IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)
BH4	1	50	2		---	1.00 to 6.00	30 secs	-	-	-	-	0.3	0.0	20.1	0.0
BH4	1	50	2		---	1.00 to 6.00	60 secs	-	-	-	-	0.2	0.0	20.2	0.0
BH4	1	50	2		---	1.00 to 6.00	90 secs	-	-	-	-	0.2	0.0	20.2	0.0
BH4	1	50	2		---	1.00 to 6.00	120 secs	-	-	-	-	0.2	0.0	20.3	0.0
BH4	1	50	2		---	1.00 to 6.00	180 secs	-	-	-	-	0.1	0.0	20.3	0.0
BH4	1	50	2		---	1.00 to 6.00	240 secs	-	-	-	-	0.1	0.0	20.3	0.0
BH4	1	50	2		---	1.00 to 6.00	300 secs	-	-	-	-	0.1	0.0	20.3	0.0
BH4	1	50	2		6.07	1.00 to 6.00	360 secs	-	-	-	0.64	-	-	-	-
BH4	1	50	3	6.00	---	1.00 to 6.00	17/06/2014 11:50:00	1025	1025	$0.1_{(I)}$	-	-	-	-	-
BH4	1	50	3		---	1.00 to 6.00	30 secs	1025	1025	$0.0_{(SS)}$	-	-	-	-	-
BH4	1	50	3	6.00	---	1.00 to 6.00	17/06/2014 11:51:00	-	-	-	-	0.3	0.0	20.8	0.0
BH4	1	50	3		---	1.00 to 6.00	15 secs	-	-	-	-	0.4	0.0	20.7	0.0
BH4	1	50	3		---	1.00 to 6.00	30 secs	-	-	-	-	0.4	0.0	20.7	0.0
BH4	1	50	3		---	1.00 to 6.00	60 secs	-	-	-	-	0.4	0.0	20.7	0.0
BH4	1	50	3		---	1.00 to 6.00	90 secs	-	-	-	-	0.4	0.0	20.7	0.0
BH4	1	50	3		---	1.00 to 6.00	120 secs	-	-	-	-	0.4	0.0	20.7	0.0
BH4	1	50	3		---	1.00 to 6.00	180 secs	-	-	-	-	0.4	0.0	20.7	0.0
BH4	1	50	3		---	1.00 to 6.00	240 secs	-	-	-	-	0.4	0.0	20.5	0.0
BH4	1	50	3		---	1.00 to 6.00	300 secs	-	-	-	-	0.2	0.0	20.8	0.0
BH4	1	50	3		---	1.00 to 6.00	360 secs	-	-	-	-	0.2	0.0	20.8	0.0
BH4	1	50	3		---	1.00 to 6.00	420 secs	-	-	-	-	0.1	0.0	20.9	0.0
BH4	1	50	3		6.06	1.00 to 6.00	480 secs	-	-	-	0.72	-	-	-	-
BH4	1	50	4	6.00	---	1.00 to 6.00	26/06/2014 15:15:00	-	1010	$-0.1_{(I)}$	-	-	-	-	-
BH4	1	50	4		---	1.00 to 6.00	4 secs	-	1010	$0.0_{(SS)}$	-	-	-	-	-
BH4	1	50	4	6.00	---	1.00 to 6.00	26/06/2014 15:16:00	-	-	-	-	0.2	0.0	20.8	0.0

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

STRUCTURAL SOILS
The Old School
Stillhouse Lane
Bedminster
Bristol BS3 4EB

Compiled By	Date	Checked By	Date	Contract Ref:
	08/07/14		08/07/14	729381

Contract: **Grovefield Way, Cheltenham**

IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)
BH4	1	50	4		---	1.00 to 6.00	15 secs	-	-	-	-	0.3	0.0	20.7	0.0
BH4	1	50	4		---	1.00 to 6.00	30 secs	-	-	-	-	0.4	0.0	20.5	0.0
BH4	1	50	4		---	1.00 to 6.00	60 secs	-	-	-	-	0.6	0.0	20.4	0.0
BH4	1	50	4		---	1.00 to 6.00	90 secs	-	-	-	-	0.4	0.0	20.6	0.0
BH4	1	50	4		---	1.00 to 6.00	120 secs	-	-	-	-	0.2	0.0	20.7	0.0
BH4	1	50	4		---	1.00 to 6.00	180 secs	-	-	-	-	0.1	0.0	20.8	0.0
BH4	1	50	4		---	1.00 to 6.00	240 secs	-	-	-	-	0.1	0.0	20.8	0.0
BH4	1	50	4		---	1.00 to 6.00	300 secs	-	-	-	-	0.1	0.0	20.8	0.0
BH4	1	50	4		---	1.00 to 6.00	360 secs	-	-	-	-	0.1	0.0	20.8	0.0
BH4	1	50	4		---	1.00 to 6.00	420 secs	-	-	-	-	0.1	0.0	20.8	0.0
BH4	1	50	4		6.08	1.00 to 6.00	660 secs	-	-	-	0.89	-	-	-	-
BH5	1	50	2	6.00	---	2.50 to 6.00	13/06/2014 12:20:00	1023	1023	$0.1_{(I)}$	-	-	-	-	-
BH5	1	50	2		---	2.50 to 6.00	30 secs	1023	1023	$0.0_{(SS)}$	-	-	-	-	-
BH5	1	50	2	6.00	---	2.50 to 6.00	13/06/2014 12:21:00	-	-	-	-	0.0	0.0	20.5	0.0
BH5	1	50	2		---	2.50 to 6.00	15 secs	-	-	-	-	0.9	0.0	18.8	0.0
BH5	1	50	2		---	2.50 to 6.00	30 secs	-	-	-	-	0.8	0.0	18.7	0.0
BH5	1	50	2		---	2.50 to 6.00	60 secs	-	-	-	-	0.7	0.0	18.9	0.0
BH5	1	50	2		---	2.50 to 6.00	90 secs	-	-	-	-	0.6	0.0	19.2	0.0
BH5	1	50	2		---	2.50 to 6.00	120 secs	-	-	-	-	0.5	0.0	19.4	0.0
BH5	1	50	2		---	2.50 to 6.00	180 secs	-	-	-	-	0.4	0.0	19.5	0.0
BH5	1	50	2		---	2.50 to 6.00	240 secs	-	-	-	-	0.3	0.0	19.7	0.0
BH5	1	50	2		---	2.50 to 6.00	300 secs	-	-	-	-	0.3	0.0	19.7	0.0
BH5	1	50	2		---	2.50 to 6.00	360 secs	-	-	-	-	0.3	0.0	19.8	0.0
BH5	1	50	2		6.00	2.50 to 6.00	420 secs	-	-	-	0.69	-	-	-	-

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)
BH5	1	50	3	6.00	---	2.50 to 6.00	17/06/2014 11:00:00	1026	1026	$0.0_{(I)}$	-	-	-	-	-
BH5	1	50	3		---	2.50 to 6.00	30 secs	1026	1026	$0.0_{(SS)}$	-	-	-	-	-
BH5	1	50	3	6.00	---	2.50 to 6.00	17/06/2014 11:01:00	-	-	-	-	0.0	0.0	20.9	0.0
BH5	1	50	3		---	2.50 to 6.00	15 secs	-	-	-	-	1.6	0.0	20.4	0.0
BH5	1	50	3		---	2.50 to 6.00	30 secs	-	-	-	-	1.7	0.0	18.8	0.0
BH5	1	50	3		---	2.50 to 6.00	60 secs	-	-	-	-	1.0	0.0	19.5	0.0
BH5	1	50	3		---	2.50 to 6.00	90 secs	-	-	-	-	0.9	0.0	19.6	0.0
BH5	1	50	3		---	2.50 to 6.00	120 secs	-	-	-	-	0.8	0.0	19.7	0.0
BH5	1	50	3		---	2.50 to 6.00	180 secs	-	-	-	-	0.6	0.0	20.1	0.0
BH5	1	50	3		---	2.50 to 6.00	240 secs	-	-	-	-	0.4	0.0	20.4	0.0
BH5	1	50	3		---	2.50 to 6.00	300 secs	-	-	-	-	0.4	0.0	20.4	0.0
BH5	1	50	3		---	2.50 to 6.00	360 secs	-	-	-	-	0.4	0.0	20.4	0.0
BH5	1	50	3		---	2.50 to 6.00	420 secs	-	-	-	-	0.3	0.0	20.5	0.0
BH5	1	50	3		6.02	2.50 to 6.00	480 secs	-	-	-	0.77	-	-	-	-
BH5	1	50	4	6.00	---	2.50 to 6.00	26/06/2014 14:40:00	1010	1010	$0.0_{(I)}$	-	-	-	-	-
BH5	1	50	4		---	2.50 to 6.00	60 secs	1010	1010	$0.0_{(SS)}$	-	-	-	-	-
BH5	1	50	4	6.00	---	2.50 to 6.00	26/06/2014 14:42:00	-	-	-	-	0.0	0.0	20.8	0.0
BH5	1	50	4		---	2.50 to 6.00	15 secs	-	-	-	-	0.1	0.0	20.7	0.0
BH5	1	50	4		---	2.50 to 6.00	30 secs	-	-	-	-	0.1	0.0	20.6	0.0
BH5	1	50	4		---	2.50 to 6.00	60 secs	-	-	-	-	0.3	0.0	20.5	0.0
BH5	1	50	4		---	2.50 to 6.00	90 secs	-	-	-	-	0.6	0.0	20.5	0.0
BH5	1	50	4		---	2.50 to 6.00	120 secs	-	-	-	-	0.9	0.0	20.3	0.0
BH5	1	50	4		---	2.50 to 6.00	180 secs	-	-	-	-	0.8	0.0	20.3	0.0
BH5	1	50	4		---	2.50 to 6.00	240 secs	-	-	-	-	0.5	0.0	20.5	0.0
BH5	1	50	4		---	2.50 to 6.00	300 secs	-	-	-	-	0.4	0.0	20.6	0.0

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

STRUCTURAL SOILS
The Old School
Stillhouse Lane
Bedminster
Bristol BS3 4EB

Compiled By	Date	Checked By	Date	Contract Ref:
[signature]	08/07/14	[signature]	08/07/14	729381

