

PHOTOGRAPHIC LOG

Site Location: Former West End Nursery, Angmering

Photo No.
7

Date:
08/03/2016

Soils
encountered
in V4.



Photo No.
8

Date:
08/03/2016

Soils
encountered
in V5.



PHOTOGRAPHIC LOG

Site Location: Former West End Nursery, Angmering

Photo No.
9

Date:
08/03/2016

Soils
encountered
in V7.





APPENDIX C TRIAL PIT LOGS

RECORD OF TRIAL PITS

Date of Investigation: 25 January and 8 March 2016

V1

Ground level- 1.00m MADE GROUND: Grey brown wet slightly sandy clayey flint gravel with much brick and concrete fragments, old wire, cable, metal and ash.

END OF TRIAL PIT

Remarks

Water seepage from 0.40m filling pit.

Black heavily stained clayey layer at 0.90m

Concrete thickness- AST slab 0.20m, Nitric acid slab 0.10m

Sample taken at 0.80-1.00m

Trial pit terminated due to groundwater and constraints between concrete slabs

V2

Ground level- 0.60m MADE GROUD: Grey gravelly clay with brick, concrete, metal amd wood fragments. Yellowish brown oily product slow seepage at approximately 0.30m, moderate to strong hydrocarbon odour.

0.70 – 0.80m MADE GROUND: Grey brown slightly gravelly SILT. Gravel is a little fine to medium flint, no odour.

Remarks

Sample taken at 0.30m

Oil noted at 0.30m

Adjacent concrete road 0.17m thick.

V3

Ground level- 0.60m	MADE GROUND: Grey brown wet clay, sand and gravel with concrete, brick, plastic and wire.
0.60 – 0.80m	MADE GROUND: Light grey brown silt with a little brick/ash.

Remarks

Groundwater seepage at approximately 0.30m with a strong sheen and moderate hydrocarbon odour
Possible product in west corner
Sample taken at 0.30-0.40m

V4

Ground level- 0.10m	MADE GROUND: Yellow medium to coarse SAND.
0.10 – 0.95m	MADE GROUND: Grey brown clayey sand and gravel with much brick, concrete, pipe, wire wool. There is a light to moderate hydrocarbon odour and black staining at approximately 0.50m.
0.95 – 1.10m	Firm grey brown SILT.

Remarks

GW Seepage at approximately 0.80m
Sample taken at 0.40-0.50m

V5

Ground level- 0.50m	MADE GROUND: Brown grey slightly clayey sand and gravel with fragments of brick, wood, crushed concrete, glass, rope. Gravel is flint and chalk.
0.50 – 0.70m	MADE GROUND: Grey brown and yellow brown sandy CLAY with occasional brick, tarmac and flint.
0.70 – 0.90m	MADE GROUND: Dark grey silty CLAY with moderate organic odour, a little brick and fine fragments of tarmac.
0.90 – 1.00m	Firm light orange brown and light grey clayey SILT.

END OF TRIAL PIT

Remarks

Sample at 0.30-0.50m and 1.00m

V6

Ground level- 0.80m	MADE GROUND: Brown grey slightly clayey sand and gravel with fragments of brick, wood, crushed concrete, glass, rope. Gravel is flint and chalk. Slight hydrocarbon odour.
0.80 – 1.00m	MADE GROUND: Dark grey silty CLAY with moderate organic odour, a little brick and fine fragments of tarmac.
1.0 – 1.2m	Firm light orange brown and light grey clayey SILT.

END OF TRIAL PIT

Remarks

Groundwater seepage at 0.70m (no sheen or odour)

Sample at 0.20-0.40m and 1.00-1.20m

V7

Ground level- 0.80m	MADE GROUND: Brown grey slightly clayey sand and gravel with fragments of brick, wood, crushed concrete, glass, rope, old electrical cables and metal frames. Gravel is flint and chalk.
0.80 – 1.10m	MADE GROUND: Dark grey silty CLAY with moderate organic odour, a little brick and fine fragments of tarmac.
1.10 – 1.30m	Firm light orange brown and light grey clayey SILT.
END OF TRIAL PIT	

Remarks

Slight groundwater seepage at 0.60m (very slow and localised)
Sample at 0.30-0.50m and 1.10-1.30m

V8

Ground level- 0.10m	MADE GROUND: Light orange brownish fine to medium SAND.
0.10 – 0.70m	MADE GROUND: Grey slightly sandy gravelly silty CLAY with occasional black staining and slight hydrocarbon odour, occasional brick fragments, crushed concrete, plastic sacking, plastic tubes, wire.
0.70 – 0.80m	MADE GROUND: Grey and yellow brown sandy GRAVEL. Gravel is flint, chalk, crushed concrete and brick.
0.80 – 1.20m	Firm grey becoming g light brown clayey SILT with slight organic and hydrocarbon odour.
END OF TRIAL PIT	

Remarks

Sample at 0.30-0.50m and 1.00m

V9

Ground level- 0.10m	Grass over topsoil (brown silty clay).
0.10 – 0.60m	MADE GROUND: Brown clayey sand and gravel. Gravel is flint, brick, crushed concrete and mortar.
0.60 – 1.20m	Possible MADE GROUND: Grey silty CLAY with occasional greenish grey fine to medium sand and abundant off white to white fine to cobble sized chalk fragments. Slight organic odour.
1.20 – 1.40m	Firm light orange brown and light grey clayey SILT.
	END OF TRIAL PIT

Remarks

Sample taken at 0.60-0.80m

V10

Ground level- 0.70m	MADE GROUND: Brown sandy gravelly clay with a little black staining and a slight hydrocarbon odour.
0.70 – 1.00m	Firm grey brown SILT. Slight organic odour.
	END OF TRIAL PIT

Remarks

No groundwater encountered
Sample at 0.50m and 0.80-1.00m



APPENDIX D LABORATORY RESULTS

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 16/01449
Issue Number: 1

Date: 24 March, 2016

Client: RSK Environment Ltd Hemel
18 Frogmore Road
Hemel Hempstead
Hertfordshire
UK
HP3 9RT

Project Manager: Andrew James/Nigel Austin/Russell Speight
Project Name: Angmering
Project Ref: 27621
Order No: N/A
Date Samples Received: 11/03/16
Date Instructions Received: 11/03/16
Date Analysis Completed: 24/03/16

Prepared by:

Approved by:

Melanie Marshall
Laboratory Coordinator

Gill Scott
Laboratory Manager

Envirolab Job Number: 16/01449

Client Project Name: Angmering

Client Project Ref: 27621

Lab Sample ID	16/01449/1	16/01449/2	16/01449/3	16/01449/4	16/01449/5	16/01449/6			Units	Method ref
Client Sample No										
Client Sample ID	V5	V6	V7	V8	V8	V10				
Depth to Top	0.30	0.20	0.30	0.30	1.00	0.50				
Depth To Bottom	0.50	0.40	0.50	0.50						
Date Sampled	08-Mar-16	08-Mar-16	08-Mar-16	08-Mar-16	08-Mar-16	08-Mar-16				
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil				
Sample Matrix Code	4A	4A	4A	4A	4A	4A				
% Stones >10mm _A [#]	10.7	7.0	6.1	9.1	<0.1	12.5			% w/w	A-T-044
pH _D ^{M#}	-	-	-	-	-	9.34			pH	A-T-031s
Nitrate (water sol 2:1) _D	-	-	-	-	-	<1			mg/kg	A-T-026s

Envirolab Job Number: 16/01449

Client Project Name: Angmering

Client Project Ref: 27621

Lab Sample ID	16/01449/1	16/01449/2	16/01449/3	16/01449/4	16/01449/5	16/01449/6			Units	Method ref
Client Sample No										
Client Sample ID	V5	V6	V7	V8	V8	V10				
Depth to Top	0.30	0.20	0.30	0.30	1.00	0.50				
Depth To Bottom	0.50	0.40	0.50	0.50						
Date Sampled	08-Mar-16	08-Mar-16	08-Mar-16	08-Mar-16	08-Mar-16	08-Mar-16				
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil				
Sample Matrix Code	4A	4A	4A	4A	4A	4A				
TPH CWG										
Ali >C5-C6 _A [#]	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04			mg/kg	A-T-022s
Ali >C6-C8 _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01			mg/kg	A-T-022s
Ali >C8-C10 _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01			mg/kg	A-T-022s
Ali >C10-C12 _A [#]	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1			mg/kg	A-T-023s
Ali >C12-C16 _A [#]	<0.1	<0.1	<0.1	15.6	<0.1	<0.1			mg/kg	A-T-023s
Ali >C16-C21 _A [#]	<0.1	<0.1	<0.1	46.0	<0.1	<0.1			mg/kg	A-T-023s
Ali >C21-C35 _A [#]	<0.1	<0.1	<0.1	1.0	<0.1	<0.1			mg/kg	A-T-023s
Total Aliphatics _A	<0.1	<0.1	<0.1	62.5	<0.1	<0.1			mg/kg	A-T-022+23s
Aro >C5-C7 _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01			mg/kg	A-T-022s
Aro >C7-C8 _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01			mg/kg	A-T-022s
Aro >C8-C9 _A [#]	<0.01	<0.01	0.04	<0.01	<0.01	0.01			mg/kg	A-T-022s
Aro >C9-C10 _A [#]	<0.01	<0.01	0.04	<0.01	<0.01	0.04			mg/kg	A-T-022s
Aro >C10-C12 _A [#]	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1			mg/kg	A-T-023s
Aro >C12-C16 _A [#]	<0.1	<0.1	<0.1	4.6	<0.1	1.5			mg/kg	A-T-023s
Aro >C16-C21 _A [#]	1.2	4.5	2.5	21.7	<0.1	14.8			mg/kg	A-T-023s
Aro >C21-C35 _A [#]	0.7	5.5	2.8	0.7	<0.1	25.2			mg/kg	A-T-023s
Total Aromatics _A	2.0	10.1	5.4	27.2	<0.1	41.5			mg/kg	A-T-022+23s
TPH (Ali & Aro) _A	2.0	10.1	5.4	89.7	<0.1	41.5			mg/kg	A-T-022+23s
BTEX - Benzene _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01			mg/kg	A-T-022s
BTEX - Toluene _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01			mg/kg	A-T-022s
BTEX - Ethyl Benzene _A [#]	<0.01	<0.01	0.01	<0.01	<0.01	<0.01			mg/kg	A-T-022s
BTEX - m & p Xylene _A [#]	<0.01	<0.01	0.01	<0.01	<0.01	<0.01			mg/kg	A-T-022s
BTEX - o Xylene _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01			mg/kg	A-T-022s
MTBE _A [#]	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01			mg/kg	A-T-022s

REPORT NOTES

Notes - Soil chemical analysis

All results are reported as dry weight (<40°C).

For samples with Matrix Codes 1 - 6 natural stones and brick and concrete fragments >10mm are removed or excluded from the sample prior to analysis and reported results corrected to a whole sample basis. For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis.

Notes - General

This report shall not be reproduced, except in full, without written approval from Envirolab.

Subscript "A" indicates analysis performed on the sample as received. "D" indicates analysis performed on the dried sample, crushed to pass a 2mm sieve, unless asbestos is found to be present in which case all analysis is performed on the sample as received.

All analysis is performed on the dried and crushed sample for samples with Matrix Code 7 and this supersedes any "A" subscripts.

All analysis is performed on the sample as received for soil samples which are positive for asbestos and/or if they are from outside the European Union and this supersedes any "D" subscripts.

Superscript "M" indicates method accredited to MCERTS.

If results are in italic font they are associated with an AQC failure. These are not accredited and are unreliable.

A deviating samples report is appended and will indicate if samples or tests have been found to be deviating. Any test results affected may not be an accurate record of the concentration at the time of sampling and, as a result, may be invalid.

TPH analysis of water by method A-T-007

Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

Asbestos in soil

Asbestos in soil analysis is performed on a dried aliquot of the submitted sample and cannot guarantee to identify asbestos if present as discrete fibres/fragments. Stones etc. are not removed from the sample prior to analysis.

Quantification of asbestos is a 3 stage process including visual identification, hand picking and weighing and fibre counting by sedimentation/phase contrast optical microscopy if required. If asbestos is identified as being present but is not in a form that is suitable for analysis by hand picking and weighing (normally if the asbestos is present as free fibres) quantification by sedimentation is performed. Where ACMs are found a percentage asbestos is assigned to each with reference to 'HSG264, Asbestos: The survey guide' and the calculated asbestos content is expressed as a percentage of the dried soil sample aliquot used.

Predominant Matrix Codes:

1 = SAND, 2 = LOAM, 3 = CLAY, 4 = LOAM/SAND, 5 = SAND/CLAY, 6 = CLAY/LOAM, 7 = OTHER, 8 = Asbestos bulk ID sample. Samples with Matrix Code 7 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our BSEN 17025 or MCERTS accreditations.

Secondary Matrix Codes:

A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal, E = contains roots/twigs.

IS indicates Insufficient sample for analysis.

NDP indicates No Determination Possible.

NAD indicates No Asbestos Detected.

N/A indicates Not Applicable.

Superscript # indicates method accredited to ISO 17025.

Analytical results reflect the quality of the sample at the time of analysis only. Opinions and interpretations expressed are outside the scope of our accreditation.

Please contact us if you need any further information.

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 16/00471
Issue Number: 1

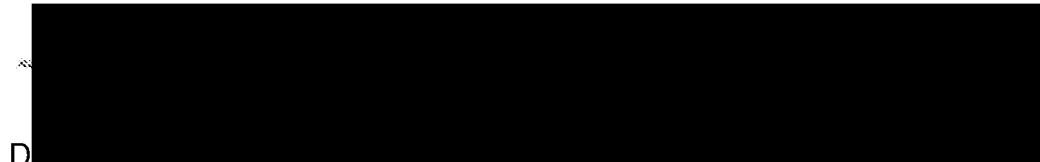
Date: 09 February, 2016

Client: RSK Environment Ltd Hemel
18 Frogmore Road
Hemel Hempstead
Hertfordshire
UK
HP3 9RT

Project Manager: Andrew James/Nigel Austin
Project Name: Angmering
Project Ref: 27621
Order No: N/A
Date Samples Received: 27/01/16
Date Instructions Received: 27/01/16
Date Analysis Completed: 09/02/16

Prepared by:

Approved by:



Danielle Denny
Administrative Assistant

Sam Scott
Laboratory Manager

Envirolab Job Number: 16/00471

Client Project Name: Angmering

Client Project Ref: 27621

Lab Sample ID	16/00471/1	16/00471/2	16/00471/3	16/00471/4					Units	Method ref
Client Sample No										
Client Sample ID	V1	V2	V3	V4						
Depth to Top	0.80	0.30	0.30	0.40						
Depth To Bottom	1.00		0.40	0.50						
Date Sampled	25-Jan-16	25-Jan-16	25-Jan-16	25-Jan-16						
Sample Type	Soil	Solid	Soil	Soil						
Sample Matrix Code	6A	7	6A	4A						
% Stones >10mm _A [#]	11.6	<0.1	7.3	31.0					% w/w	A-T-044
pH _D ^{M#}	7.91	-	-	-					pH	A-T-031 s
Nitrate (water sol 2:1) _D	<1	-	-	-					mg/kg	A-T-026 s

