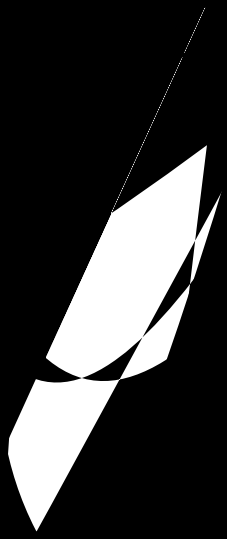
TARGETED BROWNFIELDS ASSESSMENT REPORT

be more in line with the soil cap alternative and much lower than the excavation, on-site treatment, and off-site disposal alternative.

Therefore, the selected alternative is placement of a cap with an AUL to limit future Site activities. Based on the high relative cost of the excavation, on-site treatment, and off-site disposal alternative, it was determined that the benefits of approaching or achieving background conditions would not outweigh the costs that would be incurred. The capping alternative would achieve a Permanent Solution for the Site.

cate CSX railroad tracks and the Quaboag River. This area is
ts D heries and Wildlife (MassWildlife). The abutting property to the
t tion of Spencer Metal Finishing, Inc., a full-service metal finishing
ffing, powder coating, and abrasive bead blasting.

y was



6.0 REFERENCES

Lycott Environmental Research, Inc. (Lycott). 1991. *Phase I Limited Site Investigation, Brookfield Mill, 112-114 Mill Street, Brookfield, MA.* August 1991.

Metcalf & Eddy, Inc. (M&E). 2002. *Targeted Brownfield Assessment Final Report, 54 – 67 Mill Street, Brookfield, Massachusetts*. Prepared for the U.S. Environmental Protection Agency. November 2002.

Metcalf & Eddy, Inc. (M&E) 2004a. *Phase I Initial Site Investigation Report, Mill Street Property, Brookfield,*

7.0 LIMITATIONS

No warranty, whether expressed or implied, is given with respect to this report or any opinions herein. It is expressly understood that this report and opinions expressed herein are based upon site conditions reported to AES/AECOM, observed by AES/AECOM, and as they existed only at the time this Phase III Remedial Action Plan was prepared. Without limiting the foregoing, this report, any opinions or conclusions stated herein, and its attachments are subject to the complete General Statement of Limitations and Conditions provided in Appendix D, which are incorporated by reference into, and are an integral part of, this report submittal. This report has been prepared on behalf of, and for the exclusive use of, the U.S. Environmental Protection Agency. Any use of or reliance on AES/AECOM's report by a third party, even with AES/AECOM's consent, shall be at such party's own risk.

FIGURES

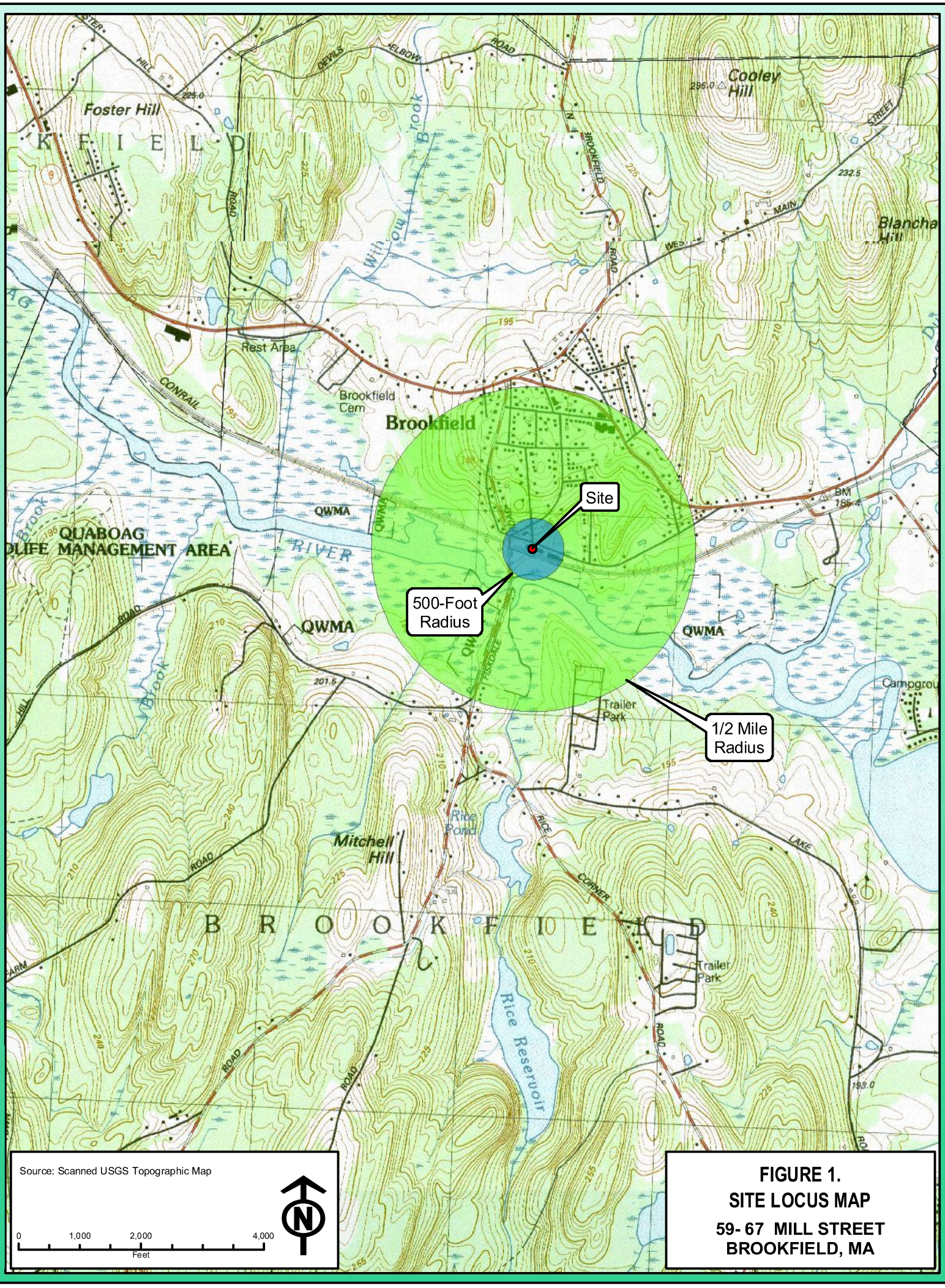


FIGURE 1.
SITE LOCUS MAP
59- 67 MILL STREET
BROOKFIELD, MA

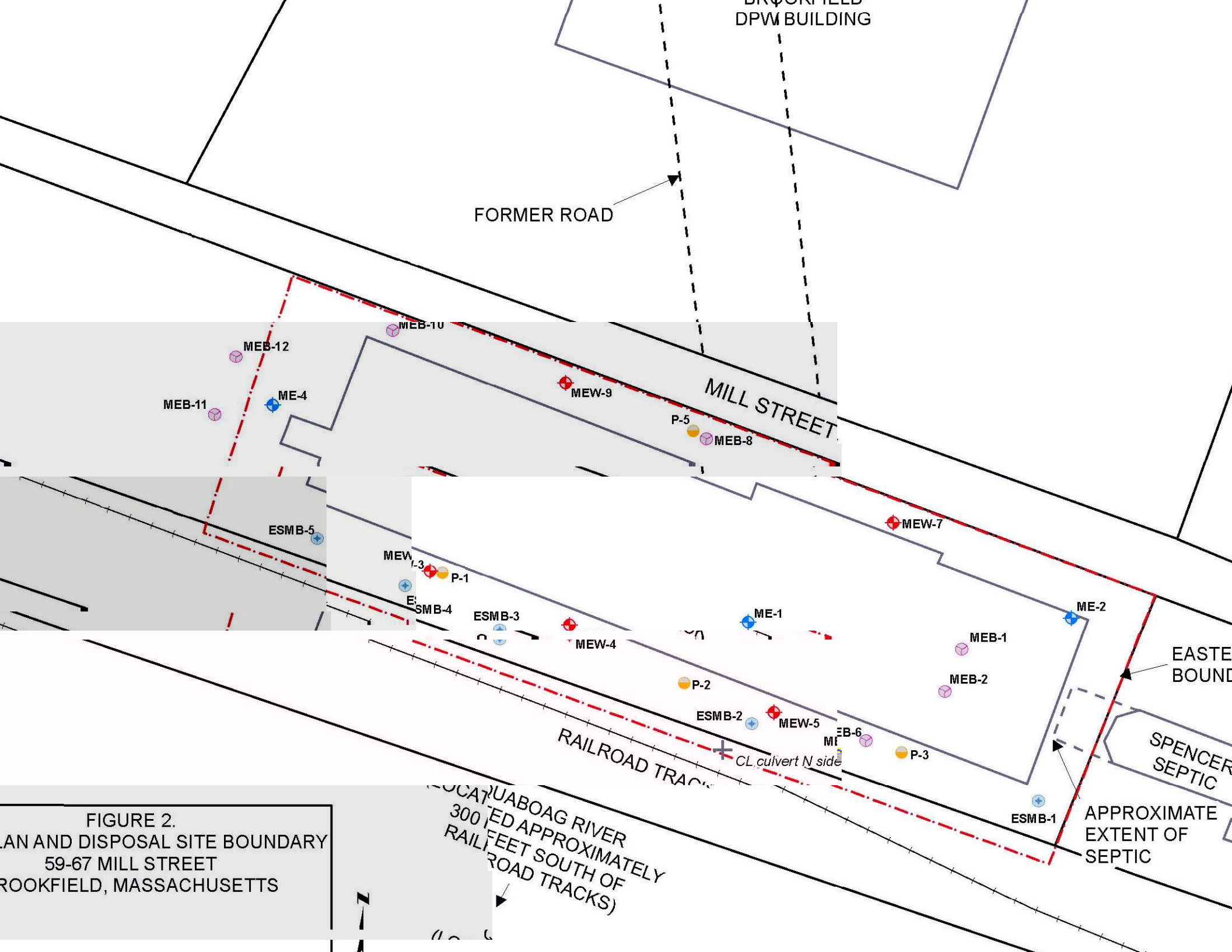


FIGURE 2.
LAN AND DISPOSAL SITE BOUNDARY
59-67 MILL STREET
ROOKFIELD, MASSACHUSETTS

APPENDIX A

SUPPLEMENTAL RISK CALCULATIONS

Gas onstant R tm/mol-K	Henry's Law Constant H'_{TS} unitless $H_{TS} / (R * T_S)$
21E-05	6.71E+01
21E-05	7.13E+01
21E-05	3.10E-02
21E-05	6.40E-03
21E-05	3.51E-04

