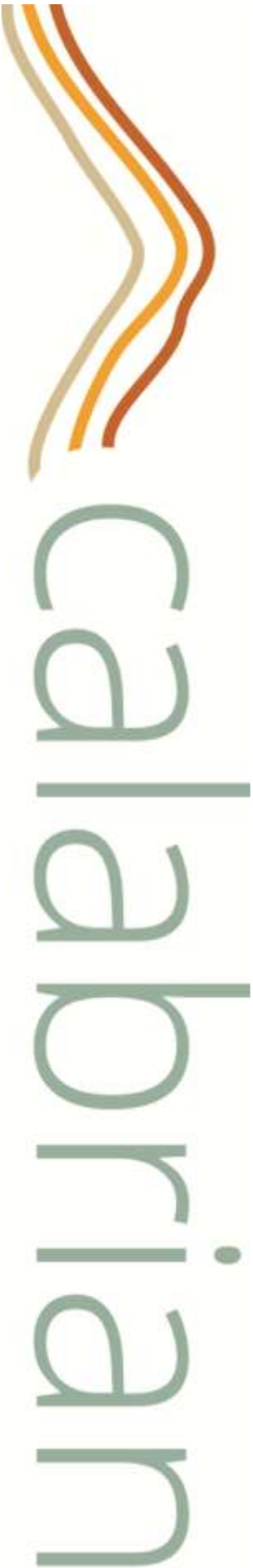


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REMEDIATION STRATEGY for land at **FORESTERS WAY, DERBY, DE23 8AG**

Prepared on behalf of LNT Care Developments (3) Limited

Report 7318/2 Revision 2.2

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DOCUMENT CONTROL FORM

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Report Reference: 7318/2 **Revision:** 2.3 **Date:** 20/08/2026

Approved By: Richard Hey - BSc MSc DIC CGeol

Signature:



FOREWORD (Geoenvironmental Investigation Report)

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The report should be read in its entirety, including all associated drawings and appendices. Calabrian cannot be held responsible for any misinterpretations arising from the use of extracts that are taken out of context.

The findings and opinions conveyed in this report (including review of any third-party reports) are based on information obtained from a variety of sources as detailed within this report, and which Calabrian believes are reliable. All reasonable care and skill has been applied in examining the information obtained. Nevertheless, Calabrian cannot and does not guarantee the authenticity or reliability of the information it has relied upon.

The report represents the findings and opinions of experienced geoenvironmental consultants. Calabrian does not provide legal advice and the advice of lawyers may also be required.

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Calabrian reserve the right to amend their conclusions and recommendations in the light of further information that may become available.



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1 INTRODUCTION

1.1 THE COMMISSION AND BRIEF

Calabrian Limited (Calabrian) has been commissioned by LNT Care Developments (3) Limited (LNT) to prepare a Remediation Strategy for land at Foresters Way, Derby, DE23 8AG.

Calabrian have already issued the following reports:

- Geoenvironmental Appraisal of land at Foresters Way, Derby, DE23 8AG. Report No. 7318/1, dated November 2024.

The appointed Contractor will need to familiarise themselves with the above Reports and comply with all relevant recommendations contained therein.

This document outlines the remediation objectives necessary to protect environmental receptors and render the site suitable for the proposed development. A Method Statement should be prepared, in order to detail how the objectives will be achieved.

The Method Statement should be accompanied by a Designer's Risk Assessment in accordance with the CDM Regulations, 2015. The Method Statement and Risk Assessment should be submitted to, and approved by, the Engineer.

1.2 THE PROPOSED DEVELOPMENT

It is proposed to redevelopment of the site with a two-storey residential care home with associated gardens/landscaping, access road and car park. A proposed site layout has been provided by LNT and is copied as Drawing 7318/2.

It should be noted that a secure fence separates the residents gardens and landscaped areas to the east of the care home building from general landscaping to the west around the car park and access road.

The care home will be founding in the clay at around 1.0m to 1.5m depth below any made ground.

2 BACKGROUND

2.1 SITE DESCRIPTION

Details of the site are given below:

- Location: 2.5km south of Derby city centre
- Nearest Post Code: DE23 8AG
- National Grid Reference: 43529, 33342 (SK 352 334)
- Area: 0.59 hectares

A location plan is shown on Drawing Nos 7318/1.

2.2 GROUND INVESTIGATION

An intrusive ground investigation comprising five trial pits and four boreholes with laboratory analysis was undertaken in October 2024.

Made Ground

Made ground was found across the site but in the majority of exploratory holes this comprises a surface cover of either asphalt (typically 50mm thick, external car parking areas) or concrete (typically around 300mm thick, internal) underlain by approximately 300mm of compacted limestone Sub-Base material that lay directly onto natural ground.

In the south-western section of the site (TP201 and TP202) made ground extended to depths of 0.75m and 1.6m respectively comprising around 300mm of Made Ground Topsoil overlying Cohesive Made Ground. Within TP201 weak concrete, Brickfill and Ash & Clinker underlay the Cohesive Made Ground.

Natural Ground

Natural ground was encountered within each of the exploratory holes and typically comprised stiff to very stiff clay with mudstone lithorelicts (Weathered Mercia Mudstone Formation).

Groundwater

No significant inflows of groundwater were encountered during the investigation.

Hazardous Gas

There is one known area of landfilling within 250m; given its distance and very low permeability deposits in the area migration risk is negligible. The site is not in area considered susceptible to mines gas, nor is it underlain by shallow mineworkings. Previous on-site monitoring classified the site as CS1.

The site is in an area where less than 1% of homes are estimated to be above the radon action level.

As such, no special precautions against hazardous gas are required.

Contamination

Elevated concentrations of lead have been found within the Made Ground Topsoil and within a single sample of Sub-Base.

Given the limited quantity of Made Ground Topsoil located on site it is recommended that it be removed from site. The sub-base material if reused on site would be beneath buildings or areas of hardstand that would isolate it from human receptors.

3 RISK ASSESSMENT & TARGET CONCENTRATIONS

Clean-up criteria relevant to the limited contamination encountered at this site are not driven by risks to controlled waters, therefore in the absence of a site-specific Quantitative Risk Assessment, it is conservatively proposed that Calabrian' generic soil screening values for a residential-with-homegrown produce end use (Calabrian Scenario A) be adopted as remedial targets for hydrocarbon contamination in soils on this site.

Information on the derivation and use of these screening values is presented in Appendix B.

4 REMEDIATION STRATEGY (GENERAL)

4.1 AIMS

Remediation aims are to:

- Resolve contamination issues in order to protect environmental receptors and render the site suitable for the proposed development;
- provide a stable development platform (to agreed levels and gradients) for subsequent construction of the proposed development and associated infrastructure; and,
- satisfy requirements of the Local Planning Authority.

4.2 OVERVIEW

The following remediation works are required:

- Demolition of the existing buildings;
- general site clearance of surface materials and vegetation;
- topsoil strip and removal from site;
- break-up of slabs and hardstand; and,
- provision of topsoil in all garden and landscaped areas.

