Appendix B
Site Photo With Soil Sampling Location

Appendix D. Risk Calculations

Shoreline Trailer Court
Branford, Connecticut

A. Noncancer risks, child aged 1-6 years
1a. Ingestion Dose-PAHS
In this calculation, we are estimating the average daily dose of PAHs a child, aged 1-6 years, would receive from via ingestion of soil.

$ADD_i = Ir_c$ * [Soil]*EF_1*ED*C1*C2*C3*EF_2*1/BW_c*1/AT_{nc}
ADD_i=100 mg/d*103.66 mg/kg*275d/y*6 yr*7 days/week *1 week/7 days*10^{-6} kg/mg* y/365d *1/16kg*1/6 yr
=4.88 E-4 mg/kg/day

2a. Dermal Dose-PAHs
In this calculation, we are estimating the average daily dose of PAHs a child, aged 1-6 years, would receive from dermal exposure to soil.

ADD_d=[Soil]*AF*ABS_d*SA*EF_1*ED*F*C1*C2*C3*EF_2*1/BW_c*1/AT_{nc}
ADD_d=103.66 mg/kg*0.2 mg/cm^2/-ev*0.13*3307cm^2*7 days/week *1 week/7 days *275d/y* 6 yr*1ev/d*10^{-6} kg/mg*y/365d*1/16kg*1/6yr
=4.20E-4 mg/kg/day

3a. Noncancer Hazard Index-PAHs
HI= (ADD_i + ADD_d)/RfD
HI=(4.89E-4 mg/kg/day + 4.20 E-4 mg/kg/day)/0.02 mg/kg/day
HI=0.045

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

B. Cancer Risks, child/adult age 1-30
1b. Ingestion Dose-PAHs
In this calculation, we are estimating the average daily dose of PAHs a child/adult, age 1-30 years would receive during ingestion of soil.

$LADD_c$=IR_c[Soil]*EF_1*EF_2*ED*C1*C2*C3*1/BW_c*1/AT_c*
*$LADD_c$=100 mg/d *32.2 mg/kg * 275 d/yr *6 yr*10^{-6} kg/mg*yr/365d*7 days/week *1 week/7 days *1/16 kg*1/70 yr*
=1.30E-5mg/kg/day

$LADD_a$=IR_a[Soil]*EF_1*EF_2*ED*C1*C2*C3*1/BW_a*1/AT_c*
*$LADD_a$= 50 mg/d *32.2 mg/kg * 275 d/yr *24 yr*10^{-6} kg/mg*yr/365d*7 days/week *1 week/7 days *1/70 kg*1/70 yr*
= 5.94E-6 mg/kg/day

Dermal Dose-PAHs (Child/Adult 1-30 Years)

*$LADDD_c$=[Soil]*AF*ABS_d*SA*EF_1*EF_2*ED*F*C1*C2*C3*1/BW_c*1/AT_c*
*$LADDD_c$=32.2 mg/kg*0.2 mg/cm^2/-ev*0.13*3307cm^2*275d/y*7 days/week *1 week/7 days *6yr* 1 ev/d*10^{-6} kg/mg*y/365d*1/16 kg*1/70 yr*
=1.12E-5mg/kg/day

*$LADDD_a$=[Soil]*AF*ABS_d*SA*EF_1*EF_2*ED*F*C1*C2*C3*1/BW_a*1/AT_c*
*$LADDD_a$=32.2 mg/kg*0.07 mg/cm^2/-ev*0.13*10,695cm^2*275d/y*7 days/week *1 week/7 days *24yr* 1 ev/d*10^{-6} kg/mg*y/365d*1/70 kg*1/70 yr*
= 1.16E-5 mg/kg/day

2b. Cancer Risk-PAHs
*ELCR=($LADD_c$ + $LADD_a$ +$LADDD_c$ + $LADDD_a$)*CSF*
*ELCR=(1.30E-5 + 5.94E-6+1.12E-5 + 1.16E-5)*7.3 $(mg/kg/day)^{-1}$*
ELCR=3.05E-4

The Estimated Lifetime Risk for PAHs is 3 E-4 (3 in 10,000). This means that if 10,000 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 3 cancers above the number of cancers that would normally be expected to occur in the population of 10,000. Background rates of cancer in the U.S. are one in 2 or 3 (NCI 2001). This means that in a population of 10,000 background numbers of cancer cases would be approximately 3300 to 5000. PAHs exposure could result in a theoretical increase of 3 cancer cases above the background number of 3300 to 5000 cancer cases. This represents minimal increased cancer risk.