) (031709)]

TABLE 1 (continued)
SOIL TO INDOOR AIR - 95% UCL SOIL CONCENTRATIONS
FORMER BROOKFIELD MILL SITE

	Depth below grade to bottom of enclosed space	Depth below grade to contamination	Source Building Separation	Diffusivity in air	Diffusivity in water	Vadose zone Effective Diffusion Coeff.	Total Overall Effective Diffusion Coeff.	Area of Enclosed Space Below Grade	Building Ventilation Rate	Pressure Diff. between soil & enclosed space	Vadose zone soil saturated hydraulic conductivity
	L_F	L_t	L_T	D_a	D_w	D_v^{eff}	D_T^{eff}	A_B	$Q_{building}$	ΔP	$K_{s,v}$
Units:	cm	cm	cm	cm^2/s	cm^2/s	cm^2/s	cm^2/s	cm^2	cm^3/s	$g/cm\text{-}s^2$	cm/hr
Formula:	(15 or 200 for screening)	(400 for screening)	L_t - L_F	lookup	lookup	(Note 13)	(Note 4)	(Note 2)	(Note 2a)	(40 for screening)	lookup
Analyte											
C9-C12 Aliphatics	2.00E+02	4.00E+02	2.00E+02	7.00E-02	1.00E-06	3.99E-03	3.99E-03	1.80E+06	2.54E+04	4.00E+01	5.50E-01
C9-C18 Aliphatics	2.00E+02	4.00E+02	2.00E+02	7.00E-02	5.00E-06	3.99E-03	3.99E-03	1.80E+06	2.54E+04	4.00E+01	5.50E-01
C11-C22 Aromatics	2.00E+02	4.00E+02	2.00E+02	6.00E-02	1.00E-06	3.42E-03	3.42E-03	1.80E+06	2.54E+04	4.00E+01	5.50E-01
2-Methylnaphthalene	2.00E+02	4.00E+02	2.00E+02	6.29E-02	7.20E-06	3.59E-03	3.59E-03	1.80E+06	2.54E+04	4.00E+01	5.50E-01
Phenanthrene	2.00E+02	4.00E+02	2.00E+02	3.33E-02	7.47E-06	2.13E-03	2.13E-03	1.80E+06	2.54E+04	4.00E+01	5.50E-01

TABLE 1 (continued)
SOIL TO INDOOR AIR - 95% UCL SOIL CONCENTRATIONS
FORMER BROOKFIELD MILL SITE

	Conversion Factor hr to s Conv02	Viscosity of water at 10°C μ_{w-10}	Viscosity of water at system temp. μ_w	Density of water ρ_w	Acceleration due to gravity g	Vadose zone soil intrinsic permeability $k_{i,v}$	Vadose zone residual soil water content $\theta_{r,v}$	Vadose zone effective total fluid saturation S_{te}	Vadose zone van Genuchten shape parameter M_v	Vadose zone soil relative air permeability k_{rg}	Vadose zone soil effective vapor permeability k_v
Units:	s/hr	g/cm-s	g/cm-s	g/cm^3	cm/s^2	cm^2	cm^3/cm^3	unitless	unitless	unitless	cm^2
rmula:			(Note 16)	(0.999 for screening)		(Note 17)	lookup	(Note 18)	lookup	(Note 19)	(Note 20)
	3.60E+03	1.31E-02	1.31E-02	9.99E-01	9.81E+02	2.04E-09	6.30E-02	2.59E-01	2.48E-01	8.59E-01	1.75E-09
	3.60E+03	1.31E-02	1.31E-02	9.99E-01	9.81E+02	2.04E-09	6.30E-02	2.59E-01	2.48E-01	8.59E-01	1.75E-09
s	3.60E+03	1.31E-02	1.31E-02	9.99E-01	9.81E+02	2.04E-09	6.30E-02	2.59E-01	2.48E-01	8.59E-01	1.75E-09
ne	3.60E+03	1.31E-02	1.31E-02	9.99E-01	9.81E+02	2.04E-09	6.30E-02	2.59E-01	2.48E-01	8.59E-01	1.75E-09
	3.60E+03	1.31E-02	1.31E-02	9.99E-01	9.81E+02	2.04E-09	6.30E-02	2.59E-01	2.48E-01	8.59E-01	1.75E-09

TABLE 1 (continued)
SOIL TO INDOOR AIR - 95% UCL SOIL CONCENTRATIONS
FORMER BROOKFIELD MILL SITE

	Floor-wall seam perimeter	Vapor viscosity at avg. soil temp.	Crack depth below grade	Total area of cracks	Crack-to-total area ratio	Equivalent crack radius	Avg. Vapor Flow Rate Into Bldg.	Foundation or Slab Thickness	Crack Effective Diffusion Coeff.	Infinite Source Indoor Attenuation Coeff.	Infinite Source Bldg. Conc.
	X_{crack}	μ_{TS}	Z_{crack}	A_{crack}	η	r_{crack}	Q_{soil}	L_{crack}	D^{crack}	α	$C_{building}$
Units:	cm	g/cm-s	cm	cm^2	unitless	cm	cm^3/s	cm	cm^2/s	unitless	$\mu g/m^3$
Formula:	(4000 for screening)	0.00018*(T'S/298.15)^0.5	(= L_F for screening)	(400 for screening)	A_{crack}/A_B	$\eta(A_B/X_{crack})$	(Note 5)	(10 for screening)	(Note 1)	(Note 6)	C_{source} * α
Analyte											
C9-C12 Aliphatics	4.00E+03	1.75E-04	2.00E+02	4.00E+02	2.22E-04	1.00E-01	1.21E+00	1.00E+01	3.99E-03	4.61E-05	5.07E+01
C9-C18 Aliphatics	4.00E+03	1.75E-04	2.00E+02	4.00E+02	2.22E-04	1.00E-01	1.21E+00	1.00E+01	3.99E-03	4.61E-05	1.27E+02
C11-C22 Aromatics	4.00E+03	1.75E-04	2.00E+02	4.00E+02	2.22E-04	1.00E-01	1.21E+00	1.00E+01	3.42E-03	4.58E-05	1.19E+01
2-Methylnaphthalene	4.00E+03	1.75E-04	2.00E+02	4.00E+02	2.22E-04	1.00E-01	1.21E+00	1.00E+01	3.59E-03	4.59E-05	2.48E-02
Phenanthrene	4.00E+03	1.75E-04	2.00E+02	4.00E+02	2.22E-04	1.00E-01	1.21E+00	1.00E+01	2.13E-03	4.48E-05	5.74E-04

- 95% UCL SOIL CONCENTRATIONS
D MILL SITE

s Guide for Evaluating Subsurface Vapor Intrusion into Buildings, USEPA, June 19, 2003.

ent to D_i^{eff} of soil layer i in contact with the floor

$_B$ = 1,000,000 cm^2 for L_F <= 15 cm and A_B = 1,800,000 cm^2 for LF > 15 cm

$_{building}$ = 25,417 cm^3/s for L_F <= 15 cm and $Q_{building}$ = 16,944 cm^3/s for LF > 15 cm

nk

D_v^{eff})

$k_v*X_{crack}) / (\mu_{TS}*\ln(2*Z_{crack}/r_{crack}))$

$Q_{building}*L_T))*EXP(Q_{soil}*L_{crack}/(D^{crack}*A_{crack}))]/[EXP(Q_{soil}*L_{crack}/(D^{crack}*A_{crack}))+(D_T^{eff}*A_B/(Q_{building}*L_T))+(D_T^{eff}*A_B/(Q_{soil}*L_T))*(EXP(Q_{soil}*L_{crack}/(D^{crack}*A_{crack}))-1)]$

ratio T_B/T_C:

T_B/T_C	n
<0.57	0.30
0.57-0.71	$0.74(T_B/T_C)-0.116$
>0.71	0.41

available for calculation, result is NA.

$(1-T_S/T_C)/(1-T_B/T_C)]^n$; if values are not available for calculation, result is NA.