Contract: **Grovefield Way, Cheltenham**

AGS

IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)
BH5	1	50	4		---	2.50 to 6.00	360 secs	-	-	-	-	0.3	0.0	20.7	0.0
BH5	1	50	4		---	2.50 to 6.00	420 secs	-	-	-	-	0.2	0.0	20.8	0.0
BH5	1	50	4		6.02	2.50 to 6.00	660 secs	-	-	-	0.86	-	-	-	-
BH7	1	50	1	5.00	---	2.00 to 5.00	03/06/2014 16:00:00	1007	1007	$0.0_{(I)}$	-	-	-	-	-
BH7	1	50	1		---	2.00 to 5.00	30 secs	1007	1007	$0.0_{(SS)}$	-	-	-	-	-
BH7	1	50	1	5.00	---	2.00 to 5.00	03/06/2014 16:01:00	-	-	-	-	0.0	0.0	20.9	0.0
BH7	1	50	1		---	2.00 to 5.00	15 secs	-	-	-	-	0.0	0.0	20.8	0.0
BH7	1	50	1		---	2.00 to 5.00	30 secs	-	-	-	-	0.0	0.0	20.8	0.0
BH7	1	50	1		---	2.00 to 5.00	60 secs	-	-	-	-	0.0	0.0	20.9	0.0
BH7	1	50	1		---	2.00 to 5.00	90 secs	-	-	-	-	0.0	0.0	20.8	0.0
BH7	1	50	1		---	2.00 to 5.00	120 secs	-	-	-	-	0.0	0.0	20.9	0.0
BH7	1	50	1		---	2.00 to 5.00	180 secs	-	-	-	-	0.0	0.0	20.9	0.0
BH7	1	50	1		---	2.00 to 5.00	240 secs	-	-	-	-	0.0	0.0	20.9	0.0
BH7	1	50	1		---	2.00 to 5.00	300 secs	-	-	-	-	0.0	0.0	20.9	0.0
BH7	1	50	1		---	2.00 to 5.00	360 secs	-	-	-	-	0.0	0.0	20.9	0.0
BH7	1	50	1		---	2.00 to 5.00	420 secs	-	-	-	-	0.0	0.0	20.9	0.0
BH7	1	50	1		3.99	2.00 to 5.00	480 secs	-	-	-	0.94	-	-	-	-
BH7	1	50	2	5.00	---	2.00 to 5.00	13/06/2014 12:41:00	1023	1023	$0.0_{(I)}$	-	-	-	-	-
BH7	1	50	2		---	2.00 to 5.00	30 secs	1023	1023	$0.0_{(SS)}$	-	-	-	-	-
BH7	1	50	2	5.00	---	2.00 to 5.00	13/06/2014 12:42:00	-	-	-	-	0.0	0.0	20.7	0.0
BH7	1	50	2		---	2.00 to 5.00	15 secs	-	-	-	-	1.6	0.0	17.7	0.0
BH7	1	50	2		---	2.00 to 5.00	30 secs	-	-	-	-	1.4	0.0	18.0	0.0
BH7	1	50	2		---	2.00 to 5.00	60 secs	-	-	-	-	0.8	0.0	19.5	0.0
BH7	1	50	2		---	2.00 to 5.00	90 secs	-	-	-	-	0.5	0.0	19.9	0.0

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)
BH7	1	50	2		---	2.00 to 5.00	120 secs	-	-	-	-	0.4	0.0	20.3	0.0
BH7	1	50	2		---	2.00 to 5.00	180 secs	-	-	-	-	0.2	0.0	20.7	0.0
BH7	1	50	2		---	2.00 to 5.00	240 secs	-	-	-	-	0.2	0.0	20.8	0.0
BH7	1	50	2		---	2.00 to 5.00	300 secs	-	-	-	-	0.1	0.0	20.9	0.0
BH7	1	50	2		---	2.00 to 5.00	360 secs	-	-	-	-	0.1	0.0	20.9	0.0
BH7	1	50	2		---	2.00 to 5.00	420 secs	-	-	-	-	0.1	0.0	20.9	0.0
BH7	1	50	2		3.96	2.00 to 5.00	480 secs	-	-	-	1.55	-	-	-	-
BH7	1	50	3	5.00	---	2.00 to 5.00	17/06/2014 11:30:00	1026	1026	$0.0_{(I)}$	-	-	-	-	-
BH7	1	50	3		---	2.00 to 5.00	30 secs	1026	1026	$0.0_{(SS)}$	-	-	-	-	-
BH7	1	50	3	5.00	---	2.00 to 5.00	17/06/2014 11:31:00	-	-	-	-	-	-	-	-
BH7	1	50	3		---	2.00 to 5.00	15 secs	-	-	-	-	1.7	0.0	19.6	0.0
BH7	1	50	3		---	2.00 to 5.00	30 secs	-	-	-	-	1.4	0.0	18.7	0.0
BH7	1	50	3		---	2.00 to 5.00	60 secs	-	-	-	-	0.5	0.0	20.2	0.0
BH7	1	50	3		---	2.00 to 5.00	90 secs	-	-	-	-	0.4	0.0	20.3	0.0
BH7	1	50	3		---	2.00 to 5.00	120 secs	-	-	-	-	0.3	0.0	20.4	0.0
BH7	1	50	3		---	2.00 to 5.00	180 secs	-	-	-	-	0.3	0.0	20.6	0.0
BH7	1	50	3		---	2.00 to 5.00	240 secs	-	-	-	-	0.2	0.0	20.6	0.0
BH7	1	50	3		---	2.00 to 5.00	300 secs	-	-	-	-	0.1	0.0	20.7	0.0
BH7	1	50	3		---	2.00 to 5.00	360 secs	-	-	-	-	0.1	0.0	20.8	0.0
BH7	1	50	3		---	2.00 to 5.00	420 secs	-	-	-	-	0.1	0.0	20.8	0.0
BH7	1	50	3		3.97	2.00 to 5.00	480 secs	-	-	-	1.66	-	-	-	-
BH7	1	50	3	5.00	---	2.00 to 5.00	18/06/2014 11:39:00	-	-	-	-	0.0	0.0	20.9	0.0
BH7	1	50	4	5.00	---	2.00 to 5.00	26/06/2014 14:50:00	-	1010	$0.0_{(I)}$	-	-	-	-	-
BH7	1	50	4		---	2.00 to 5.00	60 secs	-	1010	$0.0_{(SS)}$	-	-	-	-	-
BH7	1	50	4	5.00	---	2.00 to 5.00	26/06/2014 14:52:00	-	-	-	-	0.0	0.0	20.8	0.0

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

STRUCTURAL SOILS The Old School Stillhouse Lane Bedminster Bristol BS3 4EB	Compiled By	Date	Checked By	Date	Contract Ref: 729381
	[signature]	08/07/14	[signature]	08/07/14	
	Contract: Grovefield Way, Cheltenham				Page: 8 of 9

IN-SITU GAS MONITORING RESULTS

Exploratory Position ID	Pipe ref	Pipe diameter (mm)	Monitoring Round	Reported Installation Depth (m)	Measured Installation Depth (mbgl)	Response Zone	Date & Time of Monitoring (elapsed time)	Borehole Pressure (mb)	Atmos Pressure (mb)	Gas Flow (l/hr)	Water Depth (mbgl)	Carbon Dioxide (% / vol)	Methane (% / vol)	Oxygen (% / vol)	LEL (%)	
BH7	1	50	4		---	2.00 to 5.00	15 secs	-	-	-	-	1.9	0.0	20.1	0.0	
BH7	1	50	4		---	2.00 to 5.00	30 secs	-	-	-	-	2.0	0.0	19.5	0.0	
BH7	1	50	4		---	2.00 to 5.00	60 secs	-	-	-	-	1.8	0.0	19.6	0.0	
BH7	1	50	4		---	2.00 to 5.00	90 secs	-	-	-	-	1.6	1.0	19.7	0.0	
BH7	1	50	4		---	2.00 to 5.00	120 secs	-	-	-	-	1.3	0.0	19.8	0.0	
BH7	1	50	4		---	2.00 to 5.00	180 secs	-	-	-	-	1.2	0.0	19.9	0.0	
BH7	1	50	4		---	2.00 to 5.00	240 secs	-	-	-	-	0.9	0.0	20.2	0.0	
BH7	1	50	4		---	2.00 to 5.00	300 secs	-	-	-	-	0.9	0.0	20.4	0.0	
BH7	1	50	4		---	2.00 to 5.00	360 secs	-	-	-	-	0.6	0.0	20.5	0.0	
BH7	1	50	4		---	2.00 to 5.00	420 secs	-	-	-	-	0.2	0.0	20.7	0.0	
BH7	1	50	4		3.99	2.00 to 5.00	660 secs	-	-	-	1.65	-	-	-	-	

Key: I = Initial, P = Peak, SS = Steady State. Note: LEL = Lower Explosive Limit = 5% v/v.