4.3 SITE SET-UP, ORGANISATION AND SAFETY

All site personnel should undergo a site-specific health and safety induction prior to commencement of work on site.

During the remediation works, all personnel on site will comply with guidance provided in the Health and Safety Executive (HSE) document "Protection of Workers and the General Public during the Redevelopment of Contaminated Land". In summary, the following should be provided:

- Protective clothing, footwear, and gloves. (Personnel should be instructed in why and how they are to be used); and
- Handwashing and boot-washing facilities; and,
- Designated smoking areas.

If at any time during the works personnel begin to feel unwell, they are to inform the Engineer, who will determine appropriate action.

Access into excavations etc. must be controlled and only undertaken in accordance with the Confined Spaces Regulations 1997. The atmosphere in shored trenches in excess of 1.2m should be monitored for oxygen and hazardous gas (methane & carbon dioxide), prior to personnel entering such excavations. Monitoring should continue whilst personnel are working in deep excavations.

4.4 VERIFICATION

The purpose of verification documentation is to provide transparent reasoning why the remediation was required, a methodology about how it was to be undertaken and proof that the specified works have been undertaken and to provide confirmation that the site is “suitable for its intended use”.

The report will include supporting documentation such as laboratory analysis results, delivery tickets for material, certificates for imported material (or if unavailable, documented evidence of the source of the Greenfield material), trial pit logs etc.

The report should include details of any measures required to maintain the cover system integrity in the future e.g. successive construction phases (management plans) and longer term (restrictive covenants on title deeds).

Photographs will also be included to evidence soil cover placement and quality, these will include (where appropriate):

- Photographs of any stockpiles and quarantine areas;
- depth of soil cover installed including survey staff as a scale;
- quality of the material to be used as cover eg absence of large stones;
- location of geotextile separator and visual warning membranes;
- method of placement and different layers if appropriate;
- inclusion of background features which will aid locating the photograph; and,
- inclusion of site identification boards within the photos which show the date, position taken i.e. corner of plot 3 and the site name.

The presence of good quality photographs is essential to prove beyond doubt that the remediation has been undertaken as specified both by method and position, and that the images have been taken from the specific area stated.

5 REMEDIATION STRATEGY (SPECIFIC OBJECTIVES)

5.1 CONTINGENCY FOR UNKNOWNNS

Even after an appropriate preliminary investigation and ground investigation, with exploratory holes on a closely spaced grid (say trial pits at 30m centres), a geoenvironmental appraisal is typically based on inspection of the ground underlying less than 0.5% of the total site area (and much less at depths in excess of about 3.5m). Consequently, there is always a possibility that unanticipated ground conditions will be encountered during the remediation works.

If unanticipated ground is encountered during the remediation works, the Contractor should immediately seek further advice from the Engineer.

Where appropriate any unanticipated grossly contaminated soil/fill should be placed in temporary stockpiles on hardstand or Visqueen, suitably covered and bunded.

Analysis of at least six samples, for an appropriate range of determinands should be undertaken. On receipt of the results, the Engineer will liaise with the Contractor regarding the most appropriate remediation option.

5.2 SITE CLEARANCE & TOPSOIL REMOVAL

Any trees currently under a Tree Preservation Order (TPO) should be identified and agreed with relevant authorities prior to the commencement of the works. All trees retained trees should be clearly identified and protected by fencing in accordance with BS5837: 2012.

The site should then be cleared of all residual debris, any vegetation, shrubs, bushes, and unprotected trees as instructed by LNT.

During the summer of 2026 significant demolition and site clearance has been undertake on the site and wider area by Cawarden. Calabrian visited site on 19th August 2026 and noted that the majority of topsoil had already been removed from the Care Home site. Drawing 7318/8, Revision 8 details the areas of the site where a thin veneer of topsoil is still present. This includes an area beneath the new care home access road.

Drawing 7318/8 details the location of the access road, car parking, sub-station building and PV battery building that are currently underlain by a veneer of topsoil. This topsoil will be stripped and removed from site during construction operations. (again see Drawing 7318/8, Rev A).

The above topsoil should be stripped and removed from site; once removed a detailed photographic survey should be undertaken to demonstrate the removal. Evidence of the chain of custody for removal should also be provided. It should be noted that much of the area currently underlain by topsoil will be located beneath the access road, car park and sub-station.

Some topsoil will remain in the existing (to be retained) landscaped areas in the south-western corner of the site and to the west of the PV Battery store. This topsoil lies exclusively beneath exiting trees within the designated root protection areas.

As noted in Section 1.2 above this area of the site lies outside of the residential amenity garden and landscaped areas and is separated by secure fencing. This area can be considered as maintained public open space but in the vicinity of a residential property. In this case topsoil remaining near surface should be screened in accordance with Calabrian Scenario C (Residential apartments with landscaping/public open space (POS)).

It is recommended that six supplementary lead sampling points be selected in the small areas of topsoil that will be maintained following construction (beneath the tree canopies). If samples are found to exceed the Calabrian Scenario C Tier 1 lead concentration of 630mg/kg then very careful consideration will be required as to how this soil might be removed from site without adversely affecting the protected trees. This would likely require very careful vacuum excavation, removal and replacement with 'clean' topsoil.

5.3 DEMOLITION

Demolition works will commence on completion of any asbestos removal and a "soft-strip" of the existing buildings.

Existing buildings will be demolished in a safe and controlled manner.

All demolition operations should conform to BS 6187:2000 Code of Practice for Demolition. All personnel working on these operations should be fully qualified to do so.

A detailed Method Statement specific to the project must be prepared by the Contractor and submitted to LNT. The Method Statement should also be submitted to, and approved by, the Engineer and the Local Authority.

5.4 REMOVAL OF BELOW GROUND OBSTRUCTIONS

All foundations associated with existing buildings and other relict structures will be chased out and grubbed-up, in order to remove potential obstructions to new foundations and infrastructure.

Where significantly deep foundations (eg. piles) cannot be removed by conventional means, they are to be cut at a depth to be agreed with the Engineer and the position of the remaining lower section is to be accurately recorded by survey.

Suitable materials derived from grubbing-up should be stored in a location on site prior to crushing. Any unsuitable materials should be removed to a suitably licensed landfill site.

5.5 CRUSHING

Production of a selected granular fill should be possible if suitable materials (generated by demolition operations and grubbing-up of floor slabs, foundations, and other relict structures) are crushed.

The crushed product should be screened to remove any unsuitable elements and stockpiled for re-use during the subsequent construction works. Generation of a Class 6 material as defined in the Highways Agency Specification (Series 600) should be possible.

6F2 graded material can contain up to 50% recycled tarmac/asphalt (provided it does not pose a contamination risk to controlled waters). Recycled tarmac can be crushed to yield a 6F3 selected granular material, provided the recovered bitumen content is less than 10% (determined in accordance with BS598-102).

5.6 BOUNDARY ISSUES

LNT's Designer should ensure that proposed levels tie in with the surrounding infrastructure, and ground levels of adjacent properties (after allowance for the placement of any required soil cover).