$_{TS}/R_c*(1/T_S-1/T_R)]*H_R$; if values are not available for calculation, result assumed to be H_R

nk

soil types - if no site-specific information is available, use SCL for screening.

nk

$^3/n_v^2)+(D_w/H'_{TS})(\theta_{w,v}^{3.33}/n_v^2)$

nk

nk

$/ 283.15)^{0.5}$

$nv02 * \mu_w / (\rho_w * g)$

$/ (n_v - \theta_{r,v})$

$(1-S_{te}^{1/Mv})^{2Mv}$

e that the model is very sensitive to this parameter and if site-specific values are available, they should be used.

$_R * Conv01 * \rho_b / (\theta_{w,v} + K_d * \rho_b + H'_{TS} * \theta_{a,v}) * Conv02$

BLE 2. SUMMARY OF MODELED AIR DATA
FORMER BROOKFIELD MILL SITE

	Air Concentrations (ug/m^3)
	Indoor Air EPC
phatics	5.1E+01
phatics	1.3E+02
romatics	1.2E+01
phthalene	2.5E-02
ne	5.7E-04

osure Point Concentration

TABLE 3
ARY OF SITE HAZARD INDICES AND EXCESS LIFETIME CANCER RISK ESTIMATES

	FUTURE USE:					
	HI	ELCR	HI	ELCR	HI	
	CONSTRUCTION WORKER		RESIDENT CHILD/ADULT		RESIDENT CHILD (1-2)	
tion	7E-01	1E-08	1E+00	5E-07	4E+00	
	3E-01	1E-08	8E-01	4E-07	1E+00	
gitive Dust	2E-01	7E-08	7E-03	5E-08	7E-03	(age 0-7)
megrown Fruits	NA	NA	5E+01	4E-05	6E+01	
	1E+00	**9E-08**	**5E+01**	**5E-05**	**7E+01**	
tion	2E-03	NA	NA	NA	NA	
	3E-04	NA	NA	NA	NA	
	2E-03	**NA**	**NA**	**NA**	**NA**	
tion	NA	NA	9E-04	NA	9E-04	(age 0-7)
	NA	NA	9E-06	NA	9E-06	(age 0-7)
	NA	**NA**	**9E-04**	**NA**	**9E-04**	
R AIR:						
	7E-06	NA	1E+00	NA	1E+00	(age 0-7)
	7E-06	**NA**	**1E+00**	**NA**	**1E+00**	
	1E+00	**9E-08**	**5E+01**	**5E-05**	**7E+01**	

ne Cancer Risk

s and Excess Lifetime Cancer Risks are above the MCP risk limits of 1 for HIs and 1E-05 for ELCRs.

Method 3 Risk Assessment for Resident Exposed to Chemicals in Indoor Air - Shortform 2006 (sf06ra)

Index

Tab		
EPCs	Table RA-1:	Select chemicals and enter Exposure Point Concentrations (EPCs). Associated risks are presented to the right
C Eq	Table RA-2:	Equations to calculate cancer risks.
NC Eq	Table RA-3:	Equations to calculate noncancer risks.
Exp	Table RA-4:	Definitions and exposure factors.
Chem	Table RA-5:	Chemical-specific data.

Spreadsheets designed by Andrew Friedmann, MassDEP
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One Winter Street
Boston, MA 02108 USA
Telephone: (617) 556-1165
Fax: (617) 556-1006
Email: Lydia.Thompson@state.ma.us

Resident - Indoor Air: Table RA-1 - Plaza
Exposure Point Concentration (EPC)
Based on Resident Ages 1-31 (Cancer) and 1-8 (Noncancer)

ShortForm Version 4-06

Vlookup Version v0808

ELCR (all chemicals) =
HI (all chemicals) = 1E+00

Do not insert or delete any rows*

Click on empty cell below and select OHM using arrow.

Oil or Hazardous Material	EPC ($\mu g/m^3$)	$ELCR_{air}$	HQ_{air}
Aliphatics C9 to C12	5.1E+01		2.5E-01
Aliphatics C9 to C18	1.3E+02		6.3E-01
Aromatics C11 to C22	1.2E+01		2.4E-01
Methylnaphthalene, 2-	2.5E-02		5.0E-04
Phenanthrene	5.7E-04		1.1E-05

Resident - Indoor Air: Table RA-2

Vlookup Version v0808

Equations to Calculate Cancer Risk for Resident (Age 1-31 years)

Cancer Risk from Inhalation

$$ELCR_{air} = LADE_{(1-31)} * URF$$

$$LADE = \frac{[OHM]_{air} * EF * ED * EP}{AP_{lifetime}}$$

URF	OHM specific	(ug/m³)
LADE	m³/OHM specific	ug/m³
$[OHM]_{air}$	OHM specific	ug/m³
EF	1.00	event/day
ED	1	day/event
EP	90	years
$AP_{lifetime}$	70	year

Resident - Indoor Air: Table RA-3
Equations to Calculate Noncancer Risk for Resident Child (Age 1-8 years)

Vlookup ~~Version v0808~~

Noncancer Risk from Inhalation

$$HQ_{air} = \frac{ADE * C}{RfC}$$

$$ADE = \frac{[OHM]_{air} * EF * ED * EP}{AP}$$

Parameter	Value	Units
RfC	OHM specific	mg/m^3
ADE	OHM specific	$\mu g/m^3$
$[OHM]_{soil}$	OHM specific	$\mu g/m^3$
EF	1.00	event/day
ED	1	day/event
EP	7	years
C	0.001	mg/ug
AP	7	year

Resident - Indoor Air: Table RA-4
Definitions and Exposure Factors

Vlookup Version v0808

Parameter	Value	Units	Notes
ELCR - Excess Lifetime Cancer Risk	chemical specific	dimensionless	
URF - Unit Risk Factor	chemical specific	$(\mu g/m^3)^{-1}$	see Table RA-5
LADE - Lifetime Average Daily Exposure	chemical specific	$\mu g/m^3$	see Table RA-2
HQ - Hazard Quotient	chemical specific	dimensionless	
RfC - Reference Concentration	chemical specific	mg/m^3	see Table RA-5
ADE - Average Daily Exposure	chemical specific	$\mu g/m^3$	see Table RA-3
EPC - Exposure Point Concentration	chemical specific	µg/L	see Table RA-1
EF - Exposure Frequency	1.00	event/day	
ED - Exposure Duration	1	day/event	
$EP_{(1-8)}$ - Exposure Period age group 1-8 (noncancer)	7	years	
$EP_{(1-31)}$ - Exposure Period for age group 1-31 (cancer)	30	years	
$AP_{(noncancer)}$ - Averaging Period for noncancer	7	years	
$AP_{(lifetime)}$ - Averaging Period for lifetime	70	years	

Resident - Indoor Air: Table RA-5
Chemical-Specific Data

Vlookup Version v0808

Oil or Hazardous Material	URF $(ug/m^3)^{-1}$	RfC mg/m^3
Aliphatics C9 to C12		2.00E-01
Aliphatics C9 to C18		2.00E-01
Aromatics C11 to C22		5.00E-02
Methylnaphthalene, 2-		5.0E-02
Phenanthrene		5.0E-02

Method 3 Risk Assessment for Resident Exposed to Chemicals in Soil - Shortform 2006 (sf06rs)

Index

Tab	
EPCs	Table RS-1: Select chemicals and enter Exposure Point Concentrations (EPCs). Associated risks are shown to the right.
C Eq	Table RS-2: Equations to calculate cancer risks.
cNC Eq	Table RS-3: Equations to calculate chronic noncancer risks.
scNC Eq	Table RS-4: Equations to calculate subchronic noncancer risks.
Exp	Table RS-5: Definitions and exposure factors.
[illegible]	[illegible]

Version 4-06

ersion v0808

Shortfo

Vlook_p

Resident - Soil: Table RS-1 - 1087 Lakeview Avenue

Exposure Point Concentration (EPC)

Based on Resident Ages 1-31 (Cancer), 1-8 (Chronic Noncancer), and 1-2 (Subchronic Noncancer)