STRUCTURAL SOILS
The Old School
Stillhouse Lane
Bedminster
Bristol BS3 4EB

Compiled By	Date	Checked By	Date	Contract Ref:
	08/07/14		**08/07/14**	**729381**

Contract: **Grovefield Way, Cheltenham**

Revised Wilson and Card Classification Ground Gas Risk Assessment

Job No.:	728391
Client:	Harris Cars plc
Site:	Cheltenham

For low-rise residential developments without a clear ventilated sub-floor void, flats and commercial / industrial sites

Characteristic Situation	Risk		GSV
1	Very Low		0.07
2	Low		0.7
3	Moderate		3.5
4	Moderate to High		15
5	High		70
6	Very High		>70

From CIRIA Report 659 (2006) "Assessing Risks Posed By Hazardous Ground Gases To Buildings", Wilson **et al.**

BH NO.	DATE	CH4 I %v/v		CO2 SS %v/v	Flow I l/hr	Flow SS l/hr	Baro mbar		GSV CH4	GSV CO2	CS No.	Water depth m	Remarks
BH1	21/08/2008	<0.1		2.0	0.1	0.1	1005-8	rising	0.00	0.00	CS1	dry	
	26/08/2008	0.1		1.7	0.0	0.0	1015-16	rising	0.00	0.00	CS1	5.76	
	02/09/2008	<0.1		2.0	0.0	0.0	993	falling	0.00	0.00	CS1	5.64	
	08/09/2008	<0.1		0.3	0.1	0.1	1006-7	falling	0.00	0.00	CS1	2.63	
	03/06/2014	<0.1		0.4	0.0	0.0	1007-6	falling	0.00	0.00	CS1	1.21	
	13/06/2014	<0.1		<0.1	0.0	0.0	1023	constant	0.00	0.00	CS1	1.21	
	17/06/2014	<0.1		<0.1	0.0	0.0	1026-5	falling	0.00	0.00	CS1	1.25	
	26/06/2014	<0.1		<0.1	0.1	0.0	1010	constant	0.00	0.00	CS1	1.26	
BH2	21/08/2008	<0.1		2.0	0.1	0.1			0.00	0.00	CS1	dry	
	26/08/2008	0.1		0.5	0.0	0.0			0.00	0.00	CS1	dry	
	02/09/2008	<0.1		2.3	0.0	0.0			0.00	0.00	CS1	4.18	
	08/09/2008	<0.1		0.4	3.7	0.1			0.00	0.00	CS1	0.23	Initial flow negative, lasted for 3 sec
	03/06/2014												
	13/06/2014												
	17/06/2014												
	26/06/2014												
BH4	21/08/2008	<0.1		2.1	0.1	0.1			0.00	0.00	CS1	dry	
	26/08/2008	0.3		1.9	0.1	0.0			0.00	0.00	CS1	dry	
	02/09/2008	<0.1		2.5	0.0	0.0			0.00	0.00	CS1	5.49	
	08/09/2008	<0.1		<0.1	4.5	0.1			0.00	0.00	CS1	0.24	Initial flow negative, lasted for 5 sec
	03/06/2014	<0.1		0.3	0.0	0.0			0.00	0.00	CS1	0.24	Test abandoned: water coming up pipe
	13/06/2014	<0.1		0.3	0.0	0.0			0.00	0.00	CS1	0.64	
	17/06/2014	<0.1		0.4	0.1	0.0			0.00	0.00	CS1	0.72	
	26/06/2014	<0.1		0.6	0.1	0.0			0.00	0.00	CS1	0.89	
BH5	21/08/2008	<0.1		2.3	0.1	0.1			0.00	0.00	CS1	5.75	
	26/08/2008	0.1		0.6	0.1	0.0			0.00	0.00	CS1	5.56	
	02/09/2008	<0.1		3.4	0.0	0.0			0.00	0.00	CS1	4.67	
	08/09/2008	<0.1		1.2	0.1	0.1			0.00	0.00	CS1	0.25	
	03/06/2014												BH not located on this date
	13/06/2014	<0.1		0.9	0.1	0.0			0.00	0.00		0.69	
	17/06/2014	<0.1		1.7	0.0	0.0			0.00	0.00	CS1	0.77	
	26/06/2014	<0.1		0.9	0.0	0.0			0.00	0.00	CS1	0.86	
BH7	21/08/2008	<0.1		1.7	0.1	0.1			0.00	0.00	CS1	2.89	
	26/08/2008	28.5		1.3	0.9	0.0			0.26	0.00	CS2	3.08	
	02/09/2008	<0.1		2.0	0.0	0.0			0.00	0.00	CS1	2.72	

Characteristic Situation	Risk		GSV
1	Very Low		0.07
2	Low		0.7
3	Moderate		3.5
4	Moderate to High		15
5	High		70
6	Very High		>70

From CIRIA Report 659 (2006) "Assessing Risks Posed By Hazardous Ground Gases To Buildings", Wilson et al.

BH NO.	DATE	CH4 I %v/v		CO2 SS %v/v	Flow I l/hr	Flow SS l/hr	Baro mbar		GSV CH4	GSV CO2	CS No.	Water depth m	Remarks
	08/09/2008	<0.1		0.2	**28.0**	**0.1**			**0.00**	**0.00**	**CS1**	**0.94**	Initial flow negative and over- range, lasted for 17sec Suction in BH
	03/06/2014	<0.1		<0.1	**0.0**	**0.0**			**0.00**	**0.00**	**CS1**	0.94	
	13/06/2014	<0.1		1.6	**0.0**	**0.0**			**0.00**	**0.00**	**CS1**	1.55	
	17/06/2014	<0.1		1.7	**0.0**	**0.0**			**0.00**	**0.00**	**CS1**	1.66	
	26/06/2014	<0.1		2.0	**0.0**	**0.0**			**0.00**	**0.00**	**CS1**	1.65	
BH8	21/08/2008	<0.1		2.1	**0.1**	**0.1**			**0.00**	**0.00**	**CS1**	2.55	
	26/08/2008	0.1		0.6	**0.0**	**0.0**			**0.00**	**0.00**	**CS1**	2.49	
	02/09/2008	<0.1		0.6	**21.3**	**0.0**			**0.00**	**0.00**	**CS1**	**0.19**	
	08/09/2008	<0.1		0.3	**28.0**	**0.1**			**0.00**	**0.00**	**CS1**	**0.43**	Initial flow negative and over- range, lasted for 6sec Suction in BH
	03/06/2014								**0.00**	**0.00**			
	13/06/2014								**0.00**	**0.00**			
	17/06/2014								**0.00**	**0.00**	**CS1**		
	26/06/2014								**0.00**	**0.00**	**CS1**		

WORST-CASE VALUES PER BOREHOLE

		Maximum CH4	Maximum CO2		Max Flow	Max Flow	Not Applicable		Maximum GSVs		CS No		
BH1		0.1		2.0	0.1	0.1			**0.00**	**0.00**	**CS1**		
BH2		0.1		2.3	3.7	0.1			**0.00**	**0.00**	**CS1**		
BH4		0.3		2.5	4.5	0.1			**0.01**	**0.00**	**CS1**		
BH5		0.1		3.4	0.1	0.1			**0.00**	**0.00**	**CS1**		
BH7		28.5		2.0	0.9	0.1			**0.26**	**0.00**	**CS2**	Over-range flows discounted since they are likely to have been due to water level change in the standpipes	
BH8		0.1		2.1	21.3	0.1			**0.02**	**0.00**	**CS1**		

Generic assessment criteria for human health: commercial scenario

The human health generic assessment criteria (GAC) have been developed during a period of regulatory review and updating of the Contaminated Land Exposure Assessment (CLEA) project. Therefore, the Environment Agency (EA) is in the process of publishing updated reports relating to the CLEA project and the GAC presented in this document may change to reflect these updates. This issue was prepared following the publication of soil guideline value (SGV) reports and associated publications[1] for mercury, selenium, benzene, toluene, ethylbenzene and xylene in March 2009, arsenic and nickel in May 2009, cadmium and phenol in June 2009, dioxins, furans and dioxin-like polychlorinated biphenyls (PCBs) in September 2009. It was also produced following publication of GAC by LQM[6]. Where available, the published soil guideline values (SGV)[1] were used as the GAC. The GAC for lead is discussed separately below owing to it not being derived using the same approach as other compounds.

Lead GAC derivation

The Environment Agency SGV and Tox reports for lead were withdrawn in 2009. In addition, the provisional tolerable weekly intake data published in the Netherlands was also withdrawn in 2010 owing to concerns that it was not suitably protective of human health. The withdrawn SGV was based on a target blood lead concentration 10 μg/dl. In the absence of current guidelines, many consultants have continued to use the withdrawn SGV. However, as this is not considered sufficiently protective of human health RSK has revised its GAC for lead and is currently undertaking a review of recent toxicological developments that will be used to refine this GAC further in the coming months.

Variable	Description of variable	Units	Value in SGV10	Revised value for RSK GAC
T	Health criteria value – reduced owing to concern that 10ug/dl may not be suitably protective of human health	ug/dl	10	5
G	Geometric standard deviation for B typically in range of 1.8 to 2.1	-	2.0	1.8
B	Geometric mean of blood lead concentration in adult women. The value used in SGV10 was based on UK data from 1995 from women in an urban area aged 16–44. Data in the US has shown decreases from between 1.7 and 2.2 to 1ug/dl between the late 1980s/early 1990s and late 1990s/early 2000s for adult females between 17 and 45 years old. Lead concentrations in blood are likely to be decreasing in the UK owing to a ban on lead in internal paint, a ban on lead in fuel and replacement of lead pipes for water supply	ug/dl	2.3	1.0
n	Selected on the basis of the degree of protection needed for a population at risk at the target concentration (T); the default value is 95%	-	1.645	1.645
$AT_{S, D}$	Averaging time assuming exposure over working lifetime. The value has been revised to reflect 49 years in accordance with CLEA commercial scenario outlined in SR3	days	15695	17885
BKSF	Biokinetic slope factor	ug/dl per ug/day	0.4	0.4
IR_S	Soil ingestion rate (including soil-derived indoor dust). This value has been revised to reflect the CLEA commercial scenario outlined in SR3	g/day	0.040	0.050
$AF_{S, D}$	Absorption fraction (same for soil and dust)	-	0.12	0.12
$EF_{S, D}$	Exposure frequency – based on CLEA commercial conceptual model	days/yr	230	230
ED	Exposure duration. This value has been revised to reflect CLEA commercial conceptual model outlined in SR3	years	43	49

The methodology utilised for the adult receptor is the Adult Lead Methodology used in the USA, which is a similar equation to that used in production of the UK SGV outlined in R&D publication SGV10. Parameters within the equation are presented below and have been updated to reflect:

- a revised and more health protective target blood level
- more recent US data pertaining to the geometric blood lead concentration, which indicates decreasing concentrations from 1988 to 2004
- more recent US data regarding the geometric standard deviation (the measure of inter-individual variability in blood lead concentrations within the adult population).

