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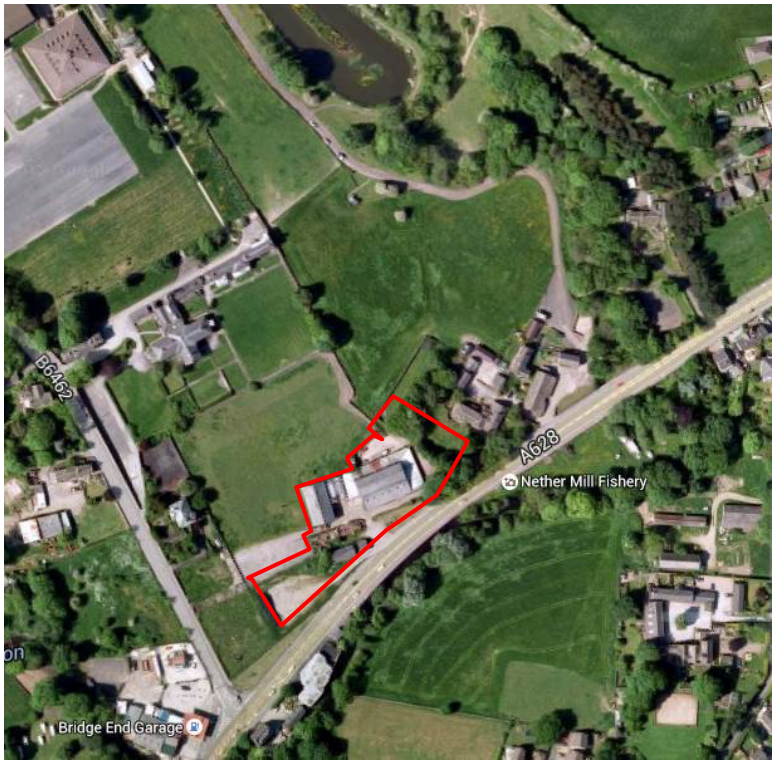
REMEDIATION IMPLEMENTATION PLAN

NETHERMILL FARM, BARNSLEY ROAD PENISTONE

FOR

DUCHY HOMES

ISSUE 1



38208-006 **6 May 2016**

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ISSUE 1

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1.0 INTRODUCTION

This Implementation Plan has been prepared by Eastwood & Partners (Consulting Engineers) Ltd, on behalf of Duchy Homes, for their site at Nethermill Farm, to the north Barnsley Road in Penistone. The purpose of this document is to detail the procedures for the implementation and subsequent verification of remedial works to deal with contamination in the ground.

This is to ensure that upon completion of the residential development, the site can be shown to be suitable for its intended use and that it will not pose unacceptable risks to future receptors. This document therefore covers the protective measures to be installed during the construction phases of the development the proposed residential development. It also covers the protective measures which will need to be put in place during construction to ensure that risks are not posed to off-site receptors.

This document is subject to the approval of the regulatory parties; the Local Authority (Barnsley Metropolitan Borough Council) and the NHBC. It is a working publication and may need to be updated, in agreement with the relevant regulatory bodies, at any stage during development dependent on what is encountered. Wherever possible, this agreement is to be sought prior to implementation. Please contact Eastwood & Partners if you are unsure of the current issue.

2.0 RATIONALE FOR REMEDIAL WORKS

2.1 Site Description

The site currently comprises farm buildings, associated hardstanding, and part of a turfed garden. It has an area of approximately 0.8 hectares, and is located to the north of Barnsley Road in Penistone. The site is irregular in shape on plan, and slopes gently down to the south, towards Barnsley Road. The site is surrounded by a new housing development to the north west and west, open fields to the north, by Nethermill House to the east, and bounded by Barnsley Road to the south.