Envirolab Job Number: 16/00471

Client Project Name: Angmering

Client Project Ref: 27621

Lab Sample ID	16/00471/1	16/00471/2	16/00471/3	16/00471/4					Units	Method ref
Client Sample No										
Client Sample ID	V1	V2	V3	V4						
Depth to Top	0.80	0.30	0.30	0.40						
Depth To Bottom	1.00		0.40	0.50						
Date Sampled	25-Jan-16	25-Jan-16	25-Jan-16	25-Jan-16						
Sample Type	Soil	Solid	Soil	Soil						
Sample Matrix Code	6A	7	6A	4A						
TPH CWG										
Ali >C5-C6 _A [#]	<0.01	<0.01	<0.01	<0.01					mg/kg	A-T-022s
Ali >C6-C8 _A [#]	<0.01	0.27	0.01	<0.01					mg/kg	A-T-022s
Ali >C8-C10 _A [#]	<0.01	3.23	0.01	<0.01					mg/kg	A-T-022s
Ali >C10-C12 _A [#]	<0.1	63.8	<0.1	<0.1					mg/kg	A-T-023s
Ali >C12-C16 _A [#]	<0.1	373	<0.1	<0.1					mg/kg	A-T-023s
Ali >C16-C21 _A [#]	<0.1	487	<0.1	<0.1					mg/kg	A-T-023s
Ali >C21-C35 _A [#]	<0.1	119	<0.1	<0.1					mg/kg	A-T-023s
Total Aliphatics _A	<0.1	1050	<0.1	<0.1					mg/kg	A-T-022+23s
Aro >C5-C7 _A [#]	<0.01	<0.01	<0.01	<0.01					mg/kg	A-T-022s
Aro >C7-C8 _A [#]	<0.01	<0.01	<0.01	<0.01					mg/kg	A-T-022s
Aro >C8-C9 _A [#]	<0.01	0.13	0.02	0.02					mg/kg	A-T-022s
Aro >C9-C10 _A [#]	<0.01	3.95	0.08	0.10					mg/kg	A-T-022s
Aro >C10-C12 _A [#]	<0.1	16.9	<0.1	<0.1					mg/kg	A-T-023s
Aro >C12-C16 _A [#]	<0.1	134	1.8	<0.1					mg/kg	A-T-023s
Aro >C16-C21 _A [#]	<0.1	169	3.6	3.4					mg/kg	A-T-023s
Aro >C21-C35 _A [#]	<0.1	49.4	0.7	2.4					mg/kg	A-T-023s
Total Aromatics _A	<0.1	374	6.1	5.9					mg/kg	A-T-022+23s
TPH (Ali & Aro) _A	<0.1	1420	6.1	5.9					mg/kg	A-T-022+23s
BTEX - Benzene _A [#]	<0.01	<0.01	<0.01	<0.01					mg/kg	A-T-022s
BTEX - Toluene _A [#]	<0.01	<0.01	<0.01	<0.01					mg/kg	A-T-022s
BTEX - Ethyl Benzene _A [#]	<0.01	0.02	<0.01	<0.01					mg/kg	A-T-022s
BTEX - m & p Xylene _A [#]	<0.01	0.07	<0.01	<0.01					mg/kg	A-T-022s
BTEX - o Xylene _A [#]	<0.01	0.06	<0.01	<0.01					mg/kg	A-T-022s
MTBE _A [#]	<0.01	<0.01	<0.01	<0.01					mg/kg	A-T-022s

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APPENDIX E

RSK GENERIC ASSESSMENT CRITERIA

Generic assessment criteria for human health: residential scenario with home-grown produce

Background

RSK's generic assessment criteria (GAC) were initially prepared following the publication by the Environment Agency (EA) of soil guideline value (SGV) and toxicological (TOX) reports, and associated publications in 2009⁽¹⁾. RSK GAC were updated following the publication of GAC by LQM/CIEH in 2009⁽²⁾. RSK GAC are periodically revised when updated information on toxicological, land use or receptor parameters is published.

Updates to the RSK GAC: 2015

In 2014, the publication of Category 4 Screening Levels (C4SL)^(3,4), as part of the Defra-funded research project SP1010, included modifications to certain exposure assumptions documented within EA Science Report SC050221/SR3 (herein after referred to as SR3)⁽⁵⁾ used in the generation of SGVs.

C4SL were published for six substances (cadmium, arsenic, benzene, benzo(a)pyrene, chromium VI and lead) for a sandy loam soil type with 6% soil organic matter, based on a low level of toxicological concern (LLTC; see Section 2.3 of research project report SP1010⁽³⁾). Where a C4SL has been published, the RSK GAC duplicates the C4SL published values using all input parameters within the SP1010 final project report⁽³⁾ and associated appendices⁽⁶⁾, and adopts them as GAC for these six substances.

For all other substances the C4SL exposure modifications, with the exception of the "top two" produce type approach taken in the C4SL, have been applied to the current RSK GAC. These include alterations to daily inhalation rates for residential and commercial scenarios, reducing soil adherence factors in children (age classes 1 to 12 only) for residential land use, reducing exposure frequency for dermal contact outdoors for residential land use, and updated produce type consumption rates (90th percentile) based on recent data from the National Diet and Nutrition Survey.

The RSK GAC have also been revised with updated toxicology published by LQM/CIEH in 2015⁽⁷⁾, where a C4SL has not been published.

RSK GAC derivation for metals and organic compounds

Model selection

Soil assessment criteria (SAC) were calculated using the Contaminated Land Exposure Assessment (CLEA) tool v1.06, supporting EA guidance^(5,8,9) and revised exposure scenarios published for the C4SL⁽³⁾. 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 EA guidance^(1,5,8,9). The SAC and GrAC collectively are termed GAC.

Conceptual model

In accordance with SR3⁽⁵⁾, the residential with home-grown produce scenario considers risks to a female child between the ages of 0 and 6 years old as the highest risk scenario. In accordance

with Box 3.1 of SR3⁽⁵⁾, the pathways considered for production of the SAC in the residential with home-grown produce scenario are

- direct soil and dust ingestion
- consumption of home-grown produce
- consumption of soil attached to home-grown produce
- dermal contact with soil and indoor dust
- inhalation of indoor and outdoor dust and vapours.

Figure 1 is a conceptual model illustrating these linkages.

In line with guidance in the EA SGV report for cadmium⁽¹⁾, the RSK GAC for cadmium has been derived based on estimates representative of lifetime exposure. Although young children are generally more likely to have higher exposures to soil contaminants, the renal toxicity of cadmium, and the derivation of the TDI_{oral} and TDI_{inh} , are based on considerations of the kidney burden accumulated over 50 years or so. It is therefore reasonable to consider exposure not just in childhood but averaged over a longer period.

The pathway considered in production of the GrAC is the volatilisation of compounds from groundwater and subsequent vapour inhalation by residents 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 chemical 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 CLEA model output cells are flagged red where the soil saturation limit has been exceeded.

With respect to volatilisation, the CLEA model assumes a simple linear partitioning of a chemical in the soil between the sorbed, dissolved and vapour phase⁽⁹⁾. The upper boundaries of this partitioning are represented by the maximum aqueous solubility and pure saturated vapour concentration of the chemical. The CLEA model estimates saturated soil concentrations where these limits are reached⁽⁹⁾. The CLEA software uses a traffic light system to identify when individual and/or combined assessment criteria exceed the lower of either the aqueous- or vapour-based soil saturation limits. Model output cells are flagged red where the saturated soil concentration has been exceeded and the contribution of the indoor and outdoor vapour pathway to total exposure is greater than 10%. In this case, further consideration of the following is required⁽⁹⁾:

- Free phase contamination may be present.
- Exposure from the vapour pathways will be over-predicted by the model, as in reality the vapour phase concentration will not increase at concentrations above saturation limits
- Where the vapour pathway contribution is greater than 90%, it is unlikely the relevant health criteria value (HCV) will be exceeded at soil concentrations at least a factor of ten higher than the relevant HCV.

Where the vapour pathway is the predominant pathway (contributes greater than 90% of exposure) or the only exposure route considered and the cell is highlighted red (SAC exceeds saturation limit), the risk based on the assumed conceptual model is likely to be negligible as the vapour risk is assumed to be tolerable at maximum possible soil concentrations. In such circumstances, the vapour pathway exposure should be considered based on the presence of free phase or non-aqueous phase liquid sources and the measured concentrations of volatile organic compounds (VOC) in the vapour phase. Screening could be considered based on setting

the SAC as the modelled soil saturation limits. However, as stated within the CLEA handbook⁽⁹⁾, this is likely to not be practical in many cases because of the very low saturation limits and, in any case, is highly conservative.

It should also be noted that for mixtures of compounds, free phase may be present where soil (or groundwater) concentrations are well below saturation limits for individual compounds.

Where the vapour pathway is only one of the exposure pathways considered, an additional approach can then be utilised as detailed within Section 4.12 of the CLEA model handbook⁽⁹⁾, which explains how to calculate an effective assessment criterion manually.

SR3⁽⁵⁾ states that, as a general rule of thumb, it is recognised that estimating vapour phase concentrations from dissolved and sorbed phase contamination by petroleum hydrocarbons are at least a factor of ten higher than those likely to be measured on-site. RSK has therefore applied an empirical subsurface to indoor air correction factor of 10 into the CLEA model chemical database for all petroleum hydrocarbon fractions (including BTEX, trimethylbenzenes and the polycyclic aromatic hydrocarbons (PAH) naphthalene, acenaphthene and acenaphthylene) to reduce this conservatism.

Input selection

The most up-to-date published chemical and toxicological data was obtained from EA Report SC050021/SR7⁽¹⁰⁾, the EA TOX⁽¹¹⁾ reports, the C4SL SP1010 project report and associated appendices^(3,6) or the 2015 LQM/CIEH report⁽⁷⁾. Where a C4SL has been published, the RSK GAC have duplicated the C4SL published values using all input parameters within the SP1010 final project report⁽³⁾ and associated appendices⁽⁶⁾, and has adopted them as GAC for these six substances. Toxicological and specific chemical parameters for aromatic hydrocarbon C₈–C₉ (styrene), 1,2,4-trimethylbenzene and methyl tertiary-butyl ether (MTBE) were obtained from the CL:AIRE Soil Generic Assessment Criteria report⁽¹¹⁾.

For TPH, aromatic hydrocarbons C₅–C₈ were not modelled, as this range comprises benzene and toluene, which are modelled separately. The aromatic C₈–C₉ hydrocarbon fraction comprises ethylbenzene, xylene and styrene. As ethylbenzene and xylene are being modelled separately, the physical, chemical and toxicological data for aromatic C₈–C₉ have been taken from styrene.

For the GrAC, owing to the lack of UK-specific data, default information in the RBCA model was used to evaluate MTBE. No published UK data was available for 1,3,5-trimethylbenzene, so information was obtained from 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

- amendments to the MDI using Table 3.4 of SR2⁽⁸⁾
- a child weighing 13.3kg (average of 0–6 year old female in accordance with Table 4.6 of SR3⁽⁵⁾) and breathing 11.85m³ (average daily inhalation rate for a 0–6-year old female in accordance with Table 4.14 of SR3⁽⁵⁾). Inhalation rates used in the derivation of the GrAC have not been updated in line with the 2011 USEPA published values⁽¹²⁾; these will be updated in subsequent revisions of the RSK GAC. The lower inhalation rates presented by the USEPA in 2011 for ages classes 1 to 11 (values are higher for age classes 12 to 18) are not considered to make a significant difference.
- the 50% rule (for petroleum hydrocarbons, trimethylbenzenes and MTBE)^(8,9) where MDI data is not available but background exposure is considered important in the overall exposure.

Physical parameters

For the residential with home-grown produce scenario, the CLEA default building is a small, two-storey terrace house with a concrete ground-bearing slab. The house is assumed to have a 100m² private garden consisting of lawn and flowerbeds, incorporating a 20m² plot for growing fruit and vegetables consumed by the residents. SR3⁽⁵⁾ notes this residential building type to be the most conservative in terms of potential for vapour intrusion. The building parameters used in the production of the RSK GACs are the default CLEA v1.06 inputs presented in Table 3.3 of SR3⁽³⁾, with a dust loading factor detailed in Section 9.3 of SR3⁽⁵⁾. The parameters for a sandy loam soil type were used in line with Table 4.4 of SR3⁽⁵⁾. 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 SOM, RSK has produced an additional set of GAC for SOM of 1% and 2.5% for all substances using the CLEA tool.

For the GrAC, the depth to groundwater was taken as 2.5m based on RSK's experience of assessing the volatilisation pathway from groundwater. The GrAC were produced using the input parameters in Table 4.

Summary of modifications to the default CLEA 1.06/SR3⁽⁵⁾ input parameters for residential with home-grown produce land-use scenario

In summary, the RSK GAC were produced using the default input parameters for soil properties, the air dispersion model, building properties and the vapour model detailed in SR3⁽⁵⁾. Modifications to the default SR3⁽⁵⁾ exposure scenarios based on the C4SL exposure scenarios⁽³⁾ are presented in Tables 2 and 3 below.

The final selected GAC are presented by pathway in Table 5 and the combined GAC in Table 6.

Figure 1: Conceptual model for residential scenario with home-grown produce

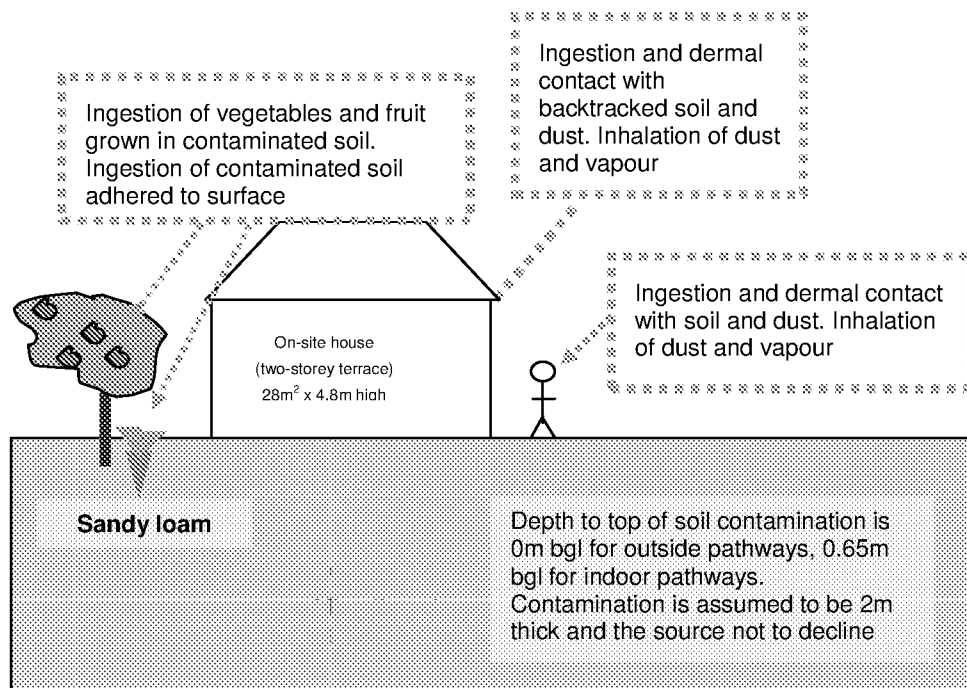


Table 1: Exposure assessment parameters for residential scenario with home-grown produce – inputs for CLEA model

Parameter	Value	Justification
Land use	Residential with homegrown produce	Chosen land use
Receptor	Female child age 1 to 6	Key generic assumption given in Box 3.1, SR3 ⁽⁵⁾
Building	Small terraced house	Key generic assumption given in Box 3.1, SR3. Small, two-storey terraced house chosen, as it is the most conservative residential building type in terms of protection from vapor intrusion (Section 3.4.6, SR3) ⁽⁵⁾
Soil type	Sandy Loam	Most common UK soil type (Section 4.3.1, from Table 3.1, SR3) ⁽⁵⁾
Start AC (age class)	1	Range of age classes corresponding to key generic assumption that the critical receptor is a young female child aged 0–6. From Box 3.1, SR3 ⁽⁵⁾
End AC (age class)	6	
SOM (%)	6	Representative of sandy loamy soil according to EA guidance note dated January 2009 entitled 'Changes We Have Made to the CLEA Framework Documents' ⁽¹³⁾
	1	To provide SAC for sites where SOM <6% as often observed by RSK
	2.5	
pH	7	Model default