Although the update is based on US data, RSK considers that background blood levels in the UK will also be decreasing owing to lead pipes being replaced, lead no longer being used in fuel and lead paints being banned from internal use. Furthermore, RSK has run the equation with varying inputs to ascertain its sensitivity to certain parameters. Using the parameters outlined above RSK obtains a GAC of **600mg/kg** for an adult in a commercial setting. A similar value is obtained if all input parameters remain equal to those used in production of the former SGV but the soil ingestion rate is increased to reflect 50mg/day reported for the commercial scenario in SR3.

GAC derivation for other metals and organic compounds

Model selection

Soil assessment criteria (SAC) were calculated for compounds where SGV have not been published using CLEA v1.06 and the supporting UK guidance(1–6). Groundwater assessment criteria (GrAC) protective of human health via the inhalation pathway were derived using the RBCA 1.3b model. RSK has updated the inputs within RBCA to reflect the UK guidance(2–5). The SAC and GrAC collectively are termed GAC.

Pathway selection

In accordance with EA Science Report SC050221/SR3(3) the commercial scenario considers risks to a female worker who works from the age of 16 to 65 years. It should be noted that this end use is not suitable for a workplace nursery but also may be appropriate for a sport centre or shopping centre where children are present. In accordance with Box 3.5, SR3(3) the pathways considered for production of the SAC in the commercial scenario are:

- direct soil and dust ingestion
- dermal contact with soil both indoor and outdoors
- indoor air inhalation from soil and vapour and outdoor inhalation of soil and vapour.

Figure 1 is a conceptual model illustrating these linkages.

The pathway considered in production of the GrAC is the volatilisation of compounds from groundwater and subsequent vapour inhalation by workers while indoors. Figure 2 illustrates this linkage. Although the outdoor air inhalation pathway is also valid, this contributes little to the overall risks owing to the dilution in outdoor air.

Within RBCA, the solubility limit of the determinant restricts the extent of volatilisation, which in turn drives the indoor air inhalation pathway. While the same restriction is not built into the CLEA model, the model output cells are flagged red where the soil saturation limit has been exceeded.

An assumption used in the CLEA model is that of simple linear partitioning of a chemical in the soil between the sorbed, dissolved and vapour phase[(4)]. The upper boundaries of this partitioning are represented by the aqueous solubility and pure saturated vapour concentration of the chemical. The CLEA software uses a traffic light system to identify when individual and/or combined assessment criteria exceed the lower of either the aqueous-based or the vapour-based saturation limits. Where model output cells are flagged red the soil or vapour saturation limit has been exceeded and further consideration of the SAC to be used within the assessment is required. One approach that could be adopted is to use the ‘modelled’ solubility saturation limit or vapour saturation limit of the compound as the SAC. However, as stated within the CLEA handbook[(4)] this is likely to be impractical in many cases because of the very low solubility/vapour saturation limits and, in any case, is highly conservative. Unless free-phase product is present, concentrations of the chemical are unlikely to be present at sufficient concentration to result in an exceedance of the health criteria value (HCV).

RSK has adopted an approach for petroleum hydrocarbons in accordance with LQM/CIEH[(6)] whereby the concentration modelled for each petroleum hydrocarbon fraction has been tabulated as the SAC with the corresponding solubility or vapour saturation limits given in brackets. Therefore, when using the SAC to screen laboratory analysis the assessor should take note if a given SAC has a corresponding solubility saturation or vapour saturation limit (in brackets), and subsequently incorporate this information within the screening analytical discussion. If further assessment is required following this process then an additional approach can be utilised as detailed within Section 4.12 of the CLEA model handbook[(4)] which explains how to calculate an effective assessment criterion manually.

Input selection

Chemical data was obtained from EA Report SC050021/SR7[(5)] and the health criteria values (HCV) from the UK TOX[(1)] reports where available. For SAC for total petroleum hydrocarbons (TPH) and polycyclic aromatic hydrocarbons (PAH), toxicological and specific chemical parameters were obtained from the LQM/CIEH report[(6)]. Similarly, toxicological and specific chemical parameters for the volatile organic compound 1,2,4-trimethylbenzene were obtained from EIC/AGS/CL:AIRE[(7)].

For TPH, aromatic hydrocarbons C_5–C_8 were not modelled since benzene and toluene are being modelled separately. The aromatic C_8-C_9 hydrocarbon fraction comprises ethylbenzene, xylene and styrene. As ethylbenzene and xylene are being modelled separately, the physical, chemical and toxicological data for this band have been taken from styrene.

Owing to the lack of UK-specific data, default information in the RBCA model was used to evaluate methyl tertiary butyl ether (MTBE). No published UK data was available for 1,3,5-trimethylbenzene, so information was obtained from the US EPA as in the RBCA model. RBCA uses toxicity data for the inhalation pathway in different units to the CLEA model and cannot consider separately the mean daily intake (MDI), occupancy periods or breathing rates. Therefore, the HCV in RBCA was amended to take account of:

- an adult weighing 70kg and breathing 14.8m^3 air per day in accordance with the UK TOX reports[(2)] and SR3[(3)]
- the 50% rule (for petroleum hydrocarbons, trimethylbenzenes and MTBE)[(2)] where MDI data is not currently available but background exposure is considered important in the overall exposure.

Physical parameters

For the commercial end use, the CLEA default pre-1970s three-storey office building was used. SR3 notes this commercial building type to be the most conservative in terms of protection from vapour intrusion. The building parameters are outlined in Table 3.

The parameters for a sandy loam soil type were used in line with SR3[(3)]. This includes a value of 6% for the percentage of soil organic matter (SOM) within the soil. In RSK's experience, this is rather high for many sites. To avoid undertaking site-specific risk assessments for this parameter, RSK has produced an additional set of SAC for an SOM of 1% and 2.5%.

For the GrAC, the depth to groundwater was taken as 2.5m based on RSK's experience of assessing the volatilisation pathway from groundwater.

GAC

The SAC were produced using the input parameters in Tables 1, 2 and 3 and the GrAC using the input parameters in Table 4. The final selected GAC are presented by pathway in Table 5 with the combined GAC in Table 6.

Figure 1: Conceptual model for CLEA commercial scenario

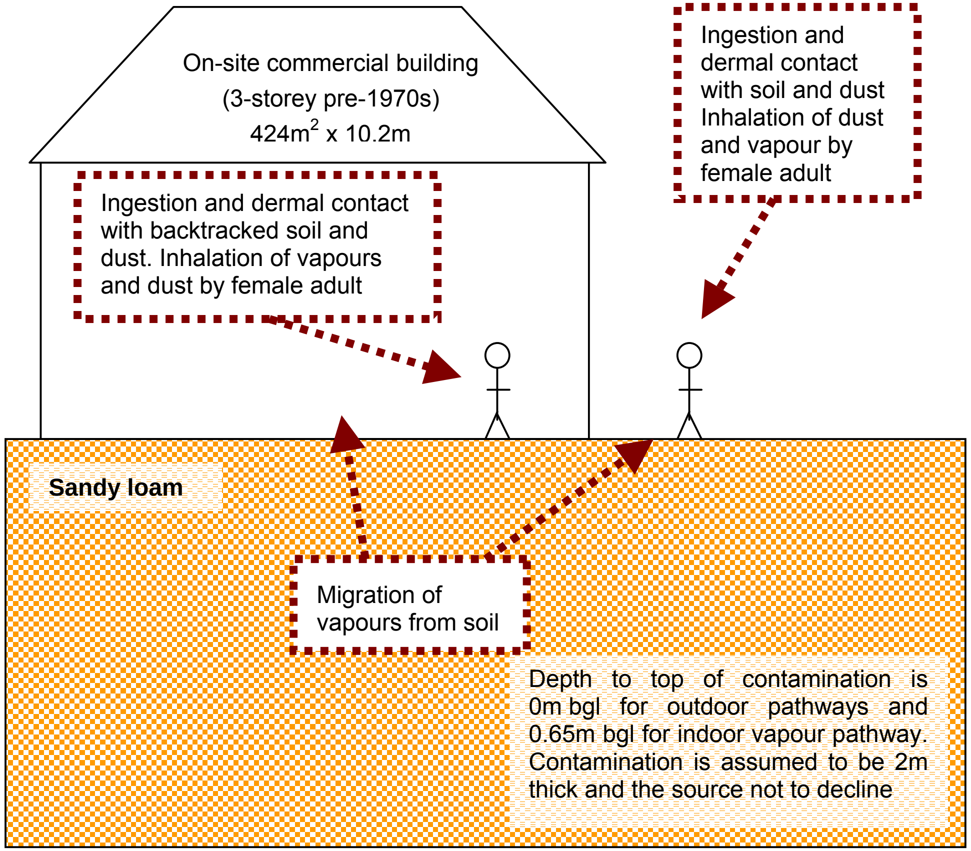

Table 1: Exposure assessment parameters for commercial scenario – inputs for CLEA model

Parameter	Value	Justification
Land use	Commercial	Chosen land use
Receptor	Female worker	Taken as female adult exposed over 49 years from age 16 to 65 years, Box 3.5, SR3[3]
Building	Office (pre-1970)	Key generic assumption given in Box 3.5, SR3[3]. Pre-1970s three-storey office building chosen as it is the most conservative in terms of protection from vapour intrusion (Section 3.4.6, SR3[3])
Soil type	Sandy loam	Most common UK soil type (Section 4.3.1, Table 4.4, SR3[3]). Table 4 presents soil-specific inputs
Start age class (AC)	17	AC corresponding to key generic assumption that the critical receptor is a working female adult exposed over a 49-year period from age 16 to 65 years. Assumption given in Box 3.5, SR3[3]. Data specific to AC exposure is presented in Table 2 and receptor specific in Table 3
End AC	17	
SOM (%)	6	Representative of sandy loam according to EA guidance note dated January 2009 entitled 'Changes We Have Made to the CLEA Framework Documents'[8]
	1	To provide SAC for sites where SOM < 6% as often observed by RSK
	2.5	
pH	7	Model default