Advice should be sought from the Engineer if mobile contamination is encountered close to the site's boundaries.

5.7 EXPORT TO LANDFILL

Any material exported from site to landfill should be hauled by a registered waste carrier in accordance with the requirements of the Duty of Care Regulations, 1991 and the Landfill (England & Wales) Regulations 2002.

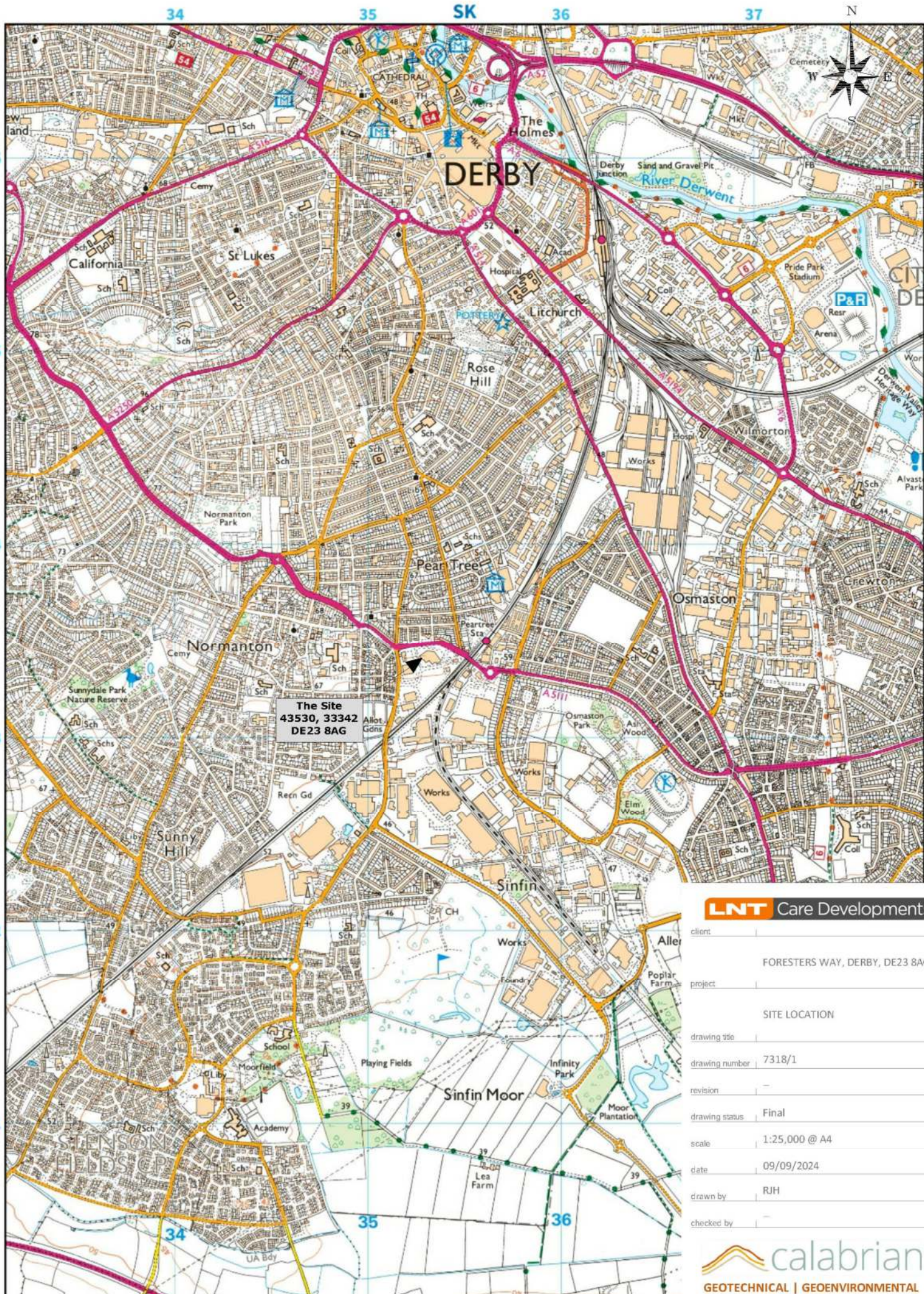
A transfer note should be completed, signed, and retained by the parties involved. The transfer note should include the volume of waste, the nature of the material and a statement of its chemical composition, details of the source and destination sites, and details of the haulier.

5.8 PLACEMENT OF SOIL COVER

The importation of suitable topsoil will be required.

Any material imported for use as cover should be validated in accordance with Calabrian's Protocol for Soil Importation, copied in Appendix A. This Protocol includes chemical assessment criteria which should not be exceeded.

DRAWINGS	
7318/1	Site Location Plan
7318/2	Proposed Site Layout
7318/7	Geoenvironmental Summary
7318/8	Topsoil Removal



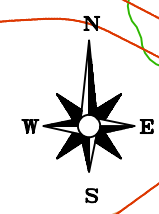
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LNT Care Developments

client	
project	FORESTERS WAY, DERBY, DE23 8AG
	SITE LOCATION
drawing title	
drawing number	7318/1
revision	
drawing status	Final
scale	1:25,000 @ A4
date	09/09/2024
drawn by	RJH
checked by	



notes
Proposed layout reproduced from
LNT Construction Drawing
referenced DE24 8AG - F-01,
dated 31/05/2024.