Table 2: Residential with home-grown produce – modified home-grown produce data

Name	Consumption rate 90 th percentile (g FW kg ⁻¹ BW day ⁻¹) by age class						Dry weight conversion factor (g DW g ⁻¹ FW)	Home-grown fraction (average)	Home-grown fraction (high end)	Soil loading factor (g g ⁻¹ DW)	Preparation correction factor
	1	2	3	4	5	6					
Green vegetables	7.12	5.87	5.87	5.87	4.53	4.53	0.096	0.05	0.33	1.00E-03	2.00E-01
Root vegetables	10.7	2.83	2.83	2.83	2.14	2.14	0.103	0.06	0.4	1.00E-03	1.00E+00
Tuber vegetables	16	6.6	6.6	6.6	4.95	4.95	0.21	0.02	0.13	1.00E-03	1.00E+00
Herbaceous fruit	1.83	3.39	3.39	3.39	2.24	2.24	0.058	0.06	0.4	1.00E-03	6.00E-01
Shrub fruit	2.23	0.46	0.46	0.46	0.19	0.19	0.166	0.09	0.6	1.00E-03	6.00E-01
Tree fruit	3.82	10.3	10.3	10.3	5.16	5.16	0.157	0.04	0.27	1.00E-03	6.00E-01
Justification	Table 3.4, SP1010 ⁽³⁾						Table 6.3, SR3 ⁽⁵⁾	Table 4.19, SR3 ⁽⁵⁾		Table 6.3, SR3 ⁽⁵⁾	

Table 3: Residential with home-grown produce – modified and use and receptor data

Parameter	Unit	Age class					
		1	2	3	4	5	6
EF (soil and dust ingestion)	day yr ⁻¹	180	365	365	365	365	365
EF (consumption of home-grown produce)	day yr ⁻¹	180	365	365	365	365	365
EF (skin contact, indoor)	day yr ⁻¹	180	365	365	365	365	365
EF (skin contact, outdoor)	day yr ⁻¹	170	170	170	170	170	170
EF (inhalation of dust and vapour, indoor)	day yr ⁻¹	365	365	365	365	365	365
EF (inhalation of dust and vapour, outdoor)	day yr ⁻¹	365	365	365	365	365	365
Justification		Table 3.5, SP1010 ⁽³⁾ ; Table 3.1, SR3 ⁽⁵⁾					
Soil to skin adherence factor (outdoor)	mg cm ⁻² day ⁻¹	0.1	0.1	0.1	0.1	0.1	0.1
Justification		Table 3.5, SP1010 ⁽³⁾					
Inhalation rate	m ³ day ⁻¹	5.4	8.0	8.9	10.1	10.1	10.1
Justification		Mean value USEPA, 2011 ⁽¹²⁾ ; Table 3.2, SP1010 ⁽³⁾					
Notes: For cadmium , the exposure assessment for a residential land use is based on estimates representative of lifetime exposure AC1-18. This is because the TDI _{oral} and TDI _{inh} are based on considerations of the kidney burden accumulated over 50 years. It is therefore reasonable to consider exposure not just in childhood but averaged over a longer period. See the Environment Agency Science Report SC05002/ TOX 3 ⁽¹⁾ , Science Report SC050021/Cadmium SGV ⁽¹⁾ and the project report SP1010 ⁽³⁾ for more information.							

Figure 2: GrAC conceptual model for RBCA residential with home-grown produce scenario

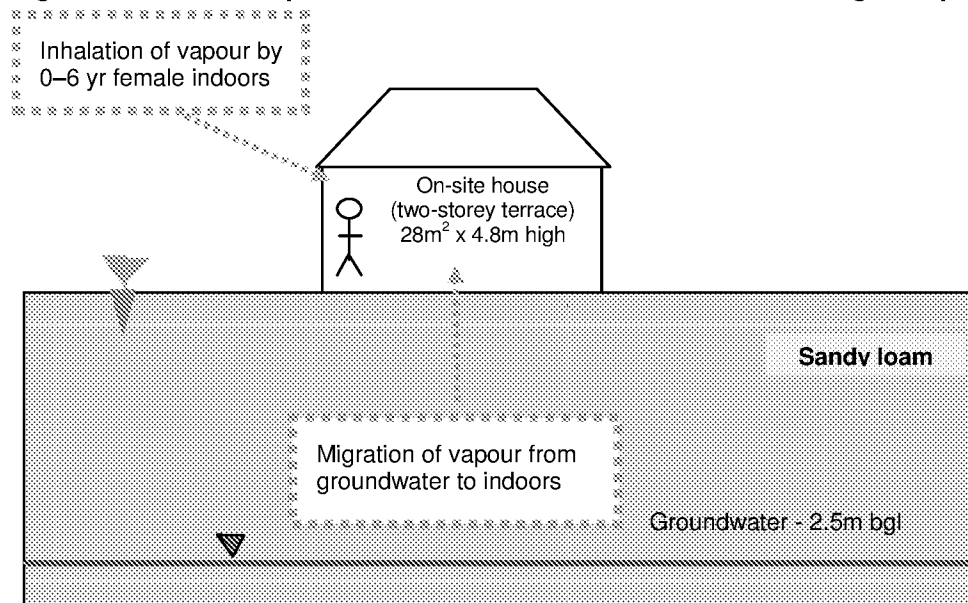


Table 4: Residential with home-grown produce – RBCA inputs

Parameter	Unit	Value	Justification
Receptor			
Averaging time	Years	6	From Box 3.1, SR3 ⁽⁵⁾
Receptor weight	kg	13.3	Average of CLEA 0–6 year old female data, Table 4.6, SR3 ⁽⁵⁾
Exposure duration	Years	6	From Box 3.1, report, SR3 ⁽⁵⁾
Exposure frequency	Days/yr	350	Weighted using occupancy period of 23 hours per day for 365 days of the year
Soil type – sandy loam			
Total porosity	-	0.53	CLEA value for sandy loam. Parameters for sandy loam from Table 4.4, SR3 ⁽⁵⁾
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 ⁽⁵⁾
Vapour permeability	m ²	3.05E-12	Calculated for sandy loam using equations in Appendix 1, SR3 ⁽⁵⁾
Capillary zone thickness	m	0.1	Professional judgement
Fraction organic carbon	%	0.0348	Representative of sandy loam according to EA guidance note dated January 2009 entitled 'Changes We Have Made to the CLEA Framework Documents' ⁽¹³⁾
Building			
Building volume/area ratio	m	4.8	Table 3.3, SR3 ⁽⁵⁾
Foundation area	m ²	28	
Foundation perimeter	m	22	Calculated assuming building measures 7m x 4m to give 28m ² foundation area
Building air exchange rate	d ⁻¹	12	Table 3.3, SR3 ⁽⁵⁾
Depth to bottom of foundation slab	m	0.15	
Foundation thickness	m	0.15	
Foundation crack fraction	-	0.0151	Calculated from floor crack area of 423 cm ² and building footprint of 28m ² in Table 4.21, SR3 ⁽⁵⁾
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 ⁽⁵⁾
Volumetric air content of cracks	-	0.2	
Indoor/outdoor differential pressure	Pa	3.1	From Table 3.3, SR3 ⁽⁵⁾

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GENERIC ASSESSMENT CRITERIA FOR HUMAN HEALTH - RESIDENTIAL WITH HOME-GROWN PRODUCE



Table 5

Human Health Generic Assessment Criteria by Pathway for Residential With Home-Grown Produce 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	
Metals														
Arsenic	(a,b)	-	3.96E-01	NR	NR	NR	3.96E-01	NR	NR	NR	3.96E-01	NR	NR	NR
Cadmium	(a)	-	NR	NR	2.60E-01	NR	NR	NR	2.60E-01	NR	NR	NR	2.60E-01	NR
Chromium (III) - trivalent	(c)	-	1.84E-04	9.07E-02	8.25E-02	NR	1.84E-04	9.07E-02	8.25E-02	NR	1.84E-04	9.07E-02	8.25E-02	NR
Chromium (VI) - hexavalent	(a,d)	-	NR	2.10E-01	NR	NR	NR	2.10E-01	NR	NR	NR	2.10E-01	NR	NR
Copper	-	-	2.72E-03	1.41E-04	8.47E-03	NR	2.72E-03	1.41E-04	8.47E-03	NR	2.72E-03	1.41E-04	8.47E-03	NR
Lead	(a)	-	NR	NR	2.0E-02	NR	NR	NR	2.0E-02	NR	NR	NR	2.0E-02	NR
Elemental Mercury (Hg ⁰)	(d)	9.40E-03	NR	2.95E-01	NR	4.31E+00	NR	9.90E-01	NR	1.07E+01	NR	1.22E-06	NR	2.58E+01
Inorganic Mercury (Hg ²⁺)	-	-	3.96E-01	3.69E-03	2.31E-01	NR	3.96E-01	3.69E-03	2.31E-01	NR	3.96E-01	3.69E-03	2.31E-01	NR
Methyl Mercury (Hg ^{Me})	-	2.00E-01	1.29E-01	1.87E-01	7.33E-01	7.33E+01	1.29E-01	2.62E-01	9.24E-01	1.42E+02	1.29E-01	7.69E-01	1.98E-01	3.04E+02
Nickel	(d)	-	5.47E-02	1.81E-02	1.84E-02	NR	5.47E-02	1.81E-02	1.84E-02	NR	5.47E-02	1.81E-02	1.84E-02	NR
Selenium	(b)	-	2.69E-02	NR	NR	NR	2.69E-02	NR	NR	NR	2.69E-02	NR	NR	NR
Zinc	(b)	-	2.89E-03	3.69E-07	NR	NR	2.89E-03	3.69E-07	NR	NR	2.89E-03	3.69E-07	NR	NR
Cyanide	-	-	3.74E-01	4.09E-06	3.79E-06	NR	2.74E-01	4.09E-06	3.79E-06	NR	2.74E-01	4.09E-06	3.79E-06	NR
Volatile Organic Compounds														
Benzene	(a)	7.20E-00	7.39E-01	1.88E-00	1.94E+00	1.22E+03	7.39E-01	1.88E+00	1.94E+00	2.26E+03	1.16E-06	3.46E-06	8.72E-01	4.71E+03
Toluene	-	8.90E-02	1.63E-02	9.08E-02	1.31E-02	8.69E+02	3.49E-02	2.00E-03	2.97E-02	1.92E+03	7.96E-02	4.55E-03	6.77E-02	4.36E+03
Ethylbenzene	-	1.60E-02	1.10E-02	3.34E-01	4.74E-01	5.18E+02	2.61E-02	1.99E-02	1.12E-02	1.22E+03	9.00E-02	4.59E-02	2.90E-02	2.84E+03
Xylene - m	-	8.40E-01	2.10E-02	8.25E-01	5.92E-01	6.25E+02	5.01E-03	1.46E-02	1.40E-02	1.47E+03	1.15E-03	4.69E-02	3.27E-02	3.46E+03
Xylene - o	-	1.60E-02	1.89E-02	6.77E-01	6.07E-01	4.78E+02	1.58E-02	2.08E-02	1.43E-02	1.12E+03	1.09E-03	4.69E-02	3.12E-02	2.62E+03
Xylene - p	-	8.70E-01	1.89E-02	7.98E-01	6.69E-01	5.76E+02	4.70E-02	1.96E-02	1.38E-02	1.35E+03	1.09E-03	4.69E-02	3.10E-02	3.17E+03
Total xylene	-	8.40E-01	1.92E-02	7.89E-01	5.86E-01	6.25E+02	4.56E-02	1.96E-02	1.39E-02	1.47E+03	1.06E-03	4.69E-02	3.10E-02	3.46E+03
Methyl tertiary-Butyl ether (MTBE)	-	2.20E+03	1.54E-02	1.04E-06	1.84E-02	2.04E+04	2.97E-02	1.69E-03	8.53E-02	3.31E+04	6.09E-02	3.21E-03	6.09E-02	6.27E+04
Trichloroethene	-	1.80E-00	2.83E-01	1.72E-02	1.62E-02	1.54E+03	8.38E-01	3.59E-02	3.40E-02	3.22E+03	1.44E-06	1.96E-02	7.95E-02	7.14E+03
Tetrachloroethene	-	3.60E+00	4.49E-01	1.79E-01	1.79E-01	4.24E+02	1.04E-01	4.02E-01	3.94E-01	9.51E+02	2.39E-01	8.21E-01	8.04E-01	2.18E+03
1,1,1-Trichloroethane	-	2.60E+01	3.39E-02	9.01E-00	8.77E+00	1.43E+03	7.89E-02	1.84E-01	1.89E-01	2.92E+03	1.62E-03	4.94E-01	3.94E-01	6.39E+03
1,1,1,2-Tetrachloroethane	-	1.40E+01	6.29E-00	1.94E-00	1.80E-00	2.60E+03	1.27E-01	3.56E-00	3.79E-00	6.02E+03	2.98E-01	8.29E-00	8.49E-00	1.40E+04
1,1,2,2-Tetrachloroethane	-	1.40E+01	2.81E-01	2.95E-00	1.64E-00	2.67E+03	6.09E-01	3.04E-00	3.47E-00	5.46E+03	1.26E-01	1.79E-01	7.67E-00	1.20E+04
Carbon Tetrachloride	-	5.50E-02	3.19E-04	5.39E-03	2.57E-02	1.52E+03	1.11E-06	5.62E-02	5.62E-02	3.32E+03	1.62E-01	1.89E-01	1.37E-01	7.54E+03
1,2-Dichloroethane	-	3.00E-01	2.13E-02	5.20E-03	7.19E-03	3.41E+03	3.79E-02	1.39E-02	1.98E-02	4.91E+03	1.09E-01	3.39E-02	1.98E-02	8.43E+03
Vinyl Chloride	-	1.90E-02	3.82E-03	7.79E-04	8.43E-04	1.36E+03	6.87E-03	1.06E-03	8.73E-04	1.76E+03	1.25E-02	1.53E-03	1.39E-03	2.69E+03
1,2,4-Trimethylbenzene	-	7.50E-02	NR	1.75E-00	NR	4.74E+02	NR	4.39E+00	NR	1.16E+03	NR	9.72E-06	NR	2.76E+03
1,3,5-Trimethylbenzene	(e)	4.70E-02	NR	NR	NR	2.30E+02	NR	NR	NR	5.52E+02	NR	NR	NR	1.30E+03
Semi-Volatile Organic Compounds														
Acenaphthene	-	3.26E+00	2.27E-02	4.86E-04	2.28E+02	5.70E+01	5.41E-02	1.18E-05	5.38E-02	1.41E+02	1.16E-03	2.88E-05	1.17E-05	3.36E+02
Acenaphthylene	-	4.20E+00	1.85E-02	4.59E-04	1.84E-02	8.61E+01	4.42E-02	1.11E-05	4.40E-02	2.12E+02	9.78E-03	2.53E-05	9.74E-02	5.06E+02
Acridene	-	2.10E-02	2.43E-03	1.59E-05	3.39E-03	1.17E+00	5.53E-02	3.77E-05	5.45E-03	2.91E+00	1.10E-04	8.76E-05	1.09E-04	6.96E+00
Benzo(a)anthracene	-	3.80E-03	1.01E-01	2.47E-01	7.16E+00	1.71E+00	1.42E-01	4.37E-01	1.07E-01	4.28E+00	1.89E-01	6.29E-01	1.39E-01	1.03E+01
Benzo(b)fluoranthene	-	2.00E-03	2.96E-00	1.89E-01	2.56E+00	1.22E+00	3.89E-00	2.13E-01	3.29E-00	3.04E+00	4.45E-06	2.22E-01	2.69E-06	7.29E+00
Benzo(g,h,i)perylene	-	2.80E-04	3.77E-02	1.87E-03	3.14E+02	1.54E+02	4.09E-02	1.94E-03	3.28E-02	3.85E+02	4.23E-02	1.97E-03	2.48E-02	9.23E+02
Benzo(k)fluoranthene	-	9.00E-04	8.92E-01	5.41E-02	7.86E-01	6.87E-01	1.10E-02	9.76E-02	9.22E-01	1.72E+00	1.21E-02	5.91E-02	1.00E-02	4.12E+00
Chrysene	-	2.00E-03	1.66E-01	1.19E-02	1.46E-01	4.40E-01	2.84E-01	1.49E-02	2.17E-01	1.10E+00	3.19E-01	1.66E-02	2.87E-01	2.64E+00
Dibenz(a,h)anthracene	-	8.00E-04	2.90E-01	1.45E-00	2.41E-01	3.93E-03	3.43E-01	1.64E-00	2.84E-01	9.82E+03	5.69E-01	1.74E-00	3.04E-01	2.36E+02
Fluoranthene	-	2.30E-01	2.87E-02	3.89E-04	2.85E-02	1.89E+01	5.63E-02	6.87E-04	5.60E-02	4.79E+01	9.00E-02	1.83E-05	8.96E-02	1.13E+02
Fluorene	-	1.80E-00	1.77E-02	6.20E-03	1.72E-02	3.09E-01	4.13E-02	1.53E-04	4.07E-02	7.65E+01	8.96E-02	3.69E-04	8.78E-02	1.83E+02
Indeno(1,2,3-cd)pyrene	-	2.00E-04	3.09E-01	2.12E-02	2.78E+01	6.13E-02	4.22E-01	2.38E-02	3.59E-01	1.53E+01	4.92E-01	2.50E-02	4.11E-01	3.68E+01
Phenanthrene	-	5.30E-01	8.89E-01	7.17E-03	9.72E-01	3.60E+01	2.24E-02	1.76E-04	2.22E-02	8.96E+01	4.48E-02	4.07E-04	4.43E-02	2.14E+02
Pyrene	-	1.30E-01	6.29E-02	8.79E-04	6.20E-02	2.20E+00	1.25E-02	2.04E-03	1.24E-03	5.49E+00	2.05E-03	4.23E-05	2.04E-03	1.32E+01
Benzo(a)pyrene	(a)	3.80E-03	4.91E+00	3.51E-01	4.30E+00	9.11E+01	4.91E+00	3.77E-01	4.34E+00	2.28E+00	4.91E+00	3.89E-01	4.39E+00	5.46E+00
Naphthalene	-	1.80E+01	2.78E-01	2.39E-01	1.37E-01	7.64E+01	8.89E-01	3.56E-01	3.04E-01	1.83E+02	1.56E-02	1.21E-02	7.96E-01	4.32E+02
Phenol	-	-	1.80E-02	4.96E-02	1.30E-02	2.42E+04	2.98E-02	8.99E-02	8.09E-02	3.81E+04	5.89E-02	1.19E-03	2.89E-02	7.03E+04