Table 2: Commercial – receptor inputs for CLEA model

Parameter	Unit	Value	Justification
Exposure frequency (EF) (soil and dust ingestion)	day yr^{-1}	230	From Table 3.9, SR3[(3)]. The working week is assumed 45 hours including a 1-hour lunch break each day. Indoor and outdoor exposure are weighted by the frequency of time spent indoors and outdoors (8.3 hours a day and 0.7 hours a day respectively)
EF (dermal contact with dust. indoor)	day yr^{-1}	230	
EF (dermal contact with soil, outdoor)	day yr^{-1}	170	
EF (inhalation of dust and vapour, indoor)	day yr^{-1}	230	
EF (inhalation of dust and vapour, outdoor)	day yr^{-1}	170	
Occupancy period (indoor)	hr day^{-1}	8.3	Box 3.6, SR3[(3)]. Weighted average based on a nine-hour day including one-hour lunch being spent outside 75% of the year
Occupancy period (outdoor)	hr day^{-1}	0.7	
Soil to skin adherence factor (indoor and outdoor)	mg cm^{-2} day^{-1}	0.14	Table 8.1, SR3[(3)] for age class 17
Soil and dust ingestion rate	g day^{-1}	0.05	Table 6.2, SR3[(3)] for age class 17
Body weight	kg	70	Table 4.6, SR3[(3)] for female AC 17
Body height	m	1.6	Table 4.6, SR3[(3)] for female AC 17
Inhalation rate	m^3 day^{-1}	14.8	Table 4.14, SR3[(3)] for female AC 17
Max. exposed skin fraction (indoor and outdoors)	m^2 m^{-2}	0.08	Based on adult female assuming face and hands are exposed. Table 4.7, SR3[(3)]

Table 3: Commercial – soil, air and building inputs for CLEA model

Parameter	Unit	Value	Justification
Soil properties for sandy loam			
Porosity, total	$cm^3\ cm^{-3}$	0.53	Default soil type is sandy loam, Section 4.3.1, SR3(3). Parameters for sandy loam from Table 4.4, SR3(3)
Porosity, air filled	$cm^3\ cm^{-3}$	0.20	
Porosity, water filled	$cm^3\ cm^{-3}$	0.33	
Residual soil water content	$cm^3\ cm^{-3}$	0.12	
Saturated hydraulic conductivity	$cm\ s^{-1}$	0.00356	
van Genuchten shape parameter (*m*)	-	0.3201	
Bulk density	$g\ cm^{-3}$	1.21	
Threshold value of wind speed at 10m	$m\ s^{-1}$	7.20	Default value taken from Section 9.2.2, SR3(3)
Empirical function (F_x) for dust model	-	1.22	Value taken from Section 9.2.2, SR3(3)
Ambient soil temperature	K	283	Annual average soil temperature of UK surface soils. Section 4.3.1, SR3(3)
Air dispersion model			
Mean annual wind speed (10m)	$m\ s^{-1}$	5.0	Default value taken from Section 9.2.2, SR3(3)
Air dispersion factor at height of 1.6m	$g\ m^{-2}\ s^{-1}$ per $kg\ m^{-3}$	120	From Table 9.1, SR3. Values for a 2ha site, appropriate to a commercial land use in Newcastle (most representative city for UK, section 9.2.1,SR3(3))
Fraction of site with hard or vegetative cover	$m^2\ m^{-2}$	0.8	Section 3.4.6 and 9.2.2, SR3(3) for average office such as that used in the commercial scenario
Building properties for office (pre-1970) with ground-bearing floor slab			
Building footprint	m^2	424	From Table 3.10, SR3(3)
Living space air exchange rate	hr^{-1}	1.0	
Living space height (above ground)	m	9.6	
Living space height (below ground)	m	0.0	Assumed no basement.
Pressure difference (soil to enclosed space)	Pa	4.4	From Table 3.10, SR3(3)
Foundation thickness	m	0.15	

Parameter	Unit	Value	Justification
Floor crack area	m^2	0.165	
Dust loading factor	$\mu g\ m^{-3}$	100	Default value for a commercial site taken from Section 9.3, SR3(3)
Vapour model			
Default soil gas ingress rate	$cm^3\ s^{-1}$	150	Section 10.3, report SC050021/SR3(3)
Depth to top of source (beneath building for indoor exposure)	cm	50	Section 3.4.6, SR3(3) states source is 50cm below building or 65cm below ground surface
Depth to top of source (outdoors)	cm	0	Section 10.2, SR3(3) assumes impact from 0-1m for outdoor inhalation pathway
Thickness of contaminant layer	cm	200	Model default for indoor air, Section 4.9, SR4(4)
Time average period for surface emissions	years	49	Working lifetime from 16–65 years. Key generic assumption given in Box 3.5, SR3(3)
User-defined effective air permeability	cm^2	3.05E-08	Calculated for sandy loam using equations in Appendix 1, SR3(3)

Figure 2: GrAC conceptual model for RBCA commercial scenario

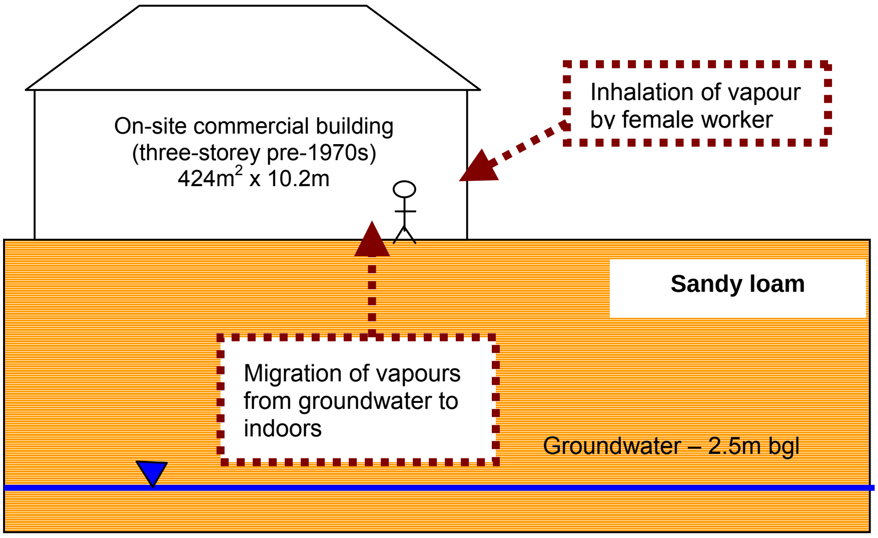

Table 4: Commercial – RBCA inputs

Parameter	Unit	Value	Justification
Receptor			
Averaging time	Years	49	From Box 3.5, SR3(3)
Receptor weight	kg	70	Female adult, Table 4.6, SR3(3)
Exposure duration	Years	49	From Box 3.5, SR3(3)
Exposure frequency	Days/yr	86.25	Weighted using occupancy period of 9 hours per day for 230 days of the year ((9hours x 230 days)/24 hours)
Soil type – sandy loam			
Total porosity	-	0.53	CLEA value for sandy loam. Parameters for sandy loam from Table 4.4, SR3(3)
Volumetric water content	-	0.33	
Volumetric air content	-	0.20	
Dry bulk density	g cm^{-3}	1.21	
Vertical hydraulic conductivity	cm s^{-1}	3.56E-3	CLEA value for saturated conductivity of sandy loam, Table 4.4, SR3(3)
Vapour permeability	m^2	3.05E-12	Calculated for sandy loam using equations in Appendix 1, SR3(3)
Capillary zone	m	0.1	Professional judgement

Parameter	Unit	Value	Justification
thickness			
Building			
Building volume/area ratio	m	9.6	Table 3.10, SR3[3]
Foundation area	m^2	424	Table 3.10, SR3[3]
Foundation perimeter	m	82.40	Based on square root of building area being 20.59m
Building air exchange rate	d^{-1}	24	Table 3.10, SR3[3]
Depth to bottom of foundation slab	m	0.15	
Foundation thickness	m	0.15	Table 3.10, SR3[3]
Foundation crack fraction	-	3.89E-04	Calculated from floor crack area of 0.165m^2 and building footprint of 424m^2 in Table 4.21, SR3[3]
Volumetric water content of cracks	-	0.33	Assumed equal to underlying soil type in assumption that cracks become filled with soil over time. Parameters for sandy loam from Table 4.4, SR3[3]
Volumetric air content of cracks	-	0.2	
Indoor/outdoor differential pressure	Pa	4.4	From Table 3.10, SR3[3]

References

1. Environment Agency (2009), 'Science Report SC050021/benzene SGV, toluene SGV, ethylbenzene SGV, xylene SGV, mercury SGV, selenium SGV, nickel SGV, arsenic SGV, cadmium SGV, phenol SGV, dioxins, furans and dioxin like PCBs SGVs', 'Supplementary information for the derivation of SGV for: benzene, toluene, ethylbenzene, xylene, mercury, selenium, nickel, arsenic, cadmium, phenol, dioxins, furans and dioxin- like PCBs', and 'Contaminants in soil: updated collation of toxicological data and intake values for humans: benzene, toluene, ethylbenzene, xylene, mercury, selenium, nickel, arsenic, cadmium, phenol, dioxins, furans and dioxin- like PCBs', March 2009, May 2009 and September 2009.

2. Environment Agency (2009), *Human health toxicological assessment of contaminants in soil. Science Report – Final SC050021/SR2*, January (Bristol: Environment Agency).

3. Environment Agency (2009), *Science Report – SC050021/SR3. Updated technical background to the CLEA model* (Bristol: Environment Agency).

4. Environment Agency (2009), Contaminated Land Exposure Assessment (CLEA) software, version 1.06.

5. Environment Agency (2008), *Science Report SC050021/SR7. Compilation of Data for Priority Organic Pollutants for Derivation of Soil Guideline Values* (Bristol: Environment Agency).

6. Chartered Institute for Environmental Health and Land Quality Management (2009), 'The LQM/CIEH Generic Assessment Criteria for Human Health', second edition.

7. CL:AIRE (2009), *Soil Generic Assessment Criteria for Human Health Risk Assessment* (London: CL:AIRE).

8. Changes made to the CLEA framework documents after the three-month evaluation period in 2008, released January 2009 by the Environment Agency.