483 and 497 E. Main Street Properties

A. Noncancer risks, trespasser, aged 13-18 years
1a. Ingestion Dose-PAHS
In this calculation, we are estimating the average daily dose of PAHs a trespasser, aged 13-18 years, would receive from via ingestion of soil.

ADD_i=Ir_a [Soil]*EF_1 *EF_2*ED*C1*C2*C3*1/BW_t*1/AT_{nc}
ADD_i=50 mg/d*63.3 mg/kg*275d/y*6 yr*2 days/week*1 week/7 days*10^{-6} kg/mg* y/365d *1/60kg*1/6 yr
= 1.1 E-5 mg/kg/day

2a. Dermal Dose-PAHs
In this calculation, we are estimating the average daily dose of PAHs a trespasser, age 13-18 years, would receive from dermal exposure to soil.

ADD_d=[Soil]*AF*ABS_d*SA*EF_1*EF_2*ED*F*C1*C2*C3*1/BW_t*1/AT_{nc}
ADD_d=63.3 mg/kg*0.01 mg/cm^2/-ev*0.13*9697cm^2*2 days/week*1 week/7 days *275d/y*6 yr*1ev/d*10^{-6} kg/mg*y/365d*1/60kg*1/6yr
= 2.86 E-6 mg/kg/day

3a. Noncancer Hazard Index-PAHs
HI= (ADD_i + ADD_d)/RfD
HI=(1.1E-5 mg/kg/day + 2.86 E-6 mg/kg/day)/0.02 mg/kg/day
HI=0.000693

A Hazard Index of 1 means that the estimated dose is equal to the safe dose. A Hazard Index less than 1 indicated that the estimated dose is below the safe dose and noncancer health effects are unlikely. A Hazard Index (HI) 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 HI for PAHs are below 1. This indicates that noncancer health impacts from PAHs are unlikely.

B. Cancer Risks, trespasser, aged 13-18
1b. Ingestion Dose-PAHs
In this calculation, we are estimating the average daily dose of PAHs a trespasser, age 13-18 years would receive during ingestion of soil.

$LADD_t$=IR_a[Soil]*EF_1*EF_2*ED*C1*C2*C3*1/BW_t*1/AT_c*
*$LADD_t$= 50 mg/d *19.13 mg/kg * 275 d/yr *6 yr*10^{-6} kg/mg*yr/365d*2 days/week*1 week/7 days *1/60 kg*1/70 yr*
= 2.94 E-7mg/kg/day

2b. Dermal Dose-PAHs

*$LADDD_t$=[Soil]*AF*ABS_d*SA*EF_1*EF_2*ED*F*C1*C2*C3*1/BW_t*1/AT_c*
*$LADDD_t$=19.13 mg/kg*0.01 mg/cm^2/-ev*0.13*9697cm^2*275d/y*2 days/week*1 week/7 days *6yr* 1 ev/d*10^{-6} kg/mg*y/365d*1/60 kg*1/70 yr*
= 7.41 E-8 mg/kg/day

3b. Cancer Risk-PAHs
*ELCR=($LADD_t$ + $LADDD_t$)*CSF*
*ELCR=(2.94 E-7 + 7.41 E-8)*7.3 (mg/kg/day)$^{-1}$*
ELCR= 2.68 E-6

The Estimated Lifetime Risk for PAHs is 3 E-6 (4 in 1,000,000). This means that if 1,000,000 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 3 cancers above the number of cancers that would normally be expected to occur in the population of 1,000,000. Background rates of cancer in the U.S. are one in 2 or 3 (NCI, 2001). This means that in a population of 1,000,000, background numbers of cancer cases would be approximately 330,00 to 500,000. PAH exposure could result in a theoretical increase of 4.47 cancer cases above the background number of 330,000 to 500,000 cancer cases. This represents a very minimal increased cancer risk above background.