GENERIC ASSESSMENT CRITERIA FOR HUMAN HEALTH - RESIDENTIAL WITH HOME-GROWN PRODUCE



Table 5

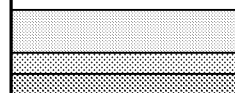
Human Health Generic Assessment Criteria by Pathway for Residential With Home-Grown Produce Scenario

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	
Total Petroleum Hydrocarbons														
Aliphatic hydrocarbons <EC ₉ -EC ₃		1.00E+01	4.96E+03	4.24E+01	4.23E+01	3.04E+02	1.12E+04	7.79E+01	7.78E+01	5.58E+02	2.41E+04	1.81E+02	1.80E+02	1.15E+03
Aliphatic hydrocarbons >EC ₉ -EC ₅		5.40E+00	1.46E+04	1.04E+02	1.03E+02	1.44E+02	3.27E+04	3.31E+02	3.31E+02	3.22E+02	6.47E+04	3.89E+02	3.88E+02	7.36E+02
Aliphatic hydrocarbons >EC ₉ -EC ₁₀		2.30E+01	1.45E+03	2.66E+03	3.87E+01	7.77E+01	2.42E+03	6.59E+01	6.50E+01	1.90E+02	3.29E+03	1.36E+02	1.34E+02	4.51E+02
Aliphatic hydrocarbons >EC ₁₀ -EC ₁₂		3.40E+02	3.47E+03	1.33E+02	1.32E+02	4.75E+01	3.98E+03	3.31E+02	3.24E+02	1.18E+02	4.23E+03	7.93E+02	7.52E+02	2.83E+02
Aliphatic hydrocarbons >EC ₁₂ -EC ₁₆		7.60E+04	4.36E+03	1.11E+03	1.03E+03	2.37E+01	4.40E+03	2.78E+03	2.22E+03	5.91E+01	4.41E+03	6.67E+03	3.47E+03	1.42E+02
Aliphatic hydrocarbons >EC ₁₆ -EC ₃₅	(b)	-	5.28E+04	NR	NR	8.48E+00	6.95E+04	NR	NR	2.12E+01	7.94E+04	NR	NR	5.09E+01
Aliphatic hydrocarbons >EC ₃₅ -EC ₄₄	(b)	-	5.28E+04	NR	NR	8.48E+00	6.95E+04	NR	NR	2.12E+01	7.94E+04	NR	NR	5.09E+01
Aromatic hydrocarbons >EC ₉ -EC ₉ (styrene)		7.40E+00	1.67E+01	5.22E+02	1.05E+01	6.26E+02	2.51E+01	1.20E+03	2.46E+01	1.44E+03	5.73E+01	3.79E+03	5.80E+01	3.35E+03
Aromatic hydrocarbons >EC ₉ -EC ₁₀		7.40E+00	6.71E+01	4.74E+01	3.44E+01	6.13E+02	1.96E+02	1.16E+02	8.39E+01	1.50E+03	2.81E+02	2.77E+02	1.69E+02	3.58E+02
Aromatic hydrocarbons >EC ₁₀ -EC ₁₂		2.50E+01	8.17E+01	2.59E+02	7.42E+01	3.64E+02	1.90E+02	6.39E+02	1.74E+02	8.99E+02	3.95E+02	1.58E+03	3.67E+02	2.15E+03
Aromatic hydrocarbons >EC ₁₂ -EC ₁₅		5.60E+00	1.42E+02	2.85E+03	1.41E+02	1.69E+02	3.18E+02	7.07E+03	3.14E+02	4.19E+02	6.06E+02	1.68E+04	6.03E+02	1.00E+03
Aromatic hydrocarbons >EC ₁₅ -EC ₂₁	(b)	-	2.46E+02	NR	NR	5.37E+01	4.84E+02	NR	NR	1.34E+02	7.69E+02	NR	NR	3.21E+02
Aromatic hydrocarbons >EC ₂₁ -EC ₂₅	(b)	-	8.72E+02	NR	NR	4.83E+00	1.10E+03	NR	NR	1.21E+01	1.22E+03	NR	NR	2.90E+01
Aromatic hydrocarbons >EC ₂₅ -EC ₄₄	(b)	-	8.72E+02	NR	NR	4.83E+00	1.10E+03	NR	NR	1.21E+01	1.22E+03	NR	NR	2.90E+01

Notes:

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

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



Calculated SAC exceeds soil saturation limit and may significantly affect the interpretation of any exceedances since the contribution of the indoor and outdoor vapour pathway to total exposure is >10%. This shading has also been used for the RSCA 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.

Calculated SAC exceeds soil saturation limit but will not effect the SSV significantly since the contribution of the indoor and outdoor vapour pathway to total exposure is <10%.

Calculated SAC does not exceed the soil saturation limit.

For consistency where the theoretical solubility limit within RSCA has been exceeded in production of the GrAC, these cells have also been hatched red.

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) SAC for arsenic, benzenes, benzo(a)pyrene, cadmium, chromium VI and lead are derived using the C4SL toxicology data.

(b) SAC for selenium should not include the inhalation pathway as no expert group HCV has been derived; aliphatic and aromatic hydrocarbons >EC16 should not include inhalation pathway due to their non-volatile nature and inhalation exposure being minimal (oral, dermal and inhalation exposure is compared to the oral HCV); arsenic should only be based on oral contribution (rather than combined) owing to the relative small contribution from inhalation in accordance with the SGV report. The Oral SAC should be adopted for zinc and benzo(a)pyrene.

(c) SAC for CrIII should be based on the lower of the oral and inhalation SAC (see LQM/CIEH 2015 Section 6.8)

(d) SAC for elemental mercury, chromium VI and nickel should be based on the inhalation pathway only.

(e) SAC for 1,3,5-trimethylbenzene is not recorded owing to the lack of toxicological data, SAC for 1,2,4 trimethylbenzene may be used.

GENERIC ASSESSMENT CRITERIA FOR HUMAN HEALTH - RESIDENTIAL WITH HOME-GROWN PRODUCE



Table 6
Human Health Generic Assessment Criteria for Residential with home-grown produce

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	-	37	37	37
Cadmium	-	30	30	30
Chromium (III) - trivalent	-	910	910	910
Chromium (VI) - hexavalent	-	21	21	21
Copper	-	2,500	2,500	2,500
Lead	-	200	200	200
Elemental Mercury (Hg ⁰)	0.0094	0.2	0.6	1.2
Inorganic Mercury (Hg ²⁺)	-	39	39	39
Methyl Mercury (Hg ⁴⁺)	20	10	10	10
Nickel	-	180	180	180
Selenium	-	258	258	258
Zinc	-	3,900	3,900	3,900
Cyanide	-	3.8	3.8	3.8
Volatile Organic Compounds				
Benzene	7.2	1.64	1.64	0.87
Toluene	590	130	300	680
Ethylbenzene	180	50	110	260
Xylene - m	84	59	140	327
Xylene - o	100	61	143	332
Xylene - p	87	57	133	310
Total xylene	84	57	133	310
Methyl tertiary-Butyl ether (MTBE)	2200	130	250	510
Trichloroethene	1.8	0.02	0.03	0.08
Tetrachloroethene	3.6	0.2	0.4	0.9
1,1,1-Trichloroethane	26	9	18	39
1,1,1,2-Tetrachloroethane	14	1.2	2.8	6.5
1,1,2,2-Tetrachloroethane	14	1.6	3.5	7.7
Carbon Tetrachloride	0.055	0.026	0.056	0.127
1,2-Dichloroethane	0.3	0.007	0.011	0.019
Vinyl Chloride	0.019	0.0006	0.0009	0.0014
1,2,4-Trimethylbenzene	0.075	1.8	4.3	9.7
1,3,5-Trimethylbenzene	0.047	NR	NR	NR
Semi-Volatile Organic Compounds				
Acenaphthene	3.2	230	540	1,170
Acenaphthylene	4.2	180	440	970
Anthracene	0.021	2,400	5,500	10,900
Benzo(a)anthracene	0.0038	7	11	13
Benzo(b)fluoranthene	0.002	2.6	3.3	3.7
Benzo(g,h,i)perylene	0.00026	310	340	350
Benzo(k)fluoranthene	0.0008	77	92	100
Chrysene	0.002	15	22	27
Dibenzo(a,h)anthracene	0.0006	0.24	0.28	0.30
Fluoranthene	0.23	280	560	900
Fluorene	1.9	170	410	880
Indeno(1,2,3-cd)pyrene	0.0002	27	36	41
Phenanthrene	0.53	100	220	440
Pyrene	0.13	620	1,240	2,040
Benzo(a)pyrene	0.0038	5	5	5
Naphthalene	19	13	30	71
Phenol	-	120	210	390
Total Petroleum Hydrocarbons				
Aliphatic hydrocarbons EC ₅ -EC ₈	10	42	78	160
Aliphatic hydrocarbons >EC ₈ -EC ₈	5.4	100	230	530
Aliphatic hydrocarbons >EC ₈ -EC ₁₀	0.23	27	65	154
Aliphatic hydrocarbons >EC ₁₀ -EC ₁₂	0.034	130 (48)	320 (118)	750 (283)
Aliphatic hydrocarbons >EC ₁₂ -EC ₁₆	0.00076	1,000 (24)	2,200 (59)	3,500 (142)
Aliphatic hydrocarbons >EC ₁₆ -EC ₃₅	-	53,000 (8)	70,000 (21)	79,000
Aliphatic hydrocarbons >EC ₃₅ -EC ₄₄	-	53,000 (8)	70,000 (21)	79,000
Aromatic hydrocarbons >EC ₈ -EC ₉ (styrene)	7.4	11	25	56
Aromatic hydrocarbons >EC ₉ -EC ₁₀	7.4	34	83	189
Aromatic hydrocarbons >EC ₁₀ -EC ₁₂	25	74	174	367
Aromatic hydrocarbons >EC ₁₂ -EC ₁₆	5.8	100	300	600
Aromatic hydrocarbons >EC ₁₆ -EC ₂₁	-	200	500	800
Aromatic hydrocarbons >EC ₂₁ -EC ₃₅	-	900	1,100	1,200
Aromatic hydrocarbons >EC ₃₅ -EC ₄₄	-	900	1,100	1,200
Minerals				
Asbestos	-	No asbestos detected with ID or <0.001% dry weight ¹		

Notes:

¹ Generic assessment criteria not calculated owing to low volatility of substance and therefore no pathway, or an absence of toxicological data.

NR - SAC for 1,3,5-trimethylbenzene is not recorded owing to the lack of toxicological data, SAC for 1,2,4-trimethylbenzene may be used

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

¹ LOD for weight of asbestos per unit weight of soil calculated on a dry weight basis using PLM, handpicking and gravimetry.

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.

(VALUE IN BRACKETS) The SAC has been set as the model calculated SAC with the saturation limit shown in brackets.

RSK has adopted an approach for petroleum hydrocarbons in accordance with LQM/CIEH 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.

(VALUE IN BRACKETS) For consistency where the GrAC exceeds the solubility limit, GrAC has been set at the solubility limit. The GrAC is conservative since 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.



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HP23 9ST

Our Ref: 27621L02/jr

24th October 2016

CALA Homes (South Home Counties) Limited
Tilford House
Farnham Business Park
Weydon Lane
Farnham
Surrey, GU9 8QT



For attention of: Mr Gary Biggs

Dear Sirs

RE: BUND VALIDATION WORKS AT FORMER WEST END NURSERY, ANGMERING

1. BACKGROUND

RSK Environment Limited (RSK) was commissioned by CALA Homes (South Home Counties) Limited to carry out validation testing of public open space and selected bunds following remediation works carried out by Keltbray Remediation Ltd (Keltbray). The site was previously occupied by a horticultural nursery growing herbs and historically comprised agricultural fields. A site location map is presented as **Figure 1**.

Several phases of investigation and risk assessment have previously been carried out by RSK. These are outlined in the following reports:

- RSK, 27621- R01(02) 'Geo-environmental Site Investigation', West End Nursery, Angmering, September 2015;
- RSK, 27621- R02 (00) 'Additional Geo-environmental Site Investigation and Remediation', West End Nursery, Angmering, June 2015;
- RSK, 27621- R03 (01) 'Remedial Strategy', West End Nursery, Angmering, January 2016; and
- RSK, 27621- R04 (01) 'Supplementary Geo-environmental Site Assessment', West End Nursery, Angmering, June 2016.

Previous investigations found evidence for asbestos containing materials (ACM) in trial pits TP1-9 (all excavated through the bund materials) and within boreholes BH1, BH4, BH12 and BH15 during the initial ground investigation. Elevated concentrations of hydrocarbons and metals were also identified within bund materials. On this basis a potentially complete pollutant linkage was identified to human health (construction workers and future residents) from asbestos in soil and elevated concentrations of hydrocarbons and metals.

In addition, elevated concentrations of pesticides were identified within shallow soils in the vicinity of HA5 (hand auger hole).



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2. REMEDIAL STRATEGY

A Remedial Strategy report (ref: 27621-R03[01]) was produced by RSK and approved by Arun District Council.