2.2 Previous Work

Details of the derivation of a conceptual model, to identify the potential sources, pathways and receptors presented by proposed development of this site, as well as the findings of site investigations, designed to test this model and provide a risk assessment for the site, are given within the following reports:

- Eastwood and Partners Ltd (Consulting Engineers), 'Phase 1 & 2 Geotechnical and Geo-Environmental Site Investigation', Issue 1, referenced 38208/003, dated November 2015.

2.3 Summary of Findings

During our site investigation, made ground was present from surface across most of the site. This predominantly comprised assorted granular materials placed along tracks and across the various storage areas. Hardstanding is present to the north of the buildings in the north west of the site. The easternmost part of the site was a private turfed garden, with 300 mm of brown clay topsoil.

Made ground was found between depths of between 0.75 and 2.65 m bgl. It comprised a mixture of firm to stiff occasionally gravelly clay, which was present to between around 1.0 and 2.0 m bgl, and had occasional layers of coal and clinker. A soft black clay with fragments of vegetation and a slight hydrocarbon or organic odour was encountered between 1.3 and 2.5 m bgl in one hole, which was considered likely to be the sediment from within the former mill dam. No other visual or olfactory evidence of possible significant contamination was identified any of the other exploratory holes.

Soft brown sandy clay and gravel were also encountered in several of the window sample holes. This material is likely to represent the deposits of alluvium and river terrace which are recorded to cover the site.

Natural ground of soft to firm sandy gravelly clay was found extending to depths of between 2.45 and 3.3 m bgl. Below this, stiff grey clay and weak mudstone was encountered in every hole from between 2.45 and 3.3 m bgl. The window sample holes refused at depths of between 3.0 and 3.6 m bgl.

Two samples of topsoil, seven samples of made ground, and three samples of the natural ground were sent for chemical testing. One of the samples of topsoil recorded significantly elevated polycyclic aromatic hydrocarbons (PAHs) including benzo(a)pyrene. The made ground with ash and clinker contained elevated concentrations of arsenic, and other samples of made ground also recorded elevated PAHs, including naphthalene and benzo(a)pyrene. None of the natural ground samples recorded any elevated concentrations of contaminants.

One sample of made ground from 0.2 m bgl, next to an existing farm building, recorded the presence of chrysotile (white asbestos) fibres/clumps.

It was therefore recommended that a capping layer of a minimum 600 mm thickness of clean inert material, with a geotextile marker layer at the base, is placed over the made ground in all gardens and soft landscaping. At least 150 mm of topsoil should be included within the capping and this topsoil will need to be imported since suitable topsoil is not present on site.

As made ground in excess of 2 m deep was encountered on the site, with some inclusions of organic materials, a potential risk of ground gas generation is also considered to be present. The level of risk anticipated to be presented to the proposed development is unlikely to exceed ‘Amber 1’ (NHBC traffic light system) or CS-2 (Card and Wilson Method) as detailed in CIRIA C665 guidance.

2.4 Mitigation measures

Incorporation of the following mitigation measures were identified as necessary:

1. A 600 mm capping layer, including a minimum of 150 mm topsoil at the surface, and a geotextile marker layer at the base, in all gardens and landscaped areas,

2. A fully lapped and sealed 2000 gauge gas resistant membrane should be incorporated into the floor slabs of all plots to mitigate against the risk of ground gas generation from within the made ground on site;

3. A design sulphate class of DS-3 AC-3 sulphate precautions are required for all sub-surface concrete in contact with the made ground. DS-1 AC-1 sulphate precautions are required elsewhere on site for all sub-surface concrete in contact with only natural ground; and

4. There is the possibility that, as with any 'brownfield site', areas more significantly contaminated than identified to date may be present. A suitable strategy to determine any remediation action therefore needs to be in place.

5. To reduce the risks to construction workers, they should ensure that appropriate personal protective equipment (PPE) is used and/worn and the requisite working practices are adhered to. No further guidance with regards to this is considered necessary as part of this document.

3.0 WORKING METHOD

During the works, procedures to protect site neighbours, the environment and amenity, and to control dust, noise and odours should be put in place by the contractor, in addition to the required site health and safety procedures that apply. Control of surface runoff over areas of potentially contaminated ground should also be taken into consideration.

