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REMEDIATION STRATEGY

for land at

PHASE 3B, EDGEHILL PARK, WHITEHAVEN

Prepared for

STORY HOMES LIMITED

Report No. 4046-G-R022

Date: July 2021

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Revision History

From	Date	Comments
4046-G-R022	July 2021	Original Report

REMEDIATION STRATEGY
for land at
PHASE 3B EDGEHILL PARK, WHITEHAVEN

1 INTRODUCTION

1.1 The Commission and Brief

1.1.1 ID Geoenvironmental Limited (IDG), were commissioned by Story Homes (the Client) to prepare a Remediation Strategy for the Phase 3B site at Edgehill park, Whitehaven hereafter referred to as the site.

1.1.2 The following reports have been prepared in respect of the site:

1.1.3 IDG have been provided with copies of the following reports prepared by Integra on behalf of Story Homes:

- Post Remediation Validation Report for the Site at the Former TDG Tanker Depot, High Road, Whitehaven, Cumbria for Story Land, reference 2074 dated June 2010.
- Geotechnical Ground Investigation at Land at High Road, Rhodia, Whitehaven, Cumbria for Story Homes Limited (Draft), reference 2546 dated September 2011.
- Phase 2 Environmental Ground Investigation at Land at High Road, Rhodia, Whitehaven, Cumbria for Story Homes Limited (Draft), reference 2725 Rev A dated February 2014.

1.1.4 IDG have prepared the following reports on behalf of Story Homes:

- Shallow Mining Report for land at Magellan Park/Edgehill Park Phase 2, Whitehaven, Cumbria, reference 4046-G-R002 dated February 2017
- Supplementary Geoenvironmental Appraisal of land at Phase 3, Edgehill Park, Whitehaven, Cumbria. Report Reference No. 4046-G-R019 Rev A dated December 2020

1.1.1 Report reference 4046-G-R002 details the findings of a shallow mining investigation carried out within Phase 3B and adjacent Phase 2A, 2B and 3A. IDG Report 4046-G-R019 Rev B provides a detailed review of all of the preceding investigations together with the findings of supplementary ground investigation undertaken by IDG during 2020.

1.1.5 This document outlines the remediation objectives necessary to protect environmental receptors, and render the site suitable for the proposed development. Revision to this document may be required upon receipt of any further Regulatory comments.

1.1.6 A Method Statement should be prepared by the Contractor undertaking the works, in order to detail how the objectives will be achieved.

1.1.7 It may be the case that the remediation works are to be undertaken by more than one contractor, for example where initial works are undertaken by a demolition and remediation contractor, with placement of soil cover by the groundworker later in the project. In this situation, the Client should ensure that each Contractor has confirmed that they understand their responsibilities.

1.1.8 The Contractor's Method Statement should be submitted to, and approved by, the Client.

1.2 Regulatory Correspondence

1.2.1 The above reports were submitted to the Local Authority and the Environment Agency for comment. Comments received from the Environment Agencies are presented in correspondence reference NO/2020/113153/01-LO01 dated 22nd December 2020. Detailed responses to the Environment Agencies comments are presented in IDG correspondence reference 4046-GLR016

Rev A. EA and IDG Comments specific to the formulation of this Remediation Strategy are summarised below.

1.2.2 In response to the Environment Agencies comments, IDG revised and re-submitted the Report reference 4046-G-R019 Rev B in February 2021, incorporating a revised Preliminary Conceptual Model (PCM). The revised report has been submitted to the Local Authority and Environment Agency for further comment (awaited).

1.2.3 The revised PCM included assessment of un-named water course which issues into a ravine, approximately 165m east of the site. However, Investigations by Story Homes undertaken at the request of the Local Lead Flood Authority (LLFA) during April 2021 to establish a possible culvert associated with the infilled reservoir, determined that a shallow and narrow stone slab lined culvert runs from infilled former clay pits on the sites eastern boundary to its issue at the head of the ravine. It is considered that the culvert was constructed to drain the clay pits during historical clay extraction operations and that the culvert does not represent a natural spring.

1.2.4 The Environment Agency correspondence states that "*Waste Permitting or (CL:AIRE) DoWCoP may apply for re-location of contaminated materials which are regarded as Controlled Waste".* Email correspondence from the Environment Agency dated 10th February 2021 confirms that DoWCoP does apply to Anhydrite Material stockpiled in the southwest of the site. Environment Agency and IDG correspondence is presented in Appendix B.

2 SITE DESCRIPTION & DEVELOPMENT PROPOSALS

2.1.1 Site details are summarised in Table 2.1 and discussed further in Section 2.1.2.

Table 2.1: Summary of Site Details

Current Access	Off Wilson Pit Road
Topography	Site occupies a shallow hollow slopes with slopes up to western northern and eastern boundaries.
Approximate Areas	20,050m^2 concrete/tarmac hardstand incl. 8,200m^2 Anhydrite/slag stockpile 50,600m^2 grass 16,000m^2 subsoil stockpile

2.1.2 The site location is shown on Drawing No 4046-G-D050 in Appendix A.

2.1.3 The southwest of the site is occupied by Story Homes construction compound and an approximately 3m high stockpile comprising approximately 17,000m3 of made ground. The Story Homes compound is surfaced with concrete and includes several steel containers and office cabins, stockpiles of brick and block and cement dispenser tanks.

2.1.4 The stockpile in the southwest corner principally comprises sand, gravel and cobbles of anhydrite with ash, gravel and cobbles of brick, concrete and slag and boulders of slag.

2.1.5 The southeast of the site is currently occupied by stockpiles of subsoil sourced from the adjacent Phase 2 development.

2.1.6 The remainder (northern half) of the site comprises vacant fields within a hollow which slopes up towards the western, northern and eastern boundaries.

2.1.7 A concrete weir within a zone of boggy hummocky ground in the centre west of the hollow indicates the centre of an infilled former "reservoir".

2.2 The Proposed Development

2.2.1 It is understood that consideration is being given to redevelopment of the site with two storey domestic dwellings, associated gardens, Public Open Space (POS) areas and adoptable roads and sewers. No site layout has been provided at this stage.

2.2.2 The Local Planning Authority have agreed planning permission for redevelopment of this site (ref 4/20/2474/0R1).

3 BACKGROUND

3.1 Site History

3.1.1 Historical plans indicate that the southwest of the site currently occupied by Story Homes compound and the anhydrite stockpile, was formerly a TDG Depot (tanker refuelling and washing facility incorporating a below ground oil/water separator), associated with the Marchon Chemical Works, formerly located on High Road and immediately east of the site.

3.1.2 The zone currently occupied by soil stockpiles in the southeast of the site was formerly a Phosphorite Storage Area associated with the former Marchon Chemical Works.

3.1.3 A "reservoir" (probable tailings pond associated with anhydrite processing), which was infilled during the late 20th Century was present in the base of the hollow in the north of the site.

3.2 Integra 2725 (2010 - 2014) Investigation Findings

3.2.1 Trial pits within the former TDG Depot encountered up to 2.0m of Made Ground, including anhydrite (TP40, 0.7m – 1.4m) underlain by either stiff clay or locally, siltstone from 0.7m depth.

3.2.2 Trial pits TP41 & TP42 within the former Phosphate Storage area encountered up to 0.4m granular made ground underlain by stiff clay and siltstone bedrock at 1.0m – 3.0m.

3.2.3 Trial pits within the infilled reservoir encountered up to 2.5m (TP66) thickness variously comprising colliery waste, coal, clay, metal, plastic, timber, wood, soil, brick and timber, typically underlain by firm clay, although green grey and pink clay was also recorded.

3.2.4 Trial pits in the open field proved natural or reworked topsoil over clay (Glacial Till), bedrock being proven between depths of 1.4m and 3.0m bgl.

3.2.5 Integra stated that with the exception of the infilled reservoir and TDG Depot no significant elevated metals semi metals or organics were recorded across the site above respective LQM Generic Assessment Criteria (GAC) 2009 (now superseded). However, IDG's comparison of Integra's Chemical Test Results with S4UL 2014 & C4SL screening criteria presented in IDG Report 4046-G-D019 Rev B identified the following:

- Arsenic, chromium, nickel, vanadium, PAH & TPH contamination within Made Ground in the infilled reservoir.
- Arsenic, chromium, nickel, PAH & TPH within Made Ground beneath the TDG Depot, (including 98mg/kg benzo(a)pyrene, 1750mg/kg of EC12-EC35 TPH at 0.5m depth in TP37).
- Localised marginally elevated concentrations of arsenic within topsoil in the undeveloped field (TP73).
- No evidence of contamination was detected in surface water samples obtained from the watercourse which issues 165m east of the site.

3.2.6 Integra 2010, carried out remedial works during 2010 to remove transformer fluids from beneath the TDG Depot which had migrated into the upper 0.2m of Made Ground. Integra's validation report demonstrates al of the spilled PCBs were removed. In the absence of any further PCB sources, no further investigation is considered necessary.

3.3 Scope of IDG Ground Investigation 2020

3.3.1 IDG carried out an intrusive ground investigation during July and September 2020 comprising a total of 28 trial pits, soil sampling and laboratory testing, a coal mining investigation comprising 6 rotary probeholes and a ground gas investigation comprising installation of ground gas monitoring wells and a gas monitoring programme.

3.3.2 Supplementary trial pitting to inform proposed earthworks was carried out during June 2021 which comprised nine trial pts (TP901-907) to classify and sample natural strata in areas of proposed cut and one trial pit (TP923) to classify the material within the subsoil stockpile.

3.3.3 The findings of these investigations are summarised in the sections below.

3.4 Ground Investigation

3.4.1 The site can be divided into 4 areas based on ground conditions encountered by IDG. These areas are shown on Drawing 4046-G-D045 and are summarised in Table 3.1:

Table 3.1: Site Areas based on Ground Conditions

General Location	Approximate area (m^2)
Former TDG Depot	20,050
Anhydrite Stockpile (within TDG Depot)	8,200
Infilled Reservoir	9100
Open/vacant fields	41,500

3.4.2 Limited access was available in the current Story Homes site compound due to site cabins, site operations, stockpiled building materials and a buried gas pipeline.

3.4.3 Trial pitting during June 2021 investigated the soil stockpiles in the southeast of the site. However, only one IDG trial pit has been excavated to date within the former Phosphate Storage Area due to the presence of the soil stockpiles.

3.4.4 Trial trenching undertaken to date has failed to locate Fox Pit or Gameriggs Pit shafts. Further investigation to establish the positions of the shafts is required during site preparatory works/topsoil strip.

3.4.5 Further investigation has been recommended within the Story Homes compound/former Tanker Depot and within the footprint of the Phosphate Storage Area to establish ground conditions.

3.5 Made Ground

3.5.1 Made Ground was encountered as summarised in Table 3.2.

Table 3.2: Summary of Made Ground Conditions

Site Area	Exploratory Locations	Hardstand (thickness/mm)	Nature of Made Ground & Typical depth (m)
TDG Depot	TP737-TP742	Concrete (250)	Between 0.4m and 1.4m of Hardcore (black and grey gravel), Granular Made Ground comprising grey sandy gravel with varying quantities of sandstone/anhydrite cobbles and boulders and Cohesive Made Ground comprising sandy gravelly clay.
Anhydrite Stockpile (within TDG Depot)	TP801-TP805	Not encountered	In excess of 2.7m thickness of pink & grey sandy gravelly cobbles and boulders of anhydrite/sandstone with large boulders of blue-grey slag, localised bands/pockets of brown-black ash and clinker & brick and concrete cobbles

Site Area	Exploratory Locations	Hardstand (thickness/mm)	Nature of Made Ground & Typical depth (m)
Infilled Reservoir	TP720-TP723 & TP729	Absent	Between 0.8m and 2.7m thickness of Reworked Glacial Till, Reworked Bedrock with brick, pottery, glass, metal wire, organic material, Granular Made Ground comprising timber, metal sheets, rubber and pockets of ash and clinker and tarmacadam. Between 1.4m and 2.7m bgl probable settlement lagoon deposits: greenish-grey silty fine sand with clay flecks and layers of partially composted grass/turf. TP723 included metal sheet, brick and glass bottles
Open/vacant fields	TP719, TP725 & TP726 TP735-TP736 TP901 – TP904 & TP907:	Absent	Between 0.35m & 0.5m Topsoil Made Ground including slag, brick, glass and pottery. Made Ground Topsoil underlain by 0.25m thickness of clayey sand and mudstone gravel, ash and brick Between 0.1m & 1.1m thickness of Cohesive Made Ground comprising sandy gravelly clay or Granular Made Ground comprising sand, gravel, brick and sandstone cobble with occasional metal and plastic fragments

3.6 Natural Ground

Superficial Deposits

3.6.1 Firm to stiff sandy gravelly clay was proven to depths of between 0.7m (TP702) and in excess of 3.2m bgl (TP723 & TP739) across the majority of the site, with the exception of TP722 within the Infilled Reservoir, where weathered Marl/Mudstone was proven at 1.9m bgl directly beneath Made Ground.

3.6.2 With the exception of TP722 the Glacial Till deposits appear to be either thickest or be present to greatest depth beneath the centre of the site and beneath the site compound and former TDG Depot. The superficial deposits are thinnest on the higher ground to the west, north and east of the Infilled Reservoir.

Solid Strata

3.6.3 Solid strata were proven in the majority of exploratory holes which generally comprised either moderately strong yellow brown sandstone and siltstone or weak, partially weathered purple-grey mudstone and muddy siltstone, recovered as angular/tabular gravel and cobbles. The solid strata were encountered between depths of 0.7m bgl (TP702) and 2.0m bgl (TP706).

3.6.4 Trial pits TP702 and TP734 located in proximity to the site's western boundary encountered thinly bedded red-brown and grey sandstone interpreted to be weathered Permo-Triassic bedrock.

3.7 Groundwater

3.7.1 Groundwater is perched within the Topsoil, Made Ground and shallow superficial deposits in the Infilled Reservoir and the central area of the site between the north-south ridge and where ground rises up to the western site boundary.

3.7.2 Shallow groundwater seepages were also recorded within the weathered solid strata between 1.7m and 3.1m considered associated with infiltration of surface water. No evidence of a deep groundwater body was encountered within any of the rotary probeholes drilled within the site.

3.8 Mining

3.8.1 No significant risk from shallow mining has been identified. However, two mine shafts, Coal Authority References 297515-001 (Gameriggs Pit) and 296515-003 (Fox Pit) are indicated to

remain within the west and centre of the site whose locations require proving during site preparatory works. Treatment (grouting and capping) of both shafts will be required.