C. Noncancer risks, trespasser, aged 13-18 years

1c. Ingestion Dose-Arsenic

In this calculation, we are estimating the average daily dose of a trespasser, age 13-18 years would receive from incidental ingestion of soil.

$ADD_i = Ir_a\ [Soil] * EF_1 * EF_2 * ED * C1 * C2 * C3 * 1/BW_t * 1/AT_{nc}$

*ADD_i=50 mg/d*11.18 mg/kg*275d/y*6yr*2 days/week*1 week/7 days *10^{-6} kg/mg*y/365d*1/60kg*1/6 yr*

=2.0E-6 mg/kg/day

2c. Dermal Dose-Arsenic

In this calculation, we are estimating the average daily dose of arsenic a trespasser, age 13-18 years, would receive through dermal contact.

*ADD_d=[Soil]*AF*ABS_d*SA*EF_1*EF_2*ED*F*C1*C2*C3*1/BW_t*1/AT_{nc}*

*ADD_d =11.18 mg/kg*0.01 mg/cm^2/-ev*0.03*9697cm^2*275d/y*2 days/week*1 week/7 days *6 yr* 1 ev/d*10^{-6} kg/mg*y/365d*1/16kg*1/6 yr*

= 4.38E-7 mg/kg/day

3c. Noncancer Hazard Index-Arsenic

HI= (ADD_i + ADD_d)/RfD

HI= (2.0E-6 + 4.38E-7)/3.4E-4

HI= 0.0072

A Hazard Index of 1 means that the estimated dose is equal to the safe dose. A Hazard Index less than 1 indicated that the estimated dose is below the safe dose and noncancer health effects 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, Health Indices for arsenic are below 1. This indicates that noncancer health impacts from arsenic are unlikely.

D. Cancer Risks, trespasser, aged 13-18 years

1d. Ingestion Dose-Arsenic

In this calculation, we are estimating the lifetime average daily dose of arsenic a trespasser, age 13-18 years would receive from ingestion of soil

$LADD_t = IR_c * [Soil] * EF_1 * EF_2 * ED * C1 * C2 * C3 * 1/BW_t * 1/AT_c$
$LADD_t = 50\ mg/d * 11.18\ mg/kg * 275d/y * 6yr * 10^{-6}\ mg/kg * y/365\ d * 2\ days/week * 1\ week/7\ days * 1/60\ kg * 1/70yr$
$= 1.72E\text{-}7\ mg/kg/day$

2d. Dermal Risk-Arsenic

In this calculation, we are estimating the average daily dose of arsenic a trespasser, aged 13-18 years would receive from dermal contact.

$LADDD_t = [Soil] * AF * ABS_d * SA * EF_1 * EF_2 * ED * F * C1 * C2 * C3 * 1/BW_t * 1/AT_c$
$LADDD_t = 11.18\ mg/kg * 0.01\ mg/cm^2\text{-}ev * 0.03 * 9697cm^2 * 275d/y * 2\ days/week * 1\ week/7\ days * 6yr * 1\ ev/d * 10^{-6}\ kg/mg * y/365d * 1/60\ kg * 1/70\ yr$
$= 1E\text{-}8\ mg/kg/day$

3d. Cancer Risk-Arsenic

$ELCR = (LADD_t + LADDD_t) * CSF$
$ELCR = (1.72E\text{-}7 + 1E\text{-}8) * 1.5\ (mg/kg/day)^{-1}$
$ELCR = 2.73E\text{-}7$

The Estimated Lifetime Risk for arsenic is 3 E-7 (3 in 10,000,000). This means that if 10,000,000 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 3 cancers above the number of cancers that would normally be expected to occur in the population of 10,000,000. Background rates of cancer in the U.S. are one in 2 or 3 (NCI 2001). This means that in a population of 10,000,000, background numbers of cancer cases would be approximately 3,300,000 to 5,000,000. Arsenic exposure could result in a theoretical increase of 3 cancer cases above the background number of 3,300,000 to 5,000,000 cancer cases. This represents an insignificant increased cancer risk. .

