



Supplementary Investigation Report

at

Cinders Nursery, Cinders Lane, Yapton, West Sussex BN18 0JJ

for

Crayfern Homes

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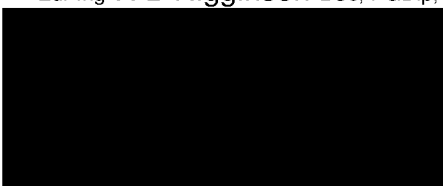
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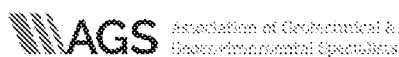
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Current regulations and good practice were used in the preparation of this report. The recommendations given in this report must be reviewed by an appropriately qualified person at the time of preparation of the scheme design to ensure that any recommendations given remain valid in light of changes in regulation and practice, or additional information obtained regarding the site.



Commission

Soils Limited was commissioned by Crayfern Homes to undertake an intrusive ground investigation and prepare a Main Investigation Report on a site known as land at Cinders Nursery, Cinders Lane, Yapton, West Sussex BN18 0JJ. The scope of the investigation was outlined in the Soils Limited quotation reference Q21009, dated 28th January 2019.

This document comprises the Supplementary Investigation Report and incorporates the results, discussion and conclusions to the supplementary intrusive works.

This Supplementary Investigation Report must be read in conjunction with the Main Investigation Report undertaken on the above site by Soils Limited, ref: 17034/MIR/Rev1.01, dated August 2019 to which this report forms an addendum.

Standards

The site works, soil descriptions and geotechnical testing was undertaken in accordance with the following standards:

- BS 10175:2011+A2:2017 - Investigation of potentially contaminated sites
- NHBC Standards 2019

The chemical analyses were undertaken by i2 Testing Services in accordance with their UKAS and MCERTS accredited test methods or their documented in-house testing procedures. This investigation did not comprise an environmental audit of the site or its environs.

Trial hole is a generic term used to describe a method of direct investigation. The term trial pit, borehole or window sample borehole implies the specific technique used to produce a trial hole.

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Section I Introduction

I.1 Objective of Investigation

Soils Limited was commissioned by Crayfern Homes to undertake an intrusive ground investigation and to prepare a Supplementary Investigation Report to supply the client and their designers with information regarding ground conditions in areas unable to be accessed prior to demolition of site structures and site clearance within areas of proposed open ground and residential back gardens – identified as the most vulnerable site areas.

Soil samples were taken for chemical laboratory testing to enable recommendations for the safe redevelopment of the site and the protection of site workers, end-users and the public from any contamination identified as dictated by the Conceptual Site Model (CSM) in the Main Investigation Report undertaken for the site by Soils Limited (ref: 17034/MIR/Rev1.01, dated August 2018).

I.2 Location

The site was located at Cinders Nursery, Cinders Lane, Yapton, West Sussex BN18 0JJ and had an approximate O.S Land Ranger Grid Reference of SU 980 026.

The site location plan is given in

Figure 1.

I.3 Site Description

At the time of the Main Investigation in August 2018, the site was a former nursery comprising industrial greenhouses to the northeast and number of bungalows to the south and southeast. The greenhouses were in poor condition.

Several metal tanks were noted on the site, although their former use was not evident, and there was no sign of material spillages or leaks or odours. A few concrete storage buildings were located to the south of the site, with stockpiles of various construction

materials also noted.

The site was generally flat with a mixture of open land, access tracks with gravel and broken tarmac surfacing, and small clusters of mature trees across the site. A ditch was evident along the western site boundary.

The site was surrounded by allotments to the north, farmland to the east and south, and residential land-use to the west.

By the time of this investigation in October 2019, the site had been cleared and was open undeveloped ground. No evidence of the former tank locations, concrete buildings or greenhouses was noted on site.

An aerial photograph has been included in Figure 2.

1.4 Proposed Development

The proposed residential development comprised 51 No. one to four-bedroom homes including detached and semi-detached houses and a single apartment block. Soft landscaping includes private gardens, informal open space and allotments. Hard landscaping includes access roads, parking and storage areas.

In compiling this report reliance was placed as in the Main Investigation Report on a drawing named Cinders Nursery, Cinders Lane, Yapton, West Sussex, undated, prepared by Land and Brand New Homes Limited. Any change or deviation from the scheme outlined in the drawing could invalidate the remediation recommendations presented within this report. Soils Limited must be notified about any such changes.

Development plans provided by the client are presented in Appendix C.

1.5 Anticipated Geology

The 1:50,000 BGS map showed the site to be located upon the bedrock Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation, Culver Chalk Formation And Portsdown Chalk Formation (Undifferentiated) (hereafter referred to as White Chalk Subgroup) with overlying superficial deposits of River Terrace Deposits.

1.5.1 River Terrace Deposits

River Terrace Deposits are superficial deposits of Quaternary age that lie along the margins of rivers and are predominantly found in the southern part of West Sussex, along the coastal plain and are typically less than 10m thick. The composition of the River Terrace Gravel varies greatly, depending on the source material available in the river's catchment. Deposits generally consist of sands and gravels of roughly bedded flint or chert gravels commonly in a matrix of silts and clays. In West Sussex the rivers flow mainly south over the Weald Clay, which contains some sandstones and limestone that could be incorporated into the river gravel.

1.5.2 White Chalk Subgroup

The White Chalk Subgroup typically comprises chalk with flints, locally with discrete marl seams, nodular chalk, sponge-rich and flint seams throughout. Typology of flints and incidence of marl seams is important for correlation.

Occasional erosional features, such as pipes, swallow holes and solution cavities, usually in-filled with drift deposits, are found in the chalk. The features sometimes manifest themselves at the surface as shallow circular depressions. Solution features may be reactivated by the concentrated ingress of water from leaking drains or soakaways. Reactivation may lead to surface collapse.

1.6 Limitations and Disclaimers

This Supplementary Report relates to the site located at Cinders Nursery, Cinders Lane, Yapton, West Sussex BN18 0JJ and was prepared for the sole benefit of Crayfern Homes (The "Client"). The report was prepared solely for the brief described in Section 1.1 of this report must be read in conjunction with the Main Investigation Report undertaken on the above site by Soils Limited, ref: 17034/MIR/Rev1.01, dated August 2019 to which this report forms an addendum.

Soils Limited disclaims any responsibility to the Client and others in respect of any matters outside the scope of the above.

This report has been prepared by Soils Limited, with all reasonable skill, care and diligence within the terms of the Contract with the Client, incorporation of our General Conditions of Contract of Business and taking into account the resources devoted to us by agreement with the Client.

The report is personal and confidential to the Client and Soils Limited accept no responsibility of whatever nature to third parties to whom this report, or any part thereof, is made known. Any such party relies on the report wholly at its own risk.

The Client may not assign the benefit of the report or any part to any third party without the written consent of Soils Limited.

The ground is a product of continuing natural and artificial processes. As a result, the ground will exhibit a variety of characteristics that vary from place to place across a site, and also with time. Whilst a ground investigation will mitigate to a greater or lesser degree against the resulting risk from variation, the risks cannot be eliminated.

The investigation, interpretations, and recommendations given in this report were prepared for the sole benefit of the client in accordance with their brief. As such these do not necessarily address all aspects of ground behaviour at the site.

Current regulations and good practice were used in the preparation of this report. An appropriately qualified person must review the recommendations given in this report at the time of preparation of the scheme design to ensure that any recommendations given remain valid in light of changes in regulation and practice, or additional information obtained regarding the site.

The depth to roots and/or of desiccation may vary from that found during the investigation. The client is responsible for establishing the depth to roots and/or of desiccation on a plot by plot basis prior to the construction of foundations. Supplied site surveys may not include substantial shrubs or bushes and is also unlikely to have data or any trees, bushes or shrubs removed prior to or following the site survey.

Where trees are mentioned in the text this means existing trees, substantial bushes or shrubs, recently removed trees (approximately 20 years to full recovery on cohesive soils) and those planned as part of the site landscaping).

Ownership of land brings with it onerous legal liabilities in respect of harm to the environment. "Contaminated Land" is defined in Section 57 of the Environment Act 1995 as:

"Land which is in such a condition by reason of substances in, on or under the land that significant harm is being caused or that there is a significant possibility of such harm being caused or that pollution of controlled waters is being, or is likely to be caused".

The investigation, analysis or recommendations in respect of contamination are made solely in respect of the prevention of harm to vulnerable receptors, using where possible best practice at the date of preparation of the report. The investigation and report do not address, define or make recommendations in respect of environmental liabilities. A separate environmental audit and liaison with statutory authorities is required to address these issues.

Ownership of copyright of all printed material including reports, laboratory test results, trial pit and borehole log sheets, including drillers log sheets remains with Soils Limited. License is for the sole use of the client and may not be assigned, transferred or given to a third party.

Section 2 Site Works

2.1 Proposed Project Works

The proposed intrusive investigation was designed to supply the client and their designers with information regarding ground conditions in areas unable to be accessed prior to demolition of site structures and site clearance within areas of proposed open ground and residential back gardens, identified as the most vulnerable site areas in the Main Investigation Report CSM undertaken by Soils Limited, ref: 17034/MIR/Rev1.01, dated August 2019, to which these works form an addendum. The intended investigation, as outlined within the Soils Limited quotation (Q21009, dated 28th January 2019), was to comprise the following items:

- 15 No. hand dug contamination samples
- Contamination laboratory testing.

2.1.1 Actual Project Works

The actual project works were undertaken on 31st October 2019 and comprised:

- 15 No. machine excavated contamination samples
- Contamination laboratory testing.

All locations were backfilled with arisings on completion.

All trial hole locations from this investigation have been presented in Figure 3.

Following completion of site works, samples were forwarded to the laboratory for contamination testing.

2.2 Ground Conditions

On 31st October 2019 fifteen locations were excavated across the site using an excavator provided by the Client to depths of 1.00m at locations selected by Soils Limited using the development plan provided by the client, concentrating on areas of open ground and residential back gardens as identified in the initial Main Investigation CSM.

The maximum depths of trial holes have been included in Table 2.1.

All trial holes were scanned with a Cable Avoidance Tool (C.A.T.) and GENNY prior to excavation to ensure the health and safety of the operatives.

Table 2.1 Final Depth of Trial Holes

<i>Trial Hole</i>	<i>Depth (m bgl)</i>
TPI – TPI5	1.00
Note:	

The approximate trial hole locations are shown on Figure 3.

The soil conditions encountered were recorded and soil sampling commensurate with the purposes of the investigation was carried out. The depths given on the trial hole logs and quoted in this report were measured from ground level.

The soils encountered from immediately below ground surface have been described in the following manner. Where the soil incorporated an organic content such as either decomposing leaf litter or roots or has been identified as part of the in-situ weathering profile, it has been described as Topsoil both on the logs and within this report. Where man has clearly either placed the soil, or the composition altered, with say greater than an estimated 5% of a non-natural constituent, it has been referred to as Made Ground both on the log and within this report.

For more complete information about the soils encountered within the general area of the site reference should be made to the detailed records given within Appendix A, but for the purposes of discussion, the succession of conditions encountered in the trial holes in descending order can be summarised as:

Made Ground/Topsoil (MG/TS)
River Terrace Deposits (RTD)
White Chalk Subgroup (WHCK)

The ground conditions encountered in the trial holes are summarised in Table 2.2.

Table 2.2 Ground Conditions

Strata	Epoch	Depth Encountered (m bgl)		Typical Thickness (m)	Typical Description
		Top	Bottom		
MG	Anthropocene	GL	0.10-0.50	0.30	Soft brown slightly sandy SILT with occasional fine to medium sub rounded to sub angular mixed gravels with roots and rootlets
RTD	Quaternary	0.10-0.50	1.00 ¹	0.70 ²	Firm orange brown slightly sandy CLAY
WHCK	Cenomanian to Maastrichtian				Not encountered during this investigation

Note: ¹ Final depth of trial hole. ² Base of strata not encountered

2.3 Ground Conditions Encountered in Trial Holes

The ground conditions encountered in trial holes have been described below in descending order. The engineering logs are presented in Appendix A.1.

