL). The CEL is the range of doses that have caused cancer in humans and animals. The estimated arsenic dose to residents in the Morse Street Property Group is 33 times lower than the CEL for lung cancer and 100,000 times lower than the CEL for bladder cancer (ATSDR, 2000). Because the dose from the site is lower than the CELs, cancer effects are unlikely. See Attachment G for the detailed dose and risk calculations.

Bryden Terrace Property Group

The second set of properties (Bryden Terrace group) consists of 39 properties. The average arsenic concentration in this group of properties is below the comparison value of 10 mg/kg. Therefore, arsenic exposure is unlikely to present a health threat to the Bryden Terrace group of properties. In the Bryden Terrace grouping, average concentrations of six individual PAH compounds (benzo(b) fluoranthene, benzo(a)anthracene, benzo(k)fluoranthene, benzo(a)pyrene and dibenzo(ah)anthracene) exceed comparison values. Therefore, exposure to these PAHs was evaluated further.

CT DPH calculated doses and risks from PAH exposure at the Bryden Terrace group of properties using the same assumptions described above for arsenic. Estimated PAHs doses were well below the EPA Reference Dose (RfD) for oral exposure to PAHs. The RfD is an estimate of the "safe dose," below which, adverse noncancer health impacts are not likely. Therefore, harmful noncancer health effects from PAH exposure are not likely. Refer to Attachment G for detailed risk calculations.

Because some PAHs are believed to cause cancer in humans, CT DPH also calculated theoretical cancer risks from exposure using the same exposure assumptions described for the arsenic cancer risk calculations. Detailed calculations are found in Attachment G. The theoretical cancer risk from PAH exposure of 8×10^{-5} (eight excess cancer cases per 100,000 exposed people) represents a non-meaningful incremental risk above the background cancer level of approximately one in three (NCI 2001). Additionally, the estimated PAH dose to residents in the

Bryden Terrace Property Group is more than 200,000 times lower than PAH doses from the scientific literature (CELs) that have been observed to cause cancer in humans and animals (ATSDR 1995). Because the dose from the site is much lower than the CELs for PAHs, cancer effects are considered very unlikely.

Pesticides and ETPH

Pesticides and Extractable Total Petroleum Hydrocarbons (ETPH) were the only other contaminants found at levels exceeding health-based comparison values in surface soil. These groups of contaminants were found at elevated levels in the samples collected from right-of-way areas adjacent to yards (see Table 1). Four pesticides (chlordane, heptachlor, beta-BHC and dieldrin) were detected very infrequently. When average levels are calculated for these pesticides, the averages are well below health-based comparison values. The same is true for ETPH. Therefore, CT DPH concludes that health impacts from exposure to pesticides and ETPH found in soil samples in the Newhall Street neighborhood do not pose a health threat.

4. Health Outcome Data

CT DPH evaluated the health survey information from local residents that was collected by QVHD. Reported cases of cancer were verified by CT DPH in the Tumor Registry records[5]. Cancer cases occurred among individuals aged 22 to 85. Some of the cases were recently diagnosed and a few dated back to 1974. Based on CT DPH's review, the number and types of cancer that were reported in the health survey conducted by QVHD do not appear to be in excess of what would be expected to occur. CT DPH reached this conclusion because there was not a preponderance of cancers of the same type, or among the same age group. Different cancers are different diseases. Causes and risk factors for one type of cancer are different from another cancer. When cancer cases in a small geographic area (such as a neighborhood) are not the same type of cancer or are not within the same age group, there is little reason to believe the cancers may have a common environmental cause. It should be noted that CT DPH's evaluation did not include statistical analyses. Information collected in a health survey is typically not evaluated quantitatively (using statistics) because of limitations in the type of data such surveys can collect and limitations in epidemiological methods. CT DPH's cancer evaluation is contained in Attachment E.

With regard to illnesses other than cancer, based on the number of dwellings (55) surveyed, CT DPH believes the number and type of reported illnesses do not look unusual. Again, this evaluation was qualitative, not quantitative. Limitations in the data that can be collected using a health survey (such as the lack of background rates of illnesses) make it impossible to quantitatively evaluate whether the reported illnesses are in excess of what would be expected to occur .

[5] According to Connecticut law, all tumors diagnosed to Connecticut residents must be reported to the CT DPH Tumor Registry. The Tumor Registry has been in existence since 1935. It collects data from reporting physicians and also has an active surveillance program which reviews hospital record to ensure complete reporting of tumors.

CT DPH also looked at the published cancer incidence for the town of Hamden for the time periods 1995-1999 and 1995-1999 (CT DPH 2002). These are the time periods for which cancer statistics compiled by town are readily available. There were no statistically meaningful elevations in cancer incidence for Hamden.

D. EVALUATION OF COMMUNITY HEALTH CONCERNS

Community health questions and concerns were collected by CT DPH during numerous public meetings and home visits in the neighborhood and from the QVHD. In this section, community health concerns are summarized. A response is provided following each concern.

1. Many residents are concerned about cancer. They wonder whether cancers in their family members could be related to living around landfill waste for so many years. They also wonder whether there are more cases of cancer in the Newhall Street neighborhood than would be expected.

Soil samples taken in areas where landfill waste is present indicates that lead is the primary contaminant. The main target for lead toxicity is the nervous system, both in adults who are exposed and in children. We have no evidence that lead causes cancer in people. Therefore, it is extremely unlikely that the cause of cancer among Newhall Street residents is exposure to lead in their soil. Arsenic and PAHs have also been found at elevated levels in soil. Arsenic is known to cause cancer in humans. It is believed that some PAHs probably cause cancer in humans. However, for both arsenic and PAHs, CT DPH's dose and risk calculations indicate that exposure to these contaminants is very unlikely to result in adverse health impacts. In most homes tested, levels of PAHs and arsenic were consistent with natural background levels. Background means levels that would be present even if the landfill was not present.