3.9 Hazardous Gas

3.9.1 A gas monitoring programme and risk assessment has classified the site as 'Characteristic Situation 1'. Therefore, gas protection measures are not required.

3.9.2 The site is not indicated to be at risk from Radon gas.

3.10 Contamination

3.10.1 The following sources of contamination have been identified:

- A hotspot of lead contamination which exceeds residential with gardens end use screening criteria in Topsoil at IDG TP733.
- Localised slightly elevated arsenic concentration in TP735 in Granular Made Ground near western boundary.
- Elevated concentrations of metal and PAH in Made Ground within the Infilled Reservoir and beneath the former TDG Depot.
- ACM in TP720 within the Infilled Reservoir.
- Slightly elevated concentrations of PAH within the Anhydrite Made Ground stockpiled within the southwest of the TDG Depot.

3.11 Conceptual Site Model

3.11.1 In terms of the proposed redevelopment plausible pollutant linkages, and feasible remediation options, are summarised in Table 3.3.

Table 3.3: Revised Conceptual Site Model and Potential Remediation Options

Sources	Receptors	Plausible Pathways	Potential Remediation Options	Post-Remediation Pollutant Linkage
Lead hotspot within Topsoil TP733	Human Health (future site users –residential with consumption of homegrown produce)	Direct contact, inhalation of dust	Delineation, excavation and placement in POS	Contaminant source removed
Arsenic lead and PAH contamination within Made Ground beneath TDG Depot	Human Health (future site users –residential with consumption of homegrown produce)	Direct contact, inhalation of dust	Isolation beneath hardstanding or 600mm of clean soil cover	Pollutant linkage broken
	Groundwater within Secondary A Aquifer	Downwards migration of leachable metal oxide/sulphate contamination	Positive surface water drainage to minimise surface water infiltration: Further investigation following slab demolition	Mitigation of impact
Nickel and PAH contamination in Made Ground within Infilled Reservoir & Localised arsenic contamination within Made Ground at TP735	Human Health (future site users –residential with consumption of homegrown produce)	Direct contact, inhalation of dust	Isolation beneath 300mm of clean soil cover in proposed POS	Pollutant linkage broken
	Groundwater within Secondary A Aquifer	Downwards migration of leachable metal oxide/sulphate contamination	Positive surface water drainage to minimise surface water infiltration: Further investigation following slab demolition	Mitigation of impact

Sources	Receptors	Plausible Pathways	Potential Remediation Options	Post-Remediation Pollutant Linkage
PAHs within Anhydrite Made Ground Stockpile	Human Health (future site users –residential with consumption of homegrown produce)	Direct contact, inhalation of dust	Off-site disposal (at this stage not considered geotechnically suitable for retention beneath hardstanding or POS)	Contaminant source removed
	Groundwater within Secondary A Aquifer	Downwards migration of leachable PAH contamination	Positive surface water drainage, minimise surface water infiltration; Further investigation following slab demolition	Mitigation of impact
Asbestos cement fragments in Made Ground at TP720	Human Health (future site users –residential with consumption of homegrown produce)	Inhalation of dust containing asbestos fibres	Controlled delineation, excavation and off-site disposal	Contaminant source removed

◊ Transient risks to construction workers will be addressed by the adoption of appropriate health and safety measures in accordance with the Health and Safety at Work Act 1974, and regulations made under the Act including for example the COSHH Regulations.

3.11.2 Following correspondence with the Environment Agency it has been determined that the Anhydrite Made Ground Stockpile may be retained on site beneath landscaped mounds to be constructed in the west of the site. Minor non-volatile PAH contamination associated with the Anhydrite Stockpile subsequently placed in residential POS may therefore be mitigated by placement of 300mm of clean soil cover.

3.11.3 Localised minor arsenic contamination detected in Granular Made Ground in TP735 will be retained beneath the proposed landscaped mounds and will not require any further action.

4 RISK ASSESSMENT & TARGET CONCENTRATIONS

4.1 General

4.1.1 Critical concentrations for the protection of Human Health for contaminants of concern for materials to remain on site are summarised in Table 4.1 and Table 4.2. Copies of the CLEA 1.071 Model Settings employed to derive the critical concentrations & CLEA Model Results are presented in Appendix C.

4.1.2 The target concentrations presented in Table 4.1 are applicable to Made Ground which will remain beneath proposed new dwellings, hardstand and 600mm of clean soil cover in gardens within the footprint of the former TDG Depot.

4.1.3 The determinand concentrations presented in Table 4.2 are for Made Ground to remain beneath proposed landscaped areas (i.e. Infilled Reservoir or Anhydrite Made Ground to be placed beneath Landscaped Mounds) and assume placement of 300mm of clean soil cover. The determinand concentrations presented in Table 4.2 were calculated using the CLEA 1.071 Model using LQM S4UL screening criteria and there is no evidence to indicate that significant concentrations are present anywhere beneath the site; soil chemical analysis to date has detected maximum EC_{16}-EC_{21} and EC_{21}-$_{44}$ TPH concentrations of 229mg/kg and1500mg/kg respectively and has not detected any significant BTEX concentrations. The CLEA 1.071 results are presented to demonstrate that placement of any soils which do contain volatile hydrocarbon concentrations will not represent a risk to end users of POS.

4.1.4 Made Ground excavated from the footprint of the TDG Depot or Infillled Reservoir may only be moved in accordance with a MMP and/or revision to this Remediation Strategy.

4.1.5 The locations of the former TDG Depot and Infilled Reservoir are shown on Drawing No. 4046-G-D051 in Appendix A.

4.1.6 It is not possible to devise an assessment concentration for asbestos in soil. However, asbestos screening tests will be used to identify whether site materials contain asbestos. Where asbestos is identified in screening tests, samples will be subjected to quantification tests as required.

4.1.7 Asbestos fibre target concentrations of <0.001% are required for granular soils retained beneath adopted highways. Asbestos fibre concentrations of 0.1% may be retained beneath 1.0m of clean soil cover within residential gardens and POS.

Table 4.1: Human Health Remediation Target Concentrations for Soils to Remain Beneath Proposed Dwellings & 600mm Clean Soil Cover in Gardens within the Footprint of the former TDG Depot.

Determinant	Target Concentrations for Made Ground Fill to remain on site below plots, hardstand or 600mm clean cover (mg/kg)
Naphthalene	2.3
Benzene	0.38
Toluene	908*
Ethylbenzene	83.4
Xylenes (p-Xylene)	79
Aliphatic C_5-C_6	42
Aliphatic C_6-C_8	104
Aliphatic C_8-C_{10}	27
Aliphatic C_{10}-C_{12}	133*
Aliphatic C_{12}-C_{16}	1,110^
Aliphatic C_{16}-C_{35}	131,000^ [F]
Aliphatic C_{35}-C_{44}	131,000^ [F]
Aromatic C_5-C_7	379
Aromatic C_7-C_8	891*
Aromatic C_8-C_{10}	7
Aromatic C_{10}-C_{12}	258
Aromatic C_{12}-C_{16}	2850^
Aromatic C_{16}-C_{21}	NR*
Aromatic C_{21}-C_{35}	NR^
Asbestos Quantification Test (if asbestos detected in screen test)	<0.001%

NR: Exceeds soil saturation limits. * : Exceeds vapour saturation limit. ^ : Exceeds solubility saturation limits. [F] : Oral, dermal & inhalation exposure compared with oral HCV

Table 4.2: Human Health Remediation Target Concentrations for Soils to Remain Beneath 300mm Clean soil Cover in POS

Determinant	Target Concentrations for Made Ground Fill to remain in POS below 300mm clean cover (mg/kg)
Naphthalene	44,900^
Benzene	7,960^
Toluene	12,400,000*
Ethylbenzene	872,000*
Xylenes (p-Xylene)	728,000^
Aliphatic C_5-C_6	3,490,000^
Aliphatic C_6-C_8	5,450,000^
Aliphatic C_8-C_{10}	668,000*
Aliphatic C_{10}-C_{12}	1,490,000*
Aliphatic C_{12}-C_{16}	4,300,000^
Aliphatic C_{16}-C_{21}	123,000,000^F
Aliphatic C_{21}-C_{35}	123,000,000^F
Aromatic C_5-C_7	7,890,000^
Aromatic C_7-C_8	12,200,000*
Aromatic C_8-C_{10}	404,000*
Aromatic C_{10}-C_{12}	942,000^
Aromatic C_{12}-C_{16}	3,120,000^
Aromatic C_{16}-C_{21}	NR*
Aromatic C_{21}-C_{35}	NR^
Asbestos Quantification Test (if asbestos detected in screen test)	<0.001%

NR: Exceeds residual soil saturation limits. * : Exceeds vapour saturation limit. ^ : Exceeds solubility saturation limits. F : Oral, dermal & inhalation exposure compared with oral HCV

4.1.8 The above table indicates that hydrocarbon contamination within materials placed in POS presents no risk to human health. However should significant hydrocarbon impacted soils be encountered during remediation works, further consultation with the EA and further assessment of the risk to controlled waters may be necessary.

4.1.9 Some contaminants (NR) reach residual saturation before a vapour risk is predicted to occur by the QRA model. However, IDG recognise that it is unacceptable to leave free product in the ground where redevelopment of a site is proposed. Consequently, this Remediation Strategy advocates the removal\treatment of soils that contain significant free product.

4.1.10 In this context, significant free product is readily identifiable by the naked eye, and pervasive throughout the soil mass, probably with noticeable seepages. Traces of free product in fissures or localised, cobble-sized pockets would not normally be considered significant.

5 DEVELOPMENT LEVELS, EARTHWORKS MODELLING & ANTICIPATED FOUNDATIONS

5.1 Development Layout and Ground Levels

5.1.1 No planning or engineering layout is currently available for Phase 3B. However, significant re-profiling within the western boundary of the site is anticipated where it is proposed to construct

landscaped screening mounds. Further reprofiling will be required within site compound and south west corner of the site, following demolition of the concrete slab and removal of the anhydrite stockpile.

5.1.2 It should also be noted that Made Ground (i.e. anhydrite stockpile material) relocated to other areas of the site, will be placed 600mm below landscaped areas.

5.2 Earthworks Modelling

5.2.1 An earthworks modelling exercise should be undertaken with a view to enabling a "materials balance" (i.e. volume of cut to broadly equal's the volume of fill).

5.2.2 The earthworks modelling exercise should consider:

- Volume reduction caused by turnover (compaction of loose Made Ground; removal of obstructions\tanks etc.);
- Whether or not processed arisings\treated soils are retained on site;
- The thickness of the soil cover required in garden areas;
- Implications for foundations.

5.3 Foundations

5.3.1 No final development layout is currently available. However, it is anticipated that the proposed plots will be constructed upon either reinforced strip or trenchfill foundations, although vibratory improvement may be adopted in areas of fill, subject to provision of an appropriate engineering specification.

5.4 Materials Management Plan

5.4.1 Remediation works are likely to require significant re-profiling within portions of the site. Excavated materials may be considered to be waste by the Environment Agency (EA). Placement of such materials back in the ground may be considered to be a permitted activity. It is therefore recommended that a Materials Management Plan be prepared for the remediation works in order to ensure that materials are not considered to be waste by the EA.

REMEDIATION STRATEGY (GENERAL)

5.5 Aims

5.5.1 The principal aim of the Remediation works is to resolve contamination issues in order to protect environmental receptors, and render the site suitable for the proposed development.

5.5.2 In addition, a stockpile comprising anhydrite aggregate is present in the southwest of the site which is geotechnical unsuitable for re-use beneath hardstanding or in proximity to below ground concrete structures. This material is suitable for placement within landscaping which is proposed upon the site's western boundary. However, it should be placed above groundwater and in order to minimise weathering processes or leaching of sulphate, the potential for surface water infiltration should be minimised.

5.6 Overview of Preparatory Works

5.6.1 The following site preparatory works are required:

- Demolition/excavation of concrete slabs and tarmac hardstand and grubbing up of below ground structures beneath current site compound former TDG Depot and stockpiling for re-use or removal from site.
- Crushing of all suitable artificial hard material (i.e. concrete/brick etc).
- Removal of soil stockpiles from former Phosphate Storage Area
- General site clearance of surface materials and vegetation.
- Topsoil strip.

5.7 Overview of Remediation Works

5.7.1 The following remediation works are required which will require supervision by the Engineer:

- Controlled delineation, excavation and off-site disposal of any asbestos containing material within 5m^2 grid centred on TP730
- Location and treatment of known mine shafts and any previously undetected mine entries present beneath the site (in accordance with an approved shaft investigation and treatment specification).
- Excavation of Anhydrite Stockpile and placement within proposed landscaping mounds along the site's western boundary
- Post slab demolition trial pit investigation in the footprint of the former TDG Depot, within areas which were inaccessible during the earlier investigations.
- Supplementary investigation of the former Phosphate Storage Area
- Contingency for previously unidentified contamination (hotspot protocol).
- Placement of 600mm clean soil cover in garden and landscaped areas within footprint of the former TDG Depot.
- Placement of 300mm of clean soil cover within footprint of the Infilled Former Reservoir.
- Provision of a minimum 150mm clean soil growing medium for plots within the undeveloped open field areas

5.7.2 Any major deviation from the works required in this Remediation Strategy must be agreed with the Local Planning Authority (LPA). In addition, any unexpected contamination encountered during the remediation works should be brought to the attention of the LPA.

5.7.3 Excavation and re-use of the Anhydrite Stockpile beneath proposed landscaping on the site's western boundary shall be detailed in a Materials Management Plan (MMP). The MMP will need to be developed using the CL:AIRE *Definition of Waste Code of Practice* for the site, in order to avoid excavated and imported materials being considered as waste by the Environment Agency. A detailed volumetric modelling exercise will need to be undertaken prior to the MMP being completed.

5.7.4 It is also anticipated that significant regrading of the site (i.e. cut/fill) will also take place to achieve the desired development platform. No engineering layout is currently available; however, it is important to note that the Contractor shall be required to ensure that all imported materials are tested to verify that they are free from contamination. A scheme for this testing shall be developed as part of the MMP and, while the proposed regrading work is not detailed within this Remediation Strategy, this Remediation Strategy will form part of the MMP.

5.8 Site Set-up, Organisation and Safety

5.8.1 The Client shall ensure that the Contractor is provided with copies of all reports produced by IDG, in order that they can carry out their own risk assessments for the works. IDG will provide information on request relating to specific hazards associated with contamination issues respectively.

5.8.2 A detailed Method Statement will be prepared by the Contractor undertaking the remediation and preparatory works. This should demonstrate how the Contractor intends to carry out the works in order to achieve the remediation objectives. In particular, details of the way in which different material types are to be kept separate should be clearly stated. The Contractor's Method Statement should be forwarded to IDG to enable comments to be made prior to works commencing and a pre-start meeting is advised.