2.3.1 Made Ground

Soils described as Made Ground were encountered in all fifteen of the trial holes

from ground level to depths ranging between 0.10 (TP7) and 0.50m bgl (TP10).

The Made Ground typically comprised soft brown slightly sandy SILT with occasional fine to medium sub rounded to sub angular mixed gravels with roots and rootlets.

The depths of Made Ground have been included in **Error! Reference source not found..**

Trial Hole	Depth (m bgl)
TP1	0.30
TP2	0.30
TP3	0.30
TP4	0.30
TP5	0.30
TP6	0.30
TP7	0.10
TP8	0.10
TP9	0.40
TP10	0.50
TP11	0.30
TP12	0.30
TP13	0.30
TP14	0.30
TP15	0.30
Note:	

2.3.2 River Terrace Deposits

River Terrace deposits were encountered at all fifteen of the trial pits to final depth at 1.00m bgl. The River Terrace Deposits were described as firm orange brown slightly sandy CLAY.

The depth of River Terrace Deposits has been included in Table 2.3.

Table 2.3 Final Depth of River Terrace Deposits

Trial Hole	Depth (m bgl)
TP1	1.00 ¹
TP2	1.00 ¹
TP3	1.00 ¹
TP4	1.00 ¹
TP5	1.00 ¹
TP6	1.00 ¹
TP7	1.00 ¹
TP8	1.00 ¹

Trial Hole	Depth (m bgl)
TP9	1.00 ¹
TPI0	1.00 ¹
TPI1	1.00 ¹
TPI2	1.00 ¹
TPI3	1.00 ¹
TPI4	1.00 ¹
TPI5	1.00 ¹

Note: ¹ Final depth of trial hole.

2.3.3 White Chalk Subgroup

Soils of the White Chalk Subgroup was not encountered during this investigation but was recorded in the Main Investigation Report as being present from depths of 2.40-4.85m bgl.

2.4 Roots

Roots / rootlets were encountered in all fifteen trial holes to depths of approximately 0.30m across the site probably reflective of the site clearance and reworking of the site surface.

Roots may be found to greater depth at other locations on the site particularly close to trees and/or trees that have been removed both within the site and its close environs as noted in the Main Investigation Report.

2.5 Groundwater

Groundwater was not encountered during this investigation due to the shallowness of the excavations. The investigation was conducted in October (2019), when groundwater levels should be rising from their annual minimum (lowest) elevation, which typically occurs around September to the annual maximum (highest) which typically occurs around March.

Groundwater equilibrium conditions were established through a period of monitoring undertaken between September 2018 and March 2019 as noted and reported in Soils Limited Letter Report, ref: 17034/GW, dated April 2019.

Section 3 Determination of Chemical Analysis

3.1 Site Characterisation and Revised Conceptual Site Model

The Main Investigation Report undertaken by Soils Limited (report ref: 17034/MIR/Rev1.01 dated August 2018) identified a low to moderate risk of ground contamination from previous usage of the site. No off-site sources were identified or confirmed as being present.

The Supplementary Investigation, post demolition and clearance, identified Made Ground to depths between 0.10m and 0.50m bgl. The Made Ground comprised soft brown slightly sandy SILT with occasional fine to medium sub rounded to sub angular mixed gravels with roots and rootlets with rare to occasional demolition materials such as brick.

No visible evidence of potential hydrocarbon staining, fibrous or distinctly coloured materials were identified in the logs or samples.

Superficial River Terrace Deposits were encountered underlying the Made Ground at all locations and no groundwater was encountered. The conceptual site model required no updating as a result of the findings of this investigation.

3.2 Soil Sampling

A non-targeted sampling strategy is appropriate when there is:

- No adequate information available regarding the likely locations of contamination;
- No sensitive areas where there is a need for a high degree of confidence.

A targeted sampling strategy is appropriate when there is:

- Adequate information available regarding the likely locations of contamination
- Sensitive areas where there is a need for a high degree of confidence.

The CSM and this investigation identified no additional sources, but a targeted sampling pattern was adopted in light of the identified remaining CSM unknowns following the demolition and site clearance. In light of the restrictions on potential site locations encountered during the initial pre-demolition and clearance Main Investigation, unquantified low to moderate risk had been identified by the CSM in terms of PAH and Metals present in isolate locations, but at sufficient concentration so as to present a potential risk to end-users and waters. This was seen as presenting most risk to the identified receptors in open and garden areas, which were therefore targeted so as to present a general site coverage of these specific areas.

Table 3.1 outlines the sampling undertaken.

Table 3.1 Sampling Strategy

Sample	Strategy	Proposed Use
TP1:1.00m	River Terrace	Garden Area
TP2:0.50m	River Terrace	Garden Area
TP3:0.20m	Made Ground	Garden Area
TP4:0.20m	Made Ground	Garden Area
TP5:0.20m	Made Ground	Open Space
TP6:0.50m	River Terrace	Open Space
TP7:0.20m	River Terrace	Open Space
TP8:0.20m	River Terrace	Garden Area
TP9:0.50m	River Terrace	Garden Area
TP10:0.50m	Made Ground	Garden Area
TP11:0.20m	Made Ground	Garden Area
TP12:0.20m	Made Ground	Garden Area
TP13:0.20m	Made Ground	Garden Area
TP14:0.50m	River Terrace	Garden Area
TP15:0.20m	Made Ground	Garden Area

Note:

3.3 Determination of Chemical Analysis

The driver for determination of the analysis suite was the information obtained from the Main Investigation Report intrusive investigation as determined by the remaining risks outlined within the updated CSM. As such, and to allow comparison, all samples during this investigation were analysed for a similar analytical suite as used during the main investigation comprising an Asbestos screen, a range of industrial metals, semi-metals and metalloids, pH, organic content, banded hydrocarbons phenols and PAH's.

Section 4 Qualitative Risk Assessment

4.1 Assessment Criteria

The assessment criteria used to determine risks to human health are derived and explained within Appendix B.3.

4.2 Representative Contamination Criteria - Soil

The proposed residential development comprised 51 No. one to four-bedroom homes including detached and semi-detached houses and a single apartment block. Soft landscaping includes private gardens, informal open space and allotments. Hard landscaping includes access roads, parking and storage areas.

In compiling this report reliance was placed as in the Main Investigation Report on a drawing named Cinders Nursery, Cinders Lane, Yapton, West Sussex, undated, prepared by Land and Brand New Homes Limited. Any change or deviation from the scheme outlined in the drawing could invalidate the remediation recommendations presented within this report. Soils Limited must be notified about any such changes.

The chemical laboratory results were compared against the representative contaminants concentration for human health receptor to Soil Guideline Values (SGV), Category 4 Screening Levels (C4SL's) or Suitable 4 Use Level (S4UL).

Table 4.1 outlines the samples that have exceeded their relevant assessment criteria for this investigation. The full laboratory report is presented in Appendix B.2.

Table 4.1 Summary of Chemical Analysis of Soils Sample Exceedance

Substance	Sample locations where SGV, C4SL or S4UL adopted were exceeded for the 'Residential' land-use scenario
PAHs	Benzo(a)anthracene 70mg/kg against 11mg/kg – TP3:0.20 (S4UL) Benzo(a)pyrene 87mg/kg against 5mg/kg – TP3:0.20 (C4SL) Benzo(b)fluoranthene 88mg/kg against 3.3mg/kg – TP3:0.20 (S4UL) Chrysene 60mg/kg against 22mg/kg – TP3:0.20 (S4UL) Di-benzo(a,h)anthracene 15mg/kg and 0.48mg/kg against 0.28mg/kg – TP3:0.20 and TP5:0.20 (S4UL) Indeno(1,2,3-cd)pyrene 50mg/kg against 36mg/kg - TP3:0.20 (S4UL)
TPH	Texas Banded C16-C21 480mg/kg against 260mg/kg - TP3:0.20 (S4UL) Texas Banded C21-C40 2200mg/kg against 11100mg/kg - TP3:0.20 (S4UL)
Asbestos locations where material found (no threshold just presence)	
None Detected	

The guideline values are assessed initially against the "Residential" land-use scenario, which was considered the most appropriate and conservative land-use scenario, given the type of the proposed redevelopment.

To assess the potential toxicity to the human health receptor from the concentrations of organic compounds tested for, Soil Organic Matter (SOM) tests were undertaken on the samples submitted for chemical testing, which revealed SOM values of between 0.2% and 9%. For each soil sample tested, the Soil Organic Matter recorded was used to derive the appropriate guideline value for organic determinants.

In summary, for this investigation two of the samples tested (TP3 at 0.20m bgl and TP5 at 0.20m bgl) showed concentrations in excess of the relevant C4SL/S4UL for a residential land-use scenario.

TP3 0.20m is an outlier to over 95% and showed potentially significant exceedances for:

- Benzo(a)anthracene 70mg/kg against 11mg/kg and exceeds the Public Residential Open Space criteria of 29mg/kg,
- Benzo(a)pyrene 87mg/kg against 5mg/kg, exceeds the Public Residential Open Space criteria of 10mg/kg and the Commercial criteria of 76mg/kg
- Benzo(b)fluoranthene 88mg/kg against 3.3mg/kg, exceeds the Public Residential Open Space criteria of 7.2mg/kg and the Commercial criteria of 44mg/kg
- Chrysene 60mg/kg against 22mg/kg and exceeds the Public Residential Open Space criteria of 57mg/kg,
- Di-benzo(a,h)anthracene 15mg/kg against 0.28mg/kg, exceeds the Public Residential Open Space criteria of 0.57mg/kg and the Commercial criteria of 3.6mg/kg,
- Indeno(1,2,3-cd)pyrene 50mg/kg against 36mg/kg,
- Texas Banded C16-C21 480mg/kg against 260mg/kg
- Texas Banded C21-C40 2200mg/kg against 11100mg/kg

TP5 0.20m is not an outlier to 95% but showed exceedances for:

- Di-benzo(a,h)anthracene 0.48mg/kg against 0.28mg/kg, but does not exceed the Public Residential Open Space criteria of 0.57mg/kg.

None of the other substances tested recorded concentrations above the most conservative residential end-use screening values and, as with the Main Investigation, no asbestos was detected in any sample analysed.

Results of PAH ratio analysis suggests sample TP3 0.20m probably contained a fragment of tarmac with a mixed coal tar and oil base. This would also explain the noted elevated levels of TPH heavily biased towards the heavier C16+ ranges in this sample and lack of any significant increases in metals noted in this sample. This sample lies within a proposed back garden area and could therefore be considered significant in context.

A similar outlier was noted in the data from the 2018 Main Investigation at WS1 0.35m in Made Ground and evidenced very similar characteristics in relation to elevated levels of select PAH's. In the context of the combined data set, WS1 0.35m has now been confirmed as being another outlier value to 95%. The PAH ratio analysis of this sample indicates a more coal tar base, but again was probably a piece of tarmacadam.

The elevated Lead value noted in the 2018 Main Investigation at WS4 0.15m can also now be confirmed as an outlier in the combined data set. The associated elevated (but not significant) metals for this sample (Arsenic and Zinc) strongly indicate that this result was probably the presence of an isolated piece of Lead flashing, probably associated with the historical presence of greenhouses at the site and has not been repeated.

The slightly elevated PAH noted in TP5 0.20m is not an outlier and lies within an area scheduled to be developed as public open space. As such it is not significant in context. Given the findings to date in relation to the outliers especially in relation to the other materials associated with them as discussed previously and shown in the logs and/or analytical results, it is also probable that these are all simply isolated fragments of tarmacadam and Lead that were incorporated into the samples and could therefore almost be considered as cross contamination artefacts.

Statistical analysis of the singular and combined results of both this investigation and the Main Investigation samples has been undertaken in line with current guidance and related to current guidance values. Following removal of the identified and 95% confirmed TP3 0.20m and WS4 0.15m PAH outliers and the WS1 0.35m Lead outlier in line with current practice, the results of the statistical analysis indicate no evidence of any systematic contamination for any of the analysed parameters as either average or US95 results in relation to a proposed residential with plants end use.

4.2.1 Asbestos

No Asbestos Containing Material (ACM) or asbestos in soil was detected within any of the 22No. samples analysed in this and the Main Investigation.