Unfortunately, cancer is relatively common. According to the National Cancer Institute (part of the National Institutes of Health), one of every three persons will be diagnosed with cancer at some point in their lifetime. To put this cancer rate into perspective for the Newhall St. neighborhood of approximately 600 residents, 200 of the 600 residents would be expected to receive a diagnosis of cancer at some point in their lifetime. These 200 cancers would be the expected background rate, even if the landfill was not present. It is also important to keep in mind that cancer is not a single disease but rather, many different diseases. The causes and risk factors for one type of cancer are different from the causes and risk factors for another type of cancer. Environmental exposures are more likely to be suspected in situations that involve only one or two types of cancer. When there are cancers of many different types clustered in one geographic area, it is less likely that environmental causes are to blame and more likely that other causes such as family history, diet and age are to blame.

2. Residents asked many questions about gardening and other yard work. They were concerned about whether it is safe to do yard work such as mowing the lawn and whether it is safe to do gardening activities such as growing and eating vegetables and fruits.

Yes, it is safe to do yard work and gardening in your yard provided that several simple precautions are observed. Following these precautions will help ensure that your exposure to *contaminants that may be in soil in your yard will be minimized as much as possible. When working in your garden, you should minimize direct contact with soil as much as possible by wearing gloves and washing your hands after gardening. If you must dig into the soil (for instance, when planting a tree or putting in a fence post), soil that you dig up from below the ground should not be left on the surface where it is accessible, especially to children. Soil that is dug up should be covered or moved to a location in the yard where it is not accessible. Avoid mowing your lawn when it is excessively dry and dusty to minimize your exposure to soil dust in the air.*

For vegetable gardening, it is advisable to use a raised bed in which new topsoil is brought in. If you cannot use a raised bed, consider adding compost or new topsoil to your garden soil. This will dilute contaminant concentrations in the soil and reduce your chance of exposure. In addition, plants tend to absorb less chemicals if the soil has neutral pH and the correct level of nutrients. The type of crops you select to grow will also impact how much chemicals are absorbed into the crops. For more details on reducing exposure to soil contaminants during gardening and other yard work, you should refer to the Fact Sheets "What Can I Do To Reduce My Exposure to Soil in my Yard?" and "Growing and Eating Fruits and Vegetables in the Newhall Neighborhood of Hamden." These fact sheets were prepared by the CT DPH and are included in Attachment B.

3. Many residents in the Newhall Street neighborhood are grandparents. They asked whether it is safe to let their grandchildren play in their yards.

Yes, based on data we have at this time, it is safe for your grandchildren to play in your yard. Children will not be exposed and will not be in any danger from contaminants that may be in the soil if they do not touch the soil on a regular and continuing basis. There are several things you can do to ensure that children playing in your yard do not come into contact with contaminants that may be present in soil. First, children should be discouraged from playing in bare soil. Grass, mulch, pavement and other coverings over the soil provide a good barrier to direct contact with the soil. Maintain good grass covering on your lawn. Bare soil areas, especially beneath play equipment, should be covered with mulch, sand, clean topsoil or any other covering. Other things you can do to minimize contact with soil are to wash toys before bringing them inside the home and make sure children wash their hands after playing in the yard, especially before eating.

4. Several residents indicated that grass would not grow in certain areas of their yards. They questioned whether this was an indication that contaminants were present in the soil and whether these bare areas should be avoided.

It is possible that the presence of very high levels of contaminants in soil could impact whether grass grows there. However, there are also other things that can affect whether grass grows (such as heavy shade) that are not related to the presence of landfill waste. It is a good idea to avoid direct contact with bare soil areas in your yard if you are not sure whether contamination is present. This is especially important for children. Encourage grass to grow in bare areas but if grass will not grow, bare soil areas can be covered with mulch or clean topsoil to minimize opportunities for exposure.

5. Many residents are very concerned about cracks in their walls from severe settling that has occurred in their homes. They expressed concerns for their safety and the structural stability of their homes. They also were concerned about contaminants moving up from the ground into their homes through the cracks.

The presence of landfill waste materials beneath homes in the Newhall Street neighborhood has caused settling and subsidence problems in some homes. In those homes with the most severe impacts, CT DEP had a structural engineer inspect the home and identify structural safety problems. Any structural safety problems that were identified have been addressed.

The primary contaminants that have been found in soil are lead, arsenic and PAHs. These chemicals do not readily evaporate out of the soil. They remain bound to the soil and will not move through the soil into homes. Volatile chemicals that could evaporate out of the soil into homes have ***not*** *been found in the soil in the Newhall Street neighborhood. There was a concern about the possibility that methane was present in the landfill because it was found beneath the boiler room floor of the nearby Hamden Middle School. Methane gas, if it were present, could move into indoor air in a home through cracks in a home's foundation. As was discussed earlier in this health assessment, a methane screening program was conducted in the neighborhood and no methane or volatile chemicals attributable to waste were found.*

6. Several residents asked about whether there was a test to determine whether their children had been exposed to lead.

The amount of lead in the blood can be measured to determine if exposure to lead has occurred. This test can tell if you have been ***recently*** *exposed to lead. However, a blood test for lead will* ***not*** *tell you the source of the lead exposure. There are a variety of ways that children can be exposed to lead, including through food, drinking water, soil and lead paint in the home. Blood tests are routinely used by pediatricians to screen young children for potential lead poisoning. It is a good idea to get a blood lead test for all children younger than two years (regardless of whether they live (or spend time) in the Newhall Street neighborhood). For children, blood lead levels greater than 10 ug/dL are cause for concern for possible adverse health impacts. If you are concerned that your child or grandchild might have elevated levels of lead in their blood, you should contact their pediatrician or the QVHD and ask about a blood test.*

7. Some residents asked about whether their drinking water was contaminated by the landfill waste material.

Drinking water for Newhall Street neighborhood residents is a public water supply provided by the South Central CT Regional Water Authority. Drinking water comes from surface water reservoirs located in either North Branford or Woodbridge. These drinking water sources are safe and are not affected by the landfill.