5.8.3 The Contractor's Method Statement should include details of how the site will be organised in order to minimise the risks to workers and the public, associated with handling contaminated materials. The following measures may need to be considered:

- Designated 'clean' and 'dirty' areas
- Wheel washing facilities for vehicles
- Protective clothing, footwear and gloves
- Boot-washing facilities
- Refuelling of mobile plant in a designated area to prevent contamination of soils on site.

5.8.4 Although carbon dioxide concentrations in the ground are likely to be relatively low, access into excavations 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.

5.8.5 The remediation works summarised above shall be supervised by a suitably qualified Geoenvironmental Engineer, and the Contractor will need to provide notice of works being carried out that require supervision.

5.9 Contractor's Responsibilities

5.9.1 Prior to the commencement of any works the Contractor, in agreement with the Client, will:

- Fulfil any requirements of the Client's contract documentation.
- Establish the boundaries of the site and the working areas.
- Undertake a dilapidation survey of site boundaries, adjacent properties and highways, via dated photographs or video footage.
- Liaise with the Local Authority regarding working hours, noise\dust\odour control, and protected trees.
- Liaise with the Local Water Company regarding any proposed discharge to sewer.
- Complete a full services search and liaise with all relevant utility companies regarding work in close proximity to their apparatus.
- Prepare a detailed Method Statement outlining how the objectives of this Remedial Strategy will be achieved (and obtain approvals).
- Inform the Engineer of any risk, identified and assessed, which could impact upon the Engineer's activities.

- Prepare the necessary COSHH statements and Health & Safety Plan in accordance with CDM regulations.

5.9.2 The Contractor shall satisfy the Health & Safety Executive with regard to all matters concerning the health, safety and welfare of persons on the site.

5.9.3 The Contractor shall ensure that:

- Personnel, plant, materials and other equipment related to the contract are confined within the boundaries of the site.
- Any live services lying within the site boundary are marked and protected, or appropriate arrangements made to truncate them.
- Good practices relating to personal hygiene are adopted.
- Suitable precautions are implemented at all times to prevent off-site migration of pollutants via airborne dust.
- Suitable precautions are taken to prevent the spread of mud and debris on public highways.
- Refuelling of mobile plant is undertaken in a designated area. Above ground oil storage tanks shall comply with the requirements of Pollution Prevention Guideline PPG2. A spill kit shall be kept on site, adjacent to the designated refuelling area.

6 REMEDIATION REQUIREMENTS

6.1 Delineation & Excavation of Asbestos Containing Material at TP720

6.1.1 Chrysotile ACM Fragments were encountered within Granular Made Ground between 0.9m and 1.4m in TP720 which also contained demolition type material including cement, timber, rubber strips, bricks and glass.

6.1.2 Further investigation centred on TP720 will be undertaken to establish whether the detected ACM fragments represent a significant source of ACM material. The excavation will be taken down to the base of the Granular Made Ground. The excavation will be expanded until the Engineer is satisfied that any significant source of ACM material (i.e. cement bonded panels etc. is not present or has been removed.

6.1.3 The location of TP720 is shown on Drawing No. 4046-G-D051 presented in Appendix A.

Contractor Requirements

6.1.4 Made Ground will be excavated under the full-time supervision of the Engineer.

6.1.5 Impacted soils will be excavated and placed in temporary bunded stockpiles on hardstand or visqueen and be suitably covered.

Validation Requirements

6.1.6 A minimum of 5 verification samples of Made Ground will be obtained from the base and sidewalls of the delineation excavation which will be dispatched to a UKAS accredited laboratory where they will be scheduled for the presence of pH and toxic metals to demonstrate complete removal of the lead impacted Topsoil.

6.1.7 On receipt of the chemical analysis results, the Engineer will liaise with the Contractor regarding the most appropriate remediation option.

6.1.8 The Engineer will instruct continued removal of soil\fill if verification samples yield concentrations in excess of the clean-up criteria stated in Section 4.

6.1.9 Photographic records of the excavation will be retained by the Engineer for the Verification Report.

6.2 Location and Treatment of Mine Shafts (and any previously undetected mine entries present beneath the site).

6.2.1 The Coal Authority have records of two shafts (296515-003 Fox Pit & 297515-001 Gameriggs Pit) beneath the site which have not been located to date. Both shafts (and any unrecorded shafts) may be located during or following the required Topsoil strip. The Engineer will supervise Topsoil stripping in the vicinity of each indicated shaft location.

6.2.2 Upon determination of the shaft positions, the Engineer will prepare a specification for investigation and treatment in accordance with guidance presented in CIRIA Abandoned Mineworkings Manual (C758) for approval by the Coal Authority.

Contractor Requirements

6.2.3 The position of any suspected shafts will be surveyed by the Contractor and the positions immediately protected by heras fencing with appropriate warning signs which will remain until the approved treatment works take place.

Validation

6.2.4 The Shaft Treatment Specification will specify testing and validation measures required within the Shaft Treatment Verification Report.

6.3 Excavation of Anhydrite Stockpile and Placement within Landscaping Mounds

6.3.1 The Anhydrite Stockpile within the southwest of the site principally comprises quarried anhydrite aggregate which is geotechnically unstable and contains high concentrations of sulphate with the potential to leach and to attack buried concrete. This material is not suitable for retention beneath highways, buildings or development infrastructure and also contains metal and PAH contamination in excess of residential with gardens screening criteria. The anhydrite material will be placed beneath landscaping mounds which form an integral aspect of an area of POS proposed within the west of the development.

6.3.2 The slopes and crowns of the landscaped mounds will be retained by placement of terram (or similar) geo-membrane to retain the aggregate. The surface of the mounds shall be capped with a 300mm thick layer of impermeable clay to minimise surface water infiltration and potential for weathering and leaching and a further 150mm thickness of topsoil (growing medium). The landscaping design should ensure that there are no potential hollows or low points upon or adjacent to the landscaped mounds with the potential for water to pool. The design should incorporate surface drainage designed to move surface water away from the mounds and into the proposed surface water drainage system.

6.3.3 Integra trial pit TP40 encountered localised evidence of anhydrite within Made Ground beneath the TDG Depot hardstanding. Any anhydrite identified during supplementary investigation or site regrade will be segregated and placed with the Anhydrite beneath the Landscaping mounds.

6.3.4 Landscape designs should be provided to the Engineer for comment and for inclusion into the MMP prior to commencement of any excavation works. Details of the volumes and movement of the anhydrite stockpile and the source, volume and movement of proposed clay capping material will be provided in a MMP which references this Remediation Strategy.

Contractor Requirements

6.3.5 The Contractor will ensure that the proposed location of the anhydrite within the landscaping mounds is surveyed and demarcated prior to deposition. The Contractor will provide a topographic survey to the Engineer on completion of the anhydrite deposition and again on completion of the clay capping works.

Validation

6.3.6 The Engineer will supervise movement of the anhydrite and will maintain records and photographs recording the movement and deposition works and placement of the clay capping.

6.3.7 Full details of the movement of the anhydrite and construction of the landscaping mounds, with any additional chemical test results and the fate of any excess arisings (see Section 7.7), together with regulatory correspondence will be provided in the Verification Report.

6.4 Supplementary Trial pit Investigation in the Footprint of the Former TDG Depot

6.4.1 Trial pit investigations within the footprint of the former TDG Depot were constrained by site cabins, building material stores, site operations and a buried gas main. It is possible that undetected pockets of inorganic, PAH or mobile TPH contamination are present beneath this area of the site associated with former site operations (tanker refuelling and washing) which represent a risk to end users and the environment.

6.4.2 The Engineer will be present immediately following demolition/grubbing up of the concrete slabs to investigate any visual or olfactory evidence of contamination. The Engineer will be equipped with a PID to monitor returns for volatile hydrocarbon vapours.

6.4.3 Any unanticipated grossly contaminated soils will be placed in temporary stockpiles on hardstand or visqueen, suitably covered and bunded.

6.4.4 The Engineer will liaise with the Local Authority EHO to obtain approval for the modification or amendment of the Remediation Strategy for the site.

Validation

6.4.5 Analysis of at least 3 samples, for an appropriate range of determinands will be undertaken. On receipt of the results, the Engineer will liaise with the Contractor regarding the most appropriate remediation option.

6.4.6 Full details of the location and nature of the contaminant source together with chemical test results and the fate of any arisings, together with regulatory correspondence will be provided in the Verification report.

6.5 Further Investigation of the Former Phosphorite Storage Area

6.5.1 Site operations and soil stockpiles have prevented appropriate investigation within the footprint of the former Phosphate Storage Area depicted on Drawing 4046-G-D051 in Appendix A.

6.5.2 Upon removal of the soil stockpiles and exposure of the original ground surface, trial pits shall be excavated under supervision of the Engineer to determine ground conditions and to assess whether any sources of contamination are present.

6.5.3 Soils samples will be obtained for chemical analysis and contamination assessment in accordance with the sites proposed residential end use.

6.5.4 The findings of the supplementary investigation will be presented in a brief factual and interpretive letter report. In the event that the investigation identifies any previously undetected sources of contamination, the Engineer will liaise with the Local Authority EHO to obtain approval for the modification or amendment of the Remediation Strategy for the site.

6.6 Contingency for Previously Unidentified Contamination (Hotspot Protocol).

6.6.1 Even after an appropriate preliminary investigation and ground investigation a geoenvironmental appraisal is typically based on inspection of the ground underlying less than 0.5% of the total site area. Consequently, there is always a possibility that unanticipated ground conditions will be encountered during the remediation works. Should this occur during remediation or site development works, the Contractor shall immediately seek further advice from the Engineer.

6.6.2 Any unanticipated grossly contaminated soils will be placed in temporary stockpiles on hardstand or visqueen, suitably covered and bunded.

6.6.3 The Engineer will liaise with the Local Authority EHO to obtain approval for the modification or amendment of the Remediation Strategy for the site.

Validation

6.6.4 Analysis of at least 3 samples, for an appropriate range of determinands will be undertaken. On receipt of the results, the Engineer will liaise with the Contractor regarding the most appropriate remediation option.

6.6.5 Full details of the location and nature of the contaminant source together with chemical test results and the fate of any arisings, together with regulatory correspondence will be provided in the Verification report.

6.7 Export to Landfill

6.7.1 It is anticipated that the majority of materials excavated from the site will comprise inert natural arisings. Excavation arisings that are unsuitable for retention and re-use on site will be placed in temporary stockpiles prior to removal from the site.

Contractor Requirements

6.7.2 Any material exported from site to an alternative site or to landfill should be hauled by a registered waste carrier in accordance with the requirements of the current regulations.

6.7.3 A transfer note will 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.

6.7.4 In order to protect the general public from dust and vapour emissions, vehicles that are to be used for the haulage of the contaminated material from the site must be sheeted. In addition, the Contractor must ensure that no fluids seep from the wagons.

Validation

6.7.5 In order to provide the landfill facility with information regarding the chemical composition of the waste, the Contractor should request the Engineer to undertake analysis of material that requires removal from site.

7 ENGINEERING SUPERVISION AND VERIFICATION

7.1.1 Provided that the Contractor's advises their intended programme of works in a timely fashion, the Geoenvironmental Engineer will ensure that the requirements of this Remediation Strategy are complied with.

7.1.2 The responsibilities of the Geoenvironmental Engineer shall include the following:

- Supervision of the remediation works outlined above.
- Advice on the correct handling of materials encountered.
- Retrieval of soil samples and the subsequent scheduling of appropriate laboratory analysis to enable verification of various aspects of the works, as required.
- Liaison with statutory authorities as required.

7.1.3 On satisfactory completion of all the works the Geoenvironmental Engineer will prepare a Verification Report. Copies of the Verification Report will be issued to the Client and the Local Authority. The Verification Report will stand as certification that the remediation and ground preparatory works have been carried out in accordance with this Remediation Strategy.

7.1.4 The Verification Report will include:

- A summary of the remediation works undertaken, including any works associated with unforeseen ground conditions
- Verification test results associated with "hot-spot" treatment, including plans showing sample locations & levels, and the extent of any "hot-spot" excavations.
- Details of the fate of any arisings excavated from contamination "hot-spots".
- Verification test results associated with site won and imported fill materials.
- Verification test results associated with the placement of any fill material to an engineering specification.
- Verification test results associated with proposed source materials for clean cover.
- Copies of any correspondence with Regulators relating to specific aspects of the remediation works.
- A summary of any constraints, such as easements associated with live services or culverts that may have led to the remedial tasks not being completed in specific areas of the site.
- A summary of the remedial works still to be undertaken upon completion of the main remediation and preparatory works by the Contractor, (e.g. placement of 600mm thick cover system in garden areas).

8 POST REMEDIATION WORKS REQUIRING VALIDATION

8.1 Placement of Soil Cover

8.1.1 Clean inert fill (600mm thick) is required to be placed over the Made Ground in proposed garden and landscaped areas within the footprint of the former TDG Depot on completion of the Construction Phase. This cover layer is to comprise 450mm of "clean" subsoil plus 150mm of topsoil.

8.1.2 Further investigation (i.e. Phosphorite Storage Area) may result in further requirement for provision of clean soil cover.