ELCR (all chemicals) = 4.5E-05

Chronic HI (all chemicals) = 4.9E+01

Subchronic HI (all chemicals) = 6.8E+01

Do not insert or delete any rows

Click on empty cell below and select CHM using arrow

CAS or Hazardous Material	EPC (mg/kg)	Cancer ELCR Ingestion	Cancer ELCR Dermal	Cancer ELCR Inhalation	Cancer ELCR Total	Chronic HQ Ingestion	Chronic HQ Dermal	Chronic HQ Inhalation	Chronic HQ Total	Subchronic HQ Ingestion	Subchronic HQ Dermal	Subchronic HQ Inhalation	Subchronic HQ Total	HQ_{total}
														1.3E-04
														0.0E+00
Aliphatics C9 to C12	5.1E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.2E-06	5.2E-04	0.0E+00	6.5E-04	3.4E-05	9.9E-05	0.0E+00		1.4E-03
		0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00		4.3E-04
Aliphatics C9 to C18	5.3E+01	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.3E-03	5.5E-03	0.0E+00	6.7E-03	3.5E-04	1.0E-03	0.0E+00		1.8E-03
Aliphatics C19 to C36	2.5E+02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	3.0E-04	2.5E-04	0.0E+00	5.5E-04	2.7E-04	1.0E-04	0.0E+00		0.0E+00
Aromatics C11 to C22	8.5E+01	0.0E+00	0.0E+00	0.0E+00	0.0E+00	2.5E-03	5.8E-03	0.0E+00	8.3E-03	6.8E-04	1.1E-03	0.0E+00		6.8E-04
		0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00		4.6E-06
Methylnaphthalene, 2-	4.3E-01	0.0E+00	0.0E+00	0.0E+00	0.0E+00	9.4E-05	2.2E-04	0.0E+00	3.1E-04	2.6E-04	4.2E-04	0.0E+00		0.0E+00
Dibenz(a,j)anthracene	5.2E-01	4.0E-07	2.9E-07	0.0E+00	6.9E-07	1.2E-05	7.1E-06	0.0E+00	1.9E-05	3.2E-06	1.3E-06	0.0E+00		2.2E+00
		0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00		0.0E+00
Polychlorinated biphenyls (PCBs)	1.2E-01	7.9E-08	1.5E-07	4.4E-05	4.4E-05	1.8E-02	2.1E-02	3.7E+00	3.8E+00	1.4E-02	1.6E-02	0.0E+00		1.1E-01
		0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00		2.6E-02
Aluminum	1.1E+04	0.0E+00	0.0E+00	0.0E+00	0.0E+00	2.6E-02	2.2E-02	0.0E+00	4.8E-02	7.2E-02	4.2E-02	0.0E+00		1.2E-01
Antimony	1.6E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	6.0E-03	5.1E-03	0.0E+00	1.1E-02	1.7E-02	9.7E-03	0.0E+00		5.0E-04
Barium	1.0E+03	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.2E-02	5.2E-03	0.0E+00	1.7E-02	9.6E-02	2.8E-02	0.0E+00		1.2E-01
Beryllium	3.2E-01	0.0E+00	0.0E+00	0.0E+00	0.0E+00	3.9E-04	9.9E-05	0.0E+00	4.9E-04	4.3E-04	7.5E-05	0.0E+00		4.9E-03
Chromium (total)	2.2E+01	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.8E-02	1.4E-02	5.0E-01	5.3E-01	7.4E-03	3.9E-03	0.0E+00		8.8E-02
Cobalt	9.2E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.1E-03	9.5E-04	0.0E+00	2.1E-03	3.1E-03	1.8E-03	0.0E+00		1.3E+00
Copper	1.4E+03	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.2E-01	3.0E-01	0.0E+00	4.1E-01	3.2E-02	5.6E-02	0.0E+00		6.0E+01
Iron	3.3E+04	0.0E+00	0.0E+00	0.0E+00	0.0E+00	2.7E-01	3.2E-01	0.0E+00	5.9E-01	7.4E-01	3.1E-01	0.0E+00		4.1E-02
Lead	5.6E+02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	9.1E-01	9.3E-02	4.0E+00	4.1E+01	2.5E+00	1.8E-01	0.0E+00		1.7E-02
Manganese	2.4E+02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	8.2E-03	9.8E-03	0.0E+00	1.8E-02	2.3E-02	1.9E-02	0.0E+00		3.2E-01
Mercury	6.0E-01	0.0E+00	0.0E+00	0.0E+00	0.0E+00	4.8E-03	2.1E-03	0.0E+00	6.9E-03	1.3E-02	3.9E-03	0.0E+00		1.8E-03
Nickel	1.6E+01	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.9E-03	5.7E-03	2.1E-01	2.2E-01	5.2E-03	1.1E-02	0.0E+00		6.8E-03
Selenium	1.3E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	6.3E-04	1.1E-05	0.0E+00	6.4E-04	1.7E-03	2.0E-05	0.0E+00		1.1E-02
Silver	2.1E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	1.0E-03	2.1E-03	0.0E+00	3.1E-03	2.8E-03	4.0E-03	0.0E+00		2.4E-02
Thallium	1.3E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	3.9E-02	3.4E-03	0.0E+00	4.3E-02	1.1E-02	6.3E-04	0.0E+00		3.3E+00
Vanadium	2.8E+01	0.0E+00	0.0E+00	0.0E+00	0.0E+00	7.5E-03	1.9E-03	0.0E+00	9.4E-03	2.1E-02	3.6E-03	0.0E+00		
Zinc	6.4E+02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	5.1E-03	8.8E-04	2.5E+00	2.3E+00	1.4E-02	1.7E-03	0.0E+00		

rookfield SS+Sub

Resident - Soil: Table RS-2
Equations to Calculate Cancer Risk for Resident (Age 1-31 years)

Vlookup Version v0808

Parameter	Value	Units
CSF	OHM specific	$(mg/kg\text{-}day)^{-1}$
LADD	age/OHM specific	mg/kg-day
$[OHM]_{soil}$	OHM specific	mg/kg
$IR_{(1-8)}$	100	mg/day
$IR_{(8-15)}$	50	mg/day

Cancer Risk from Ingestion

$$ELCR_{ing} = LADD_{ing(1\text{-}31)} * CSF$$

Cancer Risk from Dermal Absorption

$$ELCR_{derm} = LADD_{derm} * CSF$$

$$LADD_{derm\,(1\text{-}31)} = LADD_{derm\,(1\text{-}8)} + LADD_{derm\,(8\text{-}15)} + LADD_{derm\,(15\text{-}31)}$$

$$LADD_{derm\,(x\text{-}y)} = [OHM]_{soil} * SA_x * RAF_x * ... * SAF_x * EF_{dx} * ED_x * EP_{dx} * C ...$$

Parameter	Value	Units
$RAF_{(1\text{-}8)}$	OHM specific	dimensionless
$SA_{(1\text{-}8)}$	2,800	cm²/day
$EF_{(1\text{-}8)}$	1.0	dimensionless
$ED_{(1\text{-}8)}$	8	years
$BW_{(1\text{-}8)}$	15	kg

Cancer Risk from Homegrown Produce

$$ELCR_{produce} = LADD_{produce(1\text{-}31)} * CSF$$

$$LADD_{produce(1\text{-}31)} = LADD_{produce(1\text{-}8)} + LADD_{produce(8\text{-}15)} + LADD_{produce(15\text{-}31)}$$

$$LADD_{produce(x\text{-}y)} = [OHM]_{soil} * PHF * IR_x * RAF_{produce} * EF_{produce} * ED_x * EP_x * C ... / BW_x * AP_{lifetime}$$

Parameter	Value	Units
$IR_{(1\text{-}8)}$	200	g/day
$IR_{(8\text{-}15)}$	100	g/day
$IR_{(15\text{-}31)}$	100	g/day
$EF_{(1\text{-}8)}$	1.0	dimensionless
$ED_{(1\text{-}8)}$	8	years
$BW_{(1\text{-}8)}$	15	kg
$AP_{lifetime}$	25,550	days
$SAF_{(1\text{-}8)}$	0.12	mg/cm²
$SA_{(1\text{-}8)}$	2,800	cm²/day
$PHF_{(1\text{-}8)}$	0.12	mg/mg

Resident - Soil: Table RS-3

C	0.000001	kg/mg
BW	17.0	kg
AP	7	year
AP_{cancer}	[illegible]	day
SA	2451	cm^2/day
SAF	0.3	mg/cm^2
PUF	OHM specific	(mg/mg)(mg/mg)

concentrations that are often found in the environment. As such, risk
quency (EF) is 1 event/day, while both the exposure period (EP) and

Chronic Noncancer Risk from Homegrown Produce

$$HQ_{produce} = \frac{ADD_{produce}}{RfD}$$

$$ADD_{produce} = \frac{[OHM_{soil}] * PUF * PIR * RAF_{produce} * EF_{produce} * ED * EP * C}{BW * AP}$$

Cyanide can cause a significant health risk from one-time exposure to c
is calculated for a single exposure. Thus, for cyanide, the exposure fre
averaging period (AP) are 1 day.

Resident - Soil: Table RS-4
Equations to Calculate Subchronic Noncancer Risk for Resident Child (Age 1-2 years)

Vlookup Version v0808

Subchronic Noncancer Risk from Ingestion

$$HQ_{ing} = \frac{ADD_{ing}}{RfD_{subchronic}}$$

$$ADD_{ing} = \frac{[OHM]_{soil} * IR * RAF_{nc\text{-}ing} * EF_{ing} * ED * EP * C}{BW * AP}$$

Subchronic Noncancer Risk from Dermal Absorption

$$HQ_{derm} = \frac{ADD_{derm}}{RfD_{subchronic}}$$

$$ADD_{derm} = \frac{[OHM]_{soil} * SA * RAF_{nc\text{-}derm} * SAF * EF_{derm} * ED * EP * C}{BW * AP}$$

Subchronic Noncancer Risk from Homegrown Produce

$$HQ_{produce} = \frac{ADD_{produce}}{[illegible]}$$

[illegible]

Parameter	Value	Units
RfD	OHM specific	mg/kg-day
ADD	OHM specific	mg/kg-day
$[OHM]_{soil}$	OHM specific	mg/kg
IR	100	mg/day
PIR	10,900	mg/day
$RAF_{nc\text{-}ing}$	OHM specific	dimensionless
$RAF_{nc\text{-}derm}$	OHM specific	dimensionless
$RAF_{nc\text{-}produce}$	OHM specific	dimensionless
$EF_{ing/derm}$	0.714	event/day
$EF_{produce}$	1.00	event/day
$EF_{cyanide}$	1.00	event/day
ED	1	day/event
$EP_{cyanide}$	1	day
EP	[illegible]	[illegible]
C	0.000001	kg/mg
BW	107	kg
[illegible]	[illegible]	[illegible]

[illegible] calculated for a single exposure. Thus, for cyanide, the exposure frequency (EF) is 1 event/day, while both the exposure period (EP) and averaging period (AP) are 1 day.