8. Residents asked whether there were lasting health effects from exposure to lead as a child.

One of the effects that has been seen in children exposed to lead in the womb, in infancy or in early childhood is delayed mental development and lower intelligence later in childhood. There is evidence that some of these effects may persist beyond childhood.

9. There are many residents with contaminants in soil that were elevated, but not high enough to warrant immediate soil removal by EPA. Some residents are concerned that their yards are not being cleaned up right away and whether it is safe to continue living in their home.

Yes, it is safe to continue living in your home even if contaminants were found in the soil but no cleanup has yet occurred. The EPA cleanup action included only those homes with levels of contaminants so high that immediate action was determined to be necessary to protect public health. If you have contamination present in soil in your yard that has not yet been cleaned up, there are things you can do to help reduce your contact with soil until cleanup does occur. The Fact Sheet included in Attachment B provides a number of suggestions about ways to reduce soil exposure. It is also important to realize that the presence of some lead and PAHs in surface soil is not unusual, especially near older homes that have or had lead paint or are near roadways with a lot of car and truck traffic.

E. CONCLUSIONS

Environmental samples collected from residential yards in the Newhall Street neighborhood indicate that lead, arsenic and PAHs are present in surface and subsurface soils at elevated concentrations in some yards. Adults and children living in the neighborhood could be exposed to contamination while working or playing in their yards. Exposure could occur through dermal contact (direct skin contact), ingestion (eating soil particles adhered to fingers or food), or inhalation (breathing soil particles in the air). Children have a greater potential for exposure to soil than do adults because they play on the ground and have greater hand-to-mouth activity than adults. In addition, children have a greater sensitivity than adults to the harmful effects from lead exposure. Lead can affect many organs in the body. The most sensitive is the central nervous system, especially in children. Lead can cause decreased mental abilities in infants and learning difficulties and reduced growth in young children.

CT DPH used a screening procedure developed by ATSDR for estimating the incremental blood lead level for children and adults working or playing in lead-contaminated soil in their yards. CT DPH's calculations indicate that for homes with the highest concentrations of lead in surface soil (greater than 1500 mg/kg), there is the potential for increases in blood lead levels in children above levels of concern for potential adverse health impacts. *Fortunately, the homes with the highest lead levels have been already cleaned up by EPA so exposures, at levels of public health concern, are no longer occurring.* However, past exposures could have caused elevations in blood lead among children. Additionally, future exposures could lead to elevations in blood lead levels if the remainder of the homes with high lead levels are left unremediated.

With regard to arsenic and PAHs in soil, CT DPH calculated cancer and noncancer risks from exposure and has concluded that adverse health impacts are unlikely.

ATSDR has a categorization scheme whereby the level of public health hazard at a site is assigned to one of five conclusion categories. ATSDR conclusion categories are included as Attachment H to this report. CT DPH has concluded that based on the existing environmental data, exposure to lead in the yards with the highest levels, posed a “Public Health Hazard” in the past (that is, *before* EPA performed its soil cleanup activities). Based on current conditions and available data, a “No Apparent Public Health Hazard” currently exists. However, this hazard category will be re-evaluated once the full nature and extent of landfill waste contamination of the Newhall Street neighborhood is determined. For example, Olin has presented a workplan for further soil and groundwater sampling in the neighborhood. When these (or other) data are available, CT DPH will evaluate the data and will modify conclusions and recommendations contained in this Health Assessment, if necessary.

F. RECOMMENDATIONS

1. CT DPH recommends that residents follow the suggestions contained in this Public Health Assessment and the attached fact sheets regarding ways to reduce exposure to soil in their yards. This advice includes avoiding digging or other activities that disturb soils beneath the ground surface.

2. CT DPH recommends that CT DEP continue its role overseeing the process of further investigation of the nature and extent of landfill waste contaminants in the Newhall Street neighborhood and that this investigation proceed as quickly as possible so that a permanent remedy will be in place as soon as possible.

3. CT DPH recommends that QVHD offer free blood lead screening in the Newhall Street neighborhood again.

4. CT DPH recommends that QVHD expand the Community Health Concerns Survey originally conducted in 2001, to areas known to have landfill waste that were not included in the previous survey. CT DPH also recommends that QVHD conduct a community needs assessment focusing on information such as identifying stakeholders, collecting health education needs and identifying health concerns.

5. CT DPH recommends that QVHD, CT DEP or Olin Corporation perform a followup inspection on each of the properties where CT DEP found lead above the trigger value of 1200 mg/kg and where cleanup has not yet occurred. The inspection should focus on whether actions taken to reduce exposure (e.g. mulching bare soil) still provide an effective barrier to direct contact with soil.

6. CT DEP should ensure that the necessary data are collected that are needed to fully investigate the vapor intrusion pathway as an exposure pathway of concern.