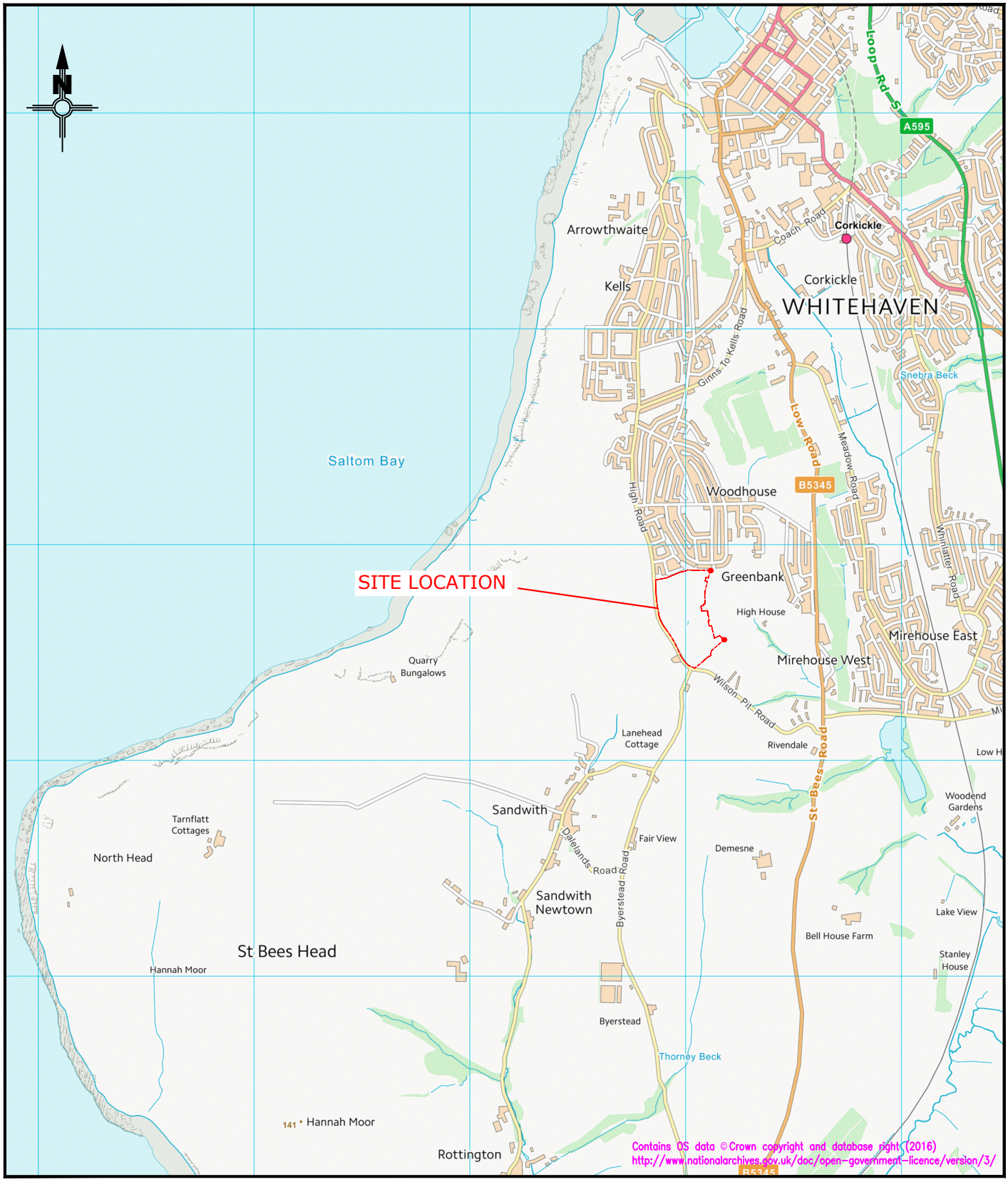
8.1.3 Clean inert fill (300mm thick) is required to be placed over the Made Ground in proposed POS and landscaped areas within the footprint of the Infilled Reservoir on completion of the Construction Phase. This cover layer is to comprise 150mm of "clean" subsoil plus 150mm of topsoil.

8.1.4 On completion of the Construction Phase and where required, a plot validation report will be provided for each plot, group of plots or landscaped area, in accordance with the requirements confirmed in the Verification Report.

8.1.5 Any site won or imported material for use as cover should be validated in accordance with the protocol presented in Appendix D. The Protocol includes assessment criteria which should not be exceeded.

8.1.6 The Developer will be responsible for arranging for a suitably qualified Geoenvironmental Engineer to visit site in order to carry out verification that the cover soils placed in the garden and landscaped areas is suitable for use and is present in sufficient thickness (i.e. 600mm thick). These visits are normally undertaken following the issue of the Verification Report for the site, and it is normal practice for the Engineer to produce an additional letter report for each plot or group of plots examined.

APPENDIX A



iGeo
iD GeoEnvironmental Limited
iD GeoEnvironmental Consulting Engineers

☒ North West & Midlands: Caledonian House Tatton Street Knutsford, Cheshire WA16 6AG
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Tel: 01748 889015
Fax: 01565 740263

CLIENT	Story Homes
JOB TITLE	Phase 3B, Edgehill Park, Whitehaven
DRAWING TITLE	Site Location Plan

DRAWN BY	SIGNATURE	DATE	STATUS
NW		22-06-21	FINAL

APPROVED	SIGNATURE	DATE	SCALE	DRG No.
BRB		23-06-21	1:25,000@A4	4046-G-D050

A4 border: 186 x 218

KEY

- P3B Site Boundary
- Former Phosphorite Storage Area
- Soil Stockpiles
- Infilled Reservoir/Settlement Lagoon (1960)
- Site Compound/Former TDG Depot
- Anhydrite Stockpile
- Open/Vacant Fields

Exploratory Holes 2010-2021

- TP900 — IDG Trial Pit 2021
- PH600 — IDG Probehole 2020
- TP700 — IDG Trial Pit 2020
- PH300 — IDG Probehole Dec 2016
- PH500 — IDG Probeholehole Sept 2018
- TP — Integra Trial Pit (June 2011)
- RH5 — Integra Probehole (2009-11)
- 296515-001 — CA Recorded Mine Shaft

Revision	Description	Date

iD GeoEnvironmental Limited

☒ North West & Midlands:
Caledonian House
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☐ North East & Yorkshire:
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Aske, Richmond
Yorkshire, DL10 5HG
Tel: 01748 889015
Fax: 01565 740263

CLIENT: Story Homes

JOB TITLE: Edgehill Park Phase 3B

DRAWING TITLE: Exploratory Hole Location Plan

STATUS: FINAL

DRAWN BY	SIGNATURE	DATE
NW		22-06-21
APPROVED: BRB	SIGNATURE	DATE: 23-06-21

SCALE: 1:1000@A1 | DRG No.: 4046-G-D051

A1 Drawings 841 X 597

APPENDIX B

Our Ref: 4046-G-LR016 Rev A

Date: 14th February 2021

Mr Craig Kerr
Story Homes
Story House
Lords Way
Kingmoor Business Park
Carlisle
CA6 4SL

iD GeoEnvironmental Limited

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Caledonian House, Tatton Street,
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Dear Mr Kerr,

Environment Agency Correspondence Reference NO/2020/113153/01-L01 in Respect of Reserved Matters - Outline Planning Application 4/13/2235/0/O1 – Wilson Pit Road/High Road, Whitehaven

We have reviewed the above Environment Agency consultation received by Copeland Borough Council and are pleased to present our comments in the order presented in the Agencies correspondence. A copy of the correspondence is provided in Appendix A to this letter.

Commission & Brief

1.4; We were not appointed to undertake a quantitative controlled waters risk assessment – previous reports by Integra Consulting which relate to the subject site have been submitted to the regulator and, on the basis of their conceptual site model, have not necessitated a quantitative controlled waters risk assessment prior to approval of the previous phases of development. However, we note that we did not present a summary of Integra's PCM, nor did we provide a detailed qualitative discussion of the site's groundwater regime indicated by our exploration findings. In light of the revised conceptual model, we shall be presenting a revised report which provides fuller discussion of the site's groundwater regime and influence of contamination sources.

Site Description & General Development Proposals

2.2.4 & 3.2.8; Acknowledged – further discussion regarding anhydrite waste stockpile is provided below.
4.4.2; Acknowledged, although we note that we incorrectly referenced NX91 NE405 as BH01. It was NX91 NE303.

Preliminary Conceptual Site Model

6.1.4: As stated in IDG Report 4046-G-R019, remediation (delineation and excavation) of the transformer fluids was supervised by Integra Consulting and is presented in Report Post Remediation Validation Report for the Site at the Former TDG Tanker Depot, High Road, Whitehaven Cumbria for Story Land reference 2074 dated June 2010. It is understood that the spillage had accumulated in a 0.2m thick granular made ground directly over natural boulder clay. Approximately 50m3 of material was removed, stockpiled and sampled. Further detail is presented in the copy of Integra's validation report presented in Appendix B.
6.1-6.13-15 & 6.2: Acknowledged – Further assessment of risks to surface water and groundwater presented in 4046-G-R019 Rev B.
7.1.3: Integra's validation report demonstrates that all of the spilled PCBs were removed. In the absence of any further source we do not consider further analysis to be necessary.

Contaminant Sources

13.2.2: Acknowledged.

Made Ground/Hydrocarbon Contamination

13.2.7/ 13.2.10: Any further risk to the secondary aquifer will be undertaken during assessment of the made ground exposed following the concrete slab removal works within the former TDG Depot.

Groundwater

13.2.11: Acknowledged – the groundwater regime is re-assessed in the revised report reference 4046-G-R019 Rev B.

We note that the anhydrite stockpile was granted temporary storage under a Waste Regulations Exemption and that this has now been exceeded. We are carrying out further geotechnical, chemical and mineralogical testing as part of ongoing remediation options appraisal. We have also advised our Client placement of the anhydrite beneath 300mm of soil cover (or anywhere else within the site) should be subject to waste permitting regulations.

Pollutant Linkages

13.3.2: Acknowledged. Further assessment of the anhydrite stockpile is ongoing to determine an appropriate means of re-use or deposition.

Potential Remedial Options

13.5.2/13.5.3/13.5.6/13.5.9 – The correspondence indicates that Waste Permitting or DOWCOP (CL:AIRE Definition of Waste Code of Practice) procedures may apply to relocation of contaminated materials which are regarded as Controlled Waste (i.e. the Anhydrite Stockpile). IDG have corresponded with the Environment Agency (email 20-1-21) and the Environment Agency have confirmed that they will not object to re-use on site in accordance with DoWCoP provided an appropriate Remediation Strategy is provided which fully complies with DoWCoP. A copy of the Environment Agencies response dated 10th February 2021 is presented in Appendix C to this letter.

13.5.4: Acknowledged, see above email comments received from the Environment Agency.

13.5.8: Further investigation to establish the chemistry, mineralogy, potential for gypsification (letter Report 4046-G-LR015) and leachability of the Anhydrite is ongoing to establish the most appropriate means of retention of the Anhydrite within the site.

13.5.11: Acknowledged.

13.5.12: Acknowledged. Further assessment of the potential for mobile/leachable contaminants beneath the TDG Depot will be required during site remediation and preparatory works.

17.7: Acknowledged. Clarification of the requirements for dewatering excavations will be presented in the Remediation Strategy Report.

Further Works

17.10.2/17.10.3/17.10.4: Acknowledged. Confirmation of the satisfactory remediation at the site of the former transformer spillage is provided in Appendix B to this letter.

We trust that that the above clarifications are appropriate. Please do not hesitate to contact us if you have any questions.

Yours sincerely,

Nick Ward BSc (Hons), FGS
for and on behalf of
iD GEOENVIRONMENTAL LIMITED

Appendix A: Environment Agency Correspondence NO/2020/113153/01-L01
Appendix B: Integra Validation Report Reference 2074 Rev SS (2010)
Appendix C : Environment Agency Correspondence dated 10th February 2021

Our ref: NO/2020/113153/01-L01
Your ref: 4/20/2474/0R1

Date: 22 December 2020

Copeland Borough Council
Development Control
The Copeland Centre Catherine Street
Whitehaven
Cumbria
CA28 7SJ

Dear Sir/Madam

RESERVED MATTERS APPLICATION (ACCESS, APPEARANCE, LANDSCAPING, LAYOUT AND SCALE) FOR ERECTION OF 335 DWELLINGS INCLUDING ASSOCIATED INFRASTRUCTURE PURSUANT TO OUTLINE PLANNING APPROVAL 4/13/2235/0O1
LAND BOUND BY WOODHOUSE TO NORTH & HIGH ROAD / WILSON PIT ROAD TO WEST & SOUTH, WHITEHAVEN

Thank you for consulting us on the above application, which we received 2 December 2020.

Environment Agency position
We have no specific comments to make regarding the Reserved Matters application for access, appearance, landscaping, layout or scale.

We have reviewed the supplementary Geoenvironmental Appraisal –Phase 3 Edgehill park, Whitehaven report 4046 –G-RO19 November 2020. We would like to make the following comments and observations, prior to any submission to discharge the contaminated land conditions (Condition 27) for Phase 3.

The comments below relate to the specified sections of the report.

The commission and Brief
1.14 – The agreed scope of works does not appear to include a quantitative risk assessment for Controlled Waters – has this been undertaken?

Site Description and general development proposals
2.2.4 - The 17,000 m3of stockpiled material from the carpark was determined as waste at the time. It was granted temporary storage for a year under the Waste Regulations Exemption, but this has now been exceeded. See 3.4.10
3.2.8 –Integra's proposal to place the geotechnically unsuitable material 300mm below

POS should comply with waste permitting Regulations.
4.2.2 Importantly one BGS borehole NX91 NE 405 in the tanker depot shows slag infill directly over bedrock, with protective cover of clay.

Preliminary Conceptual Site Model
6.1.4 – potential contamination- There is no detail regarding the remediation of the loss of PCB contaminated oil when the transformer was removed. Further detail is required concerning the excavation of, volume removed and verification/validation of that material.
6.1.13-15 The proximity of the spring discharge (20m) and the limited natural till cover over the aquifer are sufficient evidence to require the revision of the risk to Controlled Waters to 'moderate' sensitivity.
6.2 The conceptual site model has omitted the risk to Surface water and groundwater in the table and should be revised accordingly.
7.1.3 PCB compounds should be included in the list of potential contaminants.

Contaminant Sources
13.2.2 – The re-use of the clay should comply with Waste Regulations or DOWCOP.

Made ground / Hydrocarbon contamination
13.2.7 / 13.2.10– whilst the more recent soil testing did not show any evidence of significant contamination, The EA support the need for further testing following removal of the concrete slab and testing for the presence of anhydrite/gypsum material and hydrocarbons. The thin clay, or lack of clay (see BGS borehole) suggests there is a higher degree of risk of contamination to the underlying aquifer.

Groundwater
13.2.11 – 'No significant groundwater contamination was encountered..' this wording should be revised to reflect the groundwater monitoring that was undertaken, and should specifically address the status of contamination in the different groundwater systems.

Pollutant Linkages
13.3.2 The table for actions beneath the former tanker depot should be revised to reflect the need for further investigation for risk to Controlled Waters. Also the removal of the stockpiles is a necessity for breach of its temporary storage under the Waste Regulations. The fact that the material is geotechnically unsuitable supports the need for its removal. 13.5.11 addresses EA concerns

Potential Remedial options
13.5.2 /13.5.3/ 13.5.6 / 13.5.9 – Waste Permitting or DOWCOP may apply for relocation of contaminated materials which are regarded as a Controlled Waste
13.5.4 – The 2 year timescale to allow weathering of the Anhydrite stockpile is at odds with Waste Regulations for temporary storage of waste.
13.5.8 Retention of contaminants in the clay cell forming the reservoir needs further understanding and environmental assessment from a water quality perspective. The proposal of permeable topsoils and /or subsoils to form the 600mm cap over the reservoir, will need to address impact on the isolated groundwater body within the reservoir and the possible consequence of total saturation /overspill .The benefits of a low permeability cap should be considered.
13.5.11 – EA support this recommendation
13.5.12- covering is acceptable for non/low-soluble organic contaminants. Proposed mitigation is required in the event of free product and soluble contaminants in soils and groundwater.