However, given the site history it is possible that asbestos is present in other areas of the site. If encountered, care must be taken to ensure any such material is separated and disposed of in an appropriate manner to a licensed waste facility.

4.3 Risk to Groundwater

The risk to groundwater was not directly assessed as part of this investigation but In combination with the findings of the Main Investigation, assessment of the shallow soils has now identified isolated outlier exceedances of Lead and several PAHs in three discrete locations. The site is underlain by a Secondary A Aquifer (River Terrace Deposits) and Principal Aquifer (White Chalk Subgroup) at depth, both of which have been confirmed. The site was not located within a Source Protection Zone (SPZ) and no abstractions were recorded within 1km. On this basis a potential risk to groundwater

does exist on the site and from the site.

However, the superficial deposits and Made Ground encountered during this and the Main Investigation were predominately cohesive in nature with very low permeability as evidenced by the log descriptions. In addition, the range of depths to water encountered in the Main Investigation, combined with the results of the water monitoring exercise undertaken between September 2018 and March 2019 (Soils Limited ref: 17034/GW Dated April 2019), strongly suggest that local groundwater is perched and only loosely interconnected even in the more granular fractions of the River Terrace Deposits. This would significantly limit the potential for migration of any Made Ground contaminants to the underlying Principal Aquifer, essentially acting as an aquitard.

Subsequent site clearance and remedial works relating to the shallow soils appears from the results of this investigation to have removed much of the potential source material i.e. Made Ground, however outliers may remain in parts of the site. These are unlikely to be significant in relation to groundwater risk (PAH's are generally insoluble, especially as tarmacadam) but should be removed if identified.

The average and US95 values generated from the combined data set in consideration with the leaching potential for the contaminants of concern (low) would suggest that the leaching potential of any remaining Made Ground is low to negligible, even assuming a pathway is actually present through the underlying cohesive materials.

4.4 Tier 1 Quantitative Risk Assessment

Quantitative risk assessments are undertaken for the soil, groundwater and soil gas. The CSM has been updated to take account of the assessments below and presented in Appendix B.1. The full laboratory chemical report is presented in Appendix B.2.

4.4.1 Soils

One of the samples tested (TP3 0.20m) showed concentrations for a range of PAH's in excess of the relevant guidance values for a residential land-use scenario, as outlined and detailed in Section 4.2 of this report. This is an outlier and a similar outlier was also identified during the Main Investigation in 2018. In both cases this is considered likely to be the result of tarmacadam.

Technically the Tier 1 Quantitative risk assessment established that there was a potential risk to the human health receptors of construction workers or future end-users. However, in light of the findings of the investigations to date, it is not now considered as being significant for the site as a whole in context where the risk could be considered low to negligible. However, an outlier "hotspot" is still present in the area of TP3 that may present a risk.

4.4.2 Groundwater

The Groundwater Risk Assessment has established that there is likely to be a low to negligible risk to the identified groundwater receptor at depth, assuming a

pathway is present.

4.4.3 Soil Gas

No significant potential sources of soil gas have been identified in proximity to the site and risk is considered low. However, a potential risk was identified from possible Made Ground associated with historical redevelopment of the site.

Given that some of the Made ground has been removed as part of the Made Ground was typically recorded to a depth of 0.50m during the Main Investigation, now modified to 0.30m from this investigation following site clearance. Organic content (excluding the TP3 and WS2 outliers) is 2.2% with no generally elevated concentrations of hydrocarbons remaining. On the basis of current guidance, the risk is considered negligible on the basis of volume and depth from on-site sources.

4.5 Remedial Objective

Soil chemical analysis from both this and the Main Investigation Report recorded only three samples of concern, all of which were outliers and two of which were probably removed during the site clearance. However, the remaining outlier (TP3 Made Ground) does remain a potentially significant risk to Human Health in the context of the development and therefore requires further investigation and/or remediation as a hotspot.

The remedial objective for the site is to ensure site clean-up removes any unacceptable risk to the identified receptors. In essence the remedial objective should sever any source-pathway-receptor pollutant linkages that have been established. Once this has been achieved, by whatever means, there can theoretically be no risk.

4.6 Development of Soil Remediation Strategy

Production of a remediation strategy report is considered part of the brief for this Main Supplementary Intrusive Investigation. Various remedial options are outlined and discussed below in the context of the information to date and the proposed development.

4.6.1 Further Chemical Testing and Human Health Risk Assessment

Further testing and analysis could be undertaken to determine and delineate the identified area around the area of TP3 and/or confirm if the materials encountered are as postulated and therefore do not present a significant risk, i.e. they are isolated, unrepresentative small pieces and fragments of tarmacadam and lead flashing. Such works would only be concerned with Lead and PAH as potential contaminants of concern in terms of analysis.

4.6.2 Adoption of Cover System in Soft Landscaped Areas

The BRE *“Cover Systems For Land Regeneration, Thickness Design of Cover Systems for Contaminated Land, BRE, March 2004”*, allows for the design of cover systems to impacted soils where the concentration of substances within the ground

does not exceed any of the respective SGV, C4SL or S4UL by more than six times. In such a situation, a maximum cover thickness of 600mm is given. However, the concentration of substances within the certified clean soil/topsoil, which comprises the cover system, determines the overall thickness of the system and can reduce the required thickness markedly below 600mm.

In this case, the results to date clearly indicate that there is no systematic contamination across the site and contamination, where present, is isolated as hotspots and therefore a cover system would not be appropriate. The PAH outlier at TP3 is also in excess of 6 times the guidance values.

4.6.3 Excavation of Impacted Soil

It could be proposed to excavate and stockpile the impacted material on the site in preparation for classification and subsequent disposal off-site to a suitable licensed facility. The initial excavations should be centred on the outlier trial-hole with impacted soil (TP3) and then extended in all directions in the Made Ground so that the impacted soils can be 'chased' out. Once excavation of the Made Ground has been completed validation would be required to prove all impacted soil has been removed. Validation would involve taking a representative number of samples from the sides and base of any excavation sent for appropriate chemical analysis.

In this case, the impacted area (if it is small pieces of tarmacadam as suggested) is likely to be quite small and isolated being an area centred on the TP3 location to a depth of 0.30m (the depth of Made Ground) and to an extent of roughly 2m in each direction should be sufficient. Such a relatively small amount of material could be emplaced in a skip or directly into a disposal container or vehicle, thereby removing the need to stockpile the material on site.

Stockpiled soils awaiting disposal must be placed on an impermeable liner with raised edges. During periods of rainfall, the stockpile must be covered over to minimise leaching and run-off into the underlying soils. Covering of the stockpile may be required to prevent fumes impacting receptors off-site.

The remedial works must be inspected and independently validated by a suitable person and on completion of the development, a Validation and Closure Report must be supplied to both the Local Authority and the NHBC detailing the remediation works undertaken on the site. Any voids resulting from the removal of impacted soil must be backfilled with a suitable, fit for purpose certified clean material.

In this case, and given the very minor volumes, it is probable that this area can be infilled with other clean materials from the site or infilled as a result of further clearance/levelling. On the basis of the results to date, given it is a garden area, not load bearing and given the source would be mainly underlying natural ground, replacement using surplus materials from foundation and service trenches could also be suitable.

4.6.4 Excavation of All Made Ground

Made Ground was encountered across the site to depths between 0.1-0.5m bgl following site clearance. This material could be stripped entire from the site as part of the development thereby removing all potential sources including outliers. Given that the vast majority of the Made Ground is essentially fit for purpose as is, this is probably not a very sustainable or cost-effective option, especially if imported material will be required for replacement.

However, if material is to be replaced on site, imported to site (topsoil for back gardens for example) or a surplus will otherwise be created during the development (from service, foundations or other works) it may be worth considering a preference for removal from site and replacement of Made Ground with in-situ derived “natural” underlying materials.

4.6.5 Asbestos

No asbestos has been identified on this site to date, however a potential always remains on any site for unknown materials and due care in line with current guidance should be exercised during any excavation.

4.7 Duty of Care

Groundworkers must maintain a good standard of personal hygiene including the wearing of overalls, boots, gloves and eye protectors and the use of dust masks during periods of dry weather.

To prevent exposure to airborne dust by both the general public and construction personnel the site should be kept damp during dry weather and at other times when dust is generated as a result of construction activities. The site should be securely fenced at all times to prevent unauthorised access.

Washing facilities should be provided and eating restricted to mess huts.

4.8 Excavated Material

Excavated material as waste must be defined or classified prior to any disposal, transport, recycling or re-use at or by an appropriately licensed or exempt carrier and/or off-site disposal facility. The requirements inherent in both Duty of Care and Health and Safety must also be complied with. In order to determine what is to happen, what is suitable, appropriate and most effective in the disposal of wastes, especially those subject to CDM waste management plan requirements, several factors must be considered and competent advice should always be sought.

The amount, type and nature of the material to be removed will in part determine the amount and type of analysis that may be required to comply with current waste guidance, and thereby allow a competent person to suitably classify the material. Often this data is

uncertain or unavailable, especially in the early stages of a project, and therefore further investigation, testing and analysis may be required as additional information regarding the development becomes available.

Wastes must be classified and defined by their solid characteristics to comply with current waste guidance. Existing information and analysis derived for environmental purposes may therefore be suitable for use in this context. Waste Acceptance Criteria (WAC) report the leachability of materials and therefore cannot be used to classify, characterise or define wastes. The only purpose of a WAC analysis is to determine the suitability of a given material for acceptance at one of the three different types of available licenced landfills (inert, stable non-reactive hazardous or hazardous).

Other options are available that may lead to significant savings against disposal to landfill and expert advice should always be sought from a competent person to advise on their relative costs or benefits and advise on any additional analysis, sampling or investigation that may be required to reduce remaining uncertainties and comply with current guidance. Further consideration of results using HazWasteOnline™ can be undertaken on request to give an indication of potentially hazardous properties in the materials analysed.

Most of the Made Ground would probably classify as inert and is suitable and fit for purpose on site. However, as noted previously, preference could be given for re-use or replacement of Made Ground with other site won materials. This is unlikely to have a significant effect on disposal costs and options but may require additional analysis and consideration by the waste contractor.

4.9 Re-use of Excavated Material On-site

The re-use of on-site soils may be undertaken either under the Environmental Permitting Regulations 2007 (EPR), in which case soils other than uncontaminated soils are classed as waste, or under the CL:AIRE Voluntary Code of Practice (CoP) which was published in September 2008 and is accepted as an alternative regime to the EPR.

Under the EPR, material that is contaminated but otherwise suitable for re-use is also classified as waste and its re-use should be in accordance with the Environmental Permitting Regulations 2007 (EPR). Environmental Permit Exemptions (EPE) are for the re-use of non-hazardous or inert waste only; hazardous waste cannot be re-used under a permit exemption. EPE apply only to imported inert waste materials; inert material arising on site and recovered on site is not classified as waste and does not require an exemption. It is possible that materials arising on-site will be classified as inert and would not need an exemption.

Environmental Permit Exemptions are only allowed for certain activities, placing controls on the quantities that can be stored and re-used. The re-use of waste shall be within areas and levels defined in planning applications and permissions for the development. An EPE requires a site-specific risk assessment for the receptor site to demonstrate that

the materials are suitable for use, i.e. that they will not give rise to harm to human health or pollution of the environment.

Under the CL:AIRE voluntary code of practice (CoP) materials excavated on-site are not deemed contaminated if suitable for re-use at specified locations or generally within the site.

Material that may have been classified as hazardous waste under the EPR may be re-used. The CoP regime requires that a 'Qualified Person' as defined under the CoP reviews the development of the Materials Management Plan, including review of Risk Assessments and Remediation Strategy/Design Statement together with documentation relating to Planning and Regulatory issues, and signs a Declaration which is forwarded to the Environment Agency and which confirms compliance with the CoP.

Should it be necessary to import materials from another site where materials are excavated and which is not material from a quarry or produced under a WRAP protocol, then an EPE would be necessary for the imported material whether the work was managed under the CoP or the EPR.

All of the materials identified and analysed on site excepting the hotspot at TP3 should be suitable and fit for purpose in the context of the development.