G. PUBLIC HEALTH ACTION PLAN

Actions Taken

Since the time contamination was first discovered in the Newhall Street neighborhood in early 2001, CT DPH, in conjunction with QVHD have conducted many activities to assess health concerns in the community, provide health education to the community and communicate potential health risks to the public.

1. During May and June 2001, CT DPH and EPA met with most of the residents of the approximately 76 properties that were sampled by EPA. Soil results were provided to each resident and next steps were discussed. CT DPH answered questions about exposure and health impacts. A fact sheet prepared jointly by EPA and CT DPH about ways to reduce exposure to soil was distributed to residents (the fact sheet is included as Attachment B).

2. In August, 2001, the QVHD offered free blood lead screening to neighborhood residents. The screening was open to anyone interested, but residents were specifically targeted who had elevated lead in soil with children residing in the home. The purpose of the screening was to identify cases of lead poisoning among neighborhood residents so that further investigation could occur to identify possible sources of lead exposure. There were no individuals who came to the screening.

3. CT DEP referred a number of homes to the QVHD for lead exposure follow-up activities. The homes referred for follow up were those homes with elevated lead in surface soil, where young children reside (or visit often), that were *not* scheduled to receive an EPA immediate soil removal action. QVHD follow-up actions for elevated lead in soil varied depending on the specifics of the situation. Activities they conducted included the following.

- Providing educational materials to residents about reducing exposure to lead paint in soil.
- Providing educational materials to residents about health impacts to adults and children from exposure to lead.
- Conducting home visits to observe the condition of the backyard and suggest ways to reduce soil exposure (such as mulching bare soil).

4. To learn about potential elevated blood lead levels in children residing in the Newhall Street neighborhood, the QVHD performed a manual search of all QVHD files in the Newhall Street area for elevated blood lead levels.

5. During May and June 2001, staff from the QVHD collected health information from the neighborhood using a community concerns interview form (see Attachment C). QVHD staff visited 125 homes in the area where EPA sampling had occurred in April 2001. In some homes, information was collected through a personal interview with the resident. In other cases, the resident completed the survey form themselves.

6. CT DPH staff participated in four public meetings and hosted one public availability session to present health and exposure information to residents and respond to residents' questions and

concerns. In addition, CT DPH staff have provided health and exposure information and answered questions at citizen advisory group meetings.

7. In January 2004, CT DPH prepared a fact sheet on how to safely grow and eat fruits and vegetables.

<u>Actions Planned</u>

1. CT DPH will continue to work with the QVHD and CT DEP to provide technical assistance regarding developing sampling plans and evaluating data.

2. CT DPH will evaluate new sampling data from the neighborhood as it becomes available and will update conclusions and recommendations contained in this Public Health Assessment, if needed.

2. CT DPH will continue to participate in public meetings, availability sessions and other avenues for communicating health information about the site to the public.

3. CT DPH will assist QVHD in evaluating data from community needs assessment and health survey.

4. CT DPH will work with the QVHD, the Town of Hamden and CT DEP as necessary to ensure that recommendations made in this Public Health Assessment are carried out in a reasonable time frame.

5. CT DPH will prepare a written health consultation to document that recommendations were carried out and planned activities in the Public Health Action Plan were accomplished.

6. During the spring 2004, CT DPH will begin to actively distribute the fact sheet entitled "Growing and Eating Fruits and Vegetables in the Newhall Street Neighborhood," dated January 2004, to residents in the Newhall Street neighborhood as well as any other stakeholders and interested persons or organizations.

7. CT DPH will hold a public availability session on this document to receive public comments and answer questions about the information presented in this document.

8. To make it easier for residents to understand the information in this Public Health Assessment, CT DPH will prepare a fact sheet to summarize the document.

REFERENCES

ATSDR 1995. Toxicological Profile for Polycyclic Aromatic Hydrocarbons (PAHs), 1995.

ATSDR 1999. Toxicological Profile for Lead, 1999.

ATSDR 2000. Toxicological Profile for Arsenic, 2000.

ATSDR 2001. Public Health Evaluation of Soil Data, Newhall Street School, prepared by CT DPH under cooperative agreement with ATSDR, April 18, 2001.

ATSDR 2001a. Public Health Evaluation of Soil Data, Athletic Playing Field behind Hamden Middle School, prepared by CT DPH under a cooperative agreement with ATSDR, September 21, 2001.

ATSDR 2003. Public Health Assessment, Evaluation of Soil, Groundwater, Soil Gas and Indoor Air Data, Hamden Middle School, prepared by CT DPH under cooperative agreement with ATSDR, December 2003.

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CT DPH 2002. Incidence of Selected Cancers in Connecticut by Town, 1995-1999. CT DPH, CT Tumor Registry, May 2002.

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Olin 2002. Initial Investigations Findings Report, Newhall Street Residential Area, Hamden CT, Prepared by Malcolm Pirnie for Olin Corporation, December 2002.

NCI, 2001. Cancer Statistics Review 1973-1998, National Cancer Institute SEER Program 2001.

CERTIFICATION

The Public Health Assessment for the Evaluation of Residential Soils in the Newhall Street Neighborhood of Hamden was prepared by the Connecticut Department of Public Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was initiated.

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The Division of Health Assessment and Consultation (DHAC), ATSDR, has reviewed this Health Consultation and concurs with its findings.