The report included the following objectives:

- The placement of a suitable clean cover layer within any private gardens and proposed communal soft landscaped areas in accordance with Section 4.3.3.1 (R03), locally deepened (to the requirements of the Landscape Architect) in the proximity of any proposed deep root-balled shrubs and/or trees. It is noted that tree pits could alternatively be constructed in raised planting beds (set upon areas of hardstanding) in order to break potential contamination pathways with respect to the underlying made ground;
- An asbestos survey suitable for demolition purposes (if not already available) required prior to demolition of the buildings;
- Following decommissioning and demolition of the CHP building, nitric acid store, substations and ASTs, it is recommended that, in the event that any visually impacted materials are observed, an Environmental Engineer be contacted so that appropriate sampling can be implemented to determine any additional remedial and validation requirements;
- Regarding of the bund materials (where required) to form site levels in accordance with the approved development plan, and to facilitate placement of a 'clean' cover layer across the remaining bund materials. Where possible material won as part of the re-grading exercise will be re-used on site in accordance with a materials management plan following the CL:AIRE Code of Practice. For example material may be placed beneath 'clean' cover and hardstanding areas in other parts of the site;
- Incorporation of gas protection measures within the proposed buildings: structural barrier comprising suspended or ground-bearing floor slab with appropriate ventilation and a minimum thickness of gas resistant membrane of 2000 gauge, sealed at all joints and penetrations. Detailed design of the gas measures will be required once foundation solutions have been finalised and an implementation report prepared for gas alone against which future verification can be undertaken; and
- Compliance with CAR 2012 through the adoption of safe working procedures with respect to the potential presence of ACM and notification to the HSE.

This validation report has been produced to summarise validation of remedial works to re-grade the bund materials. In order to achieve this objective, the following mitigation measures were recommended:

- Re-grading and movement of the bund material – A small section of the NW bund will need to be excavated to allow for an access road. In order to allow a suitable growing medium cover layer to be placed on bund material, sections of bunds will need to be re-graded, including removal of approximately 1.3m of the top, subject to the proposed levels approved under planning, the excavated materials can be reused beneath the 'clean cap' in other areas of the site;
- It was proposed that clean natural soils within the proposed public open space (POS) area at the centre of the site be excavated and used as a subsoil material for the covering of the soft landscaped areas and bunds. The resultant excavation could then be backfilled with waste soils from the bund re-grading exercise;
- Areas of concern across the site were to be capped with clean site-won subsoil (300mm) and imported certified clean topsoil (300mm), a total of 600mm. A geo-marker layer was recommended to be

installed at the base of the clean cover layer to provide a visual guide to the extent of the cover layer and act as a warning indicator with respect to waste soils placed below; and

- Areas designated for remediation to be carried out are shown on Figure 2 'Cover Layer Distribution Plan'. The areas targeted for remedial works included any exploratory positions where evidence for soil contamination had been identified through the course of ground investigation. Any soft landscaping identified within these areas was to be subject to the 600mm capping layer.

2.1 Cover Layer

In order to break the identified pollutant linkages, within proposed areas of private gardens and communal soft landscaping, the placement of a suitable clean cover layer will be required. To address potential risks posed from the impacts identified in a sustainable manner, a zoned approach is adopted in relation to the thickness of the clean cover layer as detailed below and summarised on **Figure 2**:

- 600mm in areas of identified impact (remaining bund materials, pesticide hotspot (HA5), and made ground containing asbestos), un-investigated areas considered to potentially be impacted (i.e. made ground extending to the south of the site buildings considered to potentially contain asbestos and soils in the vicinity of the fuel tanks and nitric acid store) and in the central landscaped area;
- 450mm in lower risk areas (i.e. no impact identified during the previous phases of works, no significant un-investigated potential sources identified and distribution of exploratory locations considered appropriate for 'low risk' to be concluded. This zone primarily relates to the footprint of the green house buildings; and
- The frequency of testing for any site-derived or imported materials stockpiled for re-use for private garden areas should be a minimum of one sample for every 50m³, with a minimum of 3 samples or one sample for every 250m³ in communal soft landscaping (public open space).

3. REMEDIAL WORKS

Remedial works were carried out by the nominated remedial contractor (Keltbray) and summarised within Keltbray's Completion Report (ref: 6033.CR.LH.08072016v3, dated 30/08/2016). The remedial works were limited to selected areas and predominantly comprised the following:

- Excavation of site-derived natural clean subsoil from the POS area;
- Excavation and processing of waste soils arising from bund re-grading works (NW Bund, SW Bund A, NE Bund).
- Backfilling of processed waste soil arisings from bunds into POS area; and
- Capping of re-graded bund areas and backfilled POS area with clean site-derived subsoil.

3.1 Public Open Space (POS) Area Investigation

Prior to implementation of remedial works by Keltbray, RSK undertook a series of mechanically excavated trial pits in the POS area to obtain representative soil samples to demonstrate that natural subsoil was suitable for use as a capping material.

On 27th April 2016, five trial pits were mechanically excavated to depths up to 3.2m bgl designated TP POS1 to TP POS5. Photographs of the trial pits are presented in **Appendix B**.

Made ground was identified from surface level to depths of 0.50-1.25m and comprised grey brown sandy gravelly clay with variable proportions of brick, asphalt and glass fragments. Natural soils were encountered beneath the made ground, generally comprising brown to orange brown sandy, slightly gravelly clay or clayey, sandy flint gravel. Trial pit logs are presented in **Appendix C**.

Suspected asbestos containing materials (fragments of cement bound asbestos) were identified at surface level in the vicinity of each trial pit location. No suspected asbestos containing materials were encountered within the trial pits.

Samples of natural soils beneath the made ground were submitted for laboratory testing, at a range of depths between 1.0-2.0m. The testing suite comprised a general suite of analysis and asbestos screening. Results were compared to the RSK human health Generic Assessment Criteria (GAC) for an end-use consisting of residential with private gardens. All determinants were found to be below the respective GAC.

Samples of made ground were not tested since suspected ACM were visible at surface level and extensive laboratory testing of made ground had been carried out across the site and, where present, fragments of suspected ACM have generally been found to comprise cement bound chrysotile asbestos.

Based on the POS investigation described above, natural subsoil materials beneath the made ground were determined to be suitable for re-use on site.

4. VALIDATION WORKS

RSK attended site on 9th and 23rd June plus 7th and 25th July 2016 to undertake validation works of the capping layer placed on the re-graded bunds and POS area.

4.1 Sampling strategy and methodology

In the remediated areas, a series of hand excavated validation trial pits were undertaken to allow inspection of the capping layer and recovery of representative soils for laboratory testing. Trial pits were excavated to the base of the capping layer (i.e. when the bright orange 'geo-marker' geotextile was encountered) or up to a maximum of 600mm depth. Validation locations were targeted to give a good spread across the areas subject to remedial works, whilst working to a sampling ratio of 1 in 250m³ (for communal soft landscaping, as agreed with Arun District Council).

4.2 Health and Safety Considerations

Prior to intrusive works, the RSK engineer undertook service clearance works using a Cable Avoidance Tool (CAT) and Genny to identify any potential underground utilities. Precautions were taken to ensure PPE (and RPE where appropriate) was worn by the engineer to prevent any potential exposure to contaminants within the underlying soils.

4.3 Investigation Locations

The following validation pits were carried out:

- NWB V1-8 - 9th June 2016;
- SWB V1-4 - 23rd June 2016;
- POS V1-12 - 7th July 2016;
- NEB V1-4 - 25th July 2016; and
- Additional inspection pits POS V13-16, POS V2A-D, POS V12-A-D - 22nd August 2016.

The exploratory hole records are presented in **Appendix C**.

The locations of the validation trial pits are shown on **Figure 3**. The positions were located approximately by reference to physical features present on the site at the time of investigation and were designed to provide accurate coverage of the capped areas across the bunds and POS to determine the thickness of the capping layer and obtain representative soil samples for laboratory testing.

4.4 Soil Sampling, In-Situ Testing and Laboratory Analysis

Soils obtained for laboratory analysis were collected in a variety of containers appropriate to the testing suite carried out. Samples were stored in accordance with the RSK quality procedures to maintain sample integrity and preservation and to minimise the chance of cross-contamination.

Samples were taken from each pit along with occasional bulk samples for asbestos identification where required. The samples were transported to the laboratory in chilled cool boxes. Laboratory chain of custody forms can be provided if required.

4.5 Limitations

It should be noted that no remedial works had been undertaken on the SW bund B, SE bund or in areas outside of the site hoarding (particularly the western portion of SW bund A).

5. GROUND CONDITIONS

Ground conditions encountered during the validation works are discussed below. Full descriptions of the strata encountered, notes regarding visual or olfactory evidence of contamination, list of samples taken and field observations are included on the exploratory hole records presented in **Appendix C**.

5.1 Soil

The validation trial pits revealed the thickness of the capping layer and comments on the presence of the 'geo-marker' layer. Results of the validation inspections are summarised in **Table 1** below.

Table 1: Capping layer summary information

Validation Pit	Thickness of Capping Layer (mm)	Geo-marker Encountered (at base of trial pit)
NWBV1	500	Yes
NWBV2	700	No, but observed being placed during construction
NWBV3	300	Yes
NWBV4	400	Yes
NWBV5	750	No, but observed being placed during construction
NWBV6	550	Yes
NWBV7	550	Yes
NWBV8	380	Yes
SWBV1	750	No
SWBV2	800	No
SWBV3	550	Yes
SWBV4	450	Yes
POSV1	600	Yes
POSV2	400	No – Terminated due to Asbestos Containing Material at base
POSV3	650	No
POSV4	650	No
POSV5	650	No
POSV6	600	Yes
POSV7	650	No
POSV8	650	No
POSV9	450	Yes
POSV10	550	Yes
POSV11	650	Yes
POSV12	650	No
NEBV1	650	Yes
NEBV2	700	Yes
NEBV3	750	Yes
NEBV4	800	Yes

POSV13	650	Yes
POSV14	750	Yes
POSV15	650	Yes
POSV16	850	No
Notes: 1. Validation sample locations highlighted blue contained clean cover subsoil less than 600mm thick. 2. POSV2A-D and POSV12A-D have been excluded from this table since their purpose was to obtain additional samples for asbestos screening and note assess capping layer thickness.		

The thickness of the capping layer was found to range from 300mm to 850mm. The geo-marker layer was not identified in all positions, however it is understood that it was present at depths greater than 600mm. RSK witnessed placement of the 'geo-marker' layer by Keltbray during earlier visits while capping of the bunds was still in progress.

5.2 Evidence of contamination

Following the initial validation, asbestos-containing materials were found at surface level in selected areas of the NW bund, NE bund, SW bund A and POS. Laboratory testing confirmed presence of Chrysotile cement from surface samples obtained from the NW bund and POS. Asbestos was also identified in soil samples obtained from POSV2 and POSV12.

A recommendation for hand picking of visible fragments of asbestos from the surface of the bunds was made by RSK and completed by Keltbray (as summarised in Keltbray Completion Report). Additional delineation and soil sampling works were recommended in the vicinity of POSV2 and POSV12.

6. LABORATORY TESTING

Representative soil samples were obtained from each validation trial pit and submitted for chemical laboratory testing comprising:

- Heavy metals (arsenic, cadmium, chromium, copper, nickel, lead, mercury, selenium and zinc);
- pH;
- Speciated total petroleum hydrocarbons (TPH-CWG)
- BTEX (benzene, toluene, ethylbenzene and xylene);
- 16 No. Speciated PAH; and
- Asbestos in soil.

6.1 Direct contact with impacted soil by future residents

The validation criteria are RSK-derived GAC's suitable for a residential with plant uptake end-use for 6% soil organic matter (SOM) in accordance with the Remediation Strategy. Concentrations of potential contaminants did not exceed the GAC within any of the samples for the determinants tested.

Chrysotile asbestos was identified in samples taken from validation trial pits POSV2 and POSV12. Bulk samples of suspected ACM obtained from surface level on the bunds and POS were positive.

All other soil samples taken described above returned negative results for the presence of asbestos fibres.

7. ADDITIONAL WORKS

Following identification of ACM in several areas across the site on the surface of bunds and within two soil samples (POSV2 and POSV12), Keltbray carried out a series of hand-picking exercises across these areas. RSK reinspected areas after Keltbray had completed hand-picking and were satisfied that visually identifiable asbestos fragments had been removed.

Additional validation trial pits were excavated by RSK on 2nd August 2016 to confirm the extent of asbestos materials in the vicinity of POSV2 and POSV12. Representative soils samples were obtained from the validation pits (POSV12A-D and POSV2A-D) and submitted for laboratory testing to screen for the presence of asbestos fibres. None of the additional soil samples were found to contain asbestos fibres.

8. CONCLUSIONS

Fragments of cement-bound asbestos sampled from surface level at the NW bund, NE bund, SW bund A and POS were handpicked and removed by Keltbray. Where asbestos fibres were identified within soils at POSV2 and POSV12, additional sampling in these areas demonstrated no further evidence for asbestos.

The information on thickness of the capping layer as noted in **Table 1** demonstrates that cover soils range in thickness from 300mm to 850mm. It is understood that topsoil is to be placed in all areas of soft landscaping across the site on top of the subsoil already validated, and it is recommended that particular attention is paid to the areas highlighted above to ensure sufficient topsoil is placed to complete construction of the cover layer to the full thickness of 600mm.

The geo-marker layer was not encountered in all inspection pits however, in these areas, the thickness of the capping layer met or exceeded the recommended thickness and it is understood that the geo-marker layer will be present at depths greater than 600mm.

Additional validation works are recommended following placement of topsoil in areas where the cover layer was less than 600mm.

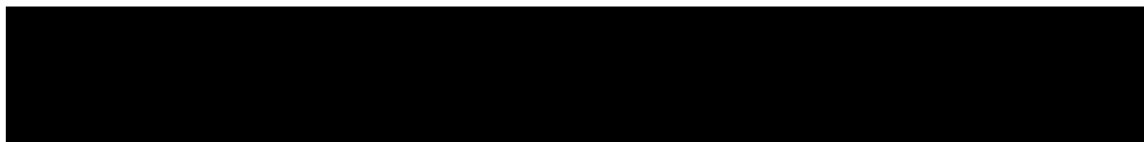
Further remedial and validation works are required with respect to SW bund B, SE bund and part of the SW bund A that was outside of the hoarding during the initial phase of remedial works.

Following completion of all remedial works on site, a verification report will be produced to summarise the extent of remediation and subsequent validation undertaken.

We trust that the information discussed above is acceptable and recommend this report be submitted to the NHBC and Local Authority accordingly. Should you require RSK to submit this information on your behalf, please do not hesitate to contact us.