rev. description

LNT Care Developments

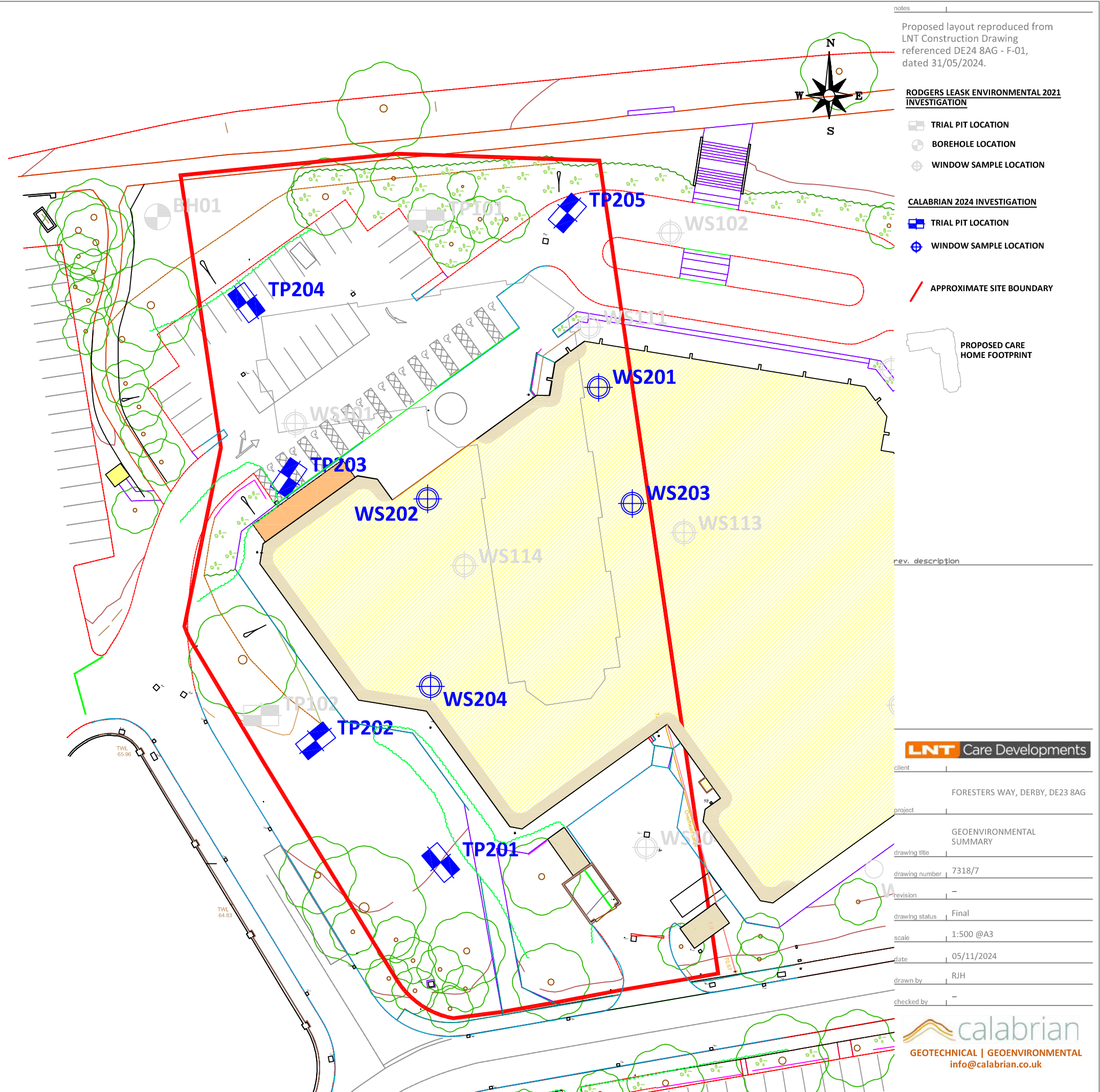
client	FORESTERS WAY, DERBY, DE23 8AG
project	PROPOSED LAYOUT
drawing title	
drawing number	7318/2
revision	-
drawing status	Final
scale	1:500 @A3
date	09/09/2024
drawn by	RJH
checked by	-


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Significant developer abnormalities relating to geoenvironmental issues at the site are:

- Demolition of existing buildings, grub-up of foundation, hardstand and redundant services.
- removal of Made Ground Topsoil from site.
- Import of topsoil for gardens/landscaped areas.

This brief summary should not be assumed to represent a complete account of all the potential geoenvironmental issues that may exist at the site. As such it is strongly recommended that the report be read in its entirety.





notes

RODGERS LEASK ENVIRONMENTAL 2021 INVESTIGATION

- TRIAL PIT LOCATION
- BOREHOLE LOCATION
- WINDOW SAMPLE LOCATION

CALABRIAN 2024 INVESTIGATION

- TRIAL PIT LOCATION
- WINDOW SAMPLE LOCATION

APPROXIMATE SITE BOUNDARY

PROPOSED CARE HOME FOOTPRINT

AREA OF RESIDUAL TOPSOIL

TOPSOIL SAMPLING POINT

rev. description

Revision A (19/08/2026): Details of residual topsoil and supplementary sampling points.

Photographs detail situation on site on 19/08/2026.

LNT Care Developments

client

FORESTERS WAY, DERBY, DE23 8AG

project

TOPSOIL REMOVAL AREA

drawing title

drawing number 7318/8

revision A

drawing status FINAL

scale 1:250 @A3

date 13/03/2026

drawn by RJH

checked by

calabrian

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APPENDIX A PROTOCOL FOR IMPORTATION & USE OF SOIL COVER

Introduction.

Isolation of made ground in garden and landscaped areas beneath a cover of “clean” subsoil, and topsoil is often recommended as a remediation solution; most notably when the made ground contains inorganic (and non-volatile organic) contaminants at concentrations above guidance threshold values. A cover solution is not appropriate for volatile or semi-volatile organic contaminants (fuels, solvents etc); removal or treatment will usually be required.

The thickness of cover is dependant on the nature and degree of contamination (and sometimes the Local Authority whose area the site lies within), but typically between 600mm and 1,000mm is required. However, if the made ground is essentially “clean”, but contains materials generally considered undesirable as a near-surface material in garden areas (colliery spoil, construction\demolition rubble etc) then a 300mm thick cover should be adequate. If the made ground is essentially “clean” and comprises reworked natural soil, the only cover likely to be required is topsoil.

The “clean” soil cover blocks potential linkages between the contaminated made ground and future residents. Soil cover is not required beneath hardstand or structures.

Soil cover is usually placed many weeks after completion of the preparatory\remediation works, and issue of the associated Verification Report, typically at a relatively late stage in the construction programme.

Prior to placement of soil cover, the appointed remediation contractor and\or groundworker should ensure that ground levels are low enough to accommodate the required cover thickness, taking account of any boundary issues, and without compromising the DPC.

Ideally soil **quality** should be determined by sampling of the **source** at least seven working days before importation to the development site. However, samples could be obtained from stockpiles on site; these may on occasion comprise subsoils associated with foundation\ drainage excavations in natural in-situ strata. Alternatively (but not recommended) soil samples could be obtained from gardens after placement.

Clearly, if soil cover is imported and placed before confirmation of its suitability, Calabrian cannot guarantee that our validation work will yield the desired results. In which case, it may be necessary to excavate and export the placed soil cover and\or import further “clean” soil.

Where samples have been tested at source, and on receipt of laboratory results, Calabrian will issue confirmation of soil suitability to the Client, who in turn will instruct his Contractor to commence importation. It will probably be necessary to stockpile soil cover materials prior to placement in garden\landscaped areas. Calabrian should inspect the stockpiled material prior to placement, to confirm that it is the same material as previously tested, and it has not been cross-contaminated, with miscellaneous arisings generated during the construction works.

Imported topsoil should be as specified in BS 3882:2007 as ‘suitable for their intended purpose’.

Sampling Frequency (to check Soil Quality): The number of samples taken will be dependant on the nature of the source, and the quantity of material to be imported. However, typically minimum are set out in Table 1 below.

It should be noted that the thickness of placed topsoil is only 100mm to 150mm (compared with subsoil thicknesses of around 500mm). Consequently, where samples are collected after placement (although testing at source is always preferable) testing one sample per trial pit results in a higher

IMPORTATION & USE OF SOIL COVER – CARE HOMES

frequency. This is not unreasonable anyway, since from a potential contaminant perspective, topsoil, being present at surface, is more important than underlying subsoil.

Occasionally a developer just places 600mm of topsoil (i.e. no subsoil is used). In such circumstances, assuming the topsoil is from a single source, Calabrian would test as per a single greenfield source.