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ATTACHMENT A

Figure 1

ATTACHMENT B

Exposure Fact Sheet

ATTACHMENT C

Community Concerns Interview Form

ATTACHMENT D

Letter from CT DPH to EPA

ATTACHMENT E

CT DPH Cancer Evaluation

ATTACHMENT F

General Toxicological and Epidemiological Information for Lead, Arsenic and PAHs

Lead

Lead is a naturally-occurring metal in the environment. However, most of the high levels of lead found in the environment come from human activities. Background levels of lead in soil collected from various locations in Hamden (outside the Newhall Street neighborhood) ranged from 35 mg/kg to 360 mg/kg. These levels are consistent with background levels reported in other urban residential areas (ATSDR 1999).

Lead has many uses, most importantly in the production of batteries. Because of health concerns, lead in gasoline, paints and ceramic products has been dramatically reduced in recent years. However, lead is still present in the environment. People can be exposed to lead from breathing workplace air or dust, eating contaminated foods and drinking contaminated water. Children can be exposed from eating lead-based paint chips or playing in lead-contaminated soil. Lead can affect many organs and systems in the body. The most sensitive is the central nervous system, particularly in children. Lead can cause decreased mental abilities in infants and learning difficulties and reduced growth in young children. Pregnant women exposed to lead can experience premature births and smaller babies (ATSDR 1999).

In adults, lead exposure (from breathing or swallowing lead) can decrease reaction time, cause weakness in fingers, wrists or ankles and possibly affect the memory. Breathing or swallowing lead may cause anemia (a low number of blood cells), may increase blood pressure in middle-aged men, and may affect sperm or damage other parts of the male reproductive system (ATSDR 1999).

With regard to the cancer causing potential of lead, animals that were given very large amounts of lead developed kidney tumors. However, there is not adequate evidence to demonstrate that lead causes cancer in humans (ATSDR 1999).

A blood test is available to measure the amount of lead in a person's blood and to estimate the amount of exposure to lead. Blood tests are routinely used to screen children for potential lead poisoning. The Centers for Disease Control and Prevention (CDC) considers 10 micrograms per deciliter (10 ug/dL) of lead in children's blood to be a level of concern for possible adverse health effects. CT DPH considers 20 ug/dL to be a level of concern for adults.

Arsenic

Arsenic is found in nature at low levels. National background levels of arsenic in soil range from about 1 to 40 mg/kg, with an average of about 5 mg/kg (ATSDR 2000). Background samples collected in Hamden (outside the Newhall Street neighborhood) ranged from 3 to 8 mg/kg. People may be exposed to arsenic by eating food, drinking water, breathing air, or through skin contact with soil or water. Children may be exposed to arsenic by playing in soil.

The most characteristic effect of ingesting arsenic for a long period of time is a pattern of skin changes. These include a darkening of the skin and the appearance of small “corns” or “warts” on the palms, soles and torso. These skin growths may ultimately develop into skin cancer. Long-term ingestion of arsenic can also lead to damage of the heart and blood vessels and increases the risk of skin, bladder, kidney, liver and lung cancer. Breathing large amounts of arsenic for a long time increases the risk of lung cancer and can also cause respiratory irritation, nausea and characteristic skin changes. (ATSDR 2000).

The most reliable test for arsenic exposure is a urine test. Since arsenic stays in the body a short time, the test must be done soon after exposure occurs. Tests on hair and fingernails can measure exposure to high levels of arsenic over the past 6-12 months. However, these tests are not very useful for low levels exposures (ATSDR 2000).

PAHs

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

People are most likely to be exposed to PAHs that are attached to dust or other particles in the air. Sources include cigarette smoke, vehicle exhaust, asphalt roads and smoke from wood fires. Cooking meat or other food at high temperatures, which happens during grilling or charring, increases the amount of PAHs in the food. National background levels of PAHs found in soil range from less than 1 mg/kg to 60 mg/kg (ATSDR 1995). Background samples in Hamden (outside the Newhall Street neighborhood) for individual PAHs ranged from 0.5 to 4.2 mg/kg. Total PAHs were as high as 12 mg/kg.

PAHs can be harmful to health under some circumstances. Studies on animals have shown that PAHs can cause harmful effects on the skin, and immune and reproductive systems. These effects have not been seen in people. Some PAHs caused cancer in animals when the PAHs were breathed in air (lung cancer), ingested in food (stomach cancer) or applied to the skin (skin cancer). Some people who breathed or touched mixtures of large amounts of PAHs for long periods of time developed cancer (ATSDR 1995).

In the body, PAHs are changed into other chemicals (called metabolites) that can attach to substances within the body. The presence of PAHs attached to these substances can then be measured in body tissues or blood after exposure to PAHs occurs. PAHs or their metabolites can also be measured in urine, blood or body tissues. Although these tests can show that you have been exposed to PAHs, the tests cannot be used to predict whether any health effects will occur or to determine the extent or source of your exposure to PAHs (ATSDR 1995). Since PAHs are so common in the environment, everyone has some PAHs in their body.

ATTACHMENT G
Risk Calculations

ARSENIC - Morse Street Group of Properties

B. Noncancer risks, child aged 1-6 years

1. Ingestion Dose-Arsenic

This calculation estimates the average daily dose of arsenic to a child, age 1-6 years from incidental soil ingestion.

$ADD_i = Ir_c$*[Soil]*EF*ED*C1*C2*1/BW_c*1/AT_{nc}

ADD_i = 100 mg/d*54 mg/kg*(7 d/w * 39 w/y) * 6 y *10^{-6} kg/mg*y/365d*1/16 kg*1/6 yr
= 2.5 E-4 mg/kg/day

2. Dermal Dose-Arsenic

This calculation estimates the average daily dose of arsenic to a child, age 1-6 years from dermal contact.