4.10 Imported Material

Any soil, which is to be imported onto the site, must undergo chemical analysis to permit classification prior to its importation and placement in order to ascertain its status with specific regard to contamination, i.e. to prove that it is suitable for the purpose for which it is intended.

4.11 Discovery Strategy

There may be further areas of contamination not identified during the course of the investigation. Such occurrences may also be discovered during the demolition and construction phases for the redevelopment of the site.

Care should be taken during excavation works especially to investigate any soils, which appear by eye (e.g. such as fibrous materials, large amounts of ash and unusual discolouration), odour (e.g. fuel, oil and chemical type odours or unusual odours such as sweet odours or fishy odours) or wellbeing (e.g. light headedness and/or nausea, burning of nasal passages and blistering or reddening of skin due to contact with soil) to be contaminated or of unusual and/or different character to standard soils or those analysed.

In the event of any discovery of potentially contaminated soils or materials, this discovery should be quarantined and reported to the most senior member of site staff or the designated responsible person at the site for action. The location, type and quantity must

be recorded and the Local Authority, and a competent and appropriate third-party Engineer/Environmental consultant notified immediately. An approval from the Local Planning Authority must be sought prior to implementing any proposed mitigation action.

The discovery strategy must remain on site at all times and must demonstrate a clear allocation of responsibility for reporting and dealing with contamination. A copy of the strategy must be placed on the health and safety notice board and /or displayed in a prominent area where all site staff are able to take note of and consult the document at any time. Any member of the workforce entering the site to undertake any excavation must be made aware of the potential to discover contamination and the discovery strategy.

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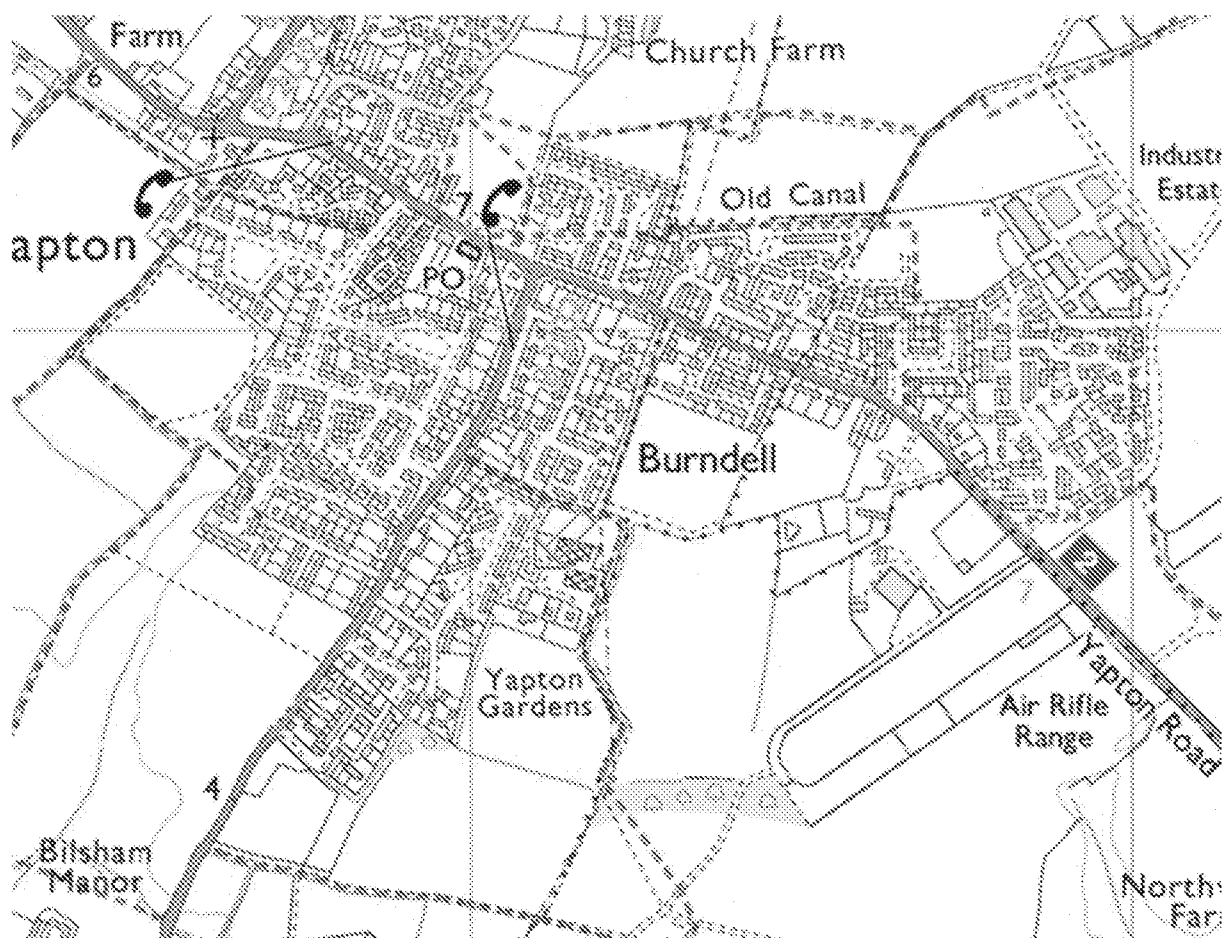


Figure 1 – Site Location Map

Job Number 17926	Project Cinders Nursery, Cinders Lane, Yapton, West Sussex BN18 0JJ
Client Crayfern Homes	Date November 2019



**Figure 2 – Aerial Photograph
-Pre-demolition and
clearance**

Project

Cinders Nursery, Cinders Lane,
Yapton, West Sussex BN18 0JJ

Client

Crayfern Homes

Date

November 2019

Job Number

17926



Figure 3 – Trial Hole Plan

Project

Cinders Nursery, Cinders Lane,
Yapton, West Sussex BN18 0JJ

Client

Crayfern Homes

Date

November 2019

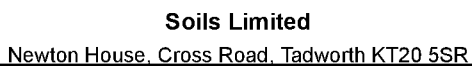
Job Number

17926



Appendix A Field Work

Appendix A.1 Engineers Logs



Trial Pit No. _____

TP1

Sheet 1 of 1

Project Name: Cinders Lane

Project No.: 17926

Method:

Plant:	Excavator
--------	-----------

Support:

Hole Type

TP

Scale

1:25

Logged By
JO

Location: Cinders Lane, Yapton, Arundel, West Sussex, BN18 0JJ

Client: Creyfern Homes

Trial Pit Length: m

Trial Pit Width:	m
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Dates: 31/10/2019

Level:

Co-ords:

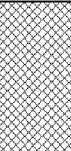
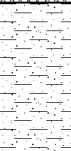
General Remarks:	Sample Type D: Disturbed B: Bulk J: Jar W: Water
Groundwater Remarks: None Encountered	

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ARUN DISTRICT COUNCIL Y/114/19/DOC

ARUN DISTRICT COUNCIL Y/114/19/DOC

		Soils Limited Newton House, Cross Road, Tadworth KT20 5SR 			Trial Pit Log		Trial Pit No. TP10 Sheet 1 of 1	
Project Name: Cinders Lane		Project No.: 17928		Method:		Hole Type		
Location: Cinders Lane, Yapton, Arundel, West Sussex, BN18 0JJ				Plant: Excavator		TP		
Client: Creyfern Homes		Trial Pit Length: m		Trial Pit Width: m		Scale 1:25		
Dates: 31/10/2019		Level:		Co-ords:		Logged By JO		
Water Strike	Samples & In Situ Testing			Depth (m)	Level (mAOD)	Legend	Stratum Description	
	Depth	Type	Results					
	0.20	ES					Soft Brown slightly sandy SILT with occasional fine to medium sub-rounded to sub-angular mixed construction and flint gravels with rare glass, roots and rootlets. MADE GROUND.	
	0.50	ES		0.50				Firm orangish brown slightly sandy CLAY.
				1.00				End of Pit at 1.000m
General Remarks: Groundwater Remarks: None Encountered Sample Type D: Disturbed B: Bulk J: Jar W: Water								

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ARUN DISTRICT COUNCIL Y/114/19/DOC



Trial Pit No.

TP14

Sheet 1 of 1

Project Name: Cinders Lane

Project No.: 17926

Method:	
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Plant:	Excavator
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Support:

Hole Type	Location	Depth (ft)	Flow Rate (gpm)	Water Level (ft)	Notes
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88	...	...	...	...	...
89	...	...	...	...	...
90	...	...			

TP

Scale

1:25

Logged By
JO

Location: Cinders Lane, Yapton, Arundel, West Sussex, BN18 0JJ

Client: Creyfern Homes

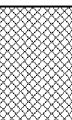
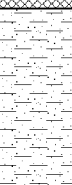
Trial Pit Length: m

Trial Pit Width:	m
------------------	---

Dates: 31/10/2019

Level:

Co-ords:

	0.20	ES					Soft Brown slightly sandy SILT with occasional fine to medium sub-rounded to sub-angular mixed construction and flint gravels with roots and rootlets. Geotechnical mesh layer at 0.40m. MADE GROUND.
	0.50	ES		0.40			Firm orangish brown slightly sandy CLAY.
				1.00			End of Pit at 1.000m

General Remarks:	
------------------	--

Geotechnical Mesh layer at 0.40m

Sample Type

D: Disturbed

B: Bulk

J: Jar
W: Water

Groundwater Remarks: None Encountered

ARUN DISTRICT COUNCIL Y/114/19/DOC

Appendix B Chemical Laboratory Testing

Appendix B.1 Conceptual Site Model

Table B.I.I CSM Revised Post Supplementary Testing

Source	Potential Contaminant	Exposure Pathway	Receptor	Initial Assessment from Preliminary Investigation Report Information			Comments	Proposed Investigation
				Severity	Probability	Risk		
Onsite Source Made Ground, and shallow soils, ASTs	Lead and PAHs	Inhalation of dust	Site Workers/Site Maintenance	Mild	Unlikely	Very Low	Excluding outliers low to negligible risk (average and US95 < critical value)	Remediation may be required in area of TP3 to remove hotspot outlier. Though the recorded values may be artefacts as small fragments of tarmacadam.
			End Users	Mild	Unlikely	Very Low		
			Off-site Users	Mild	Unlikely	Very Low		
	None noted	Inhalation of Vapour/gases (including Radon)	Site Workers/Site Maintenance	Minor	None	Limited Made Ground with low organic content, to be largely removed. RBCA <1m depth <2.5% carbon – low to negligible generation potential		
			End Users	Minor	None			
			Off-site Users	Minor	None			
	Lead and PAHs	Ingestion and absorption via direct contact	Site Workers/Site Maintenance	Mild	Unlikely	Very Low	Excluding outliers low to negligible risk (average and US95 < critical value)	
			End Users	Mild	Unlikely	Very Low		
		Migration via surface runoff	Surface Water	Mild	Unlikely	Very Low	Down towards the trainline embankment then to the south at low velocity	
		Migration in solution via groundwater	Surface Water	Mild	Unlikely	Very Low		Site underlain by Secondary A and Principal Aquifers. No SPZ. Contaminants of concern (Lead and PAH) largely in insoluble form (flashing and tarmac) and no linkage established between Made Ground and underlying aquifer.
			Shallow Aquifer	Mild	Unlikely	Very Low		
			Deep Aquifer	Mild	Unlikely	Very Low		
		Direct contact with construction material	Buried structures	Mild	Unlikely	Very Low	Possible PAH and TPH contamination. Unlikely to be in significant quantity. Structures and services likely to be emplaced in natural ground	
			Buried Services	Mild	Unlikely	Very Low		
	None noted	Migration of gases via permeable soils	Site Workers/Site Maintenance	Minor	None	None	Limited Made Ground with low organic content, to be largely removed. No external sources.	
			End Users	Minor	None	None		
			Off-site Users	Minor	None	None		
			Building and confined spaces	Minor	None	None		

Appendix B.2 Chemical Laboratory Results



Chris Swainston
Soils Ltd
Unit 11
Sun Valley Business Park
Winnall Close
Winchester
Hampshire
SO23 0LB

i2 Analytical Ltd.
7 Woodshots Meadow,
Croxley Green
Business Park,
Watford,
Herts,
WD18 8YS

e: cs@soilslimited.co.uk



Analytical Report Number : 19-69859

Project / Site name:	Cinders Nursery	Samples received on:	04/11/2019
Your job number:	17926	Samples instructed on:	04/11/2019
Your order number:	17926	Analysis completed by:	14/11/2019
Report Issue Number:	1	Report issued on:	14/11/2019
Samples Analysed:	15 soil samples		



Signed:

Marzena Babik
Quality Manager

For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :	soils	- 4 weeks from reporting
	leachates	- 2 weeks from reporting
	waters	- 2 weeks from reporting
	asbestos	- 6 months from reporting

Excel copies of reports are only valid when accompanied by this PDF certificate.