Soil **thickness** will be verified after placement; this should ideally be done before turfing, fencing etc, but after scaffolding has been dismantled. Hand excavated trial pits will be excavated at 15m intervals across garden and landscaped areas. The soil profile will be described at each location, photographs of the trial pit and arisings taken, and appropriate samples collected.

Soil Material Suitability: Inspection pits should be excavated through the entire thickness of any proposed in-situ source material, or cover material (if inspection is post-placement). Stockpiles should be assessed from both the surface and by digging into the “core”, to ensure the material is reasonably homogenous.

The soil material should:

- Be clean and free of foreign debris, building waste materials, glass sharps, or contaminants;
- topsoil should not have a gravel content of greater than 30% by dry weight and should generally have a maximum stone size of 50mm in any one direction;
- subsoil should generally have a maximum stone size of 150mm in any one direction; and,
- not have been sourced from an area within 7m laterally, or 3m vertically, of Japanese Knotweed plants, and not contain any Japanese Knotweed fragments (rhizomes, leaves, stems etc).

Laboratory Analysis: Whether samples are taken at source, from stockpiles on site, or from gardens/landscaped areas after placement, they should be forwarded to an analytical laboratory for testing in accordance with one of the Schedules detailed in Table 1.

Imported topsoil should be subject to such testing, wherever it is *not* being sourced from a reputable supplier; soil transfer stations would not usually be classed as a reputable supplier. In addition, some analysis in accordance with BS3882 may occasionally be appropriate.

Analysis of virgin quarries material should not normally be required; however, if visual inspection yields foreign clasts then the material should be treated as crushed hardcore.

Additional determinands could be scheduled, although if considered necessary, would probably suggest the material is unlikely to be suitable for use as clean cover in gardens.

Chemical assessment criteria for imported soils are provided in Table 2.

It should be noted that many of the compounds detected by laboratory analysis for TPH and PAH are naturally occurring in coal, humic acid, bark, leaf litter etc; these are clearly not ‘sources’ within the legal definition. Calabrian can undertake further risk assessment where PAH screening values are exceeded, *but* inspection of the soils has not identified any petroleum or combustion derived material.

However, it should be noted that Calabrian will only analyse for TPH where a possible source is identified or where cover material is obtained from a Brownfield site or transfer station, Calabrian will not undertake this sampling as a matter of routine on proven Greenfield sites.



IMPORTATION & USE OF SOIL COVER – CARE HOMES

Table 1 – Test schedule

Source		Definition	Test Schedule	Other requirements\Remarks
Greenfield	Minimum 3 or 1 per 250m ³ (whichever is greater)	No 'source' of contamination present i.e. undeveloped; absence of made ground.	<i>pH, total metals (Cu, Ni, Zn, Cr III, Cr VI, As, Hg, Se, Cd & Pb), water soluble boron. TOC & Speciated PAH. Asbestos ID</i>	Photographs of site and stockpiles.
"Low-risk" Brownfield	Minimum 6 or 1 per 100m ³ (whichever is greater)	Development site (on former greenfield land) with excess soils, or a "low-risk" brownfield site (eg former school, offices, housing estate etc).	<i>pH, total metals (Cu, Ni, Zn, Cr III, Cr VI, As, Hg, Se, Cd & Pb), water soluble boron. TOC & Speciated PAH. Asbestos ID</i>	Photographs of site and stockpiles.
Soil Transfer Stations & Other Brownfield	Minimum 6 or 1 per 100m ³ (whichever is greater)	Source is a soil transfer stations. Potential source anticipated i.e. current or historical industrial or commercial use; evidence of bonfires; presence of made ground.	<i>pH, total metals (Cu, Ni, Zn, Cr III, Cr VI, As, Hg, Se, Cd & Pb), water soluble boron. TOC, Speciated PAH and speciated TPH. Asbestos ID</i>	Photographs of site and stockpiles.
Crushed Hardcore, Stone, Brick	Minimum 1 per 1000m ³	Site won from processed demolition arisings or off-site sourced.	<i>pH, total metals (Cu, Ni, Zn, Cr III, Cr VI, As, Hg, Se, Cd & Pb), water soluble boron. TOC & Speciated PAH. Asbestos ID</i>	Photographs of site and stockpiles.

NB The schedules detailed above have been prepared in accordance with the Secondary Model Procedures. This document states that analysis should be relevant to potential sources and not merely a set list of parameters applied to each site.

Validation Reports

The analytical testing will usually be undertaken on a 3 or 5-day turnaround and the Client\Contractor will be notified of the soil's suitability (or otherwise) immediately after receipt of the results.

Interim validation letter reports will be issued by Calabrian as each plot, or set of plots, is completed. After Calabrian have been able to confirm placement of agreed thicknesses of suitable soil cover in all garden\landscaped areas across the site, and where required to satisfy a Local Authority planning condition, we will prepare and submit a final validation letter report.

IMPORTATION & USE OF SOIL COVER – CARE HOMES

Table 2 - Chemical Assessment Criteria for Imported Soils – Assume Gardens With Home Grown Produce

Contaminant	Source	Tier 1 Assessment Criteria (mg/kg)			Comments/Notes
		1% TOC	2.5% TOC	6% TOC	
pH	CLEA				
As	C4SL		37		
Cd	LQM/CIEH S4UL		11		
Cr (III)	CLEA		910		
Cr (VI)	CLEA		4		
Pb	C4SL		200		
B	LQM/CIEH S4UL		290		
Se			250		
Hg			40		
Cu	BS3882: 2015	100 (pH<6), 135 (pH6-7), 200 (pH>7)			
Ni		60 (pH<6), 75 (pH6-7), 110 (pH>7)			
Zn		200 (300 if pH >7.0)			
Asbestos		Not Identified			
GRO	CLEA	7.6 [#]	11 [#]	15 [#]	Conservative value based on value for aromatic fraction C7-C8 range, but assuming indoor inhalation pathway still relevant (it shouldn't be).
DRO	CLEA	66 [#]	109 [#]	151 [#]	Conservative value based on value for aliphatic fraction C10 to C12 range, but assuming indoor inhalation pathway still relevant (it shouldn't be).
LRO	CLEA	1,000 [#]	1,000 [#]	1,000 [#]	Calculated value close to soil saturation limit, screening value selected by Calabrian considering visual\olfactory impact.

[#] If the Tier 1 Assessment Criteria is exceeded then the significance of speciated TPH results will be assessed by following the 3 steps outlined in Annex I of Calabrian Report 7030/1, Rev E using LQM/CIEH S4UL assessment criteria for a residential without home grown produce end use and 1% SOM.