Yours faithfully

For RSK Environment Limited



Jennifer Russell

Graduate Geo-Environmental Engineer

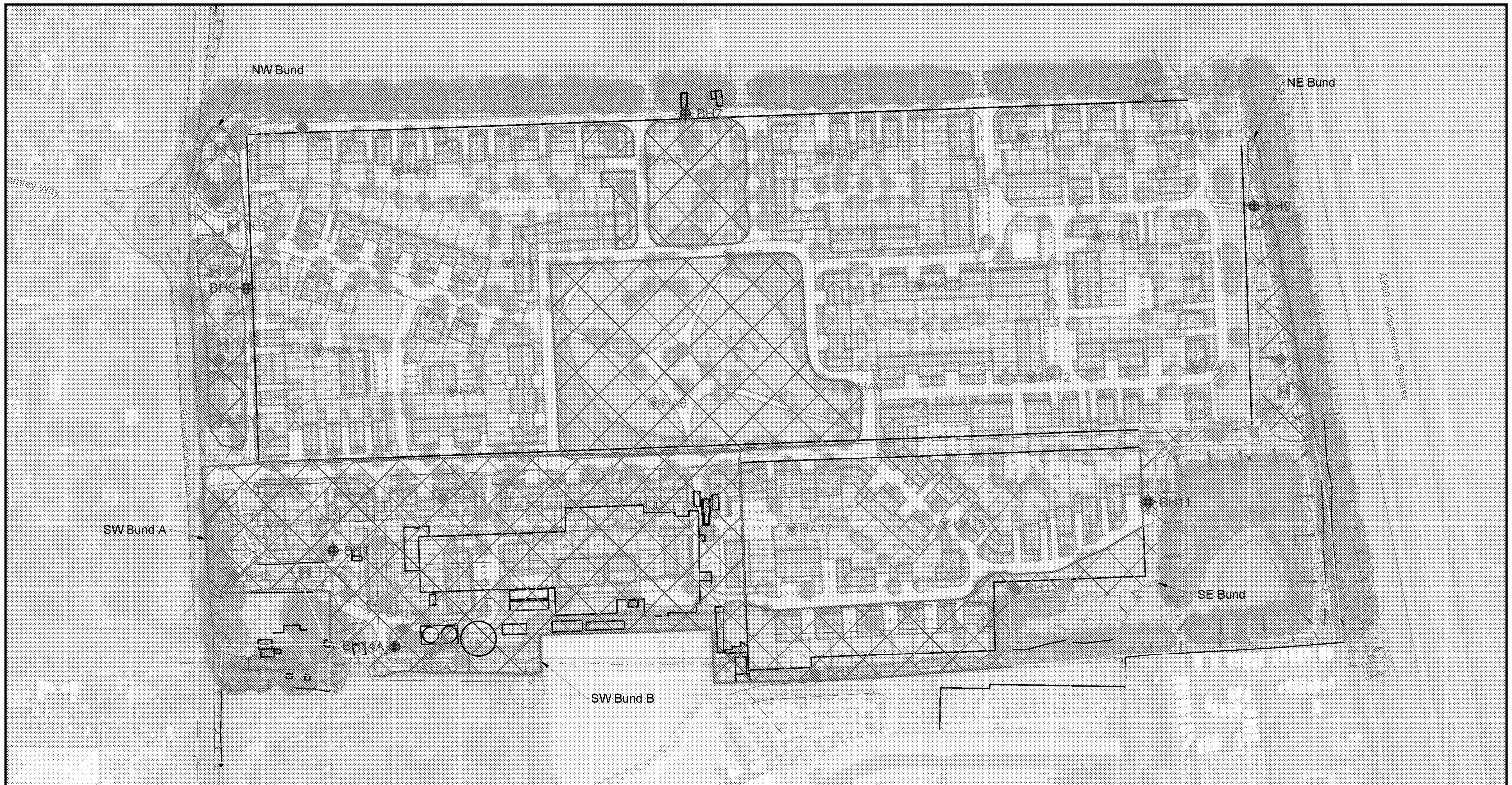
Andrew James

Principal Geo-Environmental Engineer

Figure 1 Site Location Map
Figure 2 Exploratory Hole Location Plan
Figure 3 Validation Location Plan

Appendix A Service Constraints
Appendix B Photographic Log
Appendix C Trial Pit Logs
Appendix D Laboratory Certificates
Appendix E RSK Generic Assessment Criteria

FIGURES



LEGEND

- Borehole Location - Jan 2015
- Hand Auger Location - Jan 2015
- Borehole Location with installation - Jan 2015
- Trial Pit Location - May 2015
- Borehole Location - Oct 2015
- Hand Pit Location - Oct 2015
- 600mm Cover Layer Required in Soft Landscaped/Private Gardens.



Note: All other soft landscaping/private gardens require 450mm cover layer: Refer to report 27621 R03 (00) for further details.

- ① Impacted Bund Materials
- ② Potentially Impacted Bund Materials
- ③ Pesticide Hotspot
- ④ Asbestos Containing Materials (ACM) Detected in Made Ground
- ⑤ Likely Hydrocarbon Hotspot and Potential for Nitric Acid Impacts
- ⑥ Re-use of Asbestos Impacted Soils at Depth



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Drawn	Date	Checked	Date	Approved	Date
SAY	06.11.15	ARJ	06.11.15	ARJ	06.11.15

Scale	Orig Size	Dimensions
1:1500	A3	m

Client
CALA HOMES (SOUTH HOME COUNTIES) LTD

Project Title
**WEST END NURSERY,
ANGMERING**

Drawing Title
PROPOSED DEVELOPMENT PLAN

Project No.
27621 - L02 (00)

Drawing File
27621 (L02-00).dwg

Drawing No.
FIGURE 2

Rev.
P1

Rev.	Date	Amendment	Drawn	Chkd.	Appd.



APPENDIX A

SERVICE CONSTRAINTS

1. This report and the site investigation carried out in connection with the report (together the "Services") were compiled and carried out by RSK Environment Limited (RSK) for CALA Homes (South Home Counties) (the "client") in accordance with the terms of a contract between RSK and the "client", dated 09/09/16. The Services were performed by RSK with the skill and care ordinarily exercised by a reasonable environmental consultant at the time the Services were performed. Further, and in particular, the Services were performed by RSK taking into account the limits of the scope of works required by the client, the time scale involved and the resources, including financial and manpower resources, agreed between RSK and the client.
2. Other than that expressly contained in paragraph 1 above, RSK provides no other representation or warranty whether express or implied, in relation to the Services.
3. Unless otherwise agreed in writing the Services were performed by RSK exclusively for the purposes of the client. RSK is not aware of any interest of or reliance by any party other than the client in or on the Services. Unless expressly provided in writing, RSK does not authorise, consent or condone any party other than the client relying upon the Services. Should this report or any part of this report, or otherwise details of the Services or any part of the Services be made known to any such party, and such party relies thereon that party does so wholly at its own and sole risk and RSK disclaims any liability to such parties. **Any such party would be well advised to seek independent advice from a competent environmental consultant and/or lawyer.**
4. It is RSK's understanding that this report is to be used for the purpose described in the introduction to the report. That purpose was a significant factor in determining the scope and level of the Services. Should the purpose for which the report is used, or the proposed use of the site change, this report may no longer be valid and any further use of or reliance upon the report in those circumstances by the client without RSK's review and advice shall be at the client's sole and own risk. Should RSK be requested to review the report after the date of this report, RSK shall be entitled to additional payment at the then existing rates or such other terms as agreed between RSK and the client.
5. The passage of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the report inaccurate or unreliable. The information and conclusions contained in this report should not be relied upon in the future without the written advice of RSK. In the absence of such written advice of RSK, reliance on the report in the future shall be at the client's own and sole risk. Should RSK be requested to review the report in the future, RSK shall be entitled to additional payment at the then existing rate or such other terms as may be agreed between RSK and the client.
6. The observations and conclusions described in this report are based solely upon the Services which were provided pursuant to the agreement between the client and RSK. RSK has not performed any observations, investigations, studies or testing not specifically set out or required by the contract between the client and RSK. RSK is not liable for the existence of any condition, the discovery of which would require performance of services not otherwise contained in the Services. For the avoidance of doubt, unless otherwise expressly referred to in the introduction to this report, RSK did not seek to evaluate the presence on or off the site of asbestos, electromagnetic fields, lead paint, heavy metals, radon gas or other radioactive or hazardous materials.
7. The Services are based upon RSK's observations of existing physical conditions at the Site gained from a walk-over survey of the site together with RSK's interpretation of information including documentation, obtained from third parties and from the client on the history and usage of the site. The Services are also based on information and/or analysis provided by independent testing and information services or laboratories upon which RSK was reasonably entitled to rely. The Services clearly are limited by the accuracy of the information, including documentation, reviewed by RSK and the observations possible at the time of the walk-over survey. Further RSK was not authorised and did not attempt to independently verify the accuracy or completeness of information, documentation or materials received from the client or third parties, including laboratories and information services, during the performance of the Services. RSK is not liable for any inaccurate information or conclusions, the discovery of which inaccuracies required the doing of any act including the gathering of any information which was not reasonably available to RSK and including the doing of any independent investigation of the information provided to RSK save as otherwise provided in the terms of the contract between the client and RSK.
8. The intrusive environmental site investigation aspects of the Services is a limited sampling of the site at pre-determined borehole and soil vapour locations based on the operational configuration of the site. The conclusions given in this report are based on information gathered at the specific test locations and can only be extrapolated to an undefined limited area around those locations. The extent of the limited area depends on the soil and groundwater conditions, together with the position of any current structures and underground facilities and natural and other activities on site. In addition chemical analysis was carried out for a limited number of parameters [as stipulated in the contract between the client and RSK] [based on an understanding of the available operational and historical information], and it should not be inferred that other chemical species are not present.
9. Any site drawing(s) provided in this report is (are) not meant to be an accurate base plan, but is (are) used to present the general relative locations of features on, and surrounding, the site. Features (boreholes, trial pits etc) annotated on site plans are not drawn to scale but are centred over the approximate location. Such features should not be used for setting out and should be considered indicative only.



APPENDIX B PHOTOGRAPHIC LOG

PHOTOGRAPHIC LOG

Site Location: West End Nursery

Photo No.
1

Date:
27/04/2016

TP POS1



Photo No.
2

Date:
27/04/2016

TP POS2



PHOTOGRAPHIC LOG

Site Location: West End Nursery

Photo No.
3

Date:
27/04/2016

TP POS3



Photo No.
4

Date:
27/04/2016

Soils
recovered
from TP
POS4



PHOTOGRAPHIC LOG

Site Location: West End Nursery

Photo No.
5

Date:
27/04/2016

TP POS5

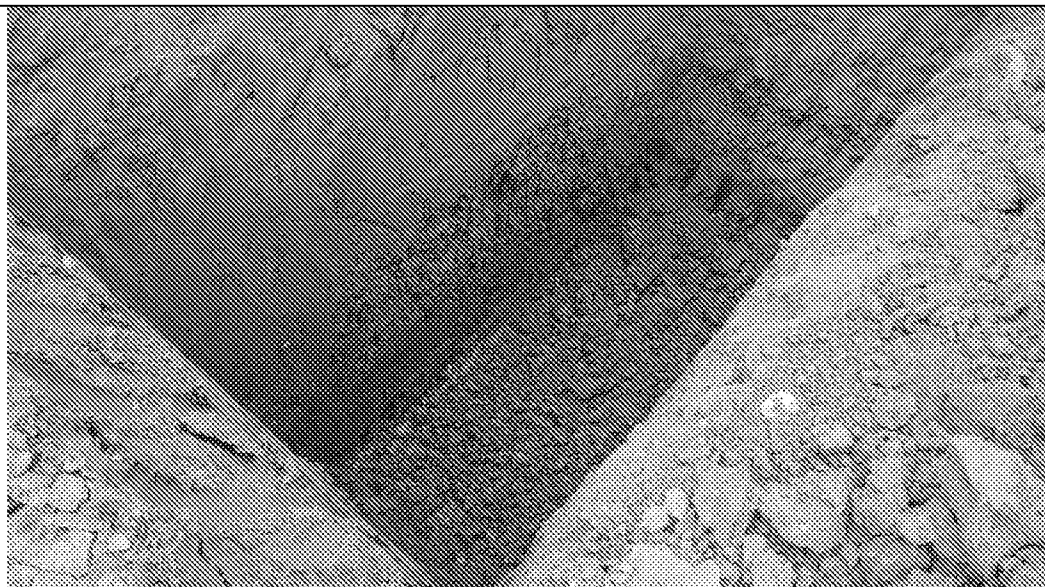


Photo No.
6

Date:
27/04/2016

View
looking
south
west
towards
north west
bund
(NWB).



PHOTOGRAPHIC LOG

Site Location: West End Nursery

Photo No.
7

Date:
09/06/2016

View looking north west showing the north west bund.



Photo No.
8

Date:
09/06/2016

NWB V1 dug to a depth of 0.50m.



PHOTOGRAPHIC LOG

Site Location: West End Nursery, Angmering

Photo No.
9

Date:
09/06/2016

NWB V2
dug to a
depth of
0.70m.



Photo No.
10

Date:
09/06/2016

NWB V3
dug to a
depth of
0.30m.



PHOTOGRAPHIC LOG

Site Location: West End Nursery, Angmering

Photo No.
11

Date:
09/06/2016

NWB V4
dug to a
depth of
0.40m.

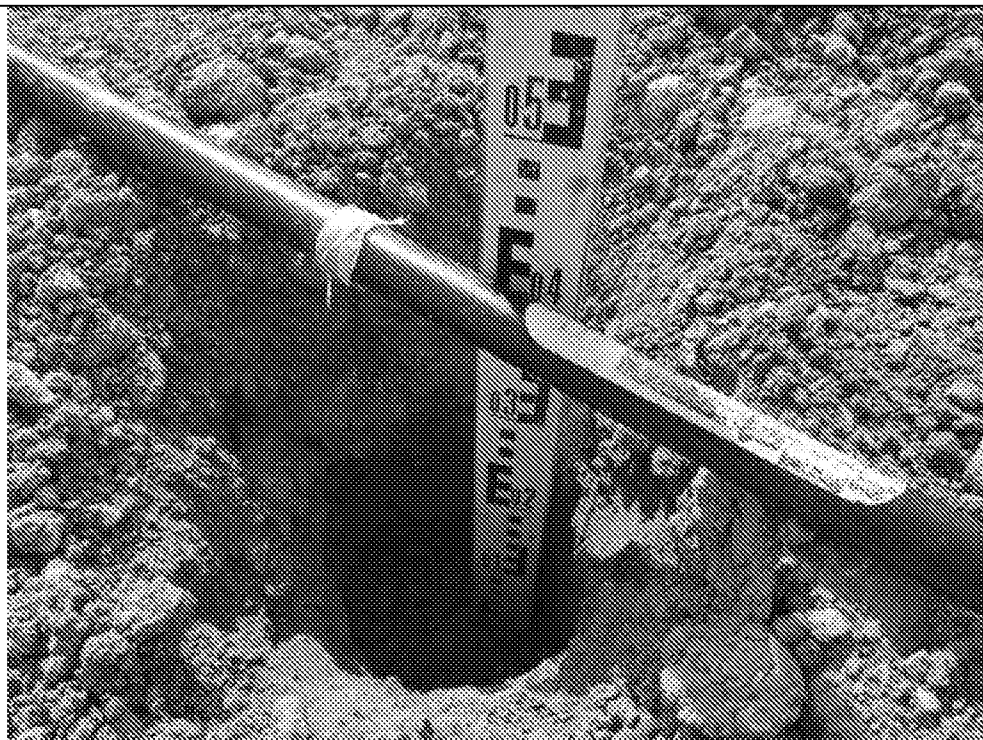


Photo No.
12

Date:
09/06/2016

NWB V5
dug to a
depth of
0.75m.



PHOTOGRAPHIC LOG

Site Location: West End Nursery, Angmering

Photo No.
13

Date:
09/06/2016

NWB V6
dug to a
depth of
0.55m.

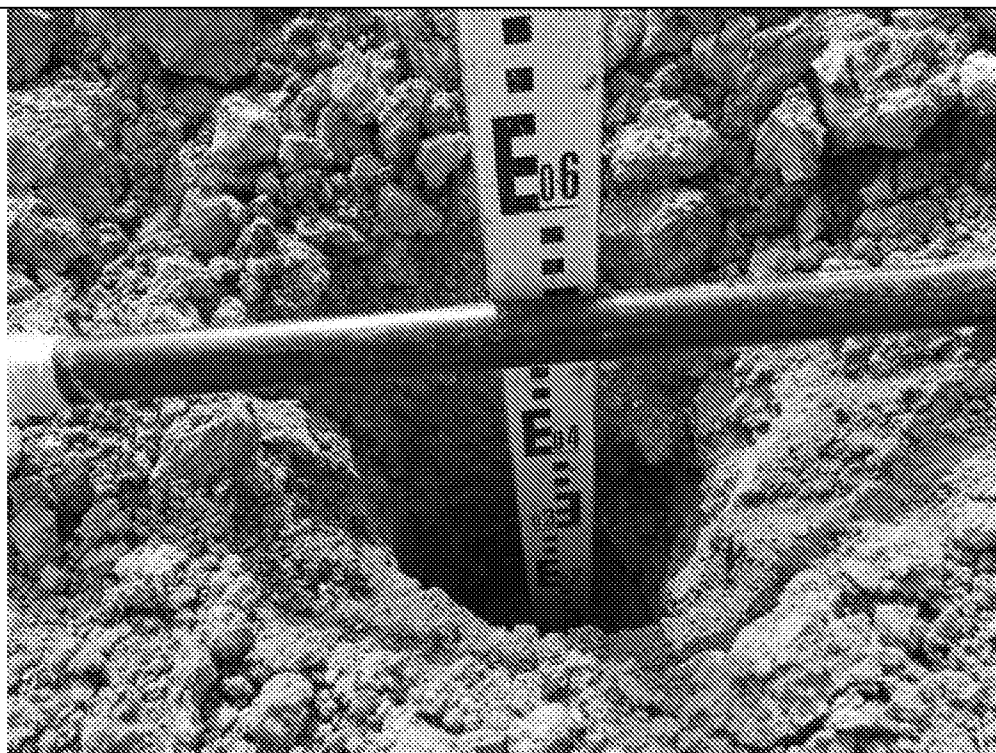


Photo No.
14

Date:
09/06/2016

NWB V7
dug to a
depth of
0.55m.