GENERIC ASSESSMENT CRITERIA FOR HUMAN HEALTH - COMMERCIAL

Table 5

Human health generic assessment criteria by pathway for commercial scenario

Compound	Notes	GrAC	SAC appropriate to pathway SOM 1% (mg/kg)			Soil saturation limit	SAC appropriate to pathway SOM 2.5% (mg/kg)			Soil saturation limit	SAC appropriate to pathway SOM 6% (mg/kg)			Soil saturation limit (mg/kg)
Compound	Notes	(mg/l)	Oral	Inhalation	Combined	(mg/kg)	Oral	Inhalation	Combined	(mg/kg)	Oral	Inhalation	Combined	
Metals														
Arsenic	(b)(c)	-	6.35E+02	6.95E+02	-	NR	6.35E+02	6.95E+02	-	NR	6.35E+02	6.95E+02	-	NR
Cadmium	(b)	-	3.99E+02	3.87E+02	2.30E+02	NR	3.99E+02	3.87E+02	2.30E+02	NR	3.99E+02	3.87E+02	2.30E+02	NR
Chromium (III) - oxide		-	3.31E+05	3.34E+04	3.04E+04	NR	3.31E+05	3.34E+04	3.04E+04	NR	3.31E+05	3.34E+04	3.04E+04	NR
Chromium (VI) - hexavalent		-	2.01E+03	3.48E+01	3.42E+01	NR	2.01E+03	3.48E+01	3.42E+01	NR	2.01E+03	3.48E+01	3.42E+01	NR
Copper		-	1.78E+05	9.60E+04	7.17E+04	NR	1.78E+05	9.60E+04	7.17E+04	NR	1.78E+05	9.60E+04	7.17E+04	NR
Lead	(a)	-	6.00E+02	-	-	NR	6.00E+02	-	-		6.00E+02	-	-	NR
Elemental mercury (Hg^0)	(b)(d)	5.60E-02	-	1.84E+01	-	4.31E+00	-	4.57E+01	-	1.07E+01	-	1.09E+02	-	2.58E+01
Inorganic mercury (Hg^{2+})	(b)	-	4.41E+03	2.09E+04	3.64E+03	NR	4.41E+03	2.09E+04	3.64E+03		4.41E+03	2.09E+04	3.64E+03	NR
Methyl mercury (Hg^{4+})	(b)	1.00E+02	4.25E+02	2.73E+03	3.68E+02	7.33E+01	4.25E+02	4.97E+03	3.91E+02	1.42E+02	4.25E+02	9.41E+03	4.07E+02	3.04E+02
Nickel	(b)	-	2.22E+04	1.79E+03	-	NR	2.22E+04	1.79E+03	-	NR	2.22E+04	1.79E+03	-	NR
Selenium	(b)(c)	-	1.30E+04	-	-	NR	1.30E+04	-	-	NR	1.30E+04	-	-	NR
Zinc	(c)	-	6.67E+05	2.09E+08	-	NR	6.67E+05	2.09E+08	-	NR	6.67E+05	2.09E+08	-	NR
Cyanide		-	1.69E+04	1.95E+03	1.81E+03	NR	1.69E+04	1.95E+03	1.81E+03	NR	1.69E+04	1.95E+03	1.81E+03	NR
Volatile organic compounds														
Benzene	(b)	1.40E+02	5.53E+02	2.96E+01	2.81E+01	1.22E+03	5.53E+02	5.51E+01	5.01E+01	2.26E+03	5.53E+02	1.14E+02	9.47E+01	4.71E+03
Toluene	(b)	5.90E+02	4.25E+05	6.85E+04	5.90E+04	8.69E+02	4.25E+05	1.51E+05	1.11E+05	1.92E+03	4.25E+05	3.42E+05	1.89E+05	4.36E+03
Ethylbenzene	(b)	1.80E+02	1.91E+05	1.84E+04	1.68E+04	5.18E+02	1.91E+05	4.31E+04	3.51E+04	1.22E+03	1.91E+05	1.00E+05	6.57E+04	2.84E+03
Xylene - m	(b)	2.00E+02	3.43E+05	6.59E+03	6.46E+03	6.25E+02	3.43E+05	1.55E+04	1.48E+04	1.47E+03	3.43E+05	3.61E+04	3.27E+04	3.46E+03
Xylene - o	(b)	1.70E+02	3.43E+05	7.08E+03	6.94E+03	4.78E+02	3.43E+05	1.65E+04	1.58E+04	1.12E+03	3.43E+05	3.84E+04	3.46E+04	2.62E+03
Xylene - p	(b)	2.00E+02	3.43E+05	6.34E+03	6.22E+03	5.76E+02	3.43E+05	1.48E+04	1.42E+04	1.35E+03	3.43E+05	3.45E+04	3.14E+04	3.17E+03
Total xylene		2.00E+02	3.43E+05	6.59E+03	6.46E+03	6.25E+02	3.43E+05	1.55E+04	1.48E+04	1.47E+03	3.43E+05	3.61E+04	3.27E+04	3.46E+03
Methyl tertiary butyl ether (MTBE)		4.80E+04	9.53E+03	2.09E+04	8.21E+03	1.66E+04	9.53E+03	2.72E+04	8.55E+03	2.16E+04	9.53E+03	4.18E+04	8.93E+03	3.34E+04
Trichloroethene		3.60E+01	9.92E+03	1.19E+01	1.19E+01	1.54E+03	9.92E+03	2.49E+01	2.49E+01	3.22E+03	9.92E+03	5.54E+01	5.50E+01	7.14E+03
Tetrachloroethene		2.30E+02	2.65E+04	1.31E+02	1.31E+02	4.24E+02	2.65E+04	2.94E+02	2.91E+02	9.51E+02	2.65E+04	6.75E+02	6.58E+02	2.18E+03
1,1,1-Trichloroethane		1.30E+03	1.14E+06	7.01E+02	7.00E+02	1.43E+03	1.14E+06	1.43E+03	1.43E+03	2.92E+03	1.14E+06	3.14E+03	3.13E+03	6.39E+03
1,1,1,2 Tetrachloroethane		1.10E+03	1.10E+04	1.16E+02	1.15E+02	2.60E+03	1.10E+04	2.68E+02	2.62E+02	6.02E+03	1.10E+04	6.24E+02	5.91E+02	1.40E+04
1,1,2,2 Tetrachloroethane		1.10E+03	1.10E+04	2.98E+02	2.90E+02	2.67E+03	1.10E+04	6.10E+02	5.78E+02	5.46E+03	1.10E+04	1.34E+03	1.19E+03	1.20E+04
Carbon Tetrachloride (tetrachloromethane)		5.70E+00	2.70E+03	3.04E+00	3.04E+00	1.52E+03	2.70E+03	6.67E+00	6.65E+00	3.32E+03	2.70E+03	1.51E+01	1.50E+01	7.54E+03
1,2-Dichloroethane		6.10E+00	2.29E+02	7.14E-01	7.12E-01	3.41E+03	2.29E+02	1.03E+00	1.03E+00	4.91E+03	2.29E+02	1.77E+00	1.75E+00	8.43E+03
Vinyl Chloride (chloroethene)		4.10E-01	2.67E+01	6.31E-02	6.30E-02	1.36E+03	2.67E+01	8.16E-02	8.14E-02	1.76E+03	2.67E+01	1.25E-01	1.24E-01	2.69E+03
1,2,4-Trimethylbenzene		5.70E+01	-	4.17E+01	-	5.57E+02	-	9.89E+01	-	1.36E+03	-	2.19E+02	-	3.25E+03
1,3,5-Trimethylbenzene		3.80E+01	2.19E+04	4.71E+01	4.71E+01	9.47E+01	2.19E+04	1.12E+02	1.12E+02	2.26E+02	2.19E+04	2.63E+02	2.63E+02	5.33E+02
Semi-volatile organic compounds														
Acenaphthene		3.20E+00	1.10E+05	3.75E+05	8.49E+04	5.70E+01	1.10E+05	8.95E+05	9.77E+04	1.41E+02	1.10E+05	2.00E+06	1.04E+05	3.36E+02
Acenaphthylene		1.61E+01	1.10E+05	3.64E+05	8.43E+04	8.61E+01	1.10E+05	8.68E+05	9.74E+04	2.12E+02	1.10E+05	1.94E+06	1.04E+05	5.06E+02
Anthracene		2.10E-02	5.49E+05	1.19E+07	5.25E+05	1.17E+00	5.49E+05	2.49E+07	5.37E+05	2.91E+00	5.49E+05	4.38E+07	5.42E+05	6.96E+00
Benzo(a)anthracene		3.80E-03	2.52E+02	1.39E+02	8.95E+01	1.71E+00	2.52E+02	1.52E+02	9.48E+01	4.28E+00	2.52E+02	1.59E+02	9.74E+01	1.03E+01
Benzo(b)fluoranthene		2.00E-03	2.60E+02	1.63E+02	1.00E+02	1.22E+00	2.60E+02	1.67E+02	1.02E+02	3.04E+00	2.60E+02	1.69E+02	1.03E+02	7.29E+00
Benzo(g,h,i)perylene		2.60E-04	1.66E+03	1.08E+03	6.54E+02	1.54E-02	1.66E+03	1.09E+03	6.59E+02	3.85E-02	1.66E+03	1.10E+03	6.61E+02	9.23E-02
Benzo(k)fluoranthene		8.00E-04	3.66E+02	2.31E+02	1.41E+02	6.87E-01	3.66E+02	2.35E+02	1.43E+02	1.72E+00	3.66E+02	2.38E+02	1.44E+02	4.12E+00
Chrysene		2.00E-03	3.66E+02	2.20E+02	1.37E+02	4.40E-01	3.66E+02	2.29E+02	1.41E+02	1.10E+00	3.66E+02	2.34E+02	1.43E+02	2.64E+00
Dibenzo(a,h)anthracene		6.00E-04	3.29E+01	2.80E+01	1.27E+01	3.93E-03	3.29E+01	2.12E+01	1.29E+01	9.82E-03	3.29E+01	2.15E+01	1.30E+01	2.36E-02
Fluoranthene		2.30E-01	2.29E+04	2.01E+06	2.26E+04	1.89E+01	2.29E+04	2.89E+06	2.27E+04	4.73E+01	2.29E+04	3.52E+06	2.27E+04	1.13E+02
Fluorene		1.90E+00	7.31E+04	4.82E+05	6.35E+04	3.09E+01	7.31E+04	1.12E+06	6.87E+04	7.65E+01	7.31E+04	2.38E+06	7.10E+04	1.83E+02
Indeno(1,2,3-cd)pyrene		2.00E-04	1.57E+02	9.71E+01	6.00E+01	6.13E-02	1.57E+02	9.98E+01	6.11E+01	1.53E-01	1.57E+02	1.01E+02	6.17E+01	3.68E-01
Phenanthrene		5.30E-01	2.28E+04	5.67E+05	2.19E+04	3.60E+01	2.28E+04	1.16E+06	2.24E+04	8.96E+01	2.28E+04	1.98E+06	2.26E+04	2.14E+02
Pyrene		1.30E-01	5.49E+04	4.74E+06	5.42E+04	2.20E+00	5.49E+04	6.86E+06	5.44E+04	5.49E+00	5.49E+04	8.39E+06	5.45E+04	1.32E+01
Benzo(a)pyrene		3.80E-03	3.66E+01	2.30E+01	1.41E+01	9.11E-01	3.66E+01	2.35E+01	1.43E+01	2.28E+00	3.66E+01	2.38E+01	1.44E+01	5.46E+00
Naphthalene		1.90E+01	3.64E+04	2.05E+02	2.04E+02	7.64E+01	3.64E+04	4.90E+02	4.83E+02	1.83E+02	3.64E+04	1.15E+03	1.12E+03	4.32E+02
Phenol	(b)(e)	-	1.54E+06	3.16E+04	3.10E+04	4.16E+04	1.00E+06	3.57E+04	3.49E+04	8.15E+04	1.54E+06	3.85E+04	3.76E+04	1.74E+05
Total petroleum hydrocarbons														
Aliphatic hydrocarbons EC_5–EC_6		3.60E+01	4.77E+06	3.38E+03	3.39E+03	3.04E+02	4.77E+06	6.21E+03	6.21E+03	5.58E+02	4.77E+06	1.28E+04	1.28E+04	1.15E+03
Aliphatic hydrocarbons >EC_6–EC_8		5.40E+00	4.77E+06	8.26E+03	8.25E+03	1.44E+02	4.77E+06	1.84E+04	1.84E+04	3.22E+02	4.77E+06	4.21E+04	4.20E+04	7.36E+02
Aliphatic hydrocarbons >EC_8–EC_{10}		4.30E-01	9.53E+04	2.14E+03	2.13E+03	7.77E+01	9.53E+04	5.21E+03	5.14E+03	1.90E+02	9.53E+04	1.24E+04	1.19E+04	4.51E+02
Aliphatic hydrocarbons >EC_{10}–EC_{12}		3.40E-02	9.53E+04	1.06E+04	1.03E+04	4.75E+01	9.53E+04	2.62E+04	2.42E+04	1.18E+02	9.53E+04	6.25E+04	4.93E+04	2.83E+02