Notes
Pathway specific (ing =ingestion, derm=dermal, inh=inhalation)
see Table RS-7
Pathway specific
Pathway specific (ing =ingestion, derm=dermal, inh=inhalation)
see Table RS-7
Pathway specific
See Table RS-7; $(mg_{OHM}/mg_{plant})/(mg_{OHM}/mg_{soil})^{-1}$
MADEP. 2002. Technical Update: Calculation of an Enhanced Soil Ingestion Rate.
(http://www.mass.gov/dep/ors/orspubs.htm)
Ibid
Ibid
Ibid
see Table RS-6
see Table RS-6
Ibid
Ibid
5 days/week
5 days/week, 30 weeks/year
5 days/week, 30 weeks/year
30 weeks
MADEP. 1995. Guidance for Disposal Site Risk Characterization. Page 5-5.
U.S. EPA. 1997. Exposure Factors Handbook. Table 7-7, females.
Ibid
Ibid
Ibid
30 weeks
MADEP. 1995. Guidance for Disposal Site Risk Characterization. Page 5-5.
50th percentile of face (1/3 head), forearms, hands, lower legs, and feet for females
MADEP. 1995. Guidance for Disposal Site Risk Characterization. Appendix Table B-2.
Ibid
Ibid
Ibid
All SAFs developed for ShortForm according to procedure outlined in MA DEP Technical Update:
Weighted Skin-Soil Adherence Factors, April 2002

of Food Intakes by Individuals (USDA). Data for both
sented in the survey represent the arithmetic average of
ume the produce item was assigned a rate of 0 g/day). To
nd nonconsumers) was divided by the percentage of
the total produce ingestion rate for each age-group and

ingestion rate from the survey
mber of years spent in the
of produce ingested was home-grown (Table RS-6C).

		Deep-yellow vegetables		
	estion e for umers (ww)	Ingestion Rate for All g/d (ww)	% of individuals that consumed item.	Ingestion Rate for Consumers g/d (ww)
	9.4	5	12.7	39.4
	6.9	7	12.7	55.1
	5.9	2	8.5	23.5
	7.0	11	15.8	69.6
	0.1	4	5.7	70.2

		Green Beans		
	estion e for umers (ww)	Ingestion Rate for All g/d (ww)	% of individuals that consumed item.	Ingestion Rate for Consumers g/d (ww)
	6.7	7	12.1	57.9
	8.6	3	5.7	52.6
	3.7	1	2	50.0
	6.2	2	2.4	83.3
	0.8	4	3.7	108.1

Table RS-6A (continued)

Age-groups studied in survey	Corn, Green peas, Lima beans Ingestion Rate for All g/d (ww)	% of individuals that consumed item.	Ingestion Rate for Consumers g/d (ww)	Melons, berries Ingestion Rate for All g/d (ww)	% of individuals that consumed item.	Ingestion Rate for Consumers g/d (ww)	Totals Wet Weight WWI g/day	Totals Dry Weight DWI g/day
1-2	12	15	80.0	7	9	77.8	436.4	43.6
3-5	14	21.7	64.5	14	11.6	120.7	506.3	50.6
6-11	9	13.6	66.2	5	5.9	84.7	498.0	49.8
12-19	14	9.9	141.4	17	5	340.0	998.1	99.8
20-39	12	7.3	164.4	6	4.5	133.3	969.7	97.0

Table RS-6B

Age-groups studied in survey	Years spent in age-group for 1-8 year old	Years spent in age-group for 8-15 year old	Years spent in age-group for 15-31 year old
1-2	2		
3-5	3		
6-11	2	4	
12-19		3	4
20-39			12
	7	7	16

Table RS-6C

	Produce Intake, dry weight			
	Child 1-2 years g/day	Child 1-8 years g/day	Child 8-15 years g/day	Adult 15-31 g/day
All Produce:	43.6	48.4	71.2	97.7
Homegrown:	10.9	12.1	17.8	24.4

Soil: Table RS-7
Specific Data

Vlookup Version v0808

erial	CSF (mg/kg-day)$^{-1}$	$RAF_{c\text{-}ing}$	$RAF_{c\text{-}derm}$	$RAF_{c\text{-}prod}$	Chronic RfD mg/kg-day	Subchronic RfD mg/kg-day	Chronic $RAF_{nc\text{-}ing}$	Chronic $RAF_{nc\text{-}derm}$	Subchronic $RAF_{nc\text{-}ing}$	Subchronic $RAF_{nc\text{-}derm}$	$RAF_{nc\text{-}prod}$	PUF
C12	0.0E+00	0.00	0.00	0.00	1.0E-01	1.0E+00	1	0.5	1	0.5	0	0
	0.0E+00	0.00	0.00	0.00	0.0E+00	0.0E+00	0	0	0	0	0	0
C18	0.0E+00	0.00	0.00	0.00	1.0E-01	1.0E+00	1	0.5	1	0.5	0	0
C36	0.0E+00	0.00	0.00	0.00	2.0E+00	6.0E+00	1	0.1	1	0.1	0	0
	0.0E+00	0.00	0.00	0.00	0.0E+00	0.0E+00	0	0	0	0	0	0
ne, 2-	0.0E+00	0.00	0.00	0.00	4.0E-03	4.0E-03	0.36	0.1	0.36	0.1	0	0
racene	7.3E+00	0.28	0.02	0.00	3.0E-02	3.0E-01	0.28	0.02	0.28	0.02	0	0
	0.0E+00	0.00	0.00	0.00	0.0E+00	0.0E+00	0	0	0	0	0	0
	0.0E+00	0.00	0.00	0.00	1.0E+00	1.0E+00	1	0.1	1	0.1	0	0
	0.0E+00	0.00	0.00	0.00	4.0E-04	4.0E-04	1	0.1	1	0.1	0	0
	0.0E+00	0.00	0.00	0.00	2.0E-01	7.0E-02	1	0.05	1	0.05	0	0
	0.0E+00	0.00	0.00	0.00	2.0E-03	5.0E-03	1	0.03	1	0.03	0	0
	0.0E+00	0.00	0.00	0.00	3.0E-03	2.0E-02	1	0.09	1	0.09	1	0.095
	0.0E+00	0.00	0.00	0.00	2.0E-02	2.0E-02	1	0.1	1	0.1	0	0
	0.0E+00	0.00	0.00	0.00	3.0E-02	3.0E-01	1	0.3	1	0.3	0	0
	0.0E+00	0.00	0.00	0.00	3.0E-01	3.0E-01	1	0.14	1	0.14	0	0
	0.0E+00	0.00	0.00	0.00	7.5E-04	7.5E-04	0.5	0.006	0.5	0.006	0.5	0.15
	0.0E+00	0.00	0.00	0.00	7.0E-02	7.0E-02	1	0.14	1	0.14	0	0
	0.0E+00	0.00	0.00	0.00	3.0E-04	3.0E-04	1	0.05	1	0.05	0	0
	0.0E+00	0.00	0.00	0.00	2.0E-02	2.0E-02	1	0.35	1	0.35	1	0.38
	0.0E+00	0.00	0.00	0.00	5.0E-03	5.0E-03	1	0.002	1	0.002	0	0
	0.0E+00	0.00	0.00	0.00	5.0E-03	5.0E-03	1	0.25	1	0.25	0	0
	0.0E+00	0.00	0.00	0.00	8.0E-05	8.0E-04	1	0.01	1	0.01	0	0
	0.0E+00	0.00	0.00	0.00	9.0E-03	9.0E-03	1	0.03	1	0.03	0	0
	0.0E+00	0.00	0.00	0.00	3.0E-01	3.0E-01	1	0.02	1	0.02	1	1.5

Method 3 Risk Assessment for Chemicals in Soil - Construction Worker Shortform 2008 (sf08cw)

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NC Eq	Table CW-3: Equations to calculate noncancer risks.
Exp	Table CW-4: Definitions and exposure factors.
Chem	Table CW-5: Chemical-specific data.

Spreadsheets designed by Andrew Friedmann, MassDEP

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ShortForm Version 08-08

Vlookup Version v0808

ELCR (all chemicals) = 9.5E-08
HI (all chemicals) = 1.2E+00

Construction Worker - Soil: Table CW-1 - 1095 Lakeview Ave
Exposure Point Concentration (EPC) and Risk
Based on Construction Worker 18-25 years of age

Do not insert or delete any rows
Click on empty cell below and select OHM using arrow.