PHOTOGRAPHIC LOG

Site Location: West End Nursery, Angmering

Photo No.
15

Date:
09/06/2016

NWB V8
dug to a
depth of
0.38m.

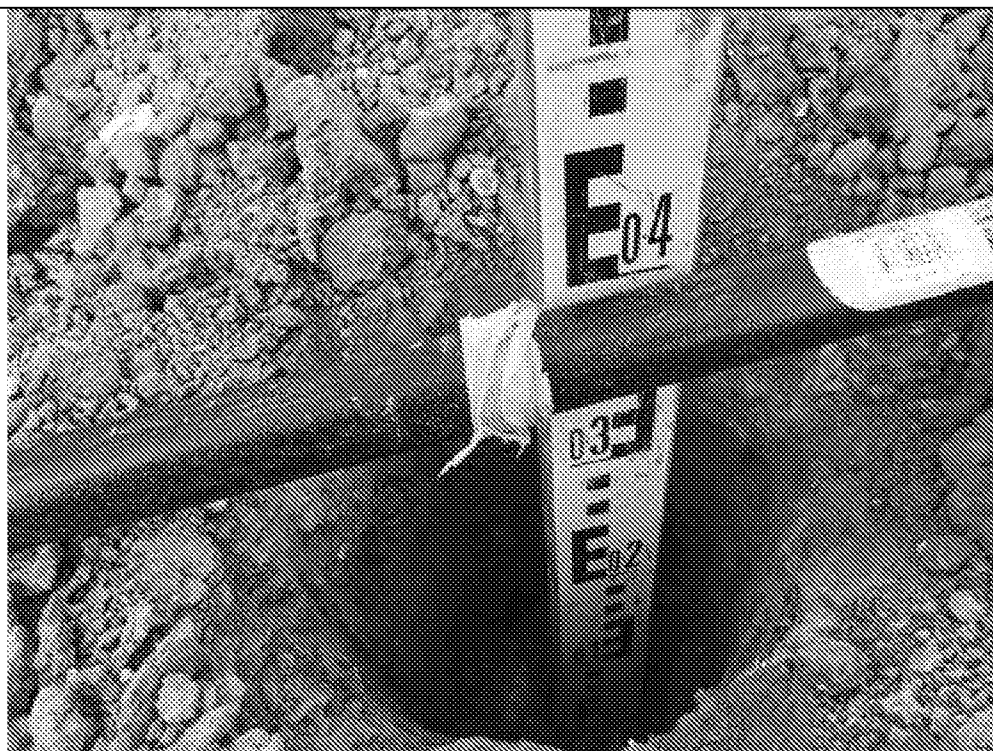


Photo No.
16

Date:
24/05/2016

Construction
of south
west bund
(SWB).



PHOTOGRAPHIC LOG

Site Location: West End Nursery, Angmering

Photo No.
17

Date:
23/06/2016

Overview photograph of SWB V1 dug to a depth of 0.75m.

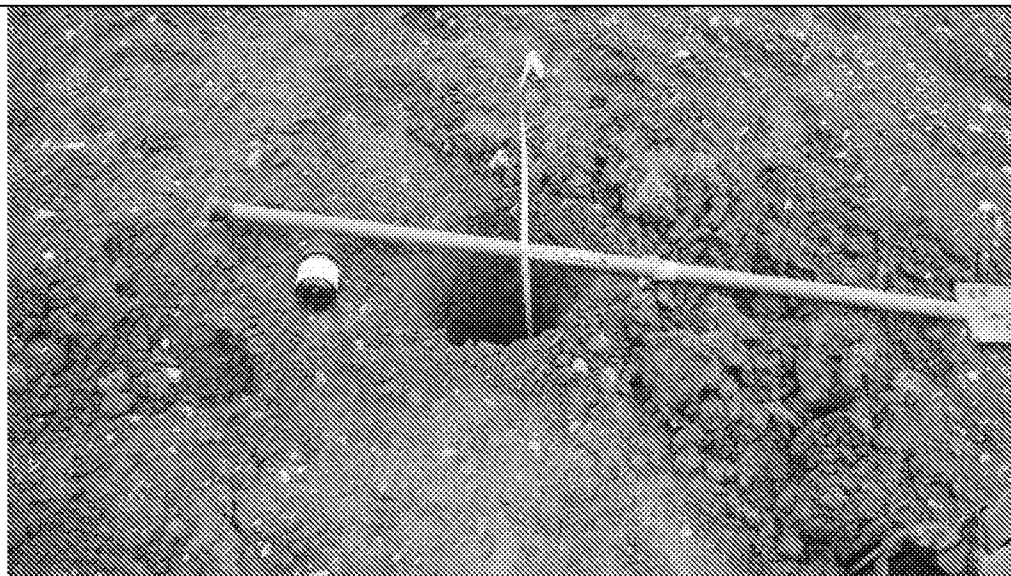


Photo No.
18

Date:
23/06/2016

A closer image of SWB V1.



PHOTOGRAPHIC LOG

Site Location: West End Nursery, Angmering

Photo No.
19

Date:
23/06/2016

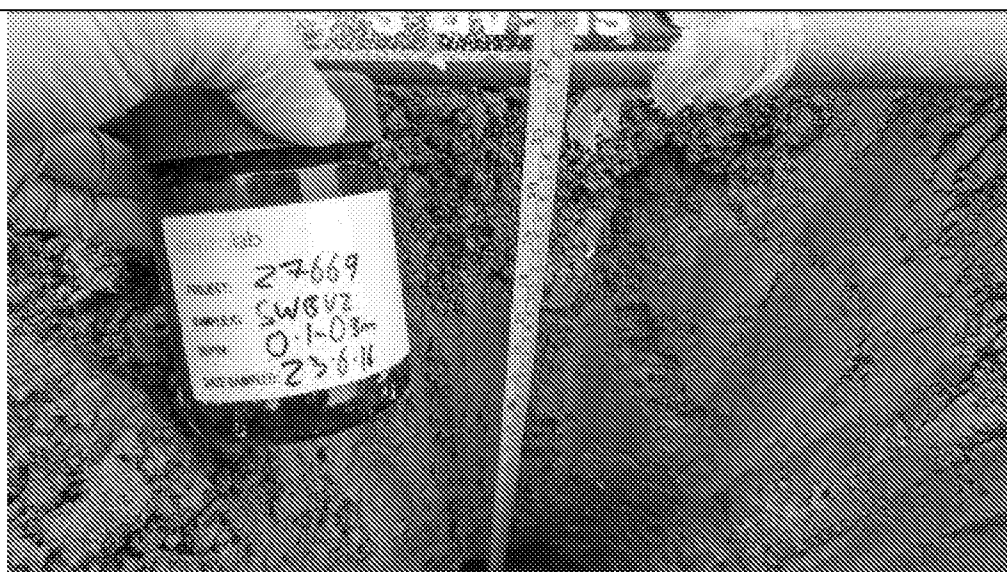
Possible ACM found to the west of the car park in between SWB C1 and SWB V2.



Photo No.
20

Date:
23/06/2016

SWB V2 dug to a depth of 0.80m.



PHOTOGRAPHIC LOG

Site Location: West End Nursery, Angmering

Photo No.
21

Date:
23/06/2016

Image showing the orange marker layer at the base of SWB V3.

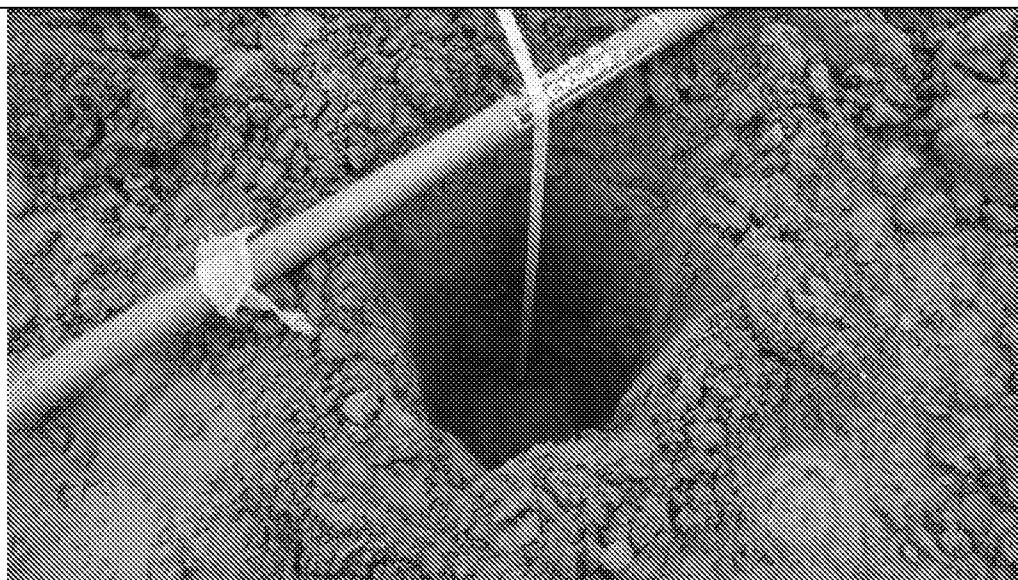
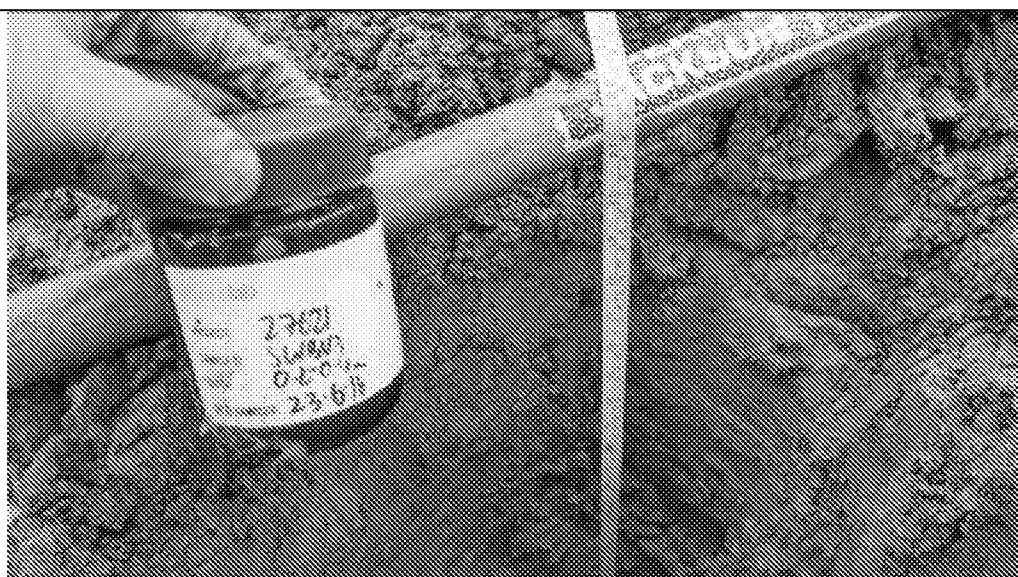


Photo No.
22

Date:
23/06/2016

SWB V3 dug to a depth of 0.55m.



PHOTOGRAPHIC LOG

Site Location: West End Nursery, Angmering

Photo No.
23

Date:
23/06/2016

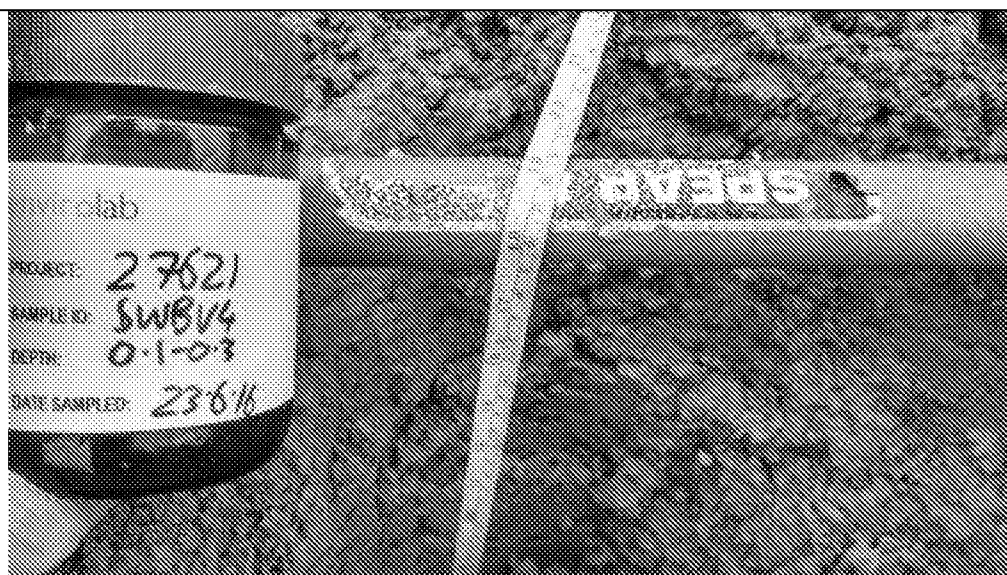
Image showing the orange marker layer encountered at the base of SWB V4.



Photo No.
24

Date:
23/06/2016

SWB V4 dug to a depth of 0.45m.



PHOTOGRAPHIC LOG

Site Location: West End Nursery, Angmering

Photo No.
25

Date:
07/07/2016

Image looking west across the POS, towards the site entrance and the south western bund.



Photo No.
26

Date:
07/07/2016

Image looking north across the POS, towards the small buildings on the boundary of the site.



PHOTOGRAPHIC LOG

Site Location: West End Nursery, Angmering

Photo No.
27

Date:
07/07/2016

Image looking east across the POS, towards the north eastern bund.



Photo No.
28

Date:
07/07/2016

POS V1 to a depth of 0.60m depth with the marker layer found at base.



PHOTOGRAPHIC LOG

Site Location: West End Nursery, Angmering

Photo No.
29

Date:
07/07/2016

Cement
bound
asbestos
found at a
depth of
0.40m in
POS V2.

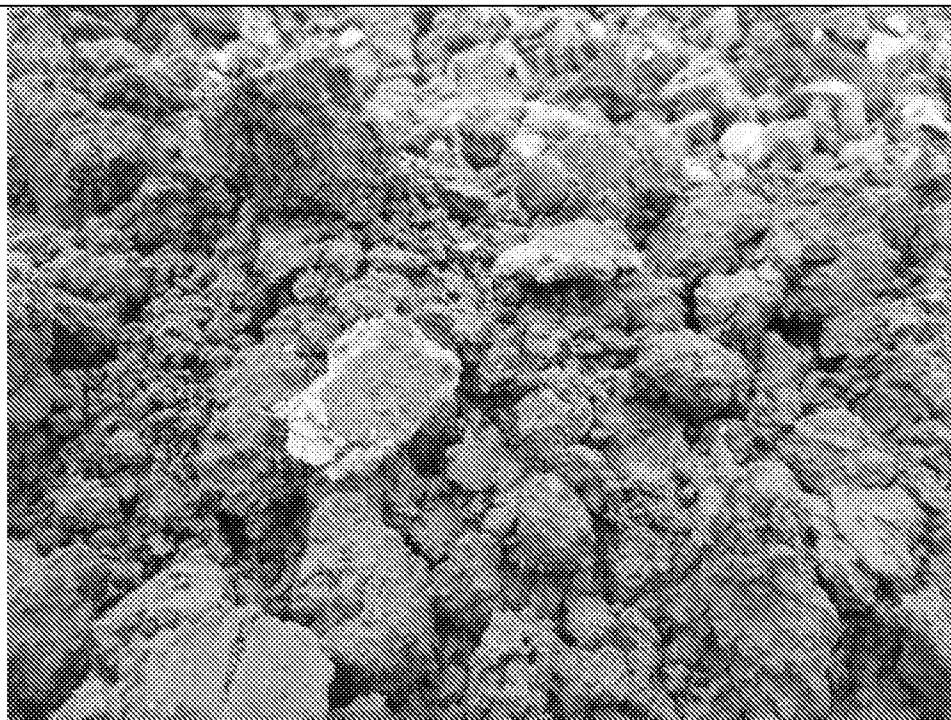


Photo No.
30

Date:
07/07/2016

POS V2
dug to a
depth of
0.40m
depth.