GENERIC ASSESSMENT CRITERIA FOR HUMAN HEALTH - COMMERCIAL

Table 5

Human health generic assessment criteria by pathway for commercial scenario

Compound	Notes	GrAC (mg/l)	SAC appropriate to pathway SOM 1% (mg/kg)			Soil saturation limit (mg/kg)	SAC appropriate to pathway SOM 2.5% (mg/kg)			Soil saturation limit (mg/kg)	SAC appropriate to pathway SOM 6% (mg/kg)			Soil saturation limit (mg/kg)
			Oral	Inhalation	Combined		Oral	Inhalation	Combined		Oral	Inhalation	Combined	
Aliphatic hydrocarbons $>EC_{12}–EC_{16}$		7.60E-04	9.53E+04	8.75E+04	6.08E+04	2.37E+01	9.53E+04	2.16E+05	8.26E+04	5.91E+01	9.53E+04	5.10E+05	9.50E+04	1.42E+02
Aliphatic hydrocarbons $>EC_{16}–EC_{35}$	(c)	-	1.59E+06	-	-	8.48E+00	1.76E+06	-	-	2.12E+01	1.83E+06	-	-	5.09E+01
Aliphatic hydrocarbons $>EC_{35}–EC_{44}$	(c)	-	1.59E+06	-	-	8.48E+00	1.76E+06	-	-	2.12E+01	1.83E+06	-	-	5.09E+01
Aromatic hydrocarbons $>EC_{8}–EC_{9}$ (styrene)		6.50E+01	1.14E+05	3.00E+04	2.77E+04	6.20E+02	1.14E+05	7.30E+04	5.81E+04	1.52E+03	1.14E+05	1.73E+05	9.00E+04	3.61E+03
Aromatic hydrocarbons $>EC_{9}–EC_{10}$		6.50E+01	3.81E+04	3.76E+03	3.67E+03	6.13E+02	3.81E+04	9.18E+03	8.56E+03	1.50E+03	3.81E+04	2.17E+04	1.78E+04	3.58E+03
Aromatic hydrocarbons $>EC_{10}–EC_{12}$		2.50E+01	3.81E+04	2.03E+04	1.69E+04	3.64E+02	3.81E+04	4.97E+04	2.85E+04	8.99E+02	3.81E+04	1.17E+05	3.45E+04	2.15E+03
Aromatic hydrocarbons $>EC_{12}–EC_{16}$	(c)	5.80E+00	3.81E+04	2.15E+05	3.63E+04	1.69E+02	3.81E+04	5.05E+05	3.74E+04	4.19E+02	3.81E+04	1.09E+06	3.78E+04	1.00E+03
Aromatic hydrocarbons $>EC_{16}–EC_{21}$	(c)	-	2.82E+04	-	-	5.37E+01	2.83E+04	-	-	1.34E+02	2.84E+04	-	-	3.21E+02
Aromatic hydrocarbons $>EC_{21}–EC_{35}$	(c)	-	2.84E+04	-	-	4.83E+00	2.84E+04	-	-	1.21E+01	2.84E+04	-	-	2.90E+01
Aromatic hydrocarbons $>EC_{35}–EC_{44}$	(c)	-	2.84E+04	-	-	4.83E+00	2.84E+04	-	-	1.21E+01	2.84E+04	-	-	2.90E+01

Notes:

'-' Generic assessment criteria not calculated owing to low volatility of substance and therefore no pathway or an absence of toxicological data.

NR - the compound is not volatile and therefore a soil saturation limit not calculated within CLEA

EC - equivalent carbon. GrAC - groundwater screening value. SAC - soil screening value.

The CLEA model output is colour coded depending upon whether the soil saturation limit has been exceeded.

(red hatched)	Calculated SAC exceeds soil saturation limit and may significantly affect the interpretation of any exceedances as the contribution of the indoor and outdoor vapour pathway to total exposure is >10%. This shading has also been used for the RBCA output where the theoretical solubility limit has been exceeded. The SAC has been set as the model calculated SAC with the saturation limits shown in brackets.
(orange)	Calculated SAC exceeds soil saturation limit but the exceedance will not affect the SAC significantly as the contribution of the indoor and outdoor vapour pathway to total exposure is <10%.
(green)	Calculated SAC does not exceed the soil saturation limit.

For consistency where the theoretical solubility limit within RBCA has been exceeded in production of the GrAC, these cellls have also been hatched red and the GrAC set at the solubility limit.

The SAC for organic compounds are dependent upon soil organic matter (SOM) (%) content. To obtain SOM from total organic carbon (TOC) (%) divide by 0.58; 1% SOM is 0.58% TOC. DL Rowell Soil Science: Methods and Applications, Longmans, 1994.

SAC for TPH fractions, polycyclic aromatic hydrocarbons, MTBE, BTEX and trimethylbenzene compounds were produced using an attenuation factor for the indoor air inhalation pathway of 10 to reduce conservatism associated with the vapour inhalation pathway, section 10.1.1, SR3

(a) RSK Lead GAC obtained following sensitivity analysis of blood lead concentrations.

(b) GAC taken from the Environment Agency SGV reports published 2009.

(c) SAC for selenium, aliphatic and aromatic hydrocarbons >EC16 does not include inhalation pathway owing to absence of toxicity data. SAC for arsenic is only based on oral contribution (rather than combined) owing to the relative small contribution from inhalation in accordance with the SGV report. The same approach has been adopted for zinc.

(d) SAC for elemental mercury, chromium VI and nickel is based on the inhalation pathway only owing to an absence of toxicity for elemental mercury, in accordance with the SGV report for nickel and LQM report for chromium VI.

(e) The GAC for phenol is based on a threshold which is protective of acute direct skin contact with phenol (the figure in brackets is based on health effects following long-term exposure and is provided for illustration only).