WHERE:

ADD_i	=	average daily dose from ingestion
ADD_d	=	average daily dose from dermal contact
$LADD_c$	=	lifetime average daily dose from ingestion for child, aged 1-6 years
$LADD_t$	=	lifetime average daily dose from ingestion for trespasser, aged 13-18 years
$LADD_a$	=	lifetime average daily dose from ingestion for adult, aged 7-30 years
$LADDD_a$	=	lifetime average dermal daily dose for child, aged 1-6 years
$LADDD_c$	=	lifetime average dermal daily dose for adult, aged 7-30 years
$LADDD_t$	=	lifetime average dermal daily dose for trespasser, aged 13-18 years
IR_c	=	soil ingestion rate for a child; 100 mg/day (EPA 1997)*
IR_a	=	soil ingestion rate for an adult; 50 mg/day (EPA 1997)*
AF	=	skin-soil adherence factor for default residential child; 0.2 mg/cm^2-ev; default residential adult; 0.07 mg/cm^2-ev. trespasser teenager; 0.01 mg/cm^2-ev. (EPA 2001b)
ABS_d	=	Soil dermal absorption fraction

Arsenic: 0.03 (EPA 2001b), PAHs: 0.13 (EPA 2001b)

SA = Skin surface area, 50th %ile legs, feet, hands, and arms, child aged 1-6; 3307 cm^2 (EPA 1997), legs, arms, hands, and feet, trespasser teenager age 13-18; 9697 cm^2, adult; 10,695 cm^2 (EPA 2001b)

[Soil] = soil concentration; Shoreline Trailer Court: PAHs (noncancer calculation): 103.66 mg/kg (Total 95% UCL for all PAHs) PAHs (cancer calculation): 32.2 mg/kg (Total TEF-adjusted 95% UCL for all PAHs); 483 and 497 E. Main St. Properties: Arsenic: 11.18 mg/kg (95% Upper Confidence Limit of the arithmetic mean), PAHs (noncancer calculation): 139.34 mg/kg (Total 95% UCL for all PAHs) PAHs (cancer calculation): 31.83 mg/kg (Total TEF-adjusted 95% UCL for all PAHs)

EF_1 = exposure frequency; 275 days/year

EF_2 = exposure frequency, 7 days/week, resident; 2 days/week, trespasser

F = event frequency, 1 ev/day

ED = exposure duration; 6 years for child, 24 years for adult, 6 years for trespasser

C1 = conversion factor; 10^{-6} kg/mg

C2 = conversion factor; 1 year/365 days

C3 = conversion factor, 1 week/7 days

Bw_c = child 50th %tile body weight for age 1-6 yrs (EPA 1997); 16 kg

Bw_a = adult 50th %tile body weight (EPA 1997); 70 kg

Bw_t = teenager body weight, 13-18 years (EPA 1997); 60kg

AT_{nc} = averaging time for noncancer risk; 6 years

AT_c = averaging time for cancer risk; 70 years

AT_{ac} = average time for 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. CTDPH 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 the Trailer Court, 483 and 497 E. Main Street 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 2001a). A 95% UCL accounts for the variability in the data and ensures that the mean is not underestimated.