ADD_d= [Soil]*AF*ABS_d*SA_c*EF*ED*F*C1*C2*C3*1/BW*1/AT_{nc}

= 54 mg/kg*0.04 mg/cm^2/-ev*0.03*3307cm^2* (7 d/w* 39 w/y)* 6 y *10^{-6} kg/mg*y/365 d*1 ev/d * 1/16 kg*1/6 yr

ADD_d = 1E-5 mg/kg/day

3. Noncancer Hazard Index-Arsenic

HI=ADD_i +ADD_d/RfD

HI= 2.5 E-4 mg/kg/day + 1 E-5 mg/kg/day = 2.6 E-4 mg/kg/day
2.6 E-4 mg/kg/day/3.4E-4 mg/kg/day

HI= 0.76

A Hazard Index of 1 means that the estimated dose is equal to the safe dose. A Hazard Index less than 1 indicates that the estimated dose is below the safe dose and noncancer health impacts are unlikely. A Hazard Index greater than 1 indicates that the estimated dose is above the safe dose and noncancer health impacts cannot be ruled out. In this case, Hazard Index for arsenic is below 1. This indicates that noncancer health impacts from arsenic are unlikely.

4. Acute Ingestion dose for a child, aged 2 years.

This calculation estimates the average daily dose of arsenic to a child, aged 2 years, from from incidental ingestion of soil, assuming a large ingestion rate over a short period of time (7 days).

$ADDa_i$= IR_p*[Soil]*EF*ED*1/BW_p*1/AT_p
= 400 mg/day*54 mg/kg*10^{-6} kg/mg*7d/w*1w*1/13kg*1/7d
= 0.0016 mg/kg/day

The acute ingestion dose for arsenic exposure for a child is 0.0016 mg/kg/day. ATSDR's Acute Oral Maximum Risk Level for arsenic is 0.005 mg/kg/day which is higher than acute ingestion dose. Therefore, these acute doses are within safe levels and do not pose a significant health threat.

C. Cancer Risks, child/adult age 1-30

1. Ingestion Dose-Arsenic

This calculation estimates the lifetime average daily dose of arsenic to a child/adult (age 1-30 years) from ingestion of soil.

$LADD_{child\ ingestion}$ = IR_c*[Soil]* EF*ED*C1*C2* 1/BW*1/AT_c

$LADD_{child\ ingestion}$ =100mg/d*54 mg/kg* (7 d/w * 39 w/y) * 6 yr *10^{-6} kg/mg* y/365 d *1/16 kg* 1/70 yr
= 2.16 E-5 mg/kg/ day

$LADD_{adult}$ = 50 mg/d * 54 mg/kg * 7 d/w * 39 w/y * 24 yr* 10^{-6} kg/mg * y/365 d*1/70 kg* 1/70 yr
= 9.89 E-6 mg/kg/day

2. Dermal Dose-Arsenic

This calculation estimates the lifetime average daily dose of arsenic to a child/adult (age 1-30 years) from dermal contact.

$LADD_{child\ dermal}$= [Soil]*AF*ABSd*SAc*EF*ED*F*C1*C2*1/BW*1/AT_c

= 54 mg/kg*0.04 mg/cm^2/-ev*0.03*3307cm^2*(7 d/w*39 w/y)*6y*1 ev/d*10^{-6} kg/mg*y/365d*1/16 kg*1/70 yr
= 8.5 E-7 mg/kg/day

$LADD_{adult\ dermal}$ = [Soil]*AF*ABSd*SAc*EF*ED*F*C1*C2*1/BW*1/ATa
= 54 mg/kg*0.01 mg/cm^2/-ev*0.03*5672 cm^2*(7 d/w * 39 w/y)*24y*1 ev/d*10^{-6} kg/mg*y/365d*1/70 kg*1/70 yr
= 3.36E-7 mg/kg/day

3. Cancer Risk-Arsenic

ELCR = ($LADD_{child\ ingestion}$ + $LADD_{adult\ ingestion}$ + $LADD_{child\ dermal}$ + $LADD_{adult\ dermal}$) * CSF
ELCR = (2.16E-5 + 9.89E-6 + 8.5E-7 + 3.36E-7) *CSF
ELCR = 3.3 E-5 mg/kg/day* 1.5 $(mg/kg/day)^{-1}$
ELCR = 5 E-5

The Estimated Lifetime Risk for arsenic is 5 E-5 (5 in 100,000). This means that if 100,000 people were exposed to arsenic in soil at the concentration, frequency and duration of exposure assumed in the calculation detailed above, there would be a theoretical increase of 5 cancers above the number of cancers that would normally be expected to occur in the population of 100,000. Background rates of cancer in the U.S. are one in 2 or 3 (American Cancer Society, 1996). This means that in a population of 100,000, background numbers of cancer cases would be approximately 33,000 to 50,000. Arsenic exposures could result in a theoretical increase of 5 cancer cases above the background number of 33,000 to 50,000 cancer cases. This represents a relatively low increased cancer risk.

PAHs - Bryden Terrace Group of Properties

A. Noncancer risks, child aged 0-6 years

1. Ingestion Dose-PAHS

This calculation estimates the average daily dose of PAHs to a child, age 1-6 years from soil ingestion.

$ADD_{ingestion}$ = 100 mg/d * 30.2 mg/kg*(7 d/w * 39 w/y) *6 yr*10^{-6} kg/mg*y/365 d*1/16kg*1/6 yr
= 1.4 E-4 mg/kg/ day

2. Dermal Dose-PAHs

This calculation estimates the average daily dose of PAHs to a child, age 1-6 years from dermal contact with soil.