GENERIC ASSESSMENT CRITERIA FOR HUMAN HEALTH - COMMERCIAL

Table 6
Selected human health generic assessment criteria for commercial scenario

Compound	GrAC for groundwater (mg/l)	SAC for soil SOM 1% (mg/kg)	SAC for soil SOM 2.5% (mg/kg)	SAC for soil SOM 6% (mg/kg)
Metals				
Arsenic	-	640	640	640
Cadmium	-	230	230	230
Chromium (III) - oxide	-	30,000	30,000	30,000
Chromium (VI) - hexavalent	-	35	35	35
Copper	-	72,000	72,000	72,000
Lead	-	600	600	600
Elemental mercury (Hg^0)	0.056	18 (4.3)	46 (11)	110 (26)
Inorganic mercury (Hg^{2+})	-	3,600	3,600	3,600
Methyl mercury (Hg^{4+})	100	370 (73)	391	410
Nickel	-	1,800	1,800	1,800
Selenium	-	13,000	13,000	13,000
Zinc	-	670,000	670,000	670,000
Cyanide	-	1,800	1,800	1,800
Volatile organic compounds				
Benzene	140	28	50	95
Toluene	590	59,000 (870)	110,000 (1,900)	189,000 (4,400)
Ethylbenzene	180	17,000 (520)	35,000 (1,200)	65,700 (2,800)
Xylene - m	200	6,500 (620)	15,000 (1,500)	32,700 (3,500)
Xylene - o	170	6,900 (480)	16,000 (1,100)	34,600 (2,600)
Xylene - p	200	6,200 (580)	14,000 (1,400)	31,400 (3,200)
Total xylene	200	6,500 (630)	15,000 (1,500)	32,700 (3,500)
Methyl tertiary butyl ether (MTBE)	48,000	8,200	8,600	8,900
Trichloroethene	36	12	25	55
Tetrachloroethene	230	130	1,400	660
1,1,1-Trichloroethane	1,300	700	1,400	3,100
1,1,1,2 Tetrachloroethane	1,100	120	260	590
1,1,2,2 Tetrachloroethane	1,100	290	580	1,200
Carbon tetrachloride (tetrachloromethane)	5.7	3.0	6.7	15
1,2-Dichloroethane	6.1	0.71	1.0	1.8
Vinyl chloride (chloroethene)	0.41	0.063	0.08	0.12
1,2,4-Trimethylbenzene	57	42	99	220
1,3,5-Trimethylbenzene	38	47	110	260
Semi-volatile organic compounds				
Acenaphthene	3.2	85,000 (57)	98,000 (141)	100,000
Acenaphthylene	16	84,000 (86)	97,000 (212)	100,000
Anthracene	0.021	530,000	540,000	540,000
Benzo(a)anthracene	0.0038	90	95	97
Benzo(b)fluoranthene	0.0020	100	100	100
Benzo(g,h,i)perylene	0.00026	650	660	660
Benzo(k)fluoranthene	0.00080	140	140	140
Chrysene	0.0020	140	140	140
Dibenzo(a,h)anthracene	0.00060	13	13	13
Fluoranthene	0.23	23,000	23,000	23,000
Fluorene	1.9	64,000 (31)	69,000	71,000
Indeno(1,2,3-cd)pyrene	0.00020	60	61	62
Phenanthrene	0.53	22,000	22,000	23,000
Pyrene	0.13	54,000	54,000	55,000
Benzo(a)pyrene	0.0038	14	14	14
Naphthalene	19	200 (76)	480 (183)	1100 (432)
Phenol	-	3,200 * (31,000)	3,200* (35,000)	3,200 * (38,000)
Total petroleum hydrocarbons				
Aliphatic hydrocarbons EC_5–EC_6	36	3,400 (304)	6,200 (558)	13,000 (1,150)
Aliphatic hydrocarbons >EC_6–EC_8	5.4	8,300 (144)	18,000 (322)	42,000 (736)
Aliphatic hydrocarbons >EC_8–EC_{10}	0.43	2,100 (78)	5,100 (190)	12,000 (451)
Aliphatic hydrocarbons >EC_{10}–EC_{12}	0.034	10,000 (48)	24,000 (118)	49,000 (283)
Aliphatic hydrocarbons >EC_{12}–EC_{16}	0.00076	61,000 (24)	83,000 (59)	91,000 (142)
Aliphatic hydrocarbons >EC_{16}–EC_{35}	-	1,000,000**	1,000,000**	1,000,000**
Aliphatic hydrocarbons >EC_{35}–EC_{44}	-	1,000,000**	1,000,000**	1,000,000**
Aromatic hydrocarbons >EC_8–EC_9 (styrene)	65	28,000 (620)	58,000 (1,500)	90,000 (3,600)
Aromatic hydrocarbons >EC_9–EC_{10}	65	3,700 (610)	8,600 (1,500)	18,000 (3,600)
Aromatic hydrocarbons >EC_{10}–EC_{12}	25	17,000 (364)	29,000 (899)	35,000 (2,150)
Aromatic hydrocarbons >EC_{12}–EC_{16}	5.8	36,000 (169)	37,000	38,000
Aromatic hydrocarbons >EC_{16}–EC_{21}	-	28,000	28,000	28,000
Aromatic hydrocarbons >EC_{21}–EC_{35}	-	28,000	28,000	28,000
Aromatic hydrocarbons >EC_{35}–EC_{44}	-	28,000	28,000	28,000

Notes:

'-' Generic assessment criteria not calculated owing to low volatility of substance and therefore no pathway or an absence of toxicological data.

** Denotes SAC calculated exceeds 100% contaminant. Hence 100% taken as SAC.

EC - equivalent carbon. GrAC - groundwater assessment criteria. SAC - soil assessment criteria.

* The GAC for phenol is based on a threshold which is protective of direct skin contact with phenol (the figure in brackets is based on health effects following long-term exposure and is provided for illustration only).

The SAC for organic compounds are dependent on soil organic matter (SOM) (%) content. To obtain SOM from total organic carbon (TOC) (%) divide by 0.58; 1% SOM is 0.58% TOC. DL Rowell Soil Science: Methods and Applications, Longmans, 1994.

SAC for TPH fractions, polycyclic aromatic hydrocarbons, MTBE, BTEX and trimethylbenzene compounds were produced using an attenuation factor for the indoor air inhalation pathway of 10 to reduce conservatism associated with the vapour inhalation pathway, section 10.1.1, SR3.

(Shaded cells) The SAC has been set as the model calculated SAC with the saturation limit shown in brackets. For consistency where the GrAC exceeds the solubility limit, GrAC has been set at the solubility limit. The GrAC are highly conservative as concentrations of the chemical are very unlikely to be at sufficient concentration to result in an exceedance of the health criteria value at the point of exposure (i.e. indoor air) provided free-phase product is absent.

APPENDIX M
GENERIC ASSESSMENT CRITERIA FOR CONTROLLED WATERS

The water environment in England and Wales is protected under a number of regulatory regimes, many regulated by the Environment Agency. The Environment Agency is consulted where there may be a risk that pollution of 'controlled waters' may occur or may have occurred in the past. Controlled waters are coastal waters, inland freshwaters and groundwaters. The EU Water Framework Directive (WFD) (2000/60/EC) is implemented via various regulations and guidance, covering aspects of groundwater, surface water and drinking water supply policy. The regulations mainly apply to England and Wales, therefore if you are working on a site in Scotland or Northern Ireland, please review the equivalent legislation and guidance provided by the Scottish Environmental Protection Agency (SEPA) or the Northern Ireland Environment Agency (NIEA).

The main objectives of the protection and remediation of groundwater under threat from land contamination are set out in the Environment Agency's Groundwater Protection: Principles and Practice (GP3) series of documents(1). When assessing risks to groundwater the following need to be taken into consideration:

- Where pollutants have not yet entered groundwater, all necessary and reasonable measures must be taken to:
    - *Prevent the input of hazardous substances into groundwater (see description of hazardous substances below)*
    - *Limit the entry of other (non-hazardous) pollutants into groundwater so as to avoid pollution, and to avoid deterioration of the status of groundwater bodies or sustained, upward trends in pollutant concentration*
- Where hazardous substances or non-hazardous pollutants have already entered groundwater, the priority is to:
    - *Minimise further entry of hazardous substances and non-hazardous pollutants into groundwater*
    - *Take necessary and reasonable measures to limit the pollution of groundwater or impact on the status of the groundwater body from the future expansion of a contaminant 'plume', if necessary by actively reducing its extent.*

Definitions

Hazardous Substances are defined in the Water Framework Directive 2000/60/EC as 'substances or groups of substances that are toxic, persistent and liable to bio-accumulate, and other substances or groups of substances which give rise to an equivalent level of concern. All List 1 substances under the old Groundwater Directive (80/68/EEC) are hazardous substances, all radioactive substances are hazardous substances.

Non-hazardous Substances are defined as 'substances capable of causing pollution that have not been classified as hazardous substances'. The non-hazardous list of pollutants does not simply replace the old WFD List II but includes a wider range.

For the current list of classified substances please visit the UKTAG website www.wfduk.org./jagdag/

When assessing the risks to surface waters, various standards apply, including Environmental Quality Standards which are protective of the water ecology[14].

The Water Supply (Water Quality) Regulations[2,3] are the primary source for assessing water bodies which may be used for public water supplies. There are also Private Water Supply Regulations which may be applicable in some cases.

This appendix presents the generic assessment criteria (GAC) that RSK considers are suitable for assessing risks to controlled waters.

The RSK GAC for controlled waters are presented in Table 1. In line with the Environment Agency's (2006b) Remedial Targets Methodology, the GAC for controlled waters are termed 'target concentrations'.

The target concentration can be derived by several means with consideration to:

- whether the substance is classified as hazardous or non-hazardous by the EU under the Water Framework Directive (2000/60/EC) and Groundwater Daughter Directive (2006/118/EC) implemented though the Environmental Permitting Regulations 2010
- background concentrations in the aquifer
- published guidance such as Environmental Quality Standards that are protective of ecology or The Water Supply (Water Quality) Regulations 2010 that are protective of drinking water
- Minimum Reporting Values (or method detection limits if MRV are not provided).

Table 1: Target concentrations for Controlled Waters

Analytes in bold are hazardous, *analytes in italics are non hazardous*, analytes in plain text are unclassified; according to JAGDAG Determination List June 2010

Target Concentrations shaded in GREEN are Statutory Values ORANGE are Non-Statutory Values

Determinant	Target concentrations (mg/l)			
	Minimum Reporting Value	UK Drinking Water Standard or Best Equivalent	Environmental Quality Standard or Best Equivalent	
			Freshwater	Transitional (estuaries) and Coastal Waters
Metals				
Arsenic	-	0.01 (2)	0.05 (13a)	0.025 (13a)
Cadmium	0.0001 (4)	0.005 (2)	≤0.00008, 0.00008, 0.00009, 0.00015, 0.00025 (13b)	0.0002 (13c)
Chromium (total)	-	0.05 (2)	Use values for chromium III and VI	
Chromium (III)	-	Use value for total chromium	0.0047 (13a)	0.032 (13c)
Chromium (VI)			0.0034 (13a)	0.0006 (13a)
Copper	-	2.0 (2)	0.001, 0.006, 0.01, 0.028 (13e)	0.005 (13a)
Lead	-	0.025 (before 25/12/2013), 0.01 (after 25/12/2013) (2)	0.0072 (13c)	0.0072 (13c)
Mercury	0.00001 (4)	0.001 (2)	0.00005 (13c)	0.00005 (13c)