Cont/d..

17.7 – A contingency plan is required for removal of groundwater from excavations. Most dewatering requires permitting, but under Regulation 5 of water Abstraction and impoundment (exemptions) Regs 2017 there are exemptions if abstraction<6 months and it either discharges to soakaway or <100m3/day (or <50m3/day or less than 500m from a designated site)

Further works
17.10.2 – agree. But this needs to include assessment of hydrocarbon contaminants and mitigation proposals for remediation of mobile contaminants of concern.
17.10.3 – trial pit investigations should undertake total and leachable tests to determine solubility and assess risk.
17.10.4 – agree
Detail of oil remediation in the former transformer should be reviewed and if necessary, further investigative work undertaken

FOR INFORMATION

All surplus contaminated material should be regarded as waste and assessed for disposal under the terms of waste regulatory controls. Re-use of material (in the absence of waste permit or exemption) is acceptable if it complies with requirements CL:AIRE Definition of Waste Code of Practice (DOWCOP) for waste management. Relocation and burial of arsenic contaminated materials under roads for example will need to be compliant with DOWCOP providing geotechnical and geoenvironmental assessments for suitability are acceptable.

The CL:AIRE Definition of Waste: Development Industry Code of Practice (version 2) provides operators with a framework for determining whether or not excavated material arising from site during remediation and/or land development works is waste or has ceased to be waste. Under the Code of Practice:

- excavated materials that are recovered via a treatment operation can be reused on-site providing they are treated to a standard such that they are fit for purpose and unlikely to cause pollution
- treated materials can be transferred between sites as part of a hub and cluster project
- some naturally occurring clean material can be transferred directly between sites

Developers should ensure that all contaminated materials are adequately characterised both chemically and physically, and that the permitting status of any proposed on-site operations are clear. If in doubt, the Environment Agency should be contacted for advice at an early stage to avoid any delays.

We recommend that developers should refer to:
the position statement on the Definition of Waste: Development Industry Code of Practice
The waste management page on GOV.UK

Waste to be taken off-site
Contaminated soil that is (or must be) disposed of is waste. Therefore, its handling, transport, treatment and disposal are subject to waste management legislation, which includes:

- Duty of Care Regulations 1991
- Hazardous Waste (England and Wales) Regulations 2005
- Environmental Permitting (England and Wales) Regulations 2016

Cont/d..

- The Waste (England and Wales) Regulations 2011

Developers should ensure that all contaminated materials are adequately characterised both chemically and physically in line with British Standard BS EN 14899:2005 'Characterization of Waste - Sampling of Waste Materials - Framework for the Preparation and Application of a Sampling Plan' and that the permitting status of any proposed treatment or disposal activity is clear. If in doubt, the Environment Agency should be contacted for advice at an early stage to avoid any delays.
If the total quantity of hazardous waste material produced or taken off-site is 500kg or greater in any 12 month period, the developer will need to register with us as a hazardous waste producer. Refer to the hazardous waste pages on GOV.UK for more information.

Consultation regarding COMAH regulations
This planning permission consultation has also been received by HSE, and passed to the Environment Agency for comment regarding any implications under the COMAH regulations. We have no comment to make concerning this regime.

Yours faithfully

Mrs Liz Locke
Sustainable Places Officer

e-mail clplanning@environment-agency.gov.uk

End

Nick Ward

From: Drewery, Sarah <sarah.drewery@environment-agency.gov.uk>
Sent: 10 February 2021 13:51
To: Nick Ward
Cc: McFarlin, Matthew; Bardsley, Peter; Locke, Liz
Subject: Anhydrite stockpile - Correspondence reference NO/2020/113153/01-LO1

Hi Nick,

As discussed earlier, as the original plan was for re-use on site under DoWCoP and the stockpiled material is site-derived we will not object to the use of DoWCoP on this occasion provided we agree with your amended remediation strategy and provided you comply fully with DoWCoP. It is unfortunate that it has been stockpiled for so long but re-use on site under an MMP would clearly be the best environmental option for the material.

Regards,

Sarah

Sarah Drewery | Senior Environment Officer, Cumbria & Lancashire Area
Environment Agency | Lutra House, Dodd Way, Walton Summit, Preston PR5 8BX
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INCIDENT HOTLINE (24 hrs) - 0800 80 70 60
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APPENDIX C

CLEA Software Version 1.071

Report generated	05-Jul-21
Report title	Remediation target Concentrations for soils to remail below plots, hardstar
Created by	Nick Ward at IDG