The procedures for implementation of the mitigation measures identified in Section 2, to ensure that the objectives detailed in Section 3 are met, are outlined in Sections 5 to 7. All remediation works are to be overseen by suitably experienced site staff.

4.0 INSTALLATION OF GAS RESISTING MEASURES

4.1 Installation

The site is taken as complying with 'Situation B' in accordance with CIRIA C665 guidance, in that the proposed development will comprise low rise housing with a ventilated sub-floor void of at least 150 mm height.

The site is underlain by made ground, which is locally deeper than 2 m and locally contains organic sediment. A significant risk of gas generation is unlikely to be presented, but some low concentrations of carbon dioxide or methane could be generated where the made ground is disturbed during construction.

It is therefore considered appropriate to adopt Amber 1 level gas resisting precautions into the proposed dwellings. A precast or reinforced suspended concrete floor with passively ventilated void below will be required for all plots, along with a gas resistant membrane which is suitably resistant to low level carbon dioxide and methane within the floor construction.

The membrane is to be continuous across the floor to the external walls. All joints between sections of membrane should be lapped over the adjacent section by a minimum of 150 mm, and sealed using gas resistant double sided tape with girthing tape applied to the top edge. All service pipe penetrations should be sealed using a preformed gas proof top-hat, lapped beneath the membrane by a minimum of 150 mm and sealed around the top of the penetration using gas resistant double sided tape and secured with a jubilee clip.

4.2 Validation of Installation of Membrane

Provided that the membrane is installed by a suitably qualified subcontractor, formal validation of the gas membrane installation is not considered to be necessary.

5.0 CAPPING MATERIALS

5.1 Sourcing of Capping Material

The only topsoil on site is present within the garden, of which one sample was tested and did not record any elevated contaminants. Subject to further testing, the regulators may agree to the use of this topsoil. Three samples of the natural ground were tested and did not record any elevated contaminants. Therefore, site-won natural ground arisings may be considered to be suitable for re-use as subsoil, subject to the agreement of the regulators. However, there are not large amounts of topsoil or natural ground on site, therefore more topsoil and subsoil will need to be imported to site.

If topsoil and subsoil are to be imported, material should be from a source not expected to be contaminated and meet both physical and chemical criteria as detailed in the following sections.

5.2 Stockpiling of Materials

On Site Stockpiling

For imported materials, copies of the carrier's consignment notes should be retained with the documentation detailed in Section 5.5 and a copy forwarded to the Engineer. The soil should be stockpiled separately and away from areas designated for storing other materials or potential sources of contamination. Separate stockpiles should also be created for each different source. All stockpiles should be suitably quarantined and identified as such until deemed suitable for use.

The following soil handling procedures should also be adhered to:

- Topsoil and subsoil should not become mixed;
- Capping should not be laid during or immediately following heavy rain;
- Double handling of material should be avoided;
- Stockpiles of topsoil should be shaped to shed water;
- Topsoil stockpiles should be low and narrow to ensure that the core is within 1 m of the surface;
- Over tracking by machinery used to place soils should be avoided.

The above handling procedures also apply to subsoil material which occurs as arisings and is stockpiled for re-use. Site won stockpiles considered as suitable for reuse in gardens and site won stockpiles considered as contaminated must not be mixed.

Topsoil should be sampled at a rate of one sample per 50 m^3. Imported subsoil must be sampled at a rate of one sample per 100 m^3. The stockpiles would be considered suitable for use within the capping layer if all of the test results are below the relevant assessment values, or if the modified mean (calculated in accordance with CLR7) is below the acceptance value. If the material is not found to be acceptable, further testing and risk assessment should be carried out to try to demonstrate its suitability, otherwise the material should not be used.

Offsite Stockpiling

Initially an offsite stockpile of topsoil and/or subsoil will be identified for potential use. This would be sourced from a site which is expected to be uncontaminated.