= 30.2 mg/kg *0.04mg/cm^2/-ev * 0.13*3307cm^2 * (7 d/w*39 w/y)* 6 yr*1 ev/d* 10^{-6} kg/mg*y/365 d*1/16 kg* 1/6 yr

ADD_{dermal} = 2.4 E-5 mg/kg/ day

3. Noncancer Hazard Index-PAHs

HI= 1.4 E-4 + 2.4 E-5 /0.02 mg/kg/day
HI= 1.64 E-4/.02 mg/kg/day
HI= 0.008

A Hazard Index of 1 means that the estimated dose is equal to the safe dose. A Hazard Index less than 1 indicates that the estimated dose is below the safe dose and noncancer health impacts are unlikely. A Hazard Index greater than 1 indicates that the estimated dose is above the safe dose and noncancer health impacts cannot be ruled out. In this case, the Hazard Indes for PAHs is well below 1. This indicates that noncancer health impacts from PAHs are unlikely.

B. Cancer Risks, child/adult age 1-30

1. Ingestion Dose-PAHs

This calculation estimates the lifetime average daily dose of PAHs to a child/adult (age 1-30 years) from soil ingestion.

$LADD_{child\ ingestion}$ = 100mg/d * 16.04 mg/kg * 7 d/w * 39 w/y * 6 yr * 10^{-6} kg/mg * y/365 d* 1/16 kg * 1/70 yr

= 6.4 E-6 mg/kg /day

$LADD_{adult\ ingestion}$ = 50 mg/d * 16.04 mg/kg * 7 d/w *39 w/y* 24 yr * 10^{-6} kg/mg * y/365 d * 1/70 kg * 1/70 yr

= 2.9 E-6 mg/kg/day

2. Dermal Dose-PAHs

This calculation estimates the lifetime average daily dose of PAHs to a child/adult (age 1-30 years) from dermal contact with soil.

$LADD_{child\ dermal}$
= 16.04 mg/kg*0.04 mg/cm^2/-ev*0.13*3307cm^2*(7 d/w*39 w/y)*6y*1 ev/d*10^{-6} kg/mg*y/365d*1/16 kg*1/70 yr
= 1.1 E-6 mg/kg/day

$LADD_{adult\ dermal}$
= 16.04 mg/kg*0.01 mg/cm^2/-ev*0.13*5672 cm^2*(7 d/w * 39 w/y)*24y*1 ev/d*10^{-6} kg/mg*y/365d*1/70 kg*1/70 yr
= 4.3 E-7 mg/kg/day

3. Cancer Risk-PAHs

ELCR = $LADD_{child\ ingestion}$ + $LADD_{adult\ ingestion}$ + $LADD_{child\ dermal}$ + $LADD_{adult\ dermal}$* CSF
ELCR= 6.4 E-6 + 2.9 E-6 + 1.1 E-6+ 4.3 E-7 = 1.08 E-5 mg/kg/day *7.3 (mg/kg/day)$^{-1}$
ELCR= 8 E-5

The Estimated Lifetime Risk for PAHs is 8 E-5 (8 in 100,000). This means that if 100,000 people were exposed to PAHs in soil at the concentration, frequency and duration of exposure assumed in the calculation detailed above, there would be a theoretical increase of 8 cancers above the number of cancers that would normally be expected to occur in the population of 100,000. Background rates of cancer in the U.S. are one in 2 or 3 (American Cancer Society, 1996). This means that in a population of 100,000, background numbers of cancer cases would be approximately 33,000 to 50,000. PAH exposures could result in a theoretical increase of 7 cancer cases above the background number of 33,000 to 50,000 cancer cases. This represents a small incremental increased cancer risk.

Definitions for Terms used in risk equations:

$ADD_{ingestion}$ = average daily dose from ingestion
ADD_{dermal} = average daily dose from dermal contact
ADDa = average daily dose from acute ingestion
$LADD_{child\ ingestion}$ = lifetime average daily dose from ingestion for child, aged 1-6 years
$LADD_{adult\ ingestion}$ = lifetime average daily dose from ingestion for adult, aged 7-18 years
$LADDD_{adult\ dermal}$ = lifetime average dermal daily dose for child, aged 1-6 years
$LADDD_{child\ dermal}$ = lifetime average dermal daily dose for child, aged 7-30 years
IR_c = soil ingestion rate for a child; 100 mg/day (EPA 1997, ATSDR 1993)*
IR_a = soil ingestion rate for an adult; 50 mg/day (EPA 1997, ATSDR 1993)*
Ir_{ac} = acute soil ingestion rate for a child (upper percentile) (EPA 1997)
AF = skin-soil adherence factor for central tendency residential child; 0.04 mg/cm^2-ev (EPA 2001)
skin-soil adherence factor for central tendency residential adult; 0.01 mg/cm2-ev (EPA 2001)ABS_d = Soil dermal absorption fraction
Arsenic: 0.03 (EPA 1999), PAHs: 0.13 (EPA 1999)
SA_c = Skin surface area, 50th %ile legs, feet, hands, and arms, child aged 1-6; 3307 cm^2 (EPA 1997)
SA_d = skin surface area, 50th %ile legs, feet, hands, and arms, adult; 5672 cm^2 (EPA 1997)
[Soil] = soil concentration;
Arsenic: 54 mg/kg (95% Upper Confidence Limit of the arithmetic mean)#
PAHs (noncancer calculation)**:** 24.4 mg/kg (Total of 95% UCLs for PAHs)
PAHs (cancer calculation): 15.46 mg/kg (Total TEF-adjusted 95% UCL for PAHs)
EF = exposure frequency; 7 days/week, 39 weeks/year (non-winter weeks)
F = event frequency, 1 ev/day
ED = exposure duration; 6 years for child, 24 years for adult
C1 = conversion factor; 10^{-6} kg/mg