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RESULTS

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		Assessment Criterion (mg kg^{-1})			Ratio of ADE to HCV			Saturation Limit (mg kg^{-1})	50% rule?		Top Two applied?	Apply Top 2 Approach to Produce Group					
		oral	inhalation	combined	oral	inhalation	combined		Oral	Inhal		Green vegetables	Root vegetables	Tuber vegetables	Herbaceous fruit	Shrub fruit	Tree fruit
1	Benzene (S4UL)	NR	3.82E-01	3.82E-01	0.00	1.00	1.00	1.22E+03 (sol)	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
2	Toluene (S4UL)	NR	9.08E+02	9.08E+02	0.00	1.00	1.00	8.69E+02 (vap)	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
3	Ethylbenzene (S4UL)	NR	8.34E+01	8.34E+01	0.00	1.00	1.00	5.18E+02 (vap)	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
4	Xylene p- (S4UL)	NR	7.93E+01	7.93E+01	0.00	1.00	1.00	5.76E+02 (sol)	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
5	Naphthalene	NR	2.33E+00	2.33E+00	0.00	1.00	1.00	7.64E+01 (sol)	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
6	ALIPHATIC C5-C6	NR	4.24E+01	4.24E+01	0.00	1.00	1.00	3.04E+02 (sol)	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
7	ALIPHATIC C6-C8	NR	1.04E+02	1.04E+02	0.00	1.00	1.00	1.44E+02 (sol)	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
8	ALIPHATIC C8-C10	NR	2.68E+01	2.68E+01	0.00	1.00	1.00	7.77E+01 (vap)	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
9	ALIPHATIC C10-C12	NR	1.33E+02	1.33E+02	0.00	1.00	1.00	4.75E+01 (vap)	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
10	ALIPHATIC C12-C16	NR	1.11E+03	1.11E+03	0.00	1.00	1.00	2.37E+01 (sol)	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
11	ALIPHATIC C16-C21	1.31E+05	NR	NR	1.00	NR	NR	8.48E+00 (sol)	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes
12	ALIPHATIC C21-C35	1.31E+05	NR	NR	1.00	NR	NR	8.48E+00 (sol)	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes
13	AROMATIC C5-C7	NR	3.79E+02	3.79E+02	0.00	1.00	1.00	1.22E+03 (sol)	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
14	AROMATIC C7-C8	NR	8.91E+02	8.91E+02	0.00	1.00	1.00	8.69E+02 (vap)	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
15	AROMATIC C8-C10	NR	4.74E+01	4.74E+01	0.00	1.00	1.00	6.13E+02 (vap)	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
16	AROMATIC C10-C12	NR	2.58E+02	2.58E+02	0.00	1.00	1.00	3.64E+02 (sol)	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
17	AROMATIC C12-C16	NR	2.85E+03	2.85E+03	0.00	1.00	1.00	1.69E+02 (sol)	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
18	AROMATIC C16-C21	NR	NR	NR	0.00	NR	NR	5.37E+01 (vap)	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes
19	AROMATIC C21-C35	NR	NR	NR	0.00	NR	NR	4.83E+00 (sol)	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes
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	Assessment Criterion (mg kg^{-1})			Ratio of ADE to HCV			Saturation Limit (mg kg^{-1})	50% rule?		Top Two applied?	Apply Top 2 Approach to Produce Group						
	oral	inhalation	combined	oral	inhalation	combined		Oral	Inhal		Green vegetables	Root vegetables	Tuber vegetables	Herbaceous fruit	Shrub fruit	Tree fruit
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		Soil Distribution				Media Concentrations													
		Sorbed	Dissolved	Vapour	Total	Soil	Soil gas	Indoor Dust	Outdoor dust at 0.8m	Outdoor dust at 1.6m	Indoor Vapour	Outdoor vapour at 0.8m	Outdoor vapour at 1.6m	Green vegetables	Root vegetables	Tuber vegetables	Herbaceous fruit	Shrub fruit	Tree fruit
		%	%	%	%	mg kg^{-1}	mg m^{-3}	mg kg^{-1}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW
1	Benzene (S4UL)	57.3	39.9	2.8	100.0	3.82E-01	6.48E+01	NA	NA	NA	2.15E-03	2.27E-06	0.00E+00	NA	NA	NA	NA	NA	NA
2	Toluene (S4UL)	80.2	18.5	1.3	100.0	9.08E+02	7.07E+04	NA	NA	NA	2.15E+00	3.45E-03	0.00E+00	NA	NA	NA	NA	NA	NA
3	Ethylbenzene (S4UL)	89.8	9.4	0.8	100.0	8.34E+01	4.02E+03	NA	NA	NA	1.13E-01	2.37E-04	0.00E+00	NA	NA	NA	NA	NA	NA
4	Xylene p- (S4UL)	89.9	9.5	0.6	100.0	7.93E+01	2.95E+03	NA	NA	NA	8.26E-02	1.98E-04	0.00E+00	NA	NA	NA	NA	NA	NA
5	Naphthalene	93.2	6.8	0.0	100.0	2.33E+00	3.84E+00	NA	NA	NA	1.06E-03	1.21E-06	0.00E+00	NA	NA	NA	NA	NA	NA
6	ALIPHATIC C5-C6	55.7	3.2	41.0	100.0	4.24E+01	1.05E+05	NA	NA	NA	3.85E+00	1.03E-03	0.00E+00	NA	NA	NA	NA	NA	NA
7	ALIPHATIC C6-C8	82.2	1.0	16.8	100.0	1.04E+02	1.05E+05	NA	NA	NA	3.85E+00	1.61E-03	0.00E+00	NA	NA	NA	NA	NA	NA
8	ALIPHATIC C8-C10	96.1	0.1	3.8	100.0	2.68E+01	6.11E+03	NA	NA	NA	2.23E-01	1.97E-04	0.00E+00	NA	NA	NA	NA	NA	NA
9	ALIPHATIC C10-C12	99.2	0.0	0.8	100.0	1.33E+02	6.11E+03	NA	NA	NA	2.23E-01	4.39E-04	0.00E+00	NA	NA	NA	NA	NA	NA
10	ALIPHATIC C12-C16	99.9	0.0	0.1	100.0	1.11E+03	6.11E+03	NA	NA	NA	2.23E-01	1.27E-03	0.00E+00	NA	NA	NA	NA	NA	NA
11	ALIPHATIC C16-C21	100.0	0.0	0.0	100.0	1.31E+05	4.21E+04	NA	NA	NA	1.54E+00	3.62E-02	0.00E+00	NA	NA	NA	NA	NA	NA
12	ALIPHATIC C21-C35	100.0	0.0	0.0	100.0	1.31E+05	4.21E+04	NA	NA	NA	1.54E+00	3.62E-02	0.00E+00	NA	NA	NA	NA	NA	NA
13	AROMATIC C5-C7	57.3	39.9	2.8	100.0	3.79E+02	6.43E+04	NA	NA	NA	2.14E+00	2.25E-03	0.00E+00	NA	NA	NA	NA	NA	NA
14	AROMATIC C7-C8	80.2	18.5	1.3	100.0	8.91E+02	6.94E+04	NA	NA	NA	2.11E+00	3.38E-03	0.00E+00	NA	NA	NA	NA	NA	NA
15	AROMATIC C8-C10	96.7	2.9	0.4	100.0	4.74E+01	1.26E+03	NA	NA	NA	4.62E-02	1.19E-04	0.00E+00	NA	NA	NA	NA	NA	NA
16	AROMATIC C10-C12	98.1	1.8	0.1	100.0	2.58E+02	1.26E+03	NA	NA	NA	4.61E-02	2.78E-04	0.00E+00	NA	NA	NA	NA	NA	NA
17	AROMATIC C12-C16	99.1	0.9	0.0	100.0	2.85E+03	1.23E+03	NA	NA	NA	4.61E-02	9.29E-04	0.00E+00	NA	NA	NA	NA	NA	NA
18	AROMATIC C16-C21	0.0	0.0	0.0	0.0	0.00E+00	0.00E+00	NA	NA	NA	0.00E+00	0.00E+00	0.00E+00	NA	NA	NA	NA	NA	NA
19	AROMATIC C21-C35	0.0	0.0	0.0	0.0	0.00E+00	0.00E+00	NA	NA	NA	0.00E+00	0.00E+00	0.00E+00	NA	NA	NA	NA	NA	NA
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	Soil Distribution				Media Concentrations													
	Sorbed	Dissolved	Vapour	Total	Soil	Soil gas	Indoor Dust	Outdoor dust at 0.8m	Outdoor dust at 1.6m	Indoor Vapour	Outdoor vapour at 0.8m	Outdoor vapour at 1.6m	Green vegetables	Root vegetables	Tuber vegetables	Herbaceous fruit	Shrub fruit	Tree fruit
	%	%	%	%	mg kg^{-1}	mg m^{-3}	mg kg^{-1}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW
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		Average Daily Exposure (mg kg^{-1} bw day^{-1})							Distribution by Pathway (%)							
		Direct soil ingestion	Consumption of homegrown produce and attached soil	Dermal contact with soil and dust	Inhalation of dust	Inhalation of vapour	Background (oral)	Background (inhalation)	Direct soil ingestion	Consumption of homegrown produce and attached soil	Dermal contact with soil and dust	Inhalation of dust	Inhalation of vapour (indoor)	Inhalation of vapour (outdoor)	Background (oral)	Background (inhalation)
1	Benzene (S4UL)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.40E-03	0.00E+00	0.00E+00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00
2	Toluene (S4UL)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.39E+00	5.63E-04	5.58E-03	0.00	0.00	0.00	0.00	99.59	0.01	0.00	0.40
3	Ethylbenzene (S4UL)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.32E-02	2.81E-04	1.13E-03	0.00	0.00	0.00	0.00	98.47	0.01	0.00	1.52
4	Xylene p- (S4UL)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.37E-02	6.19E-04	6.30E-03	0.00	0.00	0.00	0.00	89.48	0.01	0.00	10.51
5	Naphthalene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.90E-04	3.94E-04	1.70E-04	0.00	0.00	0.00	0.00	80.26	0.00	0.00	19.74
6	ALIPHATIC C5-C6	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.50E+00	5.62E+95	6.06E+95	0.00	0.00	0.00	0.00	50.00	0.00	0.00	50.00
7	ALIPHATIC C6-C8	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.50E+00	5.62E+95	6.06E+95	0.00	0.00	0.00	0.00	50.00	0.00	0.00	50.00
8	ALIPHATIC C8-C10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.45E-01	5.62E+95	6.06E+95	0.00	0.00	0.00	0.00	50.00	0.00	0.00	50.00
9	ALIPHATIC C10-C12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.45E-01	5.62E+95	6.06E+95	0.00	0.00	0.00	0.00	50.00	0.00	0.00	50.00
10	ALIPHATIC C12-C16	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.45E-01	5.62E+95	6.06E+95	0.00	0.00	0.00	0.00	49.99	0.01	0.00	50.00
11	ALIPHATIC C16-C21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E+00	5.62E+95	0.00E+00	0.00	0.00	0.00	0.00	49.95	0.05	50.00	0.00
12	ALIPHATIC C21-C35	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E+00	5.62E+95	0.00E+00	0.00	0.00	0.00	0.00	49.95	0.05	50.00	0.00
13	AROMATIC C5-C7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.39E+00	1.69E-04	1.21E-02	0.00	0.00	0.00	0.00	99.13	0.00	0.00	0.87
14	AROMATIC C7-C8	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.37E+00	5.63E-04	3.15E-02	0.00	0.00	0.00	0.00	97.74	0.01	0.00	2.25
15	AROMATIC C8-C10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-02	5.62E+95	6.06E+95	0.00	0.00	0.00	0.00	49.99	0.01	0.00	50.00
16	AROMATIC C10-C12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-02	5.62E+95	6.06E+95	0.00	0.00	0.00	0.00	49.99	0.01	0.00	50.00
17	AROMATIC C12-C16	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-02	5.62E+95	6.06E+95	0.00	0.00	0.00	0.00	49.95	0.05	0.00	50.00
18	AROMATIC C16-C21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.62E+95	0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	AROMATIC C21-C35	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.62E+95	0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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	Average Daily Exposure (mg kg^{-1} bw day^{-1})							Distribution by Pathway (%)							
	Direct soil ingestion	Consumption of homegrown produce and attached soil	Dermal contact with soil and dust	Inhalation of dust	Inhalation of vapour	Background (oral)	Background (inhalation)	Direct soil ingestion	Consumption of homegrown produce	Dermal contact with soil and dust	Inhalation of dust	Inhalation of vapour (indoor)	Inhalation of vapour (outdoor)	Background (oral)	Background (inhalation)
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		Oral Health Criteria Value ($\mu g\ kg^{-1}\ BW\ day^{-1}$)		Inhalation Health Criteria Value ($\mu g\ kg^{-1}\ BW\ day^{-1}$)		Oral Mean Daily Intake ($\mu g\ day^{-1}$)	Inhalation Mean Daily Intake ($\mu g\ day^{-1}$)	Air-water partition coefficient (K_{aw}) ($cm^3\ cm^{-3}$)	Coefficient of Diffusion in Air ($m^2\ s^{-1}$)	Coefficient of Diffusion in Water ($m^2\ s^{-1}$)	log K_{oc} ($cm^3\ g^{-1}$)	log K_{ow} (dimensionless)	Dermal Absorption Fraction (dimensionless)	Soil-to-dust transport factor ($g\ g^{-1}$ DW)	Sub-surface soil to indoor air correction factor (dimensionless)	Relative bioavailability via soil ingestion (unitless)	Relative bioavailability via dust inhalation (unitless)
1	Benzene (S4UL)	ID	0.29	ID	1.4	NR	NR	1.16E-01	8.77E-06	6.64E-10	1.83	2.13	0.1	0.5	10	1	1
2	Toluene (S4UL)	TDI	223	TDI	1400	10	92	1.15E-01	7.78E-06	5.88E-10	2.31	2.73	0.1	0.5	10	1	1
3	Ethylbenzene (S4UL)	TDI	100	TDI	74.3	5	18.6	1.39E-01	7.04E-06	5.31E-10	2.65	3.15	0.1	0.5	10	1	1
4	Xylene p- (S4UL)	TDI	180	TDI	60	11	104	1.07E-01	7.04E-06	5.31E-10	2.65	3.15	0.1	0.5	10	1	1
5	Naphthalene	TDI	20	TDI	0.86	7	2.8	6.62E-03	6.52E-06	5.16E-10	2.81	3.34	0.13	0.5	1	1	1
6	ALIPHATIC C5-C6	TDI	5000	TDI	5000	9.99E+99	9.99E+99	2.10E+01	1.00E-05	1.00E-09	2.91	3.31	0.1	0.5	10	1	1
7	ALIPHATIC C6-C8	TDI	5000	TDI	5000	9.99E+99	9.99E+99	2.73E+01	1.00E-05	1.00E-09	3.58	4.13	0.1	0.5	10	1	1
8	ALIPHATIC C8-C10	TDI	100	TDI	290	9.99E+99	9.99E+99	4.15E+01	1.00E-05	1.00E-09	4.48	5.22	0.1	0.5	10	1	1
9	ALIPHATIC C10-C12	TDI	100	TDI	290	9.99E+99	9.99E+99	6.44E+01	1.00E-05	1.00E-09	5.38	6.3	0.1	0.5	10	1	1
10	ALIPHATIC C12-C16	TDI	100	TDI	290	9.99E+99	9.99E+99	1.71E+02	1.00E-05	1.00E-09	6.73	7.94	0.1	0.5	10	1	1
11	ALIPHATIC C16-C21	TDI	2000	NR	NR	9.99E+99	NR	1.07E+03	1.00E-05	1.00E-09	8.76	10.39	0.1	0.5	10	1	1
12	ALIPHATIC C21-C35	TDI	2000	NR	NR	9.99E+99	NR	1.07E+03	1.00E-05	1.00E-09	8.76	10.39	0.1	0.5	10	1	1
13	AROMATIC C5-C7	TDI	223	TDI	1400	3	200	1.16E-01	8.77E-06	6.64E-10	1.83	2.13	0.1	0.5	10	1	1
14	AROMATIC C7-C8	TDI	223	TDI	1400	10	520	1.15E-01	7.78E-06	5.88E-10	2.31	2.73	0.1	0.5	10	1	1
15	AROMATIC C8-C10	TDI	40	TDI	60	9.99E+99	9.99E+99	2.53E-01	1.00E-05	1.00E-09	3.2	3.69	0.1	0.5	10	1	1
16	AROMATIC C10-C12	TDI	40	TDI	60	9.99E+99	9.99E+99	7.22E-02	1.00E-05	1.00E-09	3.4	3.93	0.1	0.5	10	1	1
17	AROMATIC C12-C16	TDI	40	TDI	60	9.99E+99	9.99E+99	1.26E-02	1.00E-05	1.00E-09	3.7	4.29	0.1	0.5	10	1	1
18	AROMATIC C16-C21	TDI	30	NR	NR	9.99E+99	NR	6.95E-04	1.00E-05	1.00E-09	4.15	4.82	0.1	0.5	10	1	1
19	AROMATIC C21-C35	TDI	30	NR	NR	9.99E+99	NR	2.48E-05	1.00E-05	1.00E-09	5.1	5.95	0.1	0.5	10	1	1
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	Oral Health Criteria Value (µg kg^{-1} BW day^{-1})	Inhalation Health Criteria Value (µg kg^{-1} BW day^{-1})	Oral Mean Daily Intake (µg day^{-1})	Inhalation Mean Daily Intake (µg day^{-1})	Air-water partition coefficient (K_{aw}) (cm^3 cm^{-3})	Coefficient of Diffusion in Air (m^2 s^{-1})	Coefficient of Diffusion in Water (m^2 s^{-1})	log K_{oc} (cm^3 g^{-1})	log K_{ow} (dimensionless)	Dermal Absorption Fraction (dimensionless)	Soil-to-dust transport factor (g g^{-1} DW)	Sub-surface soil to indoor air correction factor (dimensionless)	Relative bioavailability via soil ingestion (unitless)	Relative bioavailability via dust inhalation (unitless)
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		Soil-to-water partition coefficient ($cm^3 g^{-1}$)	Vapour pressure (Pa)	Water solubility ($mg L^{-1}$)	Soil-to-plant concentration factor for green vegetables (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for root vegetables (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for tuber vegetables (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for herbaceous fruit (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for shrub fruit (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for tree fruit (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)
1	Benzene (S4UL)	3.92E-01	6.24E+03	1.78E+03	model	model	model	model	model	model
2	Toluene (S4UL)	1.18E+00	1.73E+03	5.90E+02	model	model	model	model	model	model
3	Ethylbenzene (S4UL)	2.59E+00	5.53E+02	1.80E+02	model	model	model	model	model	model
4	Xylene p- (S4UL)	2.59E+00	4.75E+02	2.00E+02	model	model	model	model	model	model
5	Naphthalene	3.74E+00	2.31E+00	1.90E+01	model	model	model	model	model	model
6	ALIPHATIC C5-C6	4.71E+00	2.19E+04	3.59E+01	model	model	model	model	model	model
7	ALIPHATIC C6-C8	2.21E+01	3.45E+03	5.37E+00	model	model	model	model	model	model
8	ALIPHATIC C8-C10	1.75E+02	3.20E+02	4.27E-01	model	model	model	model	model	model
9	ALIPHATIC C10-C12	1.39E+03	3.21E+01	3.39E-02	model	model	model	model	model	model
10	ALIPHATIC C12-C16	3.11E+04	1.53E+00	7.59E-04	model	model	model	model	model	model
11	ALIPHATIC C16-C21	3.34E+06	2.38E-02	2.54E-06	model	model	model	model	model	model
12	ALIPHATIC C21-C35	3.34E+06	2.38E-02	2.54E-06	model	model	model	model	model	model
13	AROMATIC C5-C7	3.92E-01	6.24E+03	1.78E+03	model	model	model	model	model	model
14	AROMATIC C7-C8	1.18E+00	1.73E+03	5.90E+02	model	model	model	model	model	model
15	AROMATIC C8-C10	9.19E+00	3.20E+02	6.46E+01	model	model	model	model	model	model
16	AROMATIC C10-C12	1.46E+01	3.21E+01	2.45E+01	model	model	model	model	model	model
17	AROMATIC C12-C16	2.91E+01	1.14E+00	5.75E+00	model	model	model	model	model	model
18	AROMATIC C16-C21	8.19E+01	5.62E-03	6.53E-01	model	model	model	model	model	model
19	AROMATIC C21-C35	7.30E+02	1.61E-06	6.61E-03	model	model	model	model	model	model
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	Soil-to-water partition coefficient ($cm^3\ g^{-1}$)	Vapour pressure (Pa)	Water solubility ($mg\ L^{-1}$)	Soil-to-plant concentration factor for green vegetables (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for root vegetables (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for tuber vegetables (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for herbaceous fruit (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for shrub fruit (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for tree fruit (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)
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CLEA Software Version 1.071

Report generated	05/07/2021
Report title	Remediation target Concentrations for soils to remail below plots, hardstand & 600mm clean cover
Created by	Nick Ward at IDG

BASIC SETTINGS

Land Use	Residential with produce (C4SL)					
Building	Small terraced house					
Receptor	Female (res C4SL)	Start age class	1	End age class	6	Exposure Duration 6 years
Soil	Sandy loam					

Exposure Pathways

Direct soil and dust ingestion	✘	Dermal contact with indoor dust	✘	Inhalation of indoor dust	✘
Consumption of homegrown produce	✘	Dermal contact with soil	✘	Inhalation of soil dust	✘
Soil attached to homegrown produce	✘			Inhalation of indoor vapour	✓
				Inhalation of outdoor vapour	✓

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Land Use Residential with produce (C4SL) **Receptor** Female (res C4SL)

Age Class	Exposure Frequencies (days yr^{-1})						Occupation Periods (hr day^{-1})		Soil to skin adherence factors (mg cm^{2})		Direct soil ingestion rate (g day^{-1})	Body weight (kg)	Body height (m)	Inhalation rate (m^{3} day^{-1})	Max exposed skin factor		Total skin area (m^{2})
	Direct soil ingestion	Consumption of homegrown produce	Dermal contact with indoor dust	Dermal contact with soil	Inhalation of dust and vapour, indoor	Inhalation of dust and vapour, outdoor	Indoors	Outdoors	Indoor	Outdoor					Indoor (m^{2} m^{-2})	Outdoor (m^{2} m^{-2})	
1	180	180	180	170	365	365	23.0	1.0	0.06	0.10	0.10	5.60	0.7	5.4	0.32	0.26	3.43E-01
2	365	365	365	170	365	365	23.0	1.0	0.06	0.10	0.10	9.80	0.8	8.0	0.33	0.26	4.84E-01
3	365	365	365	170	365	365	23.0	1.0	0.06	0.10	0.10	12.70	0.9	8.9	0.32	0.25	5.82E-01
4	365	365	365	170	365	365	23.0	1.0	0.06	0.10	0.10	15.10	0.9	10.1	0.35	0.28	6.36E-01
5	365	365	365	170	365	365	19.0	1.0	0.06	0.10	0.10	16.90	1.0	10.1	0.35	0.28	7.04E-01
6	365	365	365	170	365	365	19.0	1.0	0.06	0.10	0.10	19.70	1.1	10.1	0.33	0.26	7.94E-01
7	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	22.10	1.2	12.0	0.22	0.15	8.73E-01
8	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	25.30	1.2	12.0	0.22	0.15	9.36E-01
9	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	27.50	1.3	12.0	0.22	0.15	1.01E+00
10	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	31.40	1.3	12.0	0.22	0.15	1.08E+00
11	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	35.70	1.4	12.0	0.22	0.14	1.19E+00
12	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	41.30	1.4	15.2	0.22	0.14	1.29E+00
13	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	47.20	1.5	15.2	0.22	0.14	1.42E+00
14	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	51.20	1.6	15.2	0.22	0.14	1.52E+00
15	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	56.70	1.6	15.2	0.21	0.14	1.60E+00
16	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	59.00	1.6	15.2	0.21	0.14	1.63E+00
17	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	70.00	1.6	15.7	0.33	0.27	1.78E+00
18	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	70.90	1.6	13.6	0.33	0.27	1.80E+00