Any assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement. Application of uncertainty of measurement would provide a range within which the true result lies. An estimate of measurement uncertainty can be provided on request.



4841



Environmental Science

Analytical Report Number: 19-69859

Project / Site name: Cinders Nursery

Your Order No: 17926

Lab Sample Number				1351089	1351090	1351091	1351092	1351093
Sample Reference				TP1	TP2	TP3	TP4	TP5
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				1.00	0.50	0.20	0.20	0.20
Date Sampled				31/10/2019	31/10/2019	31/10/2019	31/10/2019	31/10/2019
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Limit of Detection	Accreditation Status					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	16	17	10	15	9.5
Total mass of sample received	kg	0.001	NONE	1.1	1.0	1.3	1.3	1.2

Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	Not-detected	Not-detected	Not-detected	Not-detected
------------------	------	-----	-----------	--------------	--------------	--------------	--------------	--------------

General Inorganics

pH - Automated	pH Units	N/A	MCERTS	8.4	8.1	7.9	7.8	10.0
Organic Matter	%	0.1	MCERTS	0.4	0.5	9.0	1.4	4.4

Total Phenols

Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
----------------------------	-------	---	--------	-------	-------	-------	-------	-------

Speciated PAHs

Naphthalene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	1.1	< 0.05	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	11	< 0.05	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	3.2	< 0.05	< 0.05
Fluorene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	3.5	< 0.05	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	< 0.05	0.30	48	< 0.05	2.0
Anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	19	< 0.05	0.45
Fluoranthene	mg/kg	0.05	MCERTS	< 0.05	0.64	110	< 0.05	4.9
Pyrene	mg/kg	0.05	MCERTS	< 0.05	0.69	110	< 0.05	4.6
Benzo(a)anthracene	mg/kg	0.05	MCERTS	< 0.05	0.33	70	< 0.05	2.5
Chrysene	mg/kg	0.05	MCERTS	< 0.05	0.41	60	< 0.05	2.4
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	0.52	88	< 0.05	3.0
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	0.27	46	< 0.05	1.5
Benzo(a)pyrene	mg/kg	0.05	MCERTS	< 0.05	0.46	87	< 0.05	3.0
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	< 0.05	0.34	50	< 0.05	1.8
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	15	< 0.05	0.48
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05	0.40	58	< 0.05	2.3

Total PAH

Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	< 0.80	4.36	785	< 0.80	28.9
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Heavy Metals / Metalloids

Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	10	12	5.8	7.6	8.9
Boron (water soluble)	mg/kg	0.2	MCERTS	0.5	0.4	1.5	1.1	1.6
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2	0.4	0.3	0.6
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	36	39	23	25	410
Copper (aqua regia extractable)	mg/kg	1	MCERTS	19	18	51	18	70
Lead (aqua regia extractable)	mg/kg	1	MCERTS	20	16	56	40	130
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	0.9	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	37	29	15	15	25
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Vanadium (aqua regia extractable)	mg/kg	1	MCERTS	46	50	40	29	79
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	61	63	97	140	360

Petroleum Hydrocarbons

TPH Texas (C6 - C8)	mg/kg	0.1	ISO 17025	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
TPH Texas (C8 - C10)	mg/kg	10	MCERTS	< 10	< 10	< 10	< 10	< 10
TPH Texas (C10 - C12)	mg/kg	1	MCERTS	< 1.0	< 1.0	7.1	< 1.0	2.5
TPH Texas (C12 - C16)	mg/kg	4	MCERTS	< 4.0	< 4.0	48	< 4.0	7.1
TPH Texas (C16 - C21)	mg/kg	10	MCERTS	< 10	< 10	480	< 10	62
TPH Texas (C21 - C40)	mg/kg	10	MCERTS	< 10	< 10	2200	< 10	440
TPH Texas (C6 - C40)	mg/kg	10	NONE	< 10	< 10	2800	< 10	520



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Environmental Science

Analytical Report Number: 19-69859

Project / Site name: Cinders Nursery

Your Order No: 17926

Lab Sample Number				1351094	1351095	1351096	1351097	1351098
Sample Reference				TP6	TP7	TP8	TP9	TP10
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.50	0.20	0.20	0.50	0.50
Date Sampled				31/10/2019	31/10/2019	31/10/2019	31/10/2019	31/10/2019
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Limit of Detection	Accreditation Status					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	16	13	15	17	18
Total mass of sample received	kg	0.001	NONE	1.2	1.2	1.2	1.1	1.0

Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	Not-detected	Not-detected	Not-detected	Not-detected
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General Inorganics

pH - Automated	pH Units	N/A	MCERTS	8.4	7.1	7.1	7.3	7.3
Organic Matter	%	0.1	MCERTS	0.3	1.4	0.7	0.2	0.7

Total Phenols

Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
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Speciated PAHs

Naphthalene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Fluorene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(a)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Chrysene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(a)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05

Total PAH

Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	< 0.80	< 0.80	< 0.80	< 0.80	< 0.80
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Heavy Metals / Metalloids

Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	10	8.8	6.3	11	8.5
Boron (water soluble)	mg/kg	0.2	MCERTS	0.7	1.1	0.7	0.6	0.7
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	0.2	< 0.2	< 0.2	< 0.2	< 0.2
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	37	26	22	41	33
Copper (aqua regia extractable)	mg/kg	1	MCERTS	18	30	12	20	11
Lead (aqua regia extractable)	mg/kg	1	MCERTS	13	29	12	14	12
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	33	17	12	44	16
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Vanadium (aqua regia extractable)	mg/kg	1	MCERTS	45	30	29	52	42
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	63	100	38	57	45

Petroleum Hydrocarbons

TPH Texas (C6 - C8)	mg/kg	0.1	ISO 17025	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
TPH Texas (C8 - C10)	mg/kg	10	MCERTS	< 10	< 10	< 10	< 10	< 10
TPH Texas (C10 - C12)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH Texas (C12 - C16)	mg/kg	4	MCERTS	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0
TPH Texas (C16 - C21)	mg/kg	10	MCERTS	< 10	< 10	< 10	< 10	< 10
TPH Texas (C21 - C40)	mg/kg	10	MCERTS	< 10	< 10	< 10	< 10	12
TPH Texas (C6 - C40)	mg/kg	10	NONE	< 10	< 10	< 10	< 10	12



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Environmental Science

Analytical Report Number: 19-69859

Project / Site name: Cinders Nursery

Your Order No: 17926

Lab Sample Number				1351099	1351100	1351101	1351102	1351103
Sample Reference				TP11	TP12	TP13	TP14	TP15
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.20	0.20	0.20	0.50	0.20
Date Sampled				31/10/2019	31/10/2019	31/10/2019	31/10/2019	31/10/2019
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Limit of Detection	Accreditation Status					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	28	25	12	16	20
Total mass of sample received	kg	0.001	NONE	1.0	1.0	1.0	1.0	1.0

Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	Not-detected	Not-detected	Not-detected	Not-detected
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General Inorganics

pH - Automated	pH Units	N/A	MCERTS	6.7	7.5	9.6	8.3	7.5
Organic Matter	%	0.1	MCERTS	7.9	5.8	5.6	0.5	3.7

Total Phenols

Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
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Speciated PAHs

Naphthalene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Fluorene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	1.6	< 0.05	< 0.05	< 0.05	0.53
Anthracene	mg/kg	0.05	MCERTS	0.41	< 0.05	< 0.05	< 0.05	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	4.4	< 0.05	0.40	< 0.05	1.1
Pyrene	mg/kg	0.05	MCERTS	3.4	< 0.05	0.32	< 0.05	0.89
Benzo(a)anthracene	mg/kg	0.05	MCERTS	1.8	< 0.05	< 0.05	< 0.05	0.43
Chrysene	mg/kg	0.05	MCERTS	1.6	< 0.05	< 0.05	< 0.05	0.59
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	2.1	< 0.05	< 0.05	< 0.05	0.66
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	0.81	< 0.05	< 0.05	< 0.05	0.24
Benzo(a)pyrene	mg/kg	0.05	MCERTS	1.7	< 0.05	< 0.05	< 0.05	0.48
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	0.99	< 0.05	< 0.05	< 0.05	0.28
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	0.27	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	1.1	< 0.05	< 0.05	< 0.05	0.33

Total PAH

Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	20.1	< 0.80	< 0.80	< 0.80	5.48
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Heavy Metals / Metalloids

Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	8.3	7.8	4.4	8.7	8.8
Boron (water soluble)	mg/kg	0.2	MCERTS	4.4	0.8	0.8	0.5	2.0
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	0.4	< 0.2	0.4	< 0.2	0.3
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	34	25	15	33	28
Copper (aqua regia extractable)	mg/kg	1	MCERTS	28	14	14	12	22
Lead (aqua regia extractable)	mg/kg	1	MCERTS	92	32	39	11	35
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	15	15	9.4	18	17
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Vanadium (aqua regia extractable)	mg/kg	1	MCERTS	30	32	19	41	32
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	150	65	100	44	210

Petroleum Hydrocarbons

TPH Texas (C6 - C8)	mg/kg	0.1	ISO 17025	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
TPH Texas (C8 - C10)	mg/kg	10	MCERTS	< 10	< 10	< 10	< 10	< 10
TPH Texas (C10 - C12)	mg/kg	1	MCERTS	12	< 1.0	2.1	< 1.0	< 1.0
TPH Texas (C12 - C16)	mg/kg	4	MCERTS	24	< 4.0	16	< 4.0	< 4.0
TPH Texas (C16 - C21)	mg/kg	10	MCERTS	61	< 10	47	< 10	16
TPH Texas (C21 - C40)	mg/kg	10	MCERTS	180	16	840	< 10	59
TPH Texas (C6 - C40)	mg/kg	10	NONE	270	16	910	< 10	75

Analytical Report Number : 19-69859

Project / Site name: Cinders Nursery

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
1351089	TP1	None Supplied	1.00	Light brown clay with vegetation.
1351090	TP2	None Supplied	0.50	Light brown clay.
1351091	TP3	None Supplied	0.20	Brown loam and sand with vegetation and gravel.
1351092	TP4	None Supplied	0.20	Brown clay and loam with vegetation and gravel
1351093	TP5	None Supplied	0.20	Brown loam and sand with brick and gravel
1351094	TP6	None Supplied	0.50	Light brown clay and sand with vegetation.
1351095	TP7	None Supplied	0.20	Brown clay and sand with vegetation.
1351096	TP8	None Supplied	0.20	Light brown clay and sand.
1351097	TP9	None Supplied	0.50	Light brown clay and sand with vegetation.
1351098	TP10	None Supplied	0.50	Light brown clay and sand with vegetation and gravel.
1351099	TP11	None Supplied	0.20	Brown loam and sand with vegetation and gravel.
1351100	TP12	None Supplied	0.20	Brown loam and clay with vegetation and gravel
1351101	TP13	None Supplied	0.20	Brown clay and sand with vegetation and gravel
1351102	TP14	None Supplied	0.50	Light brown sandy clay with vegetation.
1351103	TP15	None Supplied	0.20	Brown loam and clay with vegetation and gravel

Analytical Report Number : 19-69859

Project / Site name: Cinders Nursery

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Asbestos identification in soil	Asbestos Identification with the use of polarised light microscopy in conjunction with disperion staining techniques.	In house method based on HSG 248	A001-PL	D	ISO 17025
Boron, water soluble, in soil	Determination of water soluble boron in soil by hot water extract followed by ICP-OES.	In-house method based on Second Site Properties version 3	L038-PL	D	MCERTS
Hexavalent chromium in soil	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazine followed by colorimetry.	In-house method	L080-PL	W	MCERTS
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L038-PL	D	MCERTS
Moisture Content	Moisture content, determined gravimetrically. (30 oC)	In-house method based on BS1377 Part 2, 1990, Classification tests	L019-UK/PL	W	NONE
Monohydric phenols in soil	Determination of phenols in soil by extraction with sodium hydroxide followed by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (skalar)	L080-PL	W	MCERTS
Organic matter (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	BS1377 Part 3, 1990, Chemical and Electrochemical Tests""	L009-PL	D	MCERTS
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L099-PL	D	MCERTS
Speciated EPA-16 PAHs in soil	Determination of PAH compounds in soil by extraction in dichloromethane and hexane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L064-PL	D	MCERTS
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
TPH Texas (Soil)	Determination of dichloromethane/hexane extractable hydrocarbons in soil by GC-MS.	In-house method	L064-PL	D	MCERTS

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.