C2 = conversion factor; 1 year/365 days
Bw = child 50th %tile body weight for age 1-6 yrs (ATSDR 1993); 16 kg
Bw_a = adult 50th %tile body weight (ATSDR 1993); 70 kg
Bw_{ac} = body weight 2 year old child (EPA 1997); 13 kg
AT_{nc} = averaging time for noncancer risk; 6 years
AT_c = averaging time for cancer risk; 70 years
AT_{ac} = average time for acute noncancer risk; 7 days
RfD = EPA Reference Dose
Arsenic; 3E-4 mg/kg/day (IRIS)
PAHs: naphthalene used as a surrogate for PAHs; 0.02 mg/kg/day (IRIS)
CSF = Cancer Slope Factor
Arsenic: 1.5 $(mg/kg/day)^{-1}$ (IRIS)
PAHs: benzo(a)pyrene; 7.3 (mg/kg/day)-1 (IRIS)
HI = Hazard Index
CSF = Cancer Slope Factor

** EPA (1997) recommends using soil ingestion rates of 100 mg/day for child < 6 years and 50 mg/day a child/adult ≥6 years. EPA states that these values represent best estimates of average soil ingestion rates. EPA programs have used 200 mg/day and 100 mg/day as conservative estimates of average soil intake rates. CT DPH opted to use the best estimate average values of 100 mg/day and 50 mg/day rather than the more conservative estimates for the sake of consistency with other parameters describing the receptor which are also central estimates (for example, body weight, skin surface area and skin-soil adherence).*

 # ATSDR (2002) advises using the 95% upper confidence limit of the arithmetic mean. This was performed using Pro UCL (EPA May 2000). A 95% UCL accounts for the variability in the data and ensures that the mean is not underestimated.

Values used to calculate PAH concentrations for cancer and noncancer risk calculations.

PAH	95% UCL (mg/kg)	Toxic Equivalency Factor(TEF)	TEF Adjusted Concentration (mg/kg)
Benzo(a)anthracene	5.2	0.1	0.52
Benzo(b)fluoranthene	5.7	0.1	0.57
Benzo(k)fluoranthene	5.8	0.1	0.58
Benzo(a)pyrene	6.3	1	6.3
Indeno(1,2,3-cd)pyrene	5.7	0.1	0.57
Dibenzo(ah)anthracene	1.5	5	7.5
Total of 95% UCLs	**30.2**	**---**	**16.04**

ATTACHMENT H

ATSDR INTERIM PUBLIC HEALTH HAZARD CATEGORIES

CATEGORY / DEFINITION	*DATA SUFFICIENCY*	*CRITERIA*
A. Urgent Public Health Hazard *This category is used for sites where short-term exposures (< 1 yr) to hazardous substances or conditions could result in adverse health effects that require rapid intervention.*	*This determination represents a professional judgement based on critical data which ATSDR has judged sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may be required to confirm or further support the decision made.*	*Evaluation of available relevant information* indicates that site-specific conditions or likely exposures have had, are having, or are likely to have in the future, an adverse impact on human health that requires immediate action or intervention. Such site-specific conditions or exposures may include the presence of serious physical or safety hazards.*
B. Public Health Hazard *This category is used for sites that pose a public health hazard due to the existence of long-term exposures (> 1 yr) to hazardous substance or conditions that could result in adverse health effects.*	*This determination represents a professional judgement based on critical data which ATSDR has judged sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may be required to confirm or further support the decision made.*	*Evaluation of available relevant information* suggests that, under site-specific conditions of exposure, long-term exposures to site-specific contaminants (including radionuclides) have had, are having, or are likely to have in the future, an adverse impact on human health that requires one or more public health interventions. Such site-specific exposures may include the presence of serious physical or safety hazards.*
C. Indeterminate Public Health Hazard *This category is used for sites in which "critical" data are insufficient with regard to extent of exposure and/or toxicologic properties at estimated exposure levels.*	*This determination represents a professional judgement that critical data are missing and ATSDR has judged the data are insufficient to support a decision. This does not necessarily imply all data are incomplete; but that some additional data are required to support a decision.*	*The health assessor must determine, using professional judgement, the "criticality" of such data and the likelihood that the data can be obtained and will be obtained in a timely manner. Where some data are available, even limited data, the health assessor is encouraged to the extent possible to select other hazard categories and to support their decision with clear narrative that explains the limits of the data and the rationale for the decision.*
D. No Apparent Public Health Hazard *This category is used for sites where human exposure to contaminated media may be occurring, may have occurred in the past, and/or may occur in the future, but the exposure is not expected to cause any adverse health effects.*	*This determination represents a professional judgement based on critical data which ATSDR considers sufficient to support a decision. This does not necessarily imply that the available data are complete; in some cases additional data may be required to confirm or further support the decision made.*	*Evaluation of available relevant information* indicates that, under site-specific conditions of exposure, exposures to site-specific contaminants in the past, present, or future are not likely to result in any adverse impact on human health.*
E: No Public Health Hazard *This category is used for sites that, because of the absence of exposure, do NOT pose a public health hazard.*	*Sufficient evidence indicates that no human exposures to contaminated media have occurred, none are now occurring, and none are likely to occur in the future*	

**Such as environmental and demographic data; health outcome data; exposure data; community health concerns information; toxicologic, medical, and epidemiologic data; monitoring and management plans*

ATTACHMENT I

ATSDR Glossary of Environmental Health Terms