Each stockpile would be kept in a clearly identified fenced zone. Each stockpile would have three samples taken and tested for the suite of chemicals given below. The samples would be clearly identified with a batch reference and sampling number.

The stockpile would be considered suitable for use within a capping layer if all the test results are below the assessment values or if the modified mean calculated in accordance with CLR7 is below the acceptance value. If the material is not found to be acceptable, further testing and risk assessment might be carried out to try to demonstrate its suitability, otherwise it should not be used.

Once the offsite stockpile has been found acceptable for use, to prove that the material brought to site is that which has been tested, the approximate volume in the heap and amount of loads would be recorded and the haulage consignment notes should be retained by site staff. A representative of Eastwood & Partners would visit the offsite stockpile to check that the correct stockpile is loaded on to the lorries for transportation to the site. The Eastwood & Partners representative would then visit the site and confirm that the material is being delivered to the site and stored in an appropriate manner. This would comprise separate stockpiles to stop cross contamination, or preferably being placed directly into the plots.

As the material has been tested offsite, it would not be necessary to test the material once is has been brought to site. However, if there is deemed to be any reason to suspect that the material has been cross contaminated then it should be retested to ensure that it is still suitable for use within the capping layer.

5.3 Physical Requirements

Subsoil should comprise clay or sand. Topsoil should have a maximum of 30% of fragments in excess of 2 mm, a maximum of 10% in excess of 20 mm and nothing greater than 50 mm. Subsoil should have a maximum of 65% of fragments in excess of 2 mm, a maximum of 60% in excess of 20 mm, a maximum of 40% in excess of 50 mm and only occasional pieces in excess of 100 mm.

Topsoil should be free of fragments of glass and wire or other potentially hazardous foreign material which could cause traumatic injury. Significant quantities of extraneous material such as brick and concrete should also not be present within the topsoil. Reasonable judgement should be taken with respect to their presence in subsoil. In addition, all materials should be free from propagules of aggressive weeds and bulk vegetative growth, in order to ensure negligible risk of subsequent weed problems.

The topsoil should also be tested to comply with the requirements of BS3882:2015 'Specification for Topsoil and Requirements for Use' for multipurpose topsoil.

5.4 Chemical Requirements

Testing should be carried out for the following general suite of contaminants:

Arsenic	Mercury	Zinc
Chromium (III & VI)	Nickel	Copper
Cadmium	Lead	Selenium
Speciated PAH	Asbestos	pH
Total Sulphur*	Water Soluble Sulphate*	Acid soluble sulphate*

*Subsoil Samples Only

The above suite of testing is applicable to greenfield sourced materials. If the topsoil/subsoil is from a brownfield source, fractionated TPH analysis should also be undertaken, together with any other testing deemed applicable by the Engineer depending on the history of the source site.

The results should be compared with the current assessment criteria for residential with homegrown produce end use. If any of these values are exceeded the material shall be considered to be unsuitable unless further testing and risk assessment shows it to be satisfactory. The assessment concentrations are not intended to be applied to individual elevated sample results, as the levels of contaminants will have a natural variability within materials. The modified mean value should therefore instead be compared with the assessment concentration.

If the material is not found to be acceptable, further testing and risk assessment could be carried out to try to demonstrate its suitability, otherwise it should be removed from site or not brought to the site. The results of any further risk assessment must be agreed with the Local Authority and NHBC.

5.5 Documentation

Each stockpile of imported material should be given a clear reference number and designated sheet recording the following:

- Identification reference (e.g. Stockpile A, B, C etc.);
- Material type (e.g. Topsoil);
- Source site;
- The carrier's consignment note reference numbers;
- The approximate volume (or number of loads);
- Which plots the material is to be used on and where (i.e. Plot number and landscaped area to the front or rear garden);

Each entry shall be signed and dated by the Site Manager or his Assistant. A template is enclosed in the Appendix. These sheets should be available for inspection by the Engineer, NHBC Inspectors, Local Authority staff and others involved with this development. A copy should also be given to the Engineer when verification visits are made.