Consumption Rates

Consumption rates (g FW kg^{-1} bodyweight day^{-1}) by Produce Group

Age Class	MEAN RATES						90TH PERCENTILE RATES					
	Green veg	Root veg	Tuber veg	Herb. Fruit	Shrub fruit	Tree fruit	Green veg	Root veg	Tuber veg	Herb. Fruit	Shrub fruit	Tree fruit
1							7.12E+00	1.07E+01	1.60E+01	1.83E+00	2.23E+00	3.82E+00
2							6.85E+00	3.30E+00	5.46E+00	3.96E+00	5.40E-01	1.20E+01
3							6.85E+00	3.30E+00	5.46E+00	3.96E+00	5.40E-01	1.20E+01
4							6.85E+00	3.30E+00	5.46E+00	3.96E+00	5.40E-01	1.20E+01
5							3.74E+00	1.77E+00	3.38E+00	1.85E+00	1.60E-01	4.26E+00
6							3.74E+00	1.77E+00	3.38E+00	1.85E+00	1.60E-01	4.26E+00
7							3.74E+00	1.77E+00	3.38E+00	1.85E+00	1.60E-01	4.26E+00
8							3.74E+00	1.77E+00	3.38E+00	1.85E+00	1.60E-01	4.26E+00
9							3.74E+00	1.77E+00	3.38E+00	1.85E+00	1.60E-01	4.26E+00
10							3.74E+00	1.77E+00	3.38E+00	1.85E+00	1.60E-01	4.26E+00
11							3.74E+00	1.77E+00	3.38E+00	1.85E+00	1.60E-01	4.26E+00
12							3.74E+00	1.77E+00	3.38E+00	1.85E+00	1.60E-01	4.26E+00
13							3.74E+00	1.77E+00	3.38E+00	1.85E+00	1.60E-01	4.26E+00
14							3.74E+00	1.77E+00	3.38E+00	1.85E+00	1.60E-01	4.26E+00
15							3.74E+00	1.77E+00	3.38E+00	1.85E+00	1.60E-01	4.26E+00
16							3.74E+00	1.77E+00	3.38E+00	1.85E+00	1.60E-01	4.26E+00
17							2.94E+00	1.40E+00	1.79E+00	1.61E+00	2.20E-01	2.97E+00
18							2.94E+00	1.40E+00	1.79E+00	1.61E+00	2.20E-01	2.97E+00

Top 2 applied? No

Where top 2 method is applied, two produce categories use 90th percentile rates, while the remainder use the mean. Produce categories vary on a chemical-by-chemical basis. Where top 2 method is not used, all produce categories for all chemicals assume 90th percentile rates.

Building Small terraced house

Soil Sandy loam

Building footprint (m^2)	2.80E+01
Living space air exchange rate (hr^{-1})	5.00E-01
Living space height (above ground, m)	4.80E+00
Living space height (below ground, m)	0.00E+00
Pressure difference (soil to enclosed space, Pa)	3.10E+00
Foundation thickness (m)	1.50E-01
Floor crack area (cm^2)	4.23E+02
Dust loading factor ($\mu g\ m^{-3}$)	5.00E+01

Porosity, Total ($cm^3\ cm^{-3}$)	5.30E-01
Porosity, Air-Filled ($cm^3\ cm^{-3}$)	2.00E-01
Porosity, Water-Filled ($cm^3\ cm^{-3}$)	3.30E-01
Residual soil water content ($cm^3\ cm^{-3}$)	1.20E-01
Saturated hydraulic conductivity ($cm\ s^{-1}$)	3.56E-03
van Genuchten shape parameter *m* (dimensionless)	3.20E-01
Bulk density ($g\ cm^{-3}$)	1.21E+00
Threshold value of wind speed at 10m ($m\ s^{-1}$)	7.20E+00
Empirical function (F_x) for dust model (dimensionless)	1.22E+00
Ambient soil temperature (K)	2.83E+02
Soil pH	7.00E+00
Soil Organic Matter content (%)	1.00E+00
Fraction of organic carbon ($g\ g^{-1}$)	5.80E-03
Effective total fluid saturation (unitless)	5.12E-01
Intrinsic soil permeability (cm^2)	4.75E-08
Relative soil air permeability (unitless)	6.42E-01
Effective air permeability (cm^2)	3.05E-08

Soil - Vapour Model

Depth to top of source (no building) (cm)	**60**
Depth to top of source (beneath building) (cm)	65
Default soil gas ingress rate?	Yes
Soil gas ingress rate ($cm^3\ s^{-1}$)	2.50E+01
Building ventilation rate ($cm^3\ s^{-1}$)	1.87E+04
Averaging time surface emissions (yr)	6
Finite vapour source model?	No
Thickness of contaminated layer (cm)	200

Air Dispersion Model

Mean annual windspeed at 10m ($m\ s^{-1}$)	5.00
Air dispersion factor at height of 0.8m *	2400.00
Air dispersion factor at height of 1.6m *	0.00
Fraction of site cover ($m^2\ m^{-2}$)	0.75

* Air dispersion factor in $g\ m^{-2}\ s^{-1}$ per $kg\ m^{-3}$

Soil - Plant Model

	Dry weight conversion factor	Homegrown fraction		Soil loading factor	Preparation correction factor
		Average	High		
	$g\ DW\ g^{-1}\ FW$	dimensionless		$g\ g^{-1}\ DW$	dimensionless
Green vegetables	0.096	0.05	0.33	1.00E-03	2.00E-01
Root vegetables	0.103	0.06	0.40	1.00E-03	1.00E+00
Tuber vegetables	0.210	0.02	0.13	1.00E-03	1.00E+00
Herbaceous fruit	0.058	0.06	0.40	1.00E-03	6.00E-01
Shrub fruit	0.166	0.09	0.60	1.00E-03	6.00E-01
Tree fruit	0.157	0.04	0.27	1.00E-03	6.00E-01

Gardener type Average

CLEA Software Version 1.071

Report generated	05-Jul-21
Report title	Remediation target Concentrations for soils to remain below 300mm clear
Created by	Nick Ward at IDG

RESULTS

Environment Agency

		Assessment Criterion (mg kg^{-1})			Ratio of ADE to HCV			Saturation Limit (mg kg^{-1})	50% rule?		Top Two applied?	Apply Top 2 Approach to Produce Group					
		oral	inhalation	combined	oral	inhalation	combined		Oral	Inhal		Green vegetables	Root vegetables	Tuber vegetables	Herbaceous fruit	Shrub fruit	Tree fruit
1	Benzene (S4UL)	NR	7.96E+03	7.96E+03	0.00	1.00	1.00	1.22E+03 (sol)	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
2	Toluene (S4UL)	NR	1.24E+07	1.24E+07	0.00	1.00	1.00	8.69E+02 (vap)	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
3	Ethylbenzene (S4UL)	NR	8.72E+05	8.72E+05	0.00	1.00	1.00	5.18E+02 (vap)	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
4	Xylene p- (S4UL)	NR	7.28E+05	7.28E+05	0.00	1.00	1.00	5.76E+02 (sol)	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
5	Naphthalene	NR	4.49E+04	4.49E+04	0.00	1.00	1.00	7.64E+01 (sol)	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
6	ALIPHATIC C5-C6	NR	3.49E+06	3.49E+06	0.00	1.00	1.00	3.04E+02 (sol)	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
7	ALIPHATIC C6-C8	NR	5.45E+06	5.45E+06	0.00	1.00	1.00	1.44E+02 (sol)	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
8	ALIPHATIC C8-C10	NR	6.68E+05	6.68E+05	0.00	1.00	1.00	7.77E+01 (vap)	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
9	ALIPHATIC C10-C12	NR	1.49E+06	1.49E+06	0.00	1.00	1.00	4.75E+01 (vap)	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
10	ALIPHATIC C12-C16	NR	4.30E+06	4.30E+06	0.00	1.00	1.00	2.37E+01 (sol)	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
11	ALIPHATIC C16-C21	1.23E+08	NR	NR	1.00	NR	NR	8.48E+00 (sol)	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes
12	ALIPHATIC C21-C35	1.23E+08	NR	NR	1.00	NR	NR	8.48E+00 (sol)	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes
13	AROMATIC C5-C7	NR	7.89E+06	7.89E+06	0.00	1.00	1.00	1.22E+03 (sol)	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
14	AROMATIC C7-C8	NR	1.22E+07	1.22E+07	0.00	1.00	1.00	8.69E+02 (vap)	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
15	AROMATIC C8-C10	NR	4.04E+05	4.04E+05	0.00	1.00	1.00	6.13E+02 (vap)	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
16	AROMATIC C10-C12	NR	9.42E+05	9.42E+05	0.00	1.00	1.00	3.64E+02 (sol)	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
17	AROMATIC C12-C16	NR	3.12E+06	3.12E+06	0.00	1.00	1.00	1.69E+02 (sol)	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
18	AROMATIC C16-C21	NR	NR	NR	0.00	NR	NR	5.37E+01 (vap)	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes
19	AROMATIC C21-C35	NR	NR	NR	0.00	NR	NR	4.83E+00 (sol)	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes
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Environment Agency

	Assessment Criterion (mg kg^{-1})			Ratio of ADE to HCV			Saturation Limit (mg kg^{-1})	50% rule?		Top Two applied?	Apply Top 2 Approach to Produce Group						
	oral	inhalation	combined	oral	inhalation	combined		Oral	Inhal		Green vegetables	Root vegetables	Tuber vegetables	Herbaceous fruit	Shrub fruit	Tree fruit
21																	
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Environment Agency

		Soil Distribution				Media Concentrations													
		Sorbed	Dissolved	Vapour	Total	Soil	Soil gas	Indoor Dust	Outdoor dust at 0.8m	Outdoor dust at 1.6m	Indoor Vapour	Outdoor vapour at 0.8m	Outdoor vapour at 1.6m	Green vegetables	Root vegetables	Tuber vegetables	Herbaceous fruit	Shrub fruit	Tree fruit
		%	%	%	%	mg kg^{-1}	mg m^{-3}	mg kg^{-1}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW
1	Benzene (S4UL)	57.3	39.9	2.8	100.0	7.96E+03	1.35E+06	NA	NA	NA	NA	4.73E-02	0.00E+00	NA	NA	NA	NA	NA	NA
2	Toluene (S4UL)	80.2	18.5	1.3	100.0	1.24E+07	9.68E+08	NA	NA	NA	NA	4.71E+01	0.00E+00	NA	NA	NA	NA	NA	NA
3	Ethylbenzene (S4UL)	89.8	9.4	0.8	100.0	8.72E+05	4.20E+07	NA	NA	NA	NA	2.47E+00	0.00E+00	NA	NA	NA	NA	NA	NA
4	Xylene p- (S4UL)	89.9	9.5	0.6	100.0	7.28E+05	2.70E+07	NA	NA	NA	NA	1.81E+00	0.00E+00	NA	NA	NA	NA	NA	NA
5	Naphthalene	93.2	6.8	0.0	100.0	4.49E+04	7.39E+04	NA	NA	NA	NA	2.33E-02	0.00E+00	NA	NA	NA	NA	NA	NA
6	ALIPHATIC C5-C6	55.7	3.2	41.0	100.0	3.49E+06	8.65E+09	NA	NA	NA	NA	8.45E+01	0.00E+00	NA	NA	NA	NA	NA	NA
7	ALIPHATIC C6-C8	82.2	1.0	16.8	100.0	5.45E+06	5.54E+09	NA	NA	NA	NA	8.45E+01	0.00E+00	NA	NA	NA	NA	NA	NA
8	ALIPHATIC C8-C10	96.1	0.1	3.8	100.0	6.68E+05	1.52E+08	NA	NA	NA	NA	4.90E+00	0.00E+00	NA	NA	NA	NA	NA	NA
9	ALIPHATIC C10-C12	99.2	0.0	0.8	100.0	1.49E+06	6.83E+07	NA	NA	NA	NA	4.90E+00	0.00E+00	NA	NA	NA	NA	NA	NA
10	ALIPHATIC C12-C16	99.9	0.0	0.1	100.0	4.30E+06	2.36E+07	NA	NA	NA	NA	4.90E+00	0.00E+00	NA	NA	NA	NA	NA	NA
11	ALIPHATIC C16-C21	100.0	0.0	0.0	100.0	1.23E+08	3.93E+07	NA	NA	NA	NA	3.38E+01	0.00E+00	NA	NA	NA	NA	NA	NA
12	ALIPHATIC C21-C35	100.0	0.0	0.0	100.0	1.23E+08	3.93E+07	NA	NA	NA	NA	3.38E+01	0.00E+00	NA	NA	NA	NA	NA	NA
13	AROMATIC C5-C7	57.3	39.9	2.8	100.0	7.89E+06	1.34E+09	NA	NA	NA	NA	4.69E+01	0.00E+00	NA	NA	NA	NA	NA	NA
14	AROMATIC C7-C8	80.2	18.5	1.3	100.0	1.22E+07	9.50E+08	NA	NA	NA	NA	4.63E+01	0.00E+00	NA	NA	NA	NA	NA	NA
15	AROMATIC C8-C10	96.7	2.9	0.4	100.0	4.04E+05	1.07E+07	NA	NA	NA	NA	1.01E+00	0.00E+00	NA	NA	NA	NA	NA	NA
16	AROMATIC C10-C12	98.1	1.8	0.1	100.0	9.42E+05	4.58E+06	NA	NA	NA	NA	1.01E+00	0.00E+00	NA	NA	NA	NA	NA	NA
17	AROMATIC C12-C16	99.1	0.9	0.0	100.0	3.12E+06	1.34E+06	NA	NA	NA	NA	1.01E+00	0.00E+00	NA	NA	NA	NA	NA	NA
18	AROMATIC C16-C21	0.0	0.0	0.0	0.0	0.00E+00	0.00E+00	NA	NA	NA	NA	0.00E+00	0.00E+00	NA	NA	NA	NA	NA	NA
19	AROMATIC C21-C35	0.0	0.0	0.0	0.0	0.00E+00	0.00E+00	NA	NA	NA	NA	0.00E+00	0.00E+00	NA	NA	NA	NA	NA	NA
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Environment Agency

	Soil Distribution				Media Concentrations													
	Sorbed	Dissolved	Vapour	Total	Soil	Soil gas	Indoor Dust	Outdoor dust at 0.8m	Outdoor dust at 1.6m	Indoor Vapour	Outdoor vapour at 0.8m	Outdoor vapour at 1.6m	Green vegetables	Root vegetables	Tuber vegetables	Herbaceous fruit	Shrub fruit	Tree fruit
	%	%	%	%	mg kg^{-1}	mg m^{-3}	mg kg^{-1}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg m^{-3}	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW	mg kg^{-1} FW
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Environment Agency