Chemical Description	EPC	ELCR Inhalation Pulmonary	ELCR$_{total}$	Subchronic HQ$_{ing}$	HQ$_{derm}$	HQ$_{inh-GI}$	HQ$_{inh}$	HQ$_{total}$
Aliphatics C9 to C12	5.1E+00	0.0E+00	0.0E+00	6.3E-06	3.2E-05	1.6E-07	3.2E-07	3.8E-05
		0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Aliphatics C9 to C18	5.3E+01	0.0E+00	0.0E+00	6.5E-05	3.3E-04	1.7E-06	3.3E-06	4.0E-04
Aliphatics C19 to C36	2.5E+02	0.0E+00	0.0E+00	5.0E-05	5.1E-05	1.3E-06	0.0E+00	1.0E-04
Aromatics C11 to C22	8.5E+01	0.0E+00	0.0E+00	1.3E-04	3.5E-04	3.3E-06	6.3E-06	4.9E-04
		0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Methylnaphthalene, 2-	4.3E-01	0.0E+00	0.0E+00	4.8E-05	1.3E-04	1.2E-06	3.2E-08	1.8E-04
Dibenzo(a,h)anthracene	5.2E-01	9.3E-09	5.7E-09	6.0E-07	4.3E-07	1.5E-08	3.9E-08	1.1E-06
		0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Polychlorinated biphenyls (PCBs)	1.2E-01	1.9E-09	3.5E-09	2.6E-03	4.9E-03	6.8E-05	2.3E-04	7.8E-03
		0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Aluminum	1.1E+04	0.0E+00	0.0E+00	1.3E-02	1.3E-02	3.4E-04	0.0E+00	2.7E-02
Antimony	1.0E+00	0.0E+00	0.0E+00	3.1E-03	3.1E-03	8.0E-05	3.7E-06	6.2E-03
Barium	1.0E+03	0.0E+00	0.0E+00	1.8E-02	8.9E-03	4.6E-04	7.5E-03	3.5E-02
Beryllium	3.2E-01	0.0E+00	0.0E+00	7.9E-05	2.4E-05	2.0E-06	5.9E-04	7.0E-04
Chromium (total)	2.2E+01	0.0E+00	0.0E+00	1.4E-03	1.2E-03	3.5E-05	2.7E-03	5.4E-03
Cobalt	9.2E+00	0.0E+00	0.0E+00	5.7E-04	5.7E-04	1.5E-05	0.0E+00	1.2E-03
Copper	1.4E+03	0.0E+00	0.0E+00	5.9E-03	1.8E-02	1.5E-04	0.0E+00	2.4E-02
Iron	3.3E+04	0.0E+00	0.0E+00	1.4E-01	1.9E-01	3.5E-03	0.0E+00	3.3E-01
Lead	5.6E+02	0.0E+00	0.0E+00	4.6E-01	5.6E-02	1.2E-02	2.1E-02	5.5E-01
Manganese	2.4E+02	0.0E+00	0.0E+00	4.2E-03	5.9E-03	1.1E-04	1.8E-01	1.9E-01
Mercury	6.0E-01	0.0E+00	0.0E+00	2.4E-03	1.2E-03	6.3E-05	7.4E-05	3.8E-03
Nickel	1.6E+01	0.0E+00	0.0E+00	9.7E-04	3.4E-03	2.5E-05	5.9E-04	5.0E-03
Selenium	1.3E+00	0.0E+00	0.0E+00	3.2E-04	6.5E-06	8.3E-06	1.6E-05	3.5E-04
Silver	2.1E+00	0.0E+00	0.0E+00	5.1E-04	1.3E-03	1.3E-05	5.5E-04	2.4E-03
Thallium	1.3E+00	0.0E+00	0.0E+00	2.0E-03	2.0E-04	5.2E-05	3.5E-03	5.7E-03
Vanadium	2.8E+01	0.0E+00	0.0E+00	3.8E-03	1.2E-03	9.9E-05	1.0E-03	6.1E-03
Zinc	6.4E+02	0.0E+00	0.0E+00	2.6E-03	5.3E-04	6.8E-05	1.7E-02	2.0E-02

Construction Worker - Soil: Table CW-2
Equations to Calculate Cancer Risk for Construction Worker

#REF!

Cancer Risk from Ingestion

$$ELCR_{ing} = LADD_{ing} * CSF_{oral}$$

$$LADD_{ing} = \frac{EPC * IR * RAF_{c\text{-}ing} * EF * ED_{ing} * EP * CI}{BW * AP_{lifetime}}$$

Parameter	Value	Units
CSF	OHM-specific	$(mg/kg\text{-}day)^{-1}$
LADD	age/OHM-specific	mg/kg-day
EPC	OHM-specific	mg/kg
IR	100	mg/day
$RAF_{c\text{-}ing}$	OHM-specific	dimensionless

Cancer Risk from Dermal Absorption

$$ELCR_{dermal} = LADD_{dermal} * CSF_{oral}$$

$$LADD_{dermal} = \frac{EPC * SA * AF * RAF_{c\text{-}derm} * EF * ED_{derm} * EP * CI}{BW * AP_{lifetime}}$$

Cancer Risk from Particulate Inhalation - Gastrointestinal Absorption

$$ELCR_{inh\text{-}GI} = LADD_{inh\text{-}GI} * CSF_{oral}$$

$$LADD_{inh\text{-}GI} = \frac{EPC * RCAF_{inh\text{-}g} * PM_{10} * VR_{work} * RAF_{c\text{-}ing} * EF * ED_{inh} * EP * C2 * C3 * C4}{BW * AP_{lifetime}}$$

Cancer Risk from Particulate Inhalation - Pulmonary Absorption

$$ELCR_{inh} = LADD_{inh} * CSF_{inhalation}$$

$$LADD = \frac{EPC * RCAF_{inh} * PM_{10} * VR_{work} * RAF_{c\text{-}inh} * EF * ED_{inh} * EP * C2 * C3 * C4}{BW * AP_{lifetime}}$$

Construction Worker - Soil: Table CW-3
Equations to Calculate Noncancer Risk for Construction Worker

#REF!

Noncancer Risk from Ingestion

$$HQ_{ing} = \frac{ADD_{ing}}{RfD_{oral\text{-}subchronic}}$$

$$ADD_{ing} = \frac{EPC * IR * RAF_{nc\text{-}ing} * EF * ED_{ing} * EP * C1}{BW * AP_{noncancer}}$$

Noncancer Risk from Dermal Absorption

$$HQ_{derm} = \frac{ADD_{derm}}{}$$

Parameter	Value	Units
RfD	OHM-specific	mg/kg-day
ADD	OHM-specific	mg/kg-day
EPC	OHM-specific	mg/kg
IR	100	mg/day
$RAF_{nc\text{-}ing}$	OHM-specific	dimensionless
$RAF_{nc\text{-}derm}$	OHM-specific	dimensionless
$RAF_{nc\text{-}inh}$	OHM-specific	dimensionless
EF	0.714	event/day
$EF_{cyanide}$	1	event/day
$ED_{ing\ \&\ derm}$	1	day/event

[redacted]

ulmonary Absorption

$$\frac{VR_{work} * RAF_{nc\text{-}inh} * EF * ED_{inh} * EP * C2 * C3 * C4}{BW * AP_{noncancer}}$$

RCAF	1.7	dimensionless
$RCAF_{inh}$	100	dimensionless
PM10	60	10/10

Noncancer Risk from Particulate Inhalation - P

$$HQ_{inh} = \frac{ADD}{RfD_{inhalation\text{-}subchronic}}$$

$$ADD_{inh} = \frac{EPC_{soil} * RCAF_{inh} * PM_{10} *}{}$$

sk from a one-time exposure to concentrations that are often found in the environment. As such, risk
, for cyanide, the exposure frequency (EF) is 1 event/day, while both the exposure period (EP) and

Cyanide can cause a significant health ri
is calculated for a single exposure. Thus
averaging period (AP) are 1 day.

Construction Worker - Soil: Table CW-4
Definitions and Exposure Factors

#REF!

Parameter	Value	Units	Notes
ELCR - Excess Lifetime Cancer Risk	chemical specific	dimensionless	Pathway specific (ing =ingestion, derm=dermal, inh=inhalation)
HI - Hazard Index	chemical specific	dimensionless	Pathway specific (ing =ingestion, derm=dermal, inh=inhalation)
CSF - Cancer Slope Factor	chemical specific	$(mg/kg\text{-}day)^{-1}$	see Table CW-5.
RfD - Reference Dose	chemical specific	mg/kg-day	see Table CW-5.
LADD - Lifetime Average Daily Dose	chemical specific	mg/kg-day	Pathway specific. See Table CW-2.
ADD - Average Daily Dose	chemical specific	mg/kg-day	Pathway specific. See Table CW-3.
EPC - Exposure Point Concentration	chemical specific	µg/L	see Table CW-1
IR - Soil Ingestion Rate	100	mg/day	MADEP. 2002. Technical Update: Calculation of an Enhanced Soil [illegible]
RAF_c - Relative Absorption Factor for Cancer Effects	chemical specific	dimensionless	Pathway specific - see Table CW-5.
RAF_{nc} - Relative Absorption Factor for Noncancer Effects	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
ED_{inh} - Exposure Duration for inhalation exposure	0.333	day/event	Represents 8 hours / event.
EP - Exposure Period	182	days	6 months; MADEP 1995 Guidance for Disposal Site Risk Characterization.
$EP_{cyanide}$ - Exposure period for cyanide exposure	1	day	MADEP. 1995. Guidance for Disposal Site Risk Characterization. Page 5-5.
BW - Body Weight	58.0	kg	U.S. EPA. 1997. Exposure Factors Handbook. Table 7-7, Females, ages 18 - 25.
$AP_{(lifetime)}$ - Averaging Period for lifetime	25,550	days	Represents 70 years.
$AP_{(noncancer)}$ - Averaging Period for noncancer	182	days	6 months; MADEP 1995 Guidance for Disposal Site Risk Characterization.
$AP_{cyanide}$ - Averaging period for assessing cyanide exposure	1	day	MADEP. 1995. Guidance for Disposal Site Risk Characterization. Page 5-5.
AF - Adherence Factor	0.29	mg/cm^2	MA DEP. 2002 Technical Update: Weighted Skin-Soil Adherence Factors. (http://www.mass.gov/dep/ors/orspubs.htm)
VR_{work} - Ventilation Rate during work (heavy exertion)	60	L/min	Table B-4 MADEP 1995 Guidance for Disposal Site Risk Characterization.
SA - Surface Area	3473	cm^2/day	MADEP. 1995. Guidance for Disposal Site Risk Characterization. 50th percentile for females. Appendix Table B-2.
$RCAF_{inh\text{-}gi}$ - Relative Concentration Adjustment Factor, gastrointestinal	1.5	dimensionless	MADEP 2007. Characterization of Risks Due to Inhalation of Particulates by Construction Workers
$RCAF_{inh}$ - Relative Concentration Adjustment Factor, inhalation	0.3	dimensionless	MADEP 2002. Characterization of Risks Due to Inhalation of Particulates by Construction Workers
PM10 - Concentration of PM_{10}	60	$\mu g/m^3$	MADEP 1995 Guidance for Disposal Site Risk Characterization pg B-11

nstruction Worker - Soil: Table CW-5
emical-Specific Data

#REF!