Appendix D: Table 1. Values Used to Calculate PAH Concentrations for Cancer and Noncancer Risk Calculations for the Shoreline Trailer Court

PAH	95% UCL (ppm)	Toxic Equivalency Factor (TEF)	TEF Adjusted Concentration (ppm)
Benzo(a)anthracene	36.75	0.145	5.33
Benzo(a)pyrene	19.62	1	19.62
Benzo(b)fluoranthene	19.60	0.167	3.27
Benzo(k)fluoranthene	12.77	0.020	0.256
Dibenzo(a,h)anthracene	2.77	1.11	3.07
Indeno(1,2,3-cd)pyrene	12.15	0.055	0.67
Total of 95% UCLs	103.66	---	32.2

Appendix D:Table 2. Values Used to Calculate PAH Concentrations for Cancer and Noncancer Risk Calculations for the 483 and 497 E. Main Street Properties

PAH	95% UCL (ppm)	Toxic Equivalency Factor (TEF)	TEF Adjusted Concentration (ppm)
Benzo(a)anthracene	21.81	0.145	3.16
Benzo(a)pyrene	11.22	1	11.22
Benzo(b)fluoranthene	14.19	0.167	2.37
Benzo(k)fluoranthene	6.72	0.020	0.13
Dibenzo(a,h)anthracene	1.65	1.11	1.83
Indeno(1,2,3-cd)pyrene	7.71	0.055	0.42
Total of 95% UCLs	63.3	---	19.13

Appendix E
What Can I Do to Reduce my Exposure to Soil in My Yard?
Fact Sheet

What Can I Do To Reduce My Exposure To Soil In My Yard?

What does it mean to be exposed?

In order to be exposed to chemicals in soil, you need to come into direct contact with soil that is contaminated and the chemicals need to get into your body. There are two main ways you could be exposed to chemicals in soil in your yard:

- Ingestion; putting items into your mouth that have soil on them such as fingers, food, toys
- Breathing in soil dust

Two more ways that exposure to soil could occur are through touching the soil or eating food grown in contaminated soil. However, these are **not** likely to be major ways of exposure for you because the chemicals we have found in the soil are not easily absorbed through the skin and do not accumulate a great deal in plants or vegetables.

If contamination has been found in the soil in your yard, there are some things you can do to reduce your contact with soil in your yard.

- **Discourage children from playing in bare soil if possible**, and make sure they wash their hands after playing outside, especially before eating.
- Bare soil areas underneath play equipment can be covered with mulch or clean topsoil.
- Wash toys before bringing them into the house, or leave them outside.
- Pets can bring dirt inside on their paws or fur. Try to keep pets clean.
- Clean up dirt that is tracked into the house. Wet cleaning is recommended, but vacuuming is ok. Try to avoid sweeping.
- Consider using raised beds with fresh soil for gardening.

For More Information

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What are the chemicals that DEP sampled for?

DEP analyzed soil samples for a wide variety of chemicals. There are three main chemicals that DEP has found at elevated levels in some areas. These chemicals are total petroleum hydrocarbons (TPHs), arsenic, and polycyclic aromatic hydrocarbons (PAHs).

PAHs:

PAH's are a group of over 100 different chemicals that are formed during the imcomplete burning of coal, oil and gas, garbage, or other organic materials like tobacco or charbroiled meat. Studies in animals have shown that PAH's can affect the skin, blood, immune system and the ability to reproduce. These affects have not been reported in people. Some people who had long-term exposures to high levels of PAH's developed skin and lung cancer. Studies have shown that some PAH's caused cancer in animals.

For more information on these chemicals, visit the website for the Agency for Toxic Substances and Disease Registry (ATSDR) website at http://atsdr.cdc.gov

Arsenic:

Arsenic is found in nature at low levels. The major uses of arsenic are as wood preservatives and agricultural pesticides. Arsenic is very widely distributed in the environment and everyone is exposed to low levels. Long-term exposure to arsenic can increase the risk of skin, bladder, kidney, liver, and lung cancer. Exposure to arsenic can also lead to skin effects such as irritation and skin darkening.

Total Petroleum Hydrocarbons (TPH):

TPH's are a large group of compounds that originally come from crude oil and the products made from it. Since TPH's can come in a variety of forms and concentrations, it is very difficult to describe health effects. At high levels, some compounds can affect the central nervous system, some can cause fatigue, headache nausea and drowsiness. Usually, if someone's exposure is eliminated, adverse effects also go away. However, some chronic exposures to high levels of TPH's can result in permanent health effects which include central nervous system damage, cancer, or birth defects.