For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.

Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

Appendix B.2 Chemical Laboratory Results

HUMAN HEALTH RISK ASSESSMENT

1.1 Introduction

Human Health Generic Quantitative Risk Assessment (GQRA) involves the comparison of contaminant concentrations measured in soil at the site with Generic Assessment Criteria (GAC).

GAC are conservative values adopted to ensure that they are applicable to the majority of possible contaminated site. These values may be published Contaminated Land Exposure Assessment Model (CLEA) derived GAC derived by a third party or the Environment Agency/ DEFRA. It is imperative to the risk assessor to understand the uncertainties and limitations associated with these GAC to ensure that they are used appropriately. Where the adoption of a GAC is not appropriate, for instance when the intended land-use is at variance the CLEA standard land-uses, then a Detailed Quantitative Risk Assessment (DQRA) may be undertaken to develop site specific values for relevant soil contaminants based on the site specific conditions.

1.2 General Assessment Criteria

The Contaminated Land Regime reflects the UK Government's stated objectives of achieving sustainable development through the 'suitable for use approach'.

1.2.1 Contaminated Land Exposure Assessment Model (CLEA)

Current United Kingdom risk assessment practice is based on the Contaminated Land Exposure Assessment Model (CLEA).

The CLEA Guidance comprises the following documents:

- EA Science Report SC050021/SR2: Human health toxicological assessment of contaminants in soil.
 - EA Science Report SC050021/SR3: Updated technical background to the CLEA model.
 - EA CLEA Bulletin (2009).
 - CLEA software version 1.04 (2009)
 - Toxicological reports and SGV technical notes.
-

The CLEA guidance and tools:

1. do not cover other types of risk to humans, such as fire, suffocation or explosion, or short-term and acute exposures.
 2. do not cover risks to the environment, such as groundwater, ecosystems or buildings.
 3. do not provide a definitive test for telling when human health risks are significant.
 4. are not a legal requirement in assessing land contamination risks. They are not part of the legal regime for Part 2A of the Environmental Protection Act 1990.
-

1.3 Soil Guideline Values (2009)

The EA are publishing a series of SGV reports for a selection of common contaminants relevant to the assessment of land contamination.

SGV's are generic assessment criteria based on CLEA standard land-uses and can be used to simplify the assessment of human health risks from long-term exposure to

chemical contamination in soil. They do not cover short-term exposure (i.e. construction and maintenance workers), acute exposure or other risks such as fire, suffocation or explosion, as might arise from an accumulation of gases such as methane and carbon dioxide, or either odour or aesthetic issues.

SGV's represent 'trigger values', indicators that soil concentrations above the SGV level may pose a possibility of *significant harm* to human health. The converse, where soil concentrations are less than the SGV, is that the long-term human health risks are considered to be tolerable or minimal.

The CLEA guidance derives soil concentrations of contaminants above which (in the opinion of the EA) there may be a concern that warrants further investigation. It does not provide a definitive test for establishing that the risk is significant.

1.4 Ongoing development of CLEA based guidance

The EA is involved in a programme of publishing SGV's and related toxicity data (the TOX reports). As at July 2009 ten SGV's and matching TOX reports had been published. Soil Assessment Criteria (SAC's) may be derived using toxicity data from the updated TOX reports, where these are published, or from the original TOX reports. SGV reports also take account of recent updates for plant uptake and other factors.

-
- GAC's developed by CLEA guidance and given in this report will need to be assessed against updated TOX reports and SGV's when these are published.
-
- SGV reports may give values that differ from the GAC's used in this report.
-
- These variations may materially alter the remediation requirement for the site, requiring either an increase or decrease in the extent, type and cost of remediation.
-

1.5 Phytotoxicity

CLEA guidance only addresses human health toxicity; assessment of plant toxicity (phytotoxicity) is based on threshold trigger values obtained from the following source:

ICRCL 70/90: *Notes on the restoration and aftercare of metalliferous mining sites for pasture and grazing.*

1.6 Other Generic Assessment Criteria

If an SGV is not available for a substance identified in the soil then the range of Generic Assessment Criteria published from a collaborative research by Land Quality Management Limited (LQM) and the Chartered Institute of Environmental Health (CIEH) are used for example. In the case of Lead, Category 4 screening levels (C4SLs) have replaced the AtRisk Soil SSV.

1.6.1 EIC/AGS/CL: AIRE

The report represents the collaborative effort of risk assessors from 26 EIC and AGS member companies to produce generic assessment criteria (GAC) for soils for human health risk assessment. The project involved the collation and review of physico-chemical data, toxicological data and information on background

exposure for 44 contaminants sometimes encountered on land affected by contamination in the UK and the derivation of GAC for 351 of these using the CLEA model (v1.06). The GAC are intended to complement soil guideline values (SGV) produced by the Environment Agency of England and Wales and the 2nd edition GAC produced by LQM and CIEH (Nathanail et al, 2009). All three sets of assessment criteria have been derived in general accordance with the Environment Agency of England and Wales Contaminated Land Exposure Assessment (CLEA) guidance and thus the combined efforts of these three groups have resulted in a useful set of screening criteria for the assessment of risks to human health from soil contamination for more than 120 potentially contaminative substances.

1.6.2 Category 4 screening levels (C4SLs) (2014)

A new statutory DEFRA guidance recently (i.e. August 2014) published some GACs with a more pragmatic (but still strongly precautionary) approach in their derivation called the Category 4 screening levels (C4SLs). These values provide a higher simple test for deciding that land is suitable for use and definitely not contaminated land. They are intended as generic screening values, (ii) they describe a level of risk that whilst above 'minimal' is still 'low' and (iii) they provide a 'higher simple test' for deciding that land is suitable for use and definitely not contaminated. These values were derived for four generic land uses: residential, commercial, allotments, and public open space.

1.6.3 LQM/CIEH Suitable 4 Use Level (S4UL) (2015)

The new S4UL's ((Nathanail *et al*, 2015), was developed for around 85 substances and are intended to enable a screening assessment of the risks posed by soil quality on development sites. The updated LQM/CIEH GAC publication was developed to accommodate recent developments in the understanding of chemical, toxicological and routine exposure to soil-based contaminants. The S4ULs were:

- based on Health Criteria Values, updated to reflect changes since 2009
- derived for the standard CLEA land uses and the two public open space scenarios developed by Defra SP1010
- developed for ca 85 substances (those previously covered by the LQM/CIEH GAC and the SGV substances);
- Compliant with SR2 and the long standing principle of 'suitable for use' and reflecting changes to exposure parameters produced by Defra SP1010.

For derivation of these Generic Assessment Criteria reference must be made to: Nathanail, P., McCaffrey, C., Ashmore, M., Cheng, Y., Gillet, A., Ogden, R., Scott, D. *The LQM/CIEH Generic Assessment Criteria for Human Health Risk Assessment (3rd edition)*. **Land Quality Press**. 2015.

1.7 Standard Land-use Scenarios

The standard land-use scenarios used to develop conceptual exposure models are presented in the following sections:

1.7.1 Residential

Generic scenario assumes a typical two-storey house built on a ground bearing slab with a private garden having a lawn, flowerbeds and a small fruit and vegetable patch.

-
- Critical receptor is a young female child (zero to six years old)
 - Exposure duration is six years.
 - Exposure pathways include direct soil and indoor dust ingestion, consumption of home-grown produce and any adhering soil, skin contact with soils and indoor dust and inhalation of indoor and outdoor dust and vapours.
 - Building type is a two-storey small terraced house.
-

A sub-set of this land-use is residential apartments with communal landscaped gardens where the consumption of home grown vegetables will not occur.

1.7.2 Allotments

Provision of open space (about 250sq.m) commonly made available to tenants by the local authority to grow fruit and vegetable for their own consumption.

Typically, there are a number of plots to a site which may have a total area of up to 1 hectare. The tenants are assumed to be adults and that young children make occasional accompanied visits.

Although some allotment holders may choose to keep animals including rabbits, hens, and ducks, potential exposure to contaminated meat and eggs is not considered.

-
- Critical receptor is a young female child (zero to six years old)
 - Exposure duration is six years.
 - Exposure pathways include direct soil ingestion, consumption of homegrown produce and any adhering soil, skin contact with soils and inhalation of outdoor dust and vapours.
 - There is no building.
-

1.7.3 Commercial/Industrial

The generic scenario assumes a typical commercial or light industrial property comprising a three-storey building at which employees spend most time indoors and are involved in office-based or relatively light physical work.

-
- Critical receptor is a working female adult (aged 16 to 65 years old).
 - Exposure duration is a working lifetime of 49 years.
 - Exposure pathways include direct soil and indoor dust ingestion, skin contact with soils and dusts and inhalation of dust and vapours.
 - Building type is a three-storey office (pre 1970).
-

1.7.4 Public Open Space within Residential Area

The generic scenario refers to any grassed area 0.05 ha and that is close to Housing.

-
- Grassed area of up to 0.05 ha and a considerable proportion of this (up to 50%) may be bare soil
-
- Predominantly used by children for playing and may be used for activities such as a football kick about
-
- Sufficiently close proximity to home for tracking back of soil to occur, thus indoor exposure pathways apply
-
- older children as the critical receptor on basis that they will use site most frequently (Age class 4-9)
-
- ingestion rate 75 mg.day^{-1}
-

1.7.5 Public Open Space Park

This generic scenario refers to any public park that is more than 0.5ha in area:

-
- Public park (>0.5 ha), predominantly grassed and may also contain children's play equipment and border areas of soil containing flowers or shrubs (75% cover)
-
- Female child age classes 1-6
-
- Soil ingestion rate of 50 mg.day^{-1}
-
- Occupancy period outdoors = 2 hours.day^{-1}
-
- Exposure frequency of 170 days.year⁻¹ for age classes 2-18 and 85
-
- days.year⁻¹ for age class 1
-
- Outdoor exposure pathways only (no tracking back).
-

1.8 Detailed Quantitative Risk Assessments (DQRA)

Where the adoption of an SGV/GAC is not appropriate, for instance when the intended land-use is at variance the CLEA standard land-uses, then a DQRA may be undertaken to develop site specific values for relevant soil contaminants.

-
- Establishing the plausibility that generic exposure pathways exist in practice by measurement and observation.
-
- Developing more accurate parameters using site data.
-

1.9 Current Criteria

Table 1 presents the current Generic Assessment Criteria and reference should be made to the original publications if needed.

1.10 Statistical Tests

DEFRA R&D Publication CLR 7 (DOE 1994) and Category 4 screening levels (C4SLs) (2014) addressed the statistical treatment of test results and their comparison to Soil Guideline Values.

Consideration must be given to the appropriate area of land to be considered termed the critical averaging area.

For a communal open space or commercial land-use, the critical averaging area will depend on the proposed layout. For a residential use with private gardens the averaging area is the individual plot.

It may be appropriate to compare the upper 95th percentile concentration with the Soil Guideline Value, subject to applying a statistical test to establish that the range of concentrations are reasonably consistent and belonging to the same underlying distribution of data.