6.0 CAPPING OF GARDENS AND LANDSCAPED AREAS

6.1 Capping Installation

A capping layer comprising a total thickness of 600 mm, including a minimum of 150 mm topsoil, and a geotextile marker layer at the base, is required in all garden and landscaped areas.

The methodology below details the placement of the capping:

1. Establish the area to be capped and in this area finished ground levels over each plot. From this, the underside of the capping layer (600 mm thick) in garden and landscaped areas should be established.

2. If natural ground is found within 600 mm of finished ground level, an inspection of the surface of the natural ground will be required by the Engineer. Clean material will be required to build up levels to finished ground level, but verification of the thickness of this cover will not be required.

3. Where present ground levels are above the level of the underside of the capping layer, the extra material should be stripped off. If the material is to remain elsewhere on site it should be placed beneath 600 mm of capping in gardens, or placed beneath roads or hardstanding. Alternatively, the material can be taken offsite to a suitable facility.

4. All arisings should be regarded as contaminated. If they cannot be used on site, they are to be removed to a licensed waste management facility. The waste is to be taken by a registered waste carrier in accordance with the Waste Management Duty of Care Code of Practice. Copies of all waste transfer notices are to be retained.

5. Where the present ground levels are below the underside of the capping layer, the ground level may be made up to the underside of the capping layer using arisings or made ground. If, during any regrading work, any evidence of significant contamination is encountered it should be treated as in point 3 above.

6. Carefully inspect the sub-capping surface for evidence of localised contamination such as oil spills. If any spills are found their extent should be determined and proposals for their treatment should be agreed with regulators and then be implemented as in Section 7.0. Groundworkers should also remove pieces of man-made material, such as plastic and metal fragments from the sub-capping surface.

7. Place the geotextile marker layer. Care should be taken to ensure the marker layer is not torn in the process of being laid.

8. Place the subsoil.

9. Install house drainage, where applicable. Where materials from above and below the capping are excavated these should be kept separate. Capping materials can be reused but the made ground should be placed as detailed in 3 or removed from site following the procedures set out in 4. Care should be taken to prevent contamination of the capping. Drainage elements should not be installed in the topsoil due to settlement.

10. Place the topsoil.

6.2 Verification of the Capping Installation

Upon completion of the capping, verification pits shall be dug by an independent Engineer in order to measure the thickness of topsoil and subsoil, where present.

Verification pits will be dug at a rate of 1 pit per 3 plots.

For larger landscaped areas, such as areas of public open space, pits will be dug at a rate of one pit per 300 m^2.

If the capping is deemed to be insufficient, the Site Manager will be informed and advised on how much more material is needed for the capping to be adequate. Verification of capping can only be carried out on areas where the capping has been completed.

A verification report is to be produced by the Engineer, which includes:

- The documentation detailed in Section 5.5;
- The chemical test results for the samples taken from the stockpiles of topsoil and subsoil and confirmation that the material is visually consistent with that tested or the chemical test results for samples taken once the capping has been placed;
- Confirmation of the capping thicknesses for each plot verified;
- Confirmation of the physical suitability of the material.

The submission of verification reports is covered in Section 8.0.

7.0 UNEXPECTED CONTAMINATION FOUND DURING THE COURSE OF THE WORKS

There is the potential for areas of unexpected contamination, as is the case with any 'Brownfield' site. Any unusual, brightly coloured, oily or odorous material should be considered in this category. Significant amounts of material suspected of containing asbestos or potential tanks should also be included.

If unexpected contamination is found the following procedures should be adhered to:

1. All site works at the position of the suspected contamination should stop, and visual and olfactory observations of the condition of the ground and the extent of contamination should be made. Notification shall be given to an independent consulting Engineer not later than 24 hours after discovery.