IMPORTATION & USE OF SOIL COVER – CARE HOMES

Table 2 - Chemical Assessment Criteria for Imported Soils – Assume Gardens With Home Grown Produce

Contaminant	Source	Tier 1 Assessment Criteria (mg/kg)			Comments/Notes
		1% TOC	2.5% TOC	6% TOC	
Speciated PAH					
Acenaphthene	LQM/CIEH S4UL	3,000	4,700	6,000	
Acenaphthylene		2,900	4,600	6,000	
Anthracene		31,000	35,000	37,000	
Benzo(a)anthracene		11	14	15	
Benzo(a)pyrene		3.2	3.2	3.2	
Benzo(b)fluoranthene		3.9	4.0	4.0	
Benzo(k)fluoranthene		110	110	110	
Benzo(g,h,i)perylene		360	360	360	
Chrysene		30	3	3	
Dibenzo(a,h)anthracene		0.31	0.32	0.32	
Fluoranthene		1,500	1,600	1,600	
Fluorene		2,800	3,800	4,500	
Indeno(1,2,3-cd)pyrene		46	46	46	
Naphthalene		2.3	5.6	13	
Phenanthrene		1,300	1,500	1,500	
Pyrene		3,700	3,800	3,800	

APPENDIX B TIER 1 SCREENING VALUES

Soil Screening Values used by Calabrian

In March 2002 DEFRA and the Environment Agency published a series of technical papers (R&D Publications CLR 7, 8, 9 and 10) outlining the UK approach to the assessment of risk to human health from land contamination. In 2008 CLR 7, 9 and 10 and all corresponding SGV and Tox reports were withdrawn and superseded by new guidance including:

- Professional Guidance: Comparing Soil Contamination Data with a Critical Concentration- CL:AIRE, 2020
- Evaluation of models for predicting plant uptake of chemicals from soil - Science Report – SC050021/SR
- Human health toxicological assessment of contaminants in soil - Science Report: SC050021/SR2
- Updated technical background to the CLEA model - Science Report: SC050021/SR3
- CLEA Software (Version 1.05) Handbook Science report: SC050021/SR4
- Compilation of data for priority organic pollutants for derivation of Soil Guideline Values - Science Report: SC050021/SR7

The approach set out in these documents represents current scientific knowledge and thinking; and includes the Contaminated Land Exposure Model (CLEAv1.06). The Environment Agency are in the process of using this updated approach to regenerate a selection of Soil Guideline Values (SGVs).

CLEA SGVs were derived for standard land use scenarios predominantly in the context of Part IIA, using a conceptual site model (CSM) defined in SR3. Calabrian have incorporated amendments to the CSM used to derive SGVs that more accurately reflect redevelopment within the planning regime; consequently, Calabrian have not necessarily adopted any published SGV as a screening value.

The CLEA conceptual site model assumes a source located in a sandy loam, with 6% soil organic matter (SOM) - equivalent to 3.5% total organic carbon (TOC). Calabrian consider it reasonable to adopt the CLEA default TOC for made ground. However, where the average TOC value for a particular soil type is significantly lower than the 3.5%, Calabrian adopt refined Screening Values.

In March 2014 DEFRA published Category 4 Screening Levels (C4SLs) for six substances (arsenic, cadmium, chromium IV, lead, benzene & benzo(a)pyrene) for four generic land-uses comprising residential, commercial, allotments and public open space.

The methodology for deriving both the previous Soil Guideline Values and the new Category 4 Screening Levels is based on the Environment Agency's Contaminated Land Exposure Assessment (CLEA) methodology. Development of Category 4 Screening Levels has been achieved by modifying the toxicological and/or exposure parameters used within CLEA (while maintaining current exposure parameters).

The Part 2A Statutory Guidance was developed on the basis that Category 4 Screening Levels could be used under the planning regime. However, policy responsibility for the National Planning Policy Framework falls to the Department for Communities and Local Government. Defra anticipate that, where they exist, C4SLs will be used as generic screening criteria, and Calabrian consider C4SLs to be suitable for use as Tier 1 Screening Values. Calabrian have discussed this matter with both NHBC and YAHPAC (collection of Yorkshire & Humberside local authorities) and received confirmation that they are satisfied with this approach.

In general Calabrian have adopted the use of the LQM/CIEH Suitable 4 Use Levels (S4ULs) as Tier 1 Screening Criteria. Copyright Land Quality Management Limited reproduced with permission; Publication Number S4UL3373. All rights reversed.

Calabrian have adopted Tier 1 Screening Criteria for five different CSMs (Scenarios); these are:

- A - Residential with homegrown produce.
- B - Residential without homegrown produce.
- C – Residential apartments with landscaping/public open space (POS).
- D - Commercial/industrial with landscaping.
- E - Dedicated sports grounds or parkland/ public open space (POS).

The **exposure** pathways considered for each scenario are detailed in the Table below.

Scenario	Land use	Pathways	Justification
A	Residential with homegrown produce, but no cover (or only up to 300mm)	• Direct ingestion of soil • Dermal contact • Consumption of vegetables and soil attached to vegetables • Inhalation of indoor vapours and dust • Inhalation of outdoor vapours and dust	Minimal cover – insufficient to break any pathways therefore all exposure pathways are relevant
B	Residential without homegrown produce (landscaped areas) and minimum 300mm cover	• Direct ingestion of soil • Dermal contact • Inhalation of indoor vapours and dust • Inhalation of outdoor vapours and dust	All pathways applicable due to possible exposure from landscaped areas. However consumption of home grown produce not included as unlikely to be grown in landscaped areas. Where vegetables are to be grown site specific QRA may be required.
C	Grassed area or play park in close proximity to housing. Assumes minimum 300mm cover (growing medium).	• Direct ingestion of soil • Dermal contact • Inhalation of outdoor vapours and dust	All pathways applicable due to possible exposure from landscaped areas. Assumes an area where some children play regularly and others less.
D	Commercial/ industrial with landscaped areas no cover	• Direct ingestion of soil • Dermal contact • Inhalation of indoor vapours and dust • Inhalation of outdoor vapours and dust	All pathways applicable due to possible exposure from landscaped areas. Assumed the commercial development consists of offices to provide a conservative assessment.
E	Dedicated sports grounds. Assumes minimum 300mm cover (growing medium).	• Direct ingestion of soil • Dermal contact • Inhalation of outdoor vapours and dust	All pathways applicable due to possible exposure from landscaped areas. Assumes an where exposure only occurs to players and grounds staff

The Soil Screening Values referred to in this document are **not** intended to be used when considering potential risks associated with:

- Existing land uses in the context of Part IIA of the Environment Protection Act 1990; and
- controlled waters.