The DEFRA discussion paper Assessing risks from land contamination – a proportionate approach ('the way forward') (CLAN06/2006) aimed to increase understanding of the role that statistics can play in quantifying the uncertainty attached to the estimates of the mean concentration of contaminants in soil. In direct response CL:AIRE/CIEH published a joint report, *Guidance in comparing soil contamination data with a critical concentration* (CL:AIRE/CIEH 2008). A software implementation of the statistical techniques given in the report was published by ESI International (2008).

Treatment of Hot-Spots

- A statistical test is applied to establish whether the data is a part of a single set, or whether data outliers are present.
 - Provided that the data is based on random sampling and no distinct contamination source was present at the sampling location, the hot-spot(s) may be excluded and the mean of the remaining data assessed.
-

Land Use			Residential With or Without Plant Uptake									Public Open Space (POS)									Name	Authority	Date	
			With			Without			Allotments			Commercial			Residential			Park						
			SoM	1.0	2.5	6	1	2.5	6	1	2.5	6	1	2.5	6	1	2.5	6	1	2.5				6
Type	Contaminants	Species	Year																					
Metals	Antimony		2010	550									7500									EIC/AGS/CLAIRE	EIC/AGS/CLAIRE	2010
	Arsenic		2014	37			40			49			640			79			168			CASL	DEFRA	2014
			2015	37			40			40			640			79			170			S4UL	LQM/CIEH	2015
	Beryllium		2015	1.7			1.7			35			12			2.2			63			S4UL	LQM/CIEH	2015
	Boron		2015	290			11000			45			240000			21000			46000			S4UL	LQM/CIEH	2015
	Cadmium		2015	11			85			1.9			190			120			532			S4UL	LQM/CIEH	2015
			2014	28			149			4.9			410			220			880			CASL	DEFRA	2014
	Chromium	III	2015	910			910			18000			8600			1500			33000			S4UL	LQM/CIEH	2015
		V	2014	21			21			170			49			22			256			CASL	DEFRA	2014
		VI	2015	6			6			1.8			33			7.7			220			S4UL	LQM/CIEH	2015
	Copper		2015	2400			7100			520			68000			12000			44000			S4UL	LQM/CIEH	2015
	Lead			200			310			80			2330			630			1300			CASL	DEFRA	2014
	Mercury	Elemental	2012	1.0			1.0			26			26									SGV	DEFRA	2012
			2015	1.2			1.2			21			58			16			30			S4UL	LQM/CIEH	2015
		Inorganic	2012	170			170			80			36000									SGV	DEFRA	2012
			2015	40			56			19			1100			120			240			S4UL	LQM/CIEH	2015
		Methyl	2012	11			11			8			410									SGV	DEFRA	2012
			2015	11			15			6			320			40			68			S4UL	LQM/CIEH	2015
	Nickel		2012	130			130			230			1800									SGV	DEFRA	2012
			2015	130			180			53			980			230			800			S4UL	LQM/CIEH	2015
	Selenium		2012	350			350			120			13000									SGV	DEFRA	2012
			2015	250			430			88			12000			1100			1800			S4UL	LQM/CIEH	2015
	Vanadium		2015	410			1200			91			9000			2000			5000			S4UL	LQM/CIEH	2015
	Zinc		2015	3700			40000			620			730000			81000			170000			S4UL	LQM/CIEH	2015
BTEX & MTBE	Benzene		2012	0.33			0.33			0.07			95									SGV	DEFRA	2012
			2014	0.87			3.3			0.18			98			140			230			CASL	DEFRA	2014
			2015	0.087	0.17	0.37	0.38	0.7	1.4	0.017	0.034	0.075	27	47	90	72	72	73	90	100	110	S4UL	LQM/CIEH	2015
	Toluene		2012	610			610			120			4400									SGV	DEFRA	2012
			2015	130	290	660	880	1900	3900	22	51	120	65000	110000	180000	56000	56000	56000	87000	95000	100000	S4UL	LQM/CIEH	2015
	Ethylbenzene		2012	350			350			90			2800									SGV	DEFRA	2012
			2015	47	110	260	83	190	440	16	39	91	4700	13000	27000	24000	24000	25000	17000	22000	27000	S4UL	LQM/CIEH	2015
	Xylenes	o-xylene	2012	250			250			160			2600									SGV	DEFRA	2012
			2015	60	140	330	88	210	480	28	67	160	6600	15000	33000	41000	42000	43000	17000	24000	33000	S4UL	LQM/CIEH	2015
		m-xylene	2012	240			240			180			3500									SGV	DEFRA	2012
			2015	59	140	320	82	190	450	31	74	170	6200	14000	31000	41000	42000	43000	17000	24000	32000	S4UL	LQM/CIEH	2015
		p-xylene	2012	230			230			160			3200									SGV	DEFRA	2012
			2015	56	130	310	79	180	310	29	69	160	5900	14000	30000	41000	42000	43000	17000	23000	31000	S4UL	LQM/CIEH	2015
Petroleum Hydrocarbons Fractions	Aliphatic >C3 - C6		2015	42	78	160	42	78	160	730	1700	3900	3200	5900	12000	570000	590000	600000	95000	130000	180000	S4UL	LQM/CIEH	2015
	Aliphatic >C6 - C8		2015	100	230	530	100	230	530	2300	5600	13000	7800	17000	40000	600000	610000	620000	150000	220000	320000	S4UL	LQM/CIEH	2015
	Aliphatic >C8 - C10		2015	27	65	150	27	65	150	320	770	1700	2000	4800	11000	13000	13000	13000	14000	18000	21000	S4UL	LQM/CIEH	2015
	Aliphatic >C10 - C12		2015	130	330	760	130	330	770	2200	4400	7300	9700	23000	47000	13000	13000	13000	21000	23000	24000	S4UL	LQM/CIEH	2015
	Aliphatic >C12 - C16		2015	1100	2400	4300	1100	2400	4400	11000	13000	13000	59000	82000	90000	13000	13000	13000	25000	25000	26000	S4UL	LQM/CIEH	2015
	Aliphatic >C16 - C35		2015	65000	92000	110000	65000	92000	110000	260000	270000	270000	1600000	1700000	1800000	250000	250000	250000	450000	480000	490000	S4UL	LQM/CIEH	2015
	Aliphatic >C35 - C44		2015	65000	92000	140000	65000	92000	110000	260000	270000	270000	1600000	1700000	1800000	250000	250000	250000	450000	480000	490000	S4UL	LQM/CIEH	2015
	Aromatic >C3 - C7		2015	70	140	300	370	690	1400	13	27	57	26000	46000	86000	56000	56000	56000	76000	84000	92000	S4UL	LQM/CIEH	2015
	Aromatic >C7 - C8		2015	130	290	660	860	1800	3900	22	51	120	56000	110000	180000	56000	56000	56000	87000	95000	100000	S4UL	LQM/CIEH	2015
	Aromatic >C8 - C10		2015	34	83	190	47	110	270	8.6	21	51	3500	8100	17000	5000	5000	5000	7200	8500	9300	S4UL	LQM/CIEH	2015
	Aromatic >C10 - C12		2015	74	180	380	250	590	1200	13	31	74	16000	28000	34000	5000	5000	5000	9200	9700	10000	S4UL	LQM/CIEH	2015
	Aromatic >C12 - C16		2015	140	330	660	1800	2300	2500	23	57	130	36000	37000	38000	5100	5100	5000	10000	10000	10000	S4UL	LQM/CIEH	2015
	Aromatic >C16 - C21		2015	260	540	930	1900	1900	1900	46	110	260	28000	28000	28000	3800	3800	3800	7600	7700	7800	S4UL	LQM/CIEH	2015