2. During the presence of a suitably qualified Engineer, investigation works shall commence to recover samples for testing and, using visual and olfactory observations of the condition of the ground, accurately delineate the area over which impacted materials are present. If the contamination is considered to be serious, the Local Authority should be notified. Should the contamination be likely to affect controlled waters the Environment Agency should also be informed.

3. Should the Engineer deem it appropriate, the affected material may be excavated and placed in a stockpile on a suitable impermeable surface. This should be suitably quarantined with no addition to or removal from the stockpile while chemical analysis is being undertaken. Alternatively, the material should remain in-situ until laboratory test results have been obtained.

4. The testing suite will be determined by the Engineer on the basis of visual and olfactory observations.

5. Test results will be compared against current assessment criteria suitable for the future use of the area of the site affected.

6. If, after testing, the ground or groundwater is found to be contaminated, the Local Authority and NHBC or other regulatory body shall be informed. After consultation with the Local Authority, NHBC and if necessary the Environment Agency, materials should either be removed for disposal to a licensed waste management facility as detailed in Section 6.1, Point 4, or remediated to agreed clean-up criteria.

8.0 COMPLETION DOCUMENTATION

On completion of the verification works the appropriate verification documentation, detailing the works that have been completed in accordance with the agreed Implementation Plan, will be forwarded to the NHBC and the Local Authority. Should any remediation affecting controlled waters have been required and consequently undertaken, verification documentation will also need to be issued to the Environment Agency for their approval.

For the capping of landscaped areas, interim reports will be submitted to enable Land Quality Conditions to be lifted as plots are completed.

Necessary changes to the agreed Implementation Plan, arising during the course of the works, are to be agreed in writing with the Local Authority and NHBC prior to being undertaken on site.

Appendix 1

Table of Assessment Concentrations (Residential with Homegrown Produce)

Inorganic Compounds	Human Health - Residential with Homegrown Produce (mg/kg)
Arsenic	37
Cadmium	11
Chromium (III)	910
Chromium (VI)	6
Lead	200
Mercury	1.2
Nickel	180
Selenium	250
Copper	2400
Zinc	3700

Organic Compounds	Human Health - Residential with Homegrown Produce (mg/kg)		
	1% SOM	2.5% SOM	6% SOM
Naphthalene	2.3	5.6	13
Acenaphthene	210	510	1100
Acenaphthylene	170	420	920
Fluorene	170	400	860
Phenanthrene	95	220	440
Anthracene	2400	5400	11000
Fluoranthene	280	560	890
Pyrene	620	1200	2000
Benzo(a)anthracene	7.2	11	13
Chrysene	15	22	27
Benzo(b)fluoranthene	2.6	3.3	3.7
Benzo(k)fluoranthene	77	93	10
Benzo(a)pyrene	2.2	2.7	3.0
Dibenz(a,h)anthracene	0.24	0.28	0.3
Indeno(1,2,3-cd)pyrene	27	36	41
Benzo(g,h,i)perylene	320	340	350
Benzene	0.087	0.17	0.37
Toluene	130	290	660
Ethylbenzene	47	110	260
o-Xylene	60	140	330
m-Xylene	59	140	320
p-Xylene	56	130	310

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DUCHY HOMES

NETHERMILL FARM, BARNSLEY ROAD, PENISTONE

ASSESSMENT CRITERIA – RESIDENTIAL WITH HOMEGROWN PRODUCE

Contaminant	Phytotoxicity			
	pH 5.0 to 5.5	pH 5.5 to 6.0	pH 6.0 to 6.5	pH >7.0
Arsenic	50			
Cadmium	3			
Chromium	400			
Lead	300			
Mercury	1			
Nickel	50	60	75	110
Copper	80	100	135	200
Zinc	200	200	200	300

The assessment concentration for lead is the Category 4 Screening Level produced by Contaminated Land: Applications in Real Environments (CL:AIRE) and outlined in Appendix H of their report SP1010. The others have been taken from Nathanail, C. P., McCaffrey, C., Gillett, A., Ogden, R., and Nathanail, J., 2015, *'The LQM/CIEH S4ULs for Human Health Risk Assessment'*, Land Quality Press, Nottingham. The metals/metalloids are based on a sandy loam soil and 6% soil organic matter. The assessment values are not intended to be applied to individual sample results where materials are similar, as the levels of contaminants will have a natural variability across the site. Instead, the modified mean value should be compared with the assessment concentration.