PHOTOGRAPHIC LOG

Site Location: West End Nursery, Angmering

Photo No.
31

Date:
07/07/2016

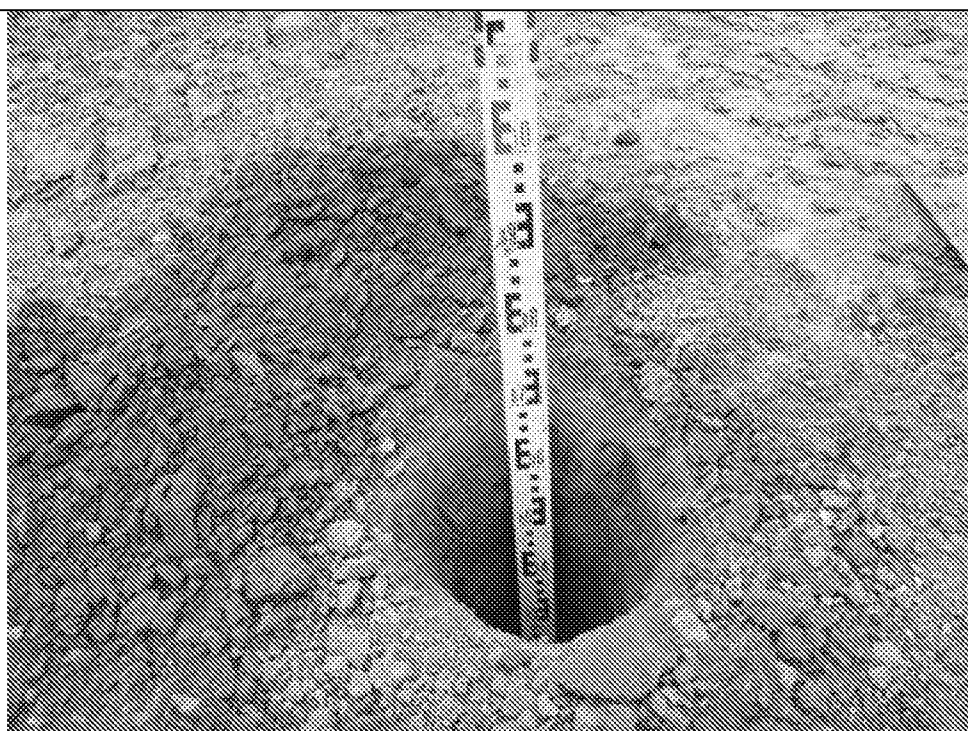
POS V3
dug to a
depth of
0.60m.



Photo No.
32

Date:
07/07/2016

POS V4
dug to a
depth of
0.65m.



PHOTOGRAPHIC LOG

Site Location: West End Nursery, Angmering

Photo No.
33

Date:
07/07/2016

POS V5
dug to a
depth of
0.65m.

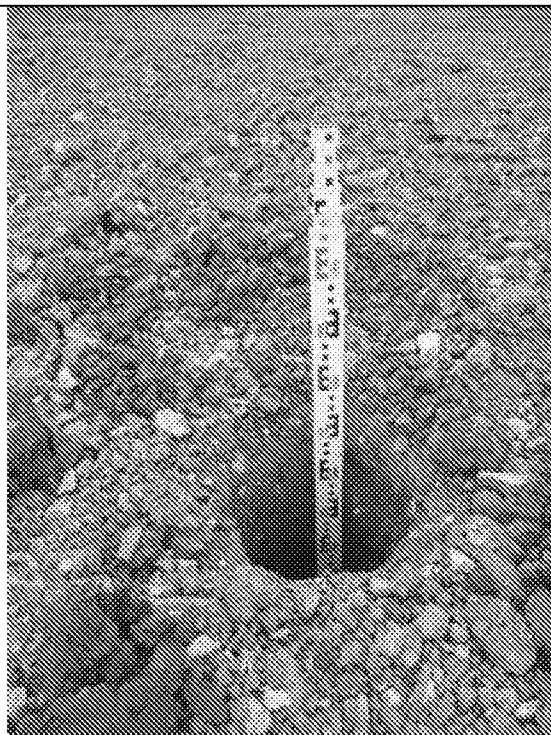
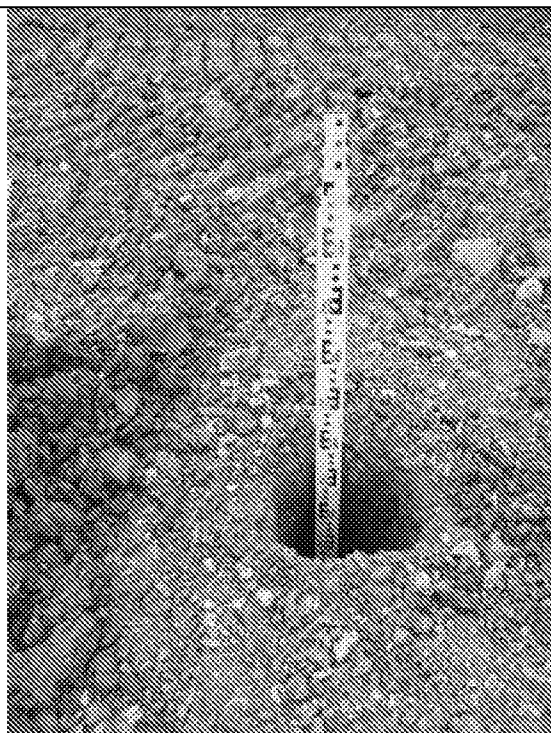


Photo No.
34

Date:
07/07/2016

POS V6
dug to a
depth of
0.60m.



PHOTOGRAPHIC LOG

Site Location: West End Nursery, Angmering

Photo No.
35

Date:
07/07/2016

POS V7
dug to a
depth of
0.65m.

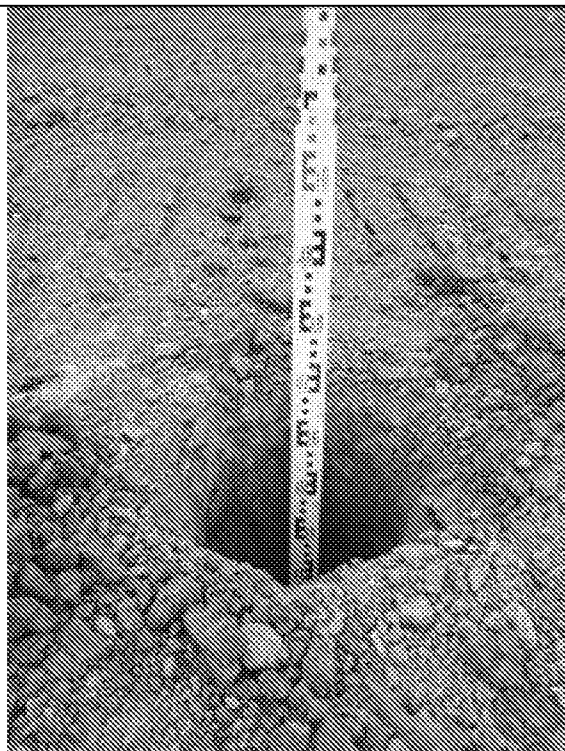
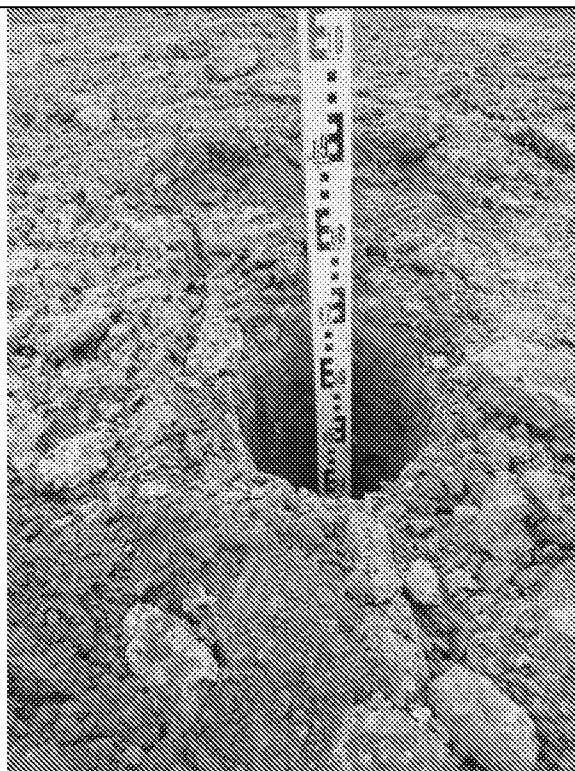


Photo No.
36

Date:
07/07/2016

POS V8
dug to a
depth of
0.65m.



PHOTOGRAPHIC LOG

Site Location: West End Nursery, Angmering

Photo No.
37

Date:
07/07/2016

POS V9
dug to a
depth of
0.45m

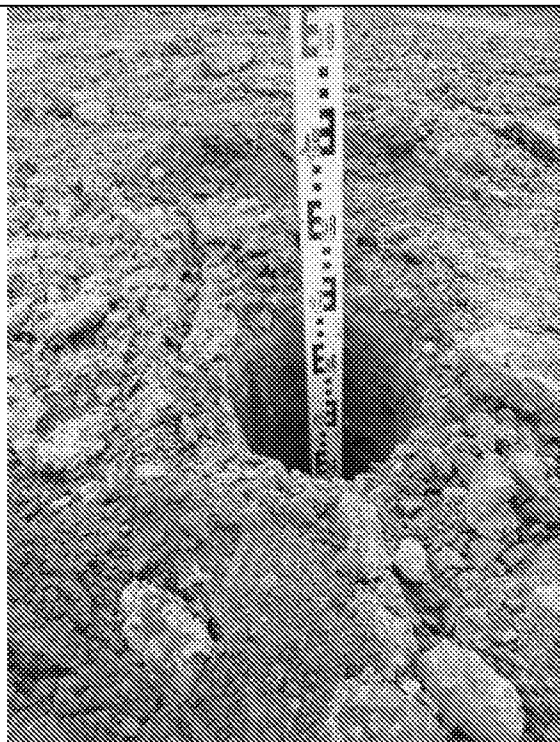
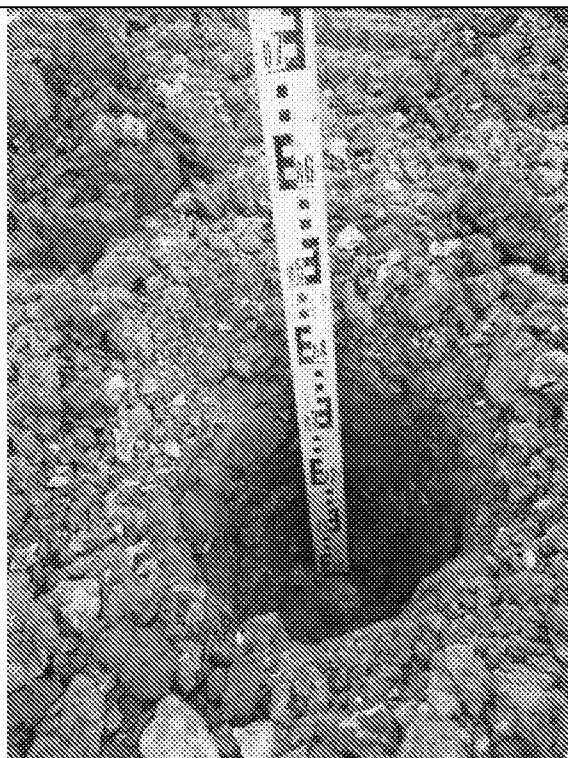


Photo No.
38

Date:
07/07/2016

POS V11
dug to a
depth of
0.63m.



PHOTOGRAPHIC LOG

Site Location: West End Nursery, Angmering

Photo No.
39

Date:
07/07/2016

POS V12
dug to a
depth of
0.65m.

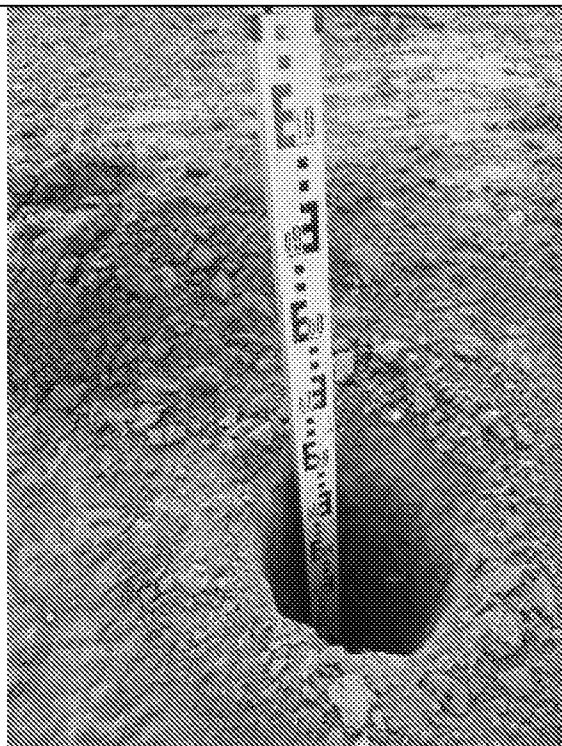
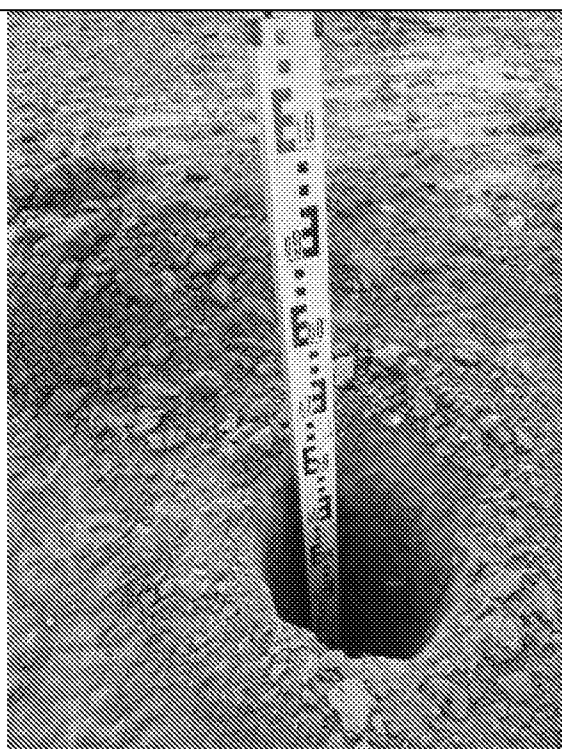


Photo No.
40

Date:
07/07/2016

POS V12
dug to a
depth of
0.65m.



PHOTOGRAPHIC LOG

Site Location: West End Nursery, Angmering

Photo No.
41

Date:
25/07/2016

Image looking north east showing the north east bund.



Photo No.
42

Date:
25/07/2016

NEB V1 to a depth of 0.65m depth.