r ardous Material	Oral CSF $(mg/kg\text{-}day)^{-1}$	$RAF_{c\text{-}ing}$	$RAF_{c\text{-}derm}$	$RAF_{c\text{-}inh}$	Inhalation CSF $(mg/kg\text{-}day)^{-1}$	Subchronic Oral RfD mg/kg-day	Subchronic $RAF_{nc\text{-}ing}$	Subchronic $RAF_{nc\text{-}derm}$	Subchronic $RAF_{nc\text{-}inh}$	Subchronic Inhalation RfD
atics C9 to C12	0.0E+00	0	0	0	0.0E+00	1.0E+00	1	0.5	1	1.7E-01
0	0.0E+00	0	0	0	0.0E+00	0.0E+00	0	0	0	0.0E+00
atics C9 to C18	0.0E+00	0	0	0	0.0E+00	1.0E+00	1	0.5	1	1.7E-01
atics C19 to C36	0.0E+00	0	0	0	0.0E+00	6.0E+00	1	0.1		0.0E+00
atics C11 to C22	0.0E+00	0	0	0	0.0E+00	3.0E-01	0.36	0.1	1	1.4E-01
0	0.0E+00	0	0	0	0.0E+00	0.0E+00	0	0	0	0.0E+00
ylnaphthalene, 2-	0.0E+00	0	0	0	0.0E+00	4.0E-03	0.36	0.1	1	1.4E-01
nzo(a,h)anthracene	7.300E+00	0.28	0.02	1.00	7.3E+00	3.0E-01	0.28	0.02	1	1.4E-01
0	0.0E+00	0	0	0	0.0E+00	0.0E+00	0	0	0	0.0E+00
chlorinated biphenyls (PCBs)	2.0E+00	0.85	0.16	1	3.5E-01	5.0E-05	0.85	0.16	1	5.7E-06
0	0.0E+00	0	0	0	0.0E+00	0.0E+00	0	0	0	0.0E+00
inum	0.0E+00	0	0	0	0.0E+00	1.0E+00	1	0.1	1	0.0E+00
nony	0.0E+00	0	0	0	0.0E+00	4.0E-04	1	0.1	1	2.9E-03
m	0.0E+00	0	0	0	0.0E+00	7.0E-02	1	0.05	1	1.4E-03
lium	0.0E+00	0	0	0	8.4E+00	5.0E-03	1	0.03	1	5.7E-06
mium (total)	0.0E+00	0	0	0	4.2E+01	2.0E-02	1	0.09	1	8.6E-05
lt	0.0E+00	0	0	0	0.0E+00	2.0E-02	1	0.1	1	0.0E+00
er	0.0E+00	0	0	0	0.0E+00	3.0E-01	1	0.3	1	0.0E+00
	0.0E+00	0	0	0	0.0E+00	3.0E-01	1	0.14	1	0.0E+00
	0.0E+00	0	0	0	0.0E+00	7.5E-04	0.5	0.006	1	2.9E-04
ganese	0.0E+00	0	0	0	0.0E+00	7.0E-02	1	0.14	1	1.4E-05
ury	0.0E+00	0	0	0	0.0E+00	3.0E-04	1	0.05	1	8.6E-05
el	0.0E+00	0	0	0	1.7E+00	2.0E-02	1	0.35	1	2.9E-04
ium	0.0E+00	0	0	0	0.0E+00	5.0E-03	1	0.002	1	8.6E-04
r	0.0E+00	0	0	0	0.0E+00	5.0E-03	1	0.25	1	4.0E-05
ium	0.0E+00	0	0	0	0.0E+00	8.0E-04	1	0.01	1	4.0E-06
dium	0.0E+00	0	0	0	0.0E+00	9.0E-03	1	0.03	1	2.9E-04
	0.0E+00	0	0	0	0.0E+00	3.0E-01	1	0.02	1	4.0E-04

APPENDIX B

SUPPLEMENTAL GROUNDWATER SAMPLING DOCUMENTATION AND LABORATORY REPORT

FIGURE 1.
AERIAL PHOTO AND SITE PLAN
59-67 MILL STREET
BROOKFIELD, MASSACHUSETTS

G:\Projects\HAZ\WASTE\60027781 MST\maps\Fig2-SiteVicinity.mxd

AES Advanced Environmental Solutions, Inc.

BORING LOG

Site:	Mill Street	Page 1 of 1				**Boring/Well #: AES-1**
	Brookfield, MA		**Feet BGS**			**Construction Material** / **Symbol**
		Riser	0	to	1.5	PVC
Date:	2/20/2009	Screen	1.5	to	6.5	20 Schedule Slotted Screen PVC
Client:	Metcalf and Eddy	Backfill		to		
Driller:	Drilex	Seal	0	to	1	
Inspector:	MvdB	Sandpack	1	to	10	Silica Sand

Depth (feet BGS)	Sample	Blow Counts per 6"	Recovery (feet)	Detail 1" Well	Soil Description	TVOCs (ppm/v)	TVOC depth (ft)
0-5		NA	3.5'		0.0'-0.8': Dark grey, fine to medium SAND, little Silt (organic material mixed in), dry. 0.8'-1.0': Red brick, dry. 1.0'-2.0': Brown, very fine to fine SAND, little Silt, moist. 2.1'-3.4': Light brown, fine to coarse SAND, trace Silt, moist. 3.4'-3.5': Greenish brown CLAY, wet.		
5-10			3.2'		0.0'-1.1': Brown, fine to coarse SAND, trace Silt, trace Gravel, wet. 1.1'-3.2' Greenish brown CLAY, wet.		
10-15					Bottom of boring @ 10'. Well set at 6.5' due to collapsed borehole.		
15-20							
20-25	2						
25-30							
30-35							
35-40							
40-45							
45-50							
50-55							

Miscellaneous Data		Portion	Percent			Sampling Protocol
Depth to Water (ft):	~3'	And	35	to	50	Method: Direct Push
Drilling Method:	Geoprobe	Some	20	to	35	Interval: Continuous
Drill Rig Model	Trackmounted 6610	Little	10	to	20	Sampler Size: 2" x 5' Acetate sleeve.

Total Borehole Depth: 10 Feet

AES Advanced Environmental Solutions, Inc.

BORING LOG

Site:	Mill Street	Page 1 of 1				**Boring/Well #: AES-2**
	Brookfield, MA		**Feet BGS**			**Construction Material** / **Symbol**
		Riser	0	to	2	PVC
Date:	2/20/2009	Screen	2	to	7	20 Schedule Slotted Screen PVC
Client:	Metcalf and Eddy	Backfill		to		
Driller:	Drilex	Seal	0	to	1	
Inspector:	MvdB	Sandpack	1	to	10	Silica Sand

Depth (feet BGS)	Sample	Blow Counts per 6"	Recovery (feet)	Detail 1" Well	Soil Description	TVOCs (ppm/v)	TVOC depth (ft)
0-5		NA	2'		0.0'-1.5': Dark brown, very fine to medium SAND, trace Silt, dry. 1.5'-1.6': Rock. 1.6'-2.0': Greenish brown CLAY, wet.		
5-10			4.2'		0.0'-4.2': Greenish brown CLAY, wet.		
10-15					Bottom of boring @ 10'. Well set at 7' due to collapsed borehole.		
15-20							
20-25	2						
25-30							
30-35							
35-40							
40-45							
45-50							
50-55							

Miscellaneous Data		Portion	Percent			Sampling Protocol
Depth to Water (ft):	~4'	And	35	to	50	Method: Direct Push
Drilling Method:	Geoprobe	Some	20	to	35	Interval: Continuous
Drill Rig Model	Trackmounted 6610	Little	10	to	20	Sampler Size: 2" x 5' Acetate sleeve.

Total Borehole Depth: 10 Feet

Figure 2. **Ground Water Sampling Log**

Project _____ **Site** _____ **Well No.** AES-5 **Date** 3/9/09

Well Depth ~10' **Screen Length** 5' **Well Diameter** 1" **Casing Type** PVC

Figure 2. **Ground Water Sampling Log**

Project Brookfield **Site** _____ **Well No.** AES-3 **Date** 3/10/09

Well Depth _____ **Screen Length** 5ft **Well Diameter** 1" **Casing Type** PVC

Figure 2. **Ground Water Sampling Log**

Project Brookfield **Site** _____ **Well No.** AES-1 **Date** 3-10-04

Well Depth ≈ 10' **Screen Length** 5' **Well Diameter** 1" **Casing Type** PVC

Sampling Device Geopump **Tubing type** 1/4" Teflon **Water Level** 2.28

Measuring Point TOC

Figure 2. **Ground Water Sampling Log**

Project _____ **Site** Brookfield **Well No.** AES-4 **Date** 3/10/09

Well Depth 9' **Screen Length** 4' **Well Diameter** 1" **Casing Type** pvc

Sampling Device geopump **Tubing type** 1/4" **Water Level** 5.85

Measuring Point _____ **Other Infor** start time 14:40

Sampling Personnel _____

Time	pH	Temp	Cond.	Dis.O_2	Turb.	~~[ ]Conc~~ ORP	DTW		Notes
14:50	6.60	6.19	0.306	5.35	1154.0	107.1	11.62		
Purged approx. 1.5 gallons returned to point of generation. Insufficient recharge.									