The assessment values for phytotoxicity are the levels at which plant growth is thought to be affected. They are taken from the maximum permissible and advisable concentrations in soil after application of soil sludge given in the *'The Code of Good Agricultural Practice for the Protection of Soil*', MAFF, 1998.

The assessment of sulphate, water soluble sulphate, elemental sulphur and sulphide is to determine the aggressive nature of the ground with respect to concrete and consequently the results are compared with BRE Special Digest 1:2005 '*Concrete in Aggressive Ground*'.

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DUCHY HOMES

NETHERMILL FARM, BARNSLEY ROAD, PENISTONE

ASSESSMENT CRITERIA – RESIDENTIAL WITH HOMEGROWN PRODUCE

TPH Fraction	Intended Land Use Residential (mg/kg)		
	1% SOM	2.5% SOM	6% SOM
Aliphatic EC 5-6	42	78	160
Aliphatic EC >6-8	100	230	530
Aliphatic EC >8-10	27	65	150
Aliphatic EC >10-12	130 (48)[vap]	330 (118)[vap]	760 (283)[vap]
Aliphatic EC >12-16	1100 (24)[sol]	2400 (59)[sol]	4,300 (142)[sol]
Aliphatic EC >16-35	65,000 (8.48)[f,sol]	92,000 (21)[f,sol]	110,000[f]
Aliphatic EC >35-44	65,000 (8.48)[f, sol]	92,000 (21)[f,sol]	110,000[f]
Aromatic EC 5-7	70	140	300
Aromatic EC >7-8	130	290	660
Aromatic EC>8-10	34	83	190
Aromatic EC >10-12	74	180	380
Aromatic EC >12-16	140	330	660
Aromatic EC >16-21	260[f]	540[f]	930[f]
Aromatic EC >21-35	1,100[f]	1,500[f]	1,700[f]
Aromatic EC >35-44	1,100[f]	1,500[f]	1,700[f]

[f] oral, dermal, and inhalation exposure compared with oral HCV

[sol] S4UL presented exceeds the solubility saturation limit, which is presented in brackets

[vap] S4UL presented exceed the vapour saturation limit, which is presented in brackets

The assessment criteria for each of the petroleum hydrocarbon fractions have been taken from Nathanail, C. P., McCaffrey, C., Gillett, A., Ogden, R., and Nathanail, J., 2015, *'The LQM/CIEH S4ULs for Human Health Risk Assessment'*, Land Quality Press, Nottingham. These are also all based on a sandy loam soil.

Within the Environment Agency Science Report P5-080/TR3, Askari, K. & Pollard, S., 2005 *'The UK Approach for Evaluating Human Health Risks from Petroleum Hydrocarbons in Soils'* it is stated that the assessment values should not be considered individually; instead the potential additive effects should be calculated. This is achieved by calculating an individual Hazard Quotient (HQ) for each fraction. The HQ is the proportion of the assessment concentration represented by the recorded concentration. The HQs are then added together to form a Hazard Index (HI) and where this exceeds unity a potential significant risk to human health may exist.

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NETHERMILL FARM, BARNSLEY ROAD, PENISTONE

ASSESSMENT CRITERIA – RESIDENTIAL WITH HOMEGROWN PRODUCE

Appendix 2

Imported Material Documentation Form

Imported Soil Documentation Form

Stockpile Identification Reference	
Material Type	
Source Site	
Consignment Note Reference Numbers	
Volume of Stockpile (or number of loads)	
Areas which Material is to be used in	

Signed _____

Position_____

Date_____