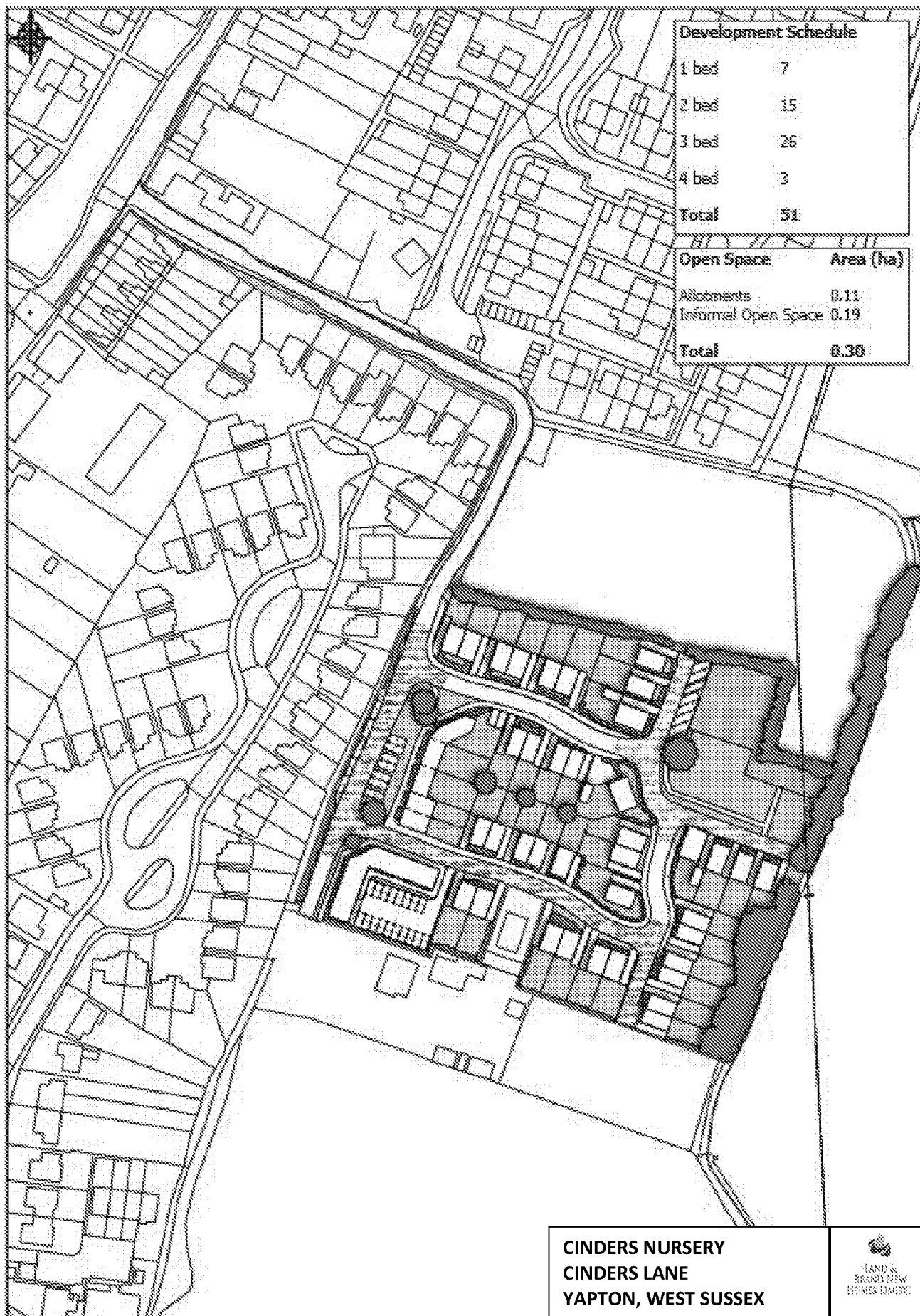
Land Use			Residential With or Without Plant Uptake									Public Open Space (POS)									Media	Authority	Date	
			Allotments						Commercial			Residential						Park						
			With home-grown produce			Without home-grown produce			1	2.5	5	1	2.5	5	1	2.5	5	1	2.5	5				
Type	Contaminants	Species	Year	SOM	1.0	2.5	5	1	2.5	5	1	2.5	5	1	2.5	5	1	2.5	5	1	2.5	5		
	Aromatic >C21 - C35		2015	1100	1500	1700	1900	1900	1900	370	820	1600	28000	28000	28000	3800	3800	3800	7800	7800	7900	S4UL	LQM/CIEH	2015
	Aromatic >C34 - C44		2015	1100	1500	1700	1900	1900	1900	370	820	1600	28000	28000	28000	3800	3800	3800	7800	7800	7900	S4UL	LQM/CIEH	2015
	Aliphatic + Aromatic >C44 - C70			1600	1800	1900	1900	1900	1900	1200	2100	3000	28000	28000	28000	3800	3800	3800	7800	7800	7900	S4UL	LQM/CIEH	2015
Polycyclic Aromatic Hydrocarbons (PAHs) (mg/kg)	Acenaphthene		2015	210	510	1100	3000	4700	6000	34	85	200	84000	97000	100000	15000	15000	15000	29000	30000	30000	S4UL	LQM/CIEH	2015
	Acenaphthylene		2015	170	420	920	2900	4600	6000	28	69	160	83000	97000	100000	15000	15000	15000	29000	30000	30000	S4UL	LQM/CIEH	2015
	Anthracene		2015	2400	5400	11000	31000	35000	37000	380	950	2200	520000	54000	540000	74000	74000	74000	150000	150000	150000	S4UL	LQM/CIEH	2015
	Benzo(a)anthracene		2015	7.2	11	13	11	14	15	2.9	6.5	13	170	170	180	29	29	29	49	56	62	S4UL	LQM/CIEH	2015
	Benzo(a)pyrene		2014			5			5.3			5.7			76			10		21	CASL	DEFRA	2014	
			2015	2.2	2.7	3	3.2	3.2	3.2	0.97	2	3.5	35	35	36	5.7	5.7	5.7	11	12	13	S4UL	LQM/CIEH	2015
	Benzo(b)fluoranthene		2015	2.6	3.3	3.7	3.9	4.0	4.0	0.99	2.1	3.9	44	44	45	7.1	7.2	7.2	13	15	16	S4UL	LQM/CIEH	2015
	Benzo(g,h)perylene		2015	320	340	250	360	360	360	290	470	640	3900	4000	4000	640	640	640	1400	1500	1600	S4UL	LQM/CIEH	2015
	Benzo(k)fluoranthene		2015	77	93	100	110	110	110	37	75	130	1200	1200	1200	190	190	190	370	410	440	S4UL	LQM/CIEH	2015
	Chrysene		2015	15	22	27	30	31	32	4.1	9.4	19	350	350	350	57	57	57	93	110	120	S4UL	LQM/CIEH	2015
	Dibenz(a,h)anthracene		2015	0.24	0.28	0.3	0.31	0.32	0.32	0.14	0.27	0.43	3.5	3.6	3.6	0.57	0.57	0.58	1.1	1.3	1.4	S4UL	LQM/CIEH	2015
	Fluoranthene		2015	280	560	890	1500	1600	1600	52	130	290	23000	23000	23000	3100	3100	3100	6300	6300	6400	S4UL	LQM/CIEH	2015
	Fluorene		2015	170	400	860	2800	3800	4500	27	67	160	63000	68000	71000	9900	9900	9900	20000	20000	20000	S4UL	LQM/CIEH	2015
	Indeno(1,2,3-cd)pyrene		2015	27	36	41	45	46	46	9.5	21	39	500	510	510	82	82	82	150	170	180	S4UL	LQM/CIEH	2015
	Naphthalene		2015	2.3	5.6	13	2.3	5.6	13	4.1	10	24	190	460	1100	4900	4900	4900	1200	1900	3000	S4UL	LQM/CIEH	2015
	Phenanthrene		2015	95	220	440	1300	1500	1500	15	38	90	22000	22000	23000	3100	3100	3100	6200	6200	6300	S4UL	LQM/CIEH	2015
	Pyrene		2015	620	1200	2000	3700	3800	3800	110	270	620	54000	54000	54000	7400	7400	7400	15000	15000	15000	S4UL	LQM/CIEH	2015
	Coal Tar(Sap as surrogate matter)		2015	0.79	0.98	1.1	1.2	1.2	1.2	0.32	0.67	1.2	15	15	15	2.2	2.2	2.2	4.4	4.7	4.8	S4UL	LQM/CIEH	2015
Chloroalkanes & alkenes	1,2 Dichloroethane		2015	0.0071	0.011	0.019	0.0092	0.013	0.023	0.0046	0.0083	0.016	0.67	0.97	1.7	29	29	29	21	24	28	S4UL	LQM/CIEH	2015
	1,1,1 Trichloroethane		2015	8.8	18	39	9	18	40	48	110	240	660	1300	3000	140000	140000	140000	57000	76000	100000	S4UL	LQM/CIEH	2015
	1,1,2,2 Tetrachloroethane		2015	1.6	3.4	7.5	3.9	8	17	0.41	0.89	2	270	550	1100	1400	1400	1400	1800	2100	2300	S4UL	LQM/CIEH	2015
	1,1,1,2 Tetrachloroethane		2015	1.2	2.8	6.4	1.5	3.5	8.2	0.79	1.9	4.4	110	250	560	1400	1400	1400	1500	1800	2100	S4UL	LQM/CIEH	2015
	Tetrachloroethene		2015	0.18	0.39	0.9	0.18	0.4	0.92	0.65	1.5	3.6	19	42	95	1400	1400	1400	810	1100	1500	S4UL	LQM/CIEH	2015
	Tetrachloromethane (Carbon Tetrachloride)		2015	0.026	0.056	0.13	0.026	0.056	0.13	0.45	1	2.4	2.9	6.3	14	890	920	950	190	270	400	S4UL	LQM/CIEH	2015
	Trichloroethene		2015	0.016	0.034	0.075	0.017	0.036	0.08	0.041	0.091	0.21	1.2	2.6	5.7	120	120	120	70	91	120	S4UL	LQM/CIEH	2015
	Trichloromethane		2015	0.91	1.7	3.4	1.2	2.1	4.2	0.42	0.83	1.7	99	170	350	2500	2500	2500	2600	2800	3100	S4UL	LQM/CIEH	2015
	Vinyl Chloride (chloroethene)		2015	0.00064	0.00087	0.0014	0.00077	0.001	0.0015	0.00055	0.001	0.0018	0.059	0.077	0.12	3.5	3.5	3.5	4.8	5	5.4	S4UL	LQM/CIEH	2015
Explosives	2,4,6 Trinitrotoluene		2015	1.6	3.7	8.1	65	66	66	0.24	0.58	1.4	1000	1000	1000	130	130	130	260	270	270	S4UL	LQM/CIEH	2015
	RDX (Hexogen/Cyclonite/1,3,5-trinitro-1,3,5-triazacyclohexane)		2015	120	250	540	13000	13000	13000	17	38	85	210000	210000	210000	26000	26000	27000	49000	51000	53000	S4UL	LQM/CIEH	2015
	HMX (Octogen/1,3,5,7-tetranitro-1,3,5,7-tetrazacyclo-octane)		2015	5.7	13	26	6700	6700	6700	0.86	1.9	3.9	110000	110000	110000	13000	13000	13000	23000	23000	24000	S4UL	LQM/CIEH	2015
Pesticides	Aldrin		2015	5.7	6.6	7.1	7.3	7.4	7.5	3.2	6.1	9.6	170	170	170	18	18	18	30	31	31	S4UL	LQM/CIEH	2015
	Dieldrin		2015	0.97	2	3.5	7	7.3	7.4	0.17	0.41	0.96	170	170	170	18	18	18	30	30	31	S4UL	LQM/CIEH	2015
	Atrazine		2015	3.3	7.6	17.4	610	620	620	0.5	1.2	2.7	9300	9400	9400	1200	1200	1200	2300	2400	2400	S4UL	LQM/CIEH	2015
	Dichlorvos		2015	0.032	0.066	0.14	6.4	6.5	6.6	0.0049	0.01	0.022	140	140	140	16	16	16	26	26	27	S4UL	LQM/CIEH	2015
	Alpha - Endosulfan		2015	7.4	18	41	160	280	410	1.2	2.9	6.8	5600	7400	8400	1200	1200	1200	2400	2400	2500	S4UL	LQM/CIEH	2015
	Beta - Endosulfan		2015	7	17	39	190	320	440	1.1	2.7	6.4	6300	7800	8700	1200	1200	1200	2400	2400	2500	S4UL	LQM/CIEH	2015
	Alpha -Hexachlorocyclohexanes		2015	0.23	0.55	1.2	6.9	9.2	11	0.035	0.087	0.21	170	180	180	24	24	24	47	48	48	S4UL	LQM/CIEH	2015
	Beta -Hexachlorocyclohexanes		2015	0.085	0.2	0.46	3.7	3.8	3.8	0.013	0.032	0.077	65	65	65	8.1	8.1	8.1	15	15	16	S4UL	LQM/CIEH	2015
	Gamma -Hexachlorocyclohexanes		2015	0.06	0.14	0.33	2.9	3.3	3.5	0.0092	0.023	0.054	67	69	70	8.2	8.2	8.						

Land Use			Residential With or Without Plant Uptake									Allotments			Commercial			Public Open Space (POS)									Media	Authority	Date
			With						Without									Residential											
			home-grown produce			home-grown produce																							
Type	Contaminants	Species	Year	SoM	1.0	2.5	8	1	2.5	8	1	2.5	8	1	2.5	8	1	2.5	8	1	2.5	8							
Phenols & Chlorophenols	1,2,3,4,-Tetrachlorobenzene		2015	15	36	78	24	56	120	4.4	11	26	1700	3080	4400	830	830	830	1500	1600	1600	S4UL	LQM/CIEH	2015					
	1,2,3,5,-Tetrachlorobenzene		2015	0.66	1.6	3.7	0.75	1.9	4.3	0.38	0.9	2.2	49	120	240	78	79	79	110	120	130	S4UL	LQM/CIEH	2015					
	1,2,4, 5,-Tetrachlorobenzene		2015	0.33	0.77	1.6	0.73	1.7	3.5	0.06	0.16	0.37	42	72	96	13	13	13	25	26	26	S4UL	LQM/CIEH	2015					
	Pentachlorobenzene		2015	5.8	12	22	19	30	38	1.2	3.1	7	640	770	830	100	100	100	190	190	190	S4UL	LQM/CIEH	2015					
	Hexachlorobenzene		2015	1.8	3.3	4.9	4.1	5.7	6.7	0.47	1.1	2.5	110	120	120	16	16	16	30	30	30	S4UL	LQM/CIEH	2015					
	Phenols		2012				420			420			280			3200						SGV	DEFRA	2012					
			2015	120	200	380	440	690	1200	23	42	83	440	690	1300	440	690	1300	440	690	1300	S4UL	LQM/CIEH	2015					
	Chlorophenols (4 Congeners)		2015	0.87	2	4.5	94	150	210	0.13	0.3	0.7	3500	4000	4300	620	620	620	1100	1100	1100	S4UL	LQM/CIEH	2015					
	Pentachlorophenols		2015	0.22	0.52	1.2	27	29	31	0.03	0.08	0.19	400	400	400	60	60	60	110	120	120	S4UL	LQM/CIEH	2015					
Others																													
	Carbon Disulphide		2015	0.14	0.29	0.62	0.14	0.29	0.62	4.8	10	23	11	22	47	11000	11000	12000	1300	1900	2700	S4UL	LQM/CIEH	2015					
	Hexachloro-1,3-Butadiene		2015	0.29	0.7	1.6	0.32	0.78	1.8	0.25	0.61	1.4	31	66	120	25	25	25	48	50	51	S4UL	LQM/CIEH	2015					
	Sum of PCDD's, PCDF's and dioxin-like PCB's.		2012				8			8			8			240						SGV	DEFRA	2012					

NOTE

Priority	Guideline (mg kg ⁻¹)
1	Site Specific Assessment Criteria (SSAC) (Soils Limited)
2	2014: Category 4 Screening Level (C4SL) (Contaminated Land: Application in Real Environment (CLARE), 2014)
3	2012: Soil Guideline Value (SGV) (Environment Agency, 2009)
4	2015: Sutable 4 Use Level (S4UL) (Nathanail <i>et al</i> , 2015)
For Generic Risk Assessment, the values in Bold have priority	
Table reviewed February 2018	

Appendix B.3 General Assessment Criteria



CINDERS NURSERY
CINDERS LANE
YAPTON, WEST SUSSEX



Appendix C Information Provided by the Client