Type of Samples Collected

_____

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft: $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

sampled @ 15:15 for Pb.

2.45

Figure 2. **Ground Water Sampling Log**

Project Brookfield **Site** _____ **Well No.** AES-2 **Date** 3/9/09
Well Depth _____ **Screen Length** 5' **Well Diameter** 1" **Casing Type** PVC
Sampling Device Geopump **Tubing type** 1/4" Teflon **Water Level** _____
Measuring Point TOC **Other Infor** _____

Sampling Personnel Kelly A. Meiler

Time	pH	Temp	Cond.	Dis.O_2	Turb.	[ ]Conc	DTW		Notes
							4.40		

Type of Samples Collected Purged appx. 1 gallon. Stopped pump because there was to much air in tubing.

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft: $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

H_2O level appears to be stabalizing after pump stopped.

~~Well Sampled because of insufficient~~

0903117-02	Ground Water	AES-3
09		AES-4

CERTIFICATE OF ANALYSIS

Client Name: Advanced Environmental Solutions, Inc.
Client Project ID: Brookfield

ESS Laboratory Work Order: 0903117

Quality Control Data

Analyte	Result	MRL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Qualifier
3005A/6000/7000 Dissolved Metals										
Batch BC91012 - 3005A										
Blank										
Lead	ND	2.5	ug/L							
LCS										
Lead	10.9	2.5	ug/L	10.00		109	80-120			
LCS Dup										
Lead	10.4	2.5	ug/L	10.00		104	80-120	5	20	

ESS Laboratory
Division of Thielsch Engineering, Inc.
185 Frances Avenue, Cranston, RI 02910-2211
Tel. (401) 461-7181 Fax (401) 461-4486
www.essslaboratory.com

CHAIN OF CUSTODY

Page 1 of 1

Turn Time ___ Standard Other X 1-day
If faster than 5 days, prior approval by laboratory is required # ____

State where samples were collected from:
(MA) RI CT NH NJ NY ME Other ____

Is this project for any of the following:
MA-(MCP) Navy USACE Other ____

Reporting Limits: GW | JEL 3/11/09

ESS LAB PROJECT ID: 0903117

Electronic Deliverable X Yes ___ No
Format: Excel ___ Access X PDF ___ Other ____

Co. Name: Advanced Environ. Solutions
Contact Person: Michael Bingham
City: Worcester State: MA
Telephone #: 508 363-4882 Fax #:
Project #: 9002
Project Name (20 Char. or less): Brookfield
Address: 90 Madison ST
Zip: 01608 PO#:
Email Address: M.bingham@

ESS LAB Sample#	Date	Collection Time	COMP	GRAB	MATRIX	Sample Identification (20 Char. or less)	Pres Code	Number of Containers	Type of Containers	Dissolved Lead (GFAA 7421)
AES-1	3-10-09	13:07		X	GW			2		X
AES-3	3-10-09	15:10		X	GW			2		X
AES-4	3-10-09	15:15		X	GW			2		X
AES-5	3-10-09	15:20		X	GW			2		X
FB-1	3-10-09	15:20		X	GW			1		X

Write Required Analysis

Container Type: P-Poly G-Glass S-Sterile V-VOA

Matrix: S-Soil SD-Solid D-Sludge WW-Waste Water GW-Ground Water SW-Surface Water DW-Drinking Water O-Oil W-Wipes F-Filters

Cooler Present: ✓ Yes ___ No
Seals Intact: ___ Yes ___ No NA: ✓
Cooler Temp: 3.0°C

Internal Use Only
Pickup
Technicians ____

Preservation Code: 1- NP, 2- HCl, 3- H_2SO_4, 4- HNO_3, 5- NaOH, 6- MeOH, 7- Asorbic Acid, 8- ZnAct, 9- ____

Sampled by: MVDB, KAM

Comments: Please hold field-filtered samples until AES has reviewed results

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time
[signature]	3/10/09 16:35	[signature]	3/10/09 16:35	[signature]	3/10/09 17:40	[signature]	17:40
Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time

*By circling MA-MCP, client acknowledges samples were collected in accordance with MADEP CAM VII A.

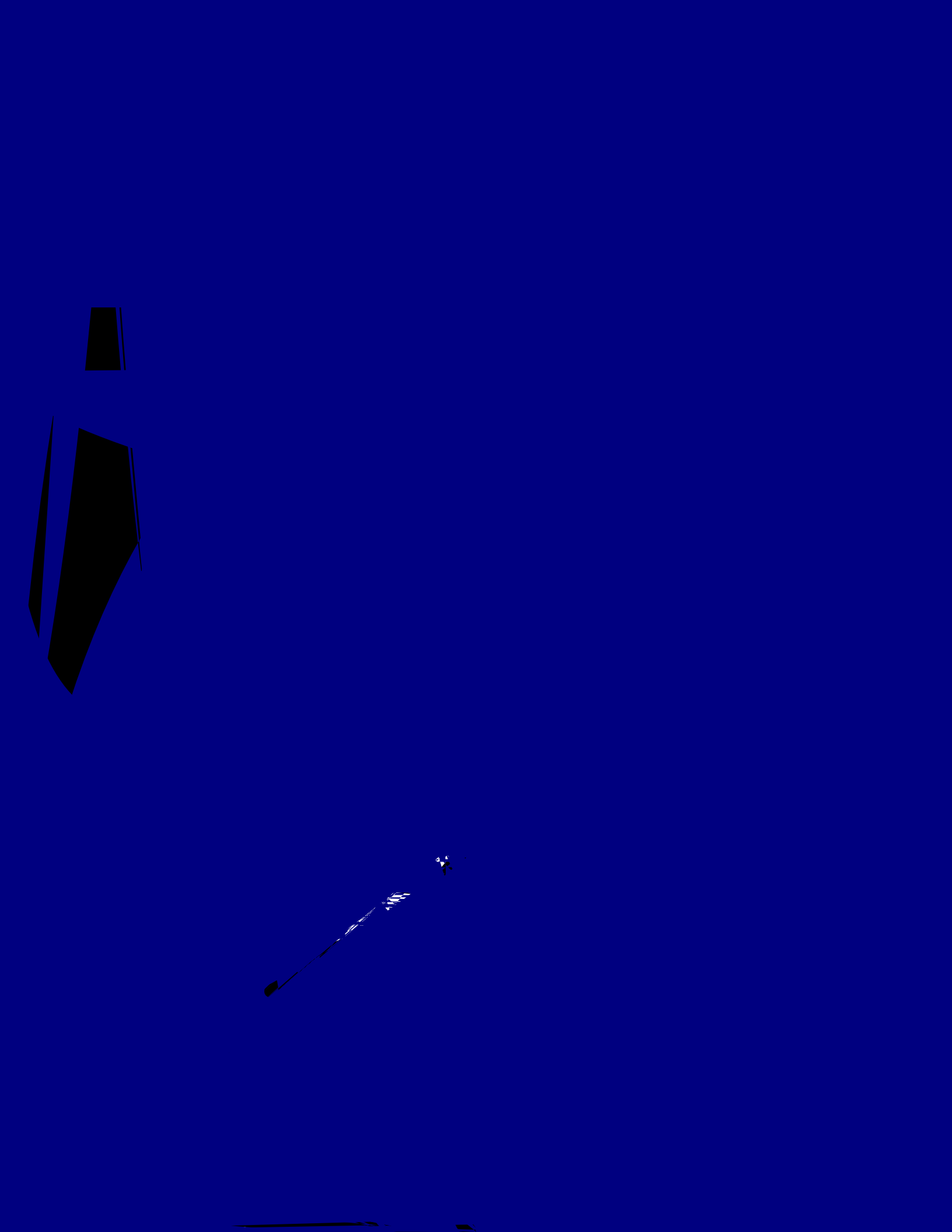
Please fax all changes to Chain of Custody in writing.

1 (White) Lab Copy 2 (Yellow) Client Receipt

10/26/04 A

APPENDIX C

ESTIMATED COSTS FOR REMEDIAL ALTERNATIVES



APPENDIX D

STATEMENT OF LIMITATIONS

MITATIONS

The data presented a n this report are

1. The sole purpose s report is to a characteristics of t esence or abs environment of oil ubstances as applicable state an and regulatio information regardi ental conditio

2. Advanced Environ ECOM Enviro derived the data in l inspections records in the publ duals with i Site, and a limited made o The passage of tim r occ require of

he t atten

4. The data re sed in the report are limite face exploration and oth quests of the Client, the time d the availability of acces

5. Because of the limit ns, and conclusions expressed by AES a should not be considered, an opinion concerni nt owner or operator of the site with any fed warranty or guarantee, whether express or reported or findings, observations, and c r, such data, findings observations, and c tions in existence at the time of investig