With respect to **inorganic** determinands, Calabrian derived Tier 1 values for the four Scenarios A to E are presented below:

Inorganic Contaminant	Source	C4SL*	LQM/ CIEH S4UL	Tier 1 Assessment Criteria (mg/kg) for Scenarios A to E					Comments/Notes
				A	B	C	D	E	
As	CLEA	37	37	37	40	79	640	170	LQM/CIEH S4UL adopted.
Cd	CLEA	26	11	11	85	120	190	532	LQM/CIEH S4UL adopted.
Cr	CLEA		910	910	910	1,500	8,600	33,000	LQM/CIEH S4UL adopted. Assumes Cr is CrIII.
Pb	CLEA	200		200	310	630	2,330	1,300	C4SLs adopted.
Ni	CLEA		130	130	180	230	980	3,400	LQM/CIEH S4UL. Assessment of health risk only.
				60 (pH<6), 75 (pH6-7), 110 (pH>7)					Phytotoxicity.
Se	CLEA		250	250	430	1,100	12,000	1,800	LQM/CIEH S4UL adopted.
Hg	CLEA		40	40	56	120	1,100	240	LQM/CIEH S4UL. Assumes in an inorganic compound.
B	Drinking		290	290	11,000	21,000	240,000	46,000	LQM/CIEH S4UL adopted.
Cu	EPA		2,400	2,400	7100	12,000	68,000	44,000	LQM/CIEH S4UL adopted. Assessment of health risk only.
				100 (pH<6), 135 (pH6-7), 200 (pH>7)					Phytotoxicity.
Zn	DoE		3,700	3,700	40,000	81,000	730,000	170,000	LQM/CIEH S4UL adopted. Assessment of health risk only.
				200 (300 if pH >7.0)					Phytotoxicity.
Cyanide	CLEA			527	530		14,000		SSV

* For a residential end use

With respect to **organic** determinands, Calabrian derived Tier 1 values (assuming 6% SOM) for the four Scenarios A to E are presented below:

Organic Contaminant (all sourced via CLEA)	Tier 1 Assessment Criteria (mg/kg) for Scenarios A to E					Comments/Notes
	A	B	C	D	E	
Benzene	0.37	1.4	73	90	110	LQM/CIEH S4UL adopted.
Toluene	660	3900	56,000	180,000 ^{VAP} (4,360)	100,000 ^{VAP} (4,360)	LQM/CIEH S4UL adopted.
Ethyl Benzene	260	440	25,000	27,000 ^{VAP} (2,840)	27,000 ^{VAP} (2,840)	LQM/CIEH S4UL adopted.
Xylenes	310	430	43,000	30,000 ^{SOL} (3,170)	31,000 ^{SOL} (3,170)	LQM/CIEH S4UL adopted (assumes worst-case p-xylene).
Phenol	412	557	557	38,700		
PCBs	1.7	1.8	1.8	1.8		Based on toxicity of EC7.
Benzo(a)pyrene	3.0	3.2	5.7	36	13	LQM/CIEH S4UL adopted.
Naphthalene	13	13	4,900	1,100 (432 ^{saturation})	3,000	LQM/CIEH S4UL adopted.
Gasoline Range Organics [#]	42	42	1,000	1,000	1,000	See 3-step assessment of TPH below.
Diesel Range Organics [#]	130	130	5,000	5,000	1,000	
Lubricating Range Org [#]	1,000	1,000	5,000	5,000	1,000	

* For a residential end use

[#] LQM/CIEH S4UL adopted, 6% SOM

Note: **PAH** cannot be assessed as a single “total” value, as each individual PAH compound has different toxicity and mobility in the environment. Speciated analysis is required to determine the concentrations of the various compounds, most notably the key PAHs: Benzo(a)Pyrene (considered the most toxic of the PAHs); and Naphthalene (the most mobile and volatile of the PAHs).

Similarly, **TPH** cannot be assessed as a single “total” value, and reference has been made to the Environment Agency’s document P5-080/TR3, “*The UK approach for evaluating human health risks from petroleum hydrocarbons in soils*”. This document supports the assumptions and recommendations made by the US Total Petroleum Hydrocarbons Criteria Working Group (TPHCWG). The TPHCWG have broken down “TPH” into thirteen representative constituent fractions or “EC Bandings”. The TPHCWG have derived a series of physiochemical and toxicological parameters for each of the thirteen bandings. The significance of speciated TPH results can be assessed by following the 3 steps outlined in the below.

Step	Result	Action
1. Consider indicator compounds: Are BTEX, Naphthalene, Benzo(a)pyrene above their respective Tier 1 values?	Yes	Remediation or DQRA required
	No	Proceed to Step 2
2. Consider individual TPH fractions: are they above respective screening values?	Yes	Remediation or DQRA required
	No	Proceed to Step 3
3. Assess Cumulative effects: Is the calculated Hazard Index for each source >1	Yes	Remediation or DQRA required
	No	TPH compounds pose no significant risk

Step 1 - Assessing indicator compounds

TPH fraction Indicator compound	End use specific screening value (mg/kg)			
	A: Residential with produce	B: Residential without produce	C: Residential with POS	D: Commercial\ Industrial
Benzene	0.37	1.4	1.4	90
Toluene	660	3900	3900	180,000 ^{VAP} (4,360)
Ethyl Benzene	260	440	440	27,000 ^{VAP} (2,840)
Xylenes	310	430	430	30,000 ^{SOL} (3,170)
Naphthalene	13	13	13	1,100

Step 2 - Assessing individual TPH fractions

TPH fraction		End use specific screening value ^{S4UL} (mg/kg) assuming 1% SOM				
		A	B	C	D	E
Aliphatic 5-6	GRO	42	42	5,000^	5,000^	5,000^
Aliphatic 6-8	GRO	100	100			
Aliphatic 8-10	GRO	27	27			
Aliphatic 10-12	DRO	130	130			
Aliphatic 12-16	DRO	1,100	1,100			
Aliphatic 16-21	DRO	5,000^	5,000^			
Aliphatic 21-35	LRO			1,000^	1,000^	1,000^
Aromatic 5-7	GRO	70	370			
Aromatic 7-8	GRO	130	860			
Aromatic 8-10	GRO	34	47			
Aromatic 10-12	DRO	74	250			
Aromatic 12-16	DRO	140	1,800			
Aromatic 16-21	DRO	260	1,900	3,800	5,000^	5,000^
Aromatic 21-35	LRO	1,100	1,900			

^ Calculated Screening Value close to soil saturation limit, screening value selected by Calabrian considering visual and olfactory impacts.

^{S4UL} LQM/CIEH S4UL adopted, 1% SOM

Step 3 - Assessing Cumulative Effects

$$HI = \sum_{F_i=1}^{16} HQ F_i = \frac{\text{Measured concentration } F_i \text{ (mg kg}^{-1}\text{)}}{SGV F_i \text{ (mg kg}^{-1}\text{)}}$$

where HI = Hazard Index
 HQ = Hazard Quotient
 F_i = Fraction _i
 SGV = Soil Guideline Value

With respect to the interpretation of the **calorific values**, at present there are no accepted methods to assess whether a sample is combustible and under what circumstances it might smoulder. Some guidance is given in ICRCL Note 61/84 "Notes on the fire hazards of contaminated land" which states that:

"In general ... it seems likely that materials whose CV's exceed 10MJ/kg are almost certainly combustible, while those with values below 2MJ/kg are unlikely to burn".

Tier 1 **groundwater** risk assessments are undertaken by comparing leachate or groundwater concentrations with the appropriate water quality standard. Tier 1 Screening Values have been in **bold** below are adopted.

Analyte	Source of Tier 1 Screening Value (µg/l)		
	UK Drinking water standard	EU Environmental Quality Standard (EQS) c,d,e,f Freshwater	Other sources
1,1,1-Trichloroethane			100
1,1 Dichloroethane			
1,2-Dichloroethane			10
1,1-Dichloroethene			
Tetrachloroethene			10
Toluene			50
Trichloroethene			10
Vinyl Chloride			.5
Trichloromethane			2.5
Petroleum products (dissolved or emulsified hydrocarbons)	-	Petroleum products must not: form a visible film on the surface of the water or form coatings on the beds of watercourses and lakes; impart a detectable 'hydrocarbon' taste to fish; produce harmful effects in fish.	
Benzene	1.0	10	1.0 ⁽ⁱ⁾
Toluene	-	74 ^e	700 ⁽ⁱ⁾
Ethylbenzene			300 ⁽ⁱⁱⁱ⁾
Xylenes	-	30 ^e	500 ⁽ⁱⁱ⁾
Naphthalene	-	2 ^e	
Benzo[a]pyrene	0.01	0.00017 ^g	0.01 ⁽ⁱ⁾
Benzo[b]fluoranthene	0.1 ^b		0.1 ⁽ⁱ⁾
Benzo[k]fluoranthene			
Benzo[g,h,i]perylene			
Indeno[1,2,3-cd]pyrene			
1,2-dichloroethane	3.0	10	
Methyl tert-butyl ether (MTBE)	-	-	15 ⁽ⁱⁱⁱ⁾ or 20 ^(iv)
TPHCWG fractions		See Table Below	

TPH Fraction	Source of Tier 1 Screening Value (µg/l) ^h	
	Aliphatic fraction (µg/l)	Aromatic fraction (µg/l)
EC5-EC6	15,000	10 (benzene)
EC>6-EC8	15,000	700 (toluene)
EC>8-EC10	300	300 (ethylbenzene)
EC>10-EC12	300	500 (xylenes)
EC>12-EC16	300	90
EC>16-EC21	-	90
EC>21-EC35	-	90

a Statutory Instruments 2016 No. 614. In addition, drinking water is required to be wholesome and therefore any substances that taint water supply (odour or taste) will effectively be set a drinking water standard equivalent to the taste/odour objection threshold. This can be very low, particularly for aromatic compounds.

b Sum of benzo[b]fluoranthene, benzo[k]fluoranthene, benzo[ghi]perylene and indeno[123 -cd]pyrene

c DIRECTIVE 2008/105/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 16 December 2008 on environmental quality standards in the field of water policy, amending and subsequently repealing Council Directives 82/176/EEC, 83/513/EEC, 84/156/EEC, 84/491/EEC, 86/280/EEC and amending Directive 2000/60/EC of the European Parliament and of the Council.

d <http://evidence.environment-agency.gov.uk/ChemicalStandards/ChemicalsByName.aspx>

(i) Private Water Supplies Regulations Statutory Instruments 2009 No. 3101 (ii) World Health Organisation (WHO) guide values; (iii) WHO Taste and Odour threshold; (iv) Lower end of USEPA guidance of taste and odour threshold at 20 – 40 µg/L. Health and ecotoxicity based criteria for ether oxygenates, including MTBE, are much higher than the T&O thresholds.

e The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015. The EQS for these substances are based on a “long term mean” or an “annual average (AA)” EQS. Note that the xylene EQS is an Environment Agency “operational” target and is not listed in the 2015 Directions:

<https://www.gov.uk/guidance/surface-water-pollution-risk-assessment-for-your-environmental-permit> (applicable to England, Northern Ireland and Wales).

f The Water Framework Directive (Classification, Priority Substances and Shellfish Waters) Regulations (Northern Ireland) 2015

g Benzo(a)pyrene can be considered as a marker for the other PAHs, hence only benzo(a)pyrene needs to be monitored: Freshwaters priority hazardous substances, priority substances and other pollutants - <https://www.gov.uk/guidance/surface-water-pollution-risk-assessment-for-your-environmental-permit>

h World Health Organization (WHO), 2008. Petroleum products in drinking-water. Background document for development of WHO guidelines for drinking water quality. WHO/SDE/WSH/05.08/123. World Health Organization, Geneva.

Analyte	Source of Tier 1 Screening Value (µg/l)		
	Surface Water (Abstraction for Drinking) 1996	Water Supply Regulations. 2000	Water Framework Directive
Arsenic	50	10	50
Selenium	10	10	
Cadmium	5	5	1.5
Chromium	50	50	32
Copper	50	2,000	28
Lead	50	10	7.2
Nickel		20	20
Zinc	3,000		125
Boron		1,000	
Mercury	1	1	0.05

Possible Action in event of Tier I exceedance

Should any of the Tier I criteria detailed above be exceeded, then three potential courses of action are available. (The first is only applicable in terms of human health, but the second and third could also be applied to groundwater or landfill gas).

1. Undertake further statistical analysis following the approach set out in “*Professional Guidance: Comparing Soil Contamination Data with a Critical Concentration- CL:AIRE, 2020*” in order to determine whether contaminant concentrations of inorganic contaminants within soil\fill actually present a risk (only applicable to assessing the risk to human health).
2. Carry out a more detailed quantitative risk assessment in order to determine whether contamination risks actually exist.
3. Based on a qualitative risk assessment, advocate an appropriate level of remediation to “break” the pollutant linkage - for example the removal of the contaminated materials or the provision of a clean cover.

Prior to undertaking any statistical analysis the issue of the **averaging area** requires further consideration. The CL:AIRE\CIEH document still refers to CLR 7, which suggests averaging area should reflect receptor behaviour and therefore might be a single garden, or an open area used by the local community as a play area. This approach to averaging areas is considered applicable within the context of Part IIA of the Environmental Protection Act (EPA) 1990, in terms of an existing residential development.

However, Calabrian consider the concept of a single garden as an averaging area to be inappropriate with respect to brownfield redevelopment, which is regulated by the planning regime. In this context, contamination across the entire site needs to be characterised by reference to the Conceptual Site Model. Consequently, Calabrian gather and analyse sample results by fill type, and/or by former use in a given sub-area of the site, before undertaking statistical analysis; ie the averaging area is associated with the extent of a particular fill type, or an area affected by spillage\leakage.

In terms of brownfield redevelopment, this is considered a more appropriate methodology which provides a more representative sample population for statistical analysis. As such the entire site is considered in terms of the proposed end use, be this residential with, or without gardens.

Analysis by soil\fill type is appropriate for essentially immobile contaminants associated with a particular fill type, for example arsenic in colliery spoil, metals in ash & clinker, sulphate in plaster-rich demolition rubble etc.

Analysis by former use is appropriate where more mobile contaminants have entered the ground, for example diesel associated with leakage from a former fuel tank, downward migration of leachable metals through granular materials, various soluble contaminants present in a wastewater leaking into the ground via a fractured sewer etc. In these circumstances, it may be appropriate to undertake statistical analysis of sample results from a variety of different soil\fill types. However, consideration would have to be given to factors such as porosity which might influence impregnation of a mobile contaminant into the soil mass; ie contamination would normally be more pervasive and significant in granular soils than cohesive soils.