		Average Daily Exposure (mg kg^{-1} bw day^{-1})							Distribution by Pathway (%)							
		Direct soil ingestion	Consumption of homegrown produce and attached soil	Dermal contact with soil and dust	Inhalation of dust	Inhalation of vapour	Background (oral)	Background (inhalation)	Direct soil ingestion	Consumption of homegrown produce and attached soil	Dermal contact with soil and dust	Inhalation of dust	Inhalation of vapour (indoor)	Inhalation of vapour (outdoor)	Background (oral)	Background (inhalation)
1	Benzene (S4UL)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.40E-03	0.00E+00	0.00E+00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00
2	Toluene (S4UL)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.39E+00	5.63E-04	5.58E-03	0.00	0.00	0.00	0.00	0.00	99.60	0.00	0.40
3	Ethylbenzene (S4UL)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.32E-02	2.81E-04	1.13E-03	0.00	0.00	0.00	0.00	0.00	98.48	0.00	1.52
4	Xylene p- (S4UL)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.37E-02	6.19E-04	6.30E-03	0.00	0.00	0.00	0.00	0.00	89.49	0.00	10.51
5	Naphthalene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.90E-04	3.94E-04	1.70E-04	0.00	0.00	0.00	0.00	0.00	80.26	0.00	19.74
6	ALIPHATIC C5-C6	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.50E+00	5.62E+95	6.06E+95	0.00	0.00	0.00	0.00	0.00	50.00	0.00	50.00
7	ALIPHATIC C6-C8	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.50E+00	5.62E+95	6.06E+95	0.00	0.00	0.00	0.00	0.00	50.00	0.00	50.00
8	ALIPHATIC C8-C10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.45E-01	5.62E+95	6.06E+95	0.00	0.00	0.00	0.00	0.00	50.00	0.00	50.00
9	ALIPHATIC C10-C12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.45E-01	5.62E+95	6.06E+95	0.00	0.00	0.00	0.00	0.00	50.00	0.00	50.00
10	ALIPHATIC C12-C16	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.45E-01	5.62E+95	6.06E+95	0.00	0.00	0.00	0.00	0.00	50.00	0.00	50.00
11	ALIPHATIC C16-C21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E+00	5.62E+95	0.00E+00	0.00	0.00	0.00	0.00	0.00	50.00	50.00	0.00
12	ALIPHATIC C21-C35	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E+00	5.62E+95	0.00E+00	0.00	0.00	0.00	0.00	0.00	50.00	50.00	0.00
13	AROMATIC C5-C7	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.39E+00	1.69E-04	1.21E-02	0.00	0.00	0.00	0.00	0.00	99.13	0.00	0.87
14	AROMATIC C7-C8	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.37E+00	5.63E-04	3.15E-02	0.00	0.00	0.00	0.00	0.00	97.75	0.00	2.25
15	AROMATIC C8-C10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-02	5.62E+95	6.06E+95	0.00	0.00	0.00	0.00	0.00	50.00	0.00	50.00
16	AROMATIC C10-C12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-02	5.62E+95	6.06E+95	0.00	0.00	0.00	0.00	0.00	50.00	0.00	50.00
17	AROMATIC C12-C16	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.00E-02	5.62E+95	6.06E+95	0.00	0.00	0.00	0.00	0.00	50.00	0.00	50.00
18	AROMATIC C16-C21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.62E+95	0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	AROMATIC C21-C35	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.62E+95	0.00E+00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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Environment Agency

	Average Daily Exposure (mg kg^{-1} bw day^{-1})							Distribution by Pathway (%)							
	Direct soil ingestion	Consumption of homegrown produce and attached soil	Dermal contact with soil and dust	Inhalation of dust	Inhalation of vapour	Background (oral)	Background (inhalation)	Direct soil ingestion	Consumption of homegrown produce	Dermal contact with soil and dust	Inhalation of dust	Inhalation of vapour (indoor)	Inhalation of vapour (outdoor)	Background (oral)	Background (inhalation)
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Environment Agency

		Oral Health Criteria Value ($\mu g\ kg^{-1}\ BW\ day^{-1}$)		Inhalation Health Criteria Value ($\mu g\ kg^{-1}\ BW\ day^{-1}$)		Oral Mean Daily Intake ($\mu g\ day^{-1}$)	Inhalation Mean Daily Intake ($\mu g\ day^{-1}$)	Air-water partition coefficient (K_{aw}) ($cm^3\ cm^{-3}$)	Coefficient of Diffusion in Air ($m^2\ s^{-1}$)	Coefficient of Diffusion in Water ($m^2\ s^{-1}$)	log K_{oc} ($cm^3\ g^{-1}$)	log K_{ow} (dimensionless)	Dermal Absorption Fraction (dimensionless)	Soil-to-dust transport factor ($g\ g^{-1}$ DW)	Sub-surface soil to indoor air correction factor (dimensionless)	Relative bioavailability via soil ingestion (unitless)	Relative bioavailability via dust inhalation (unitless)
1	Benzene (S4UL)	ID	0.29	ID	1.4	NR	NR	1.16E-01	8.77E-06	6.64E-10	1.83	2.13	0.1	0.5	10	1	1
2	Toluene (S4UL)	TDI	223	TDI	1400	10	92	1.15E-01	7.78E-06	5.88E-10	2.31	2.73	0.1	0.5	10	1	1
3	Ethylbenzene (S4UL)	TDI	100	TDI	74.3	5	18.6	1.39E-01	7.04E-06	5.31E-10	2.65	3.15	0.1	0.5	10	1	1
4	Xylene p- (S4UL)	TDI	180	TDI	60	11	104	1.07E-01	7.04E-06	5.31E-10	2.65	3.15	0.1	0.5	10	1	1
5	Naphthalene	TDI	20	TDI	0.86	7	2.8	6.62E-03	6.52E-06	5.16E-10	2.81	3.34	0.13	0.5	1	1	1
6	ALIPHATIC C5-C6	TDI	5000	TDI	5000	9.99E+99	9.99E+99	2.10E+01	1.00E-05	1.00E-09	2.91	3.31	0.1	0.5	10	1	1
7	ALIPHATIC C6-C8	TDI	5000	TDI	5000	9.99E+99	9.99E+99	2.73E+01	1.00E-05	1.00E-09	3.58	4.13	0.1	0.5	10	1	1
8	ALIPHATIC C8-C10	TDI	100	TDI	290	9.99E+99	9.99E+99	4.15E+01	1.00E-05	1.00E-09	4.48	5.22	0.1	0.5	10	1	1
9	ALIPHATIC C10-C12	TDI	100	TDI	290	9.99E+99	9.99E+99	6.44E+01	1.00E-05	1.00E-09	5.38	6.3	0.1	0.5	10	1	1
10	ALIPHATIC C12-C16	TDI	100	TDI	290	9.99E+99	9.99E+99	1.71E+02	1.00E-05	1.00E-09	6.73	7.94	0.1	0.5	10	1	1
11	ALIPHATIC C16-C21	TDI	2000	NR	NR	9.99E+99	NR	1.07E+03	1.00E-05	1.00E-09	8.76	10.39	0.1	0.5	10	1	1
12	ALIPHATIC C21-C35	TDI	2000	NR	NR	9.99E+99	NR	1.07E+03	1.00E-05	1.00E-09	8.76	10.39	0.1	0.5	10	1	1
13	AROMATIC C5-C7	TDI	223	TDI	1400	3	200	1.16E-01	8.77E-06	6.64E-10	1.83	2.13	0.1	0.5	10	1	1
14	AROMATIC C7-C8	TDI	223	TDI	1400	10	520	1.15E-01	7.78E-06	5.88E-10	2.31	2.73	0.1	0.5	10	1	1
15	AROMATIC C8-C10	TDI	40	TDI	60	9.99E+99	9.99E+99	2.53E-01	1.00E-05	1.00E-09	3.2	3.69	0.1	0.5	10	1	1
16	AROMATIC C10-C12	TDI	40	TDI	60	9.99E+99	9.99E+99	7.22E-02	1.00E-05	1.00E-09	3.4	3.93	0.1	0.5	10	1	1
17	AROMATIC C12-C16	TDI	40	TDI	60	9.99E+99	9.99E+99	1.26E-02	1.00E-05	1.00E-09	3.7	4.29	0.1	0.5	10	1	1
18	AROMATIC C16-C21	TDI	30	NR	NR	9.99E+99	NR	6.95E-04	1.00E-05	1.00E-09	4.15	4.82	0.1	0.5	10	1	1
19	AROMATIC C21-C35	TDI	30	NR	NR	9.99E+99	NR	2.48E-05	1.00E-05	1.00E-09	5.1	5.95	0.1	0.5	10	1	1
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	Oral Health Criteria Value (µg kg^{-1} BW day^{-1})	Inhalation Health Criteria Value (µg kg^{-1} BW day^{-1})	Oral Mean Daily Intake (µg day^{-1})	Inhalation Mean Daily Intake (µg day^{-1})	Air-water partition coefficient (K_{aw}) (cm^3 cm^{-3})	Coefficient of Diffusion in Air (m^2 s^{-1})	Coefficient of Diffusion in Water (m^2 s^{-1})	log K_{oc} (cm^3 g^{-1})	log K_{ow} (dimensionless)	Dermal Absorption Fraction (dimensionless)	Soil-to-dust transport factor (g g^{-1} DW)	Sub-surface soil to indoor air correction factor (dimensionless)	Relative bioavailability via soil ingestion (unitless)	Relative bioavailability via dust inhalation (unitless)
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Environment Agency

		Soil-to-water partition coefficient ($cm^3 g^{-1}$)	Vapour pressure (Pa)	Water solubility ($mg L^{-1}$)	Soil-to-plant concentration factor for green vegetables (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for root vegetables (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for tuber vegetables (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for herbaceous fruit (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for shrub fruit (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for tree fruit (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)
1	Benzene (S4UL)	3.92E-01	6.24E+03	1.78E+03	model	model	model	model	model	model
2	Toluene (S4UL)	1.18E+00	1.73E+03	5.90E+02	model	model	model	model	model	model
3	Ethylbenzene (S4UL)	2.59E+00	5.53E+02	1.80E+02	model	model	model	model	model	model
4	Xylene p- (S4UL)	2.59E+00	4.75E+02	2.00E+02	model	model	model	model	model	model
5	Naphthalene	3.74E+00	2.31E+00	1.90E+01	model	model	model	model	model	model
6	ALIPHATIC C5-C6	4.71E+00	2.19E+04	3.59E+01	model	model	model	model	model	model
7	ALIPHATIC C6-C8	2.21E+01	3.45E+03	5.37E+00	model	model	model	model	model	model
8	ALIPHATIC C8-C10	1.75E+02	3.20E+02	4.27E-01	model	model	model	model	model	model
9	ALIPHATIC C10-C12	1.39E+03	3.21E+01	3.39E-02	model	model	model	model	model	model
10	ALIPHATIC C12-C16	3.11E+04	1.53E+00	7.59E-04	model	model	model	model	model	model
11	ALIPHATIC C16-C21	3.34E+06	2.38E-02	2.54E-06	model	model	model	model	model	model
12	ALIPHATIC C21-C35	3.34E+06	2.38E-02	2.54E-06	model	model	model	model	model	model
13	AROMATIC C5-C7	3.92E-01	6.24E+03	1.78E+03	model	model	model	model	model	model
14	AROMATIC C7-C8	1.18E+00	1.73E+03	5.90E+02	model	model	model	model	model	model
15	AROMATIC C8-C10	9.19E+00	3.20E+02	6.46E+01	model	model	model	model	model	model
16	AROMATIC C10-C12	1.46E+01	3.21E+01	2.45E+01	model	model	model	model	model	model
17	AROMATIC C12-C16	2.91E+01	1.14E+00	5.75E+00	model	model	model	model	model	model
18	AROMATIC C16-C21	8.19E+01	5.62E-03	6.53E-01	model	model	model	model	model	model
19	AROMATIC C21-C35	7.30E+02	1.61E-06	6.61E-03	model	model	model	model	model	model
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	Soil-to-water partition coefficient ($cm^3\ g^{-1}$)	Vapour pressure (Pa)	Water solubility ($mg\ L^{-1}$)	Soil-to-plant concentration factor for green vegetables (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for root vegetables (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for tuber vegetables (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for herbaceous fruit (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for shrub fruit (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)	Soil-to-plant concentration factor for tree fruit (mg g^{-1} plant DW or FW basis over mg g^{-1} DW soil)
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CLEA Software Version 1.071

Report generated 05/07/2021

Report title Remediation target Concentrations for soils to remain below 300mm clean cover cover in residential POS

Created by Nick Ward at IDG

BASIC SETTINGS

Land Use Residential with produce (C4SL)

Building No building
Receptor Female (res C4SL) Start age class 1 End age class 6 Exposure Duration 6 years
Soil Sandy loam

Exposure Pathways

Direct soil and dust ingestion ✘	Dermal contact with indoor dust ✘	Inhalation of indoor dust ✘
Consumption of homegrown produce ✘	Dermal contact with soil ✘	Inhalation of soil dust ✘
Soil attached to homegrown produce ✘		Inhalation of indoor vapour ✘
		Inhalation of outdoor vapour ✓

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Land Use Residential with produce (C4SL) **Receptor** Female (res C4SL)

Age Class	Exposure Frequencies (days yr^{-1})						Occupation Periods (hr day^{-1})		Soil to skin adherence factors (mg cm^{2})		Direct soil ingestion rate (g day^{-1})	Body weight (kg)	Body height (m)	Inhalation rate (m^{3} day^{-1})	Max exposed skin factor		Total skin area (m^{2})
	Direct soil ingestion	Consumption of homegrown produce	Dermal contact with indoor dust	Dermal contact with soil	Inhalation of dust and vapour, indoor	Inhalation of dust and vapour, outdoor	Indoors	Outdoors	Indoor	Outdoor					Indoor (m^{2} m^{-2})	Outdoor (m^{2} m^{-2})	
1	180	180	180	170	365	365	23.0	1.0	0.06	0.10	0.10	5.60	0.7	5.4	0.32	0.26	3.43E-01
2	365	365	365	170	365	365	23.0	1.0	0.06	0.10	0.10	9.80	0.8	8.0	0.33	0.26	4.84E-01
3	365	365	365	170	365	365	23.0	1.0	0.06	0.10	0.10	12.70	0.9	8.9	0.32	0.25	5.82E-01
4	365	365	365	170	365	365	23.0	1.0	0.06	0.10	0.10	15.10	0.9	10.1	0.35	0.28	6.36E-01
5	365	365	365	170	365	365	19.0	1.0	0.06	0.10	0.10	16.90	1.0	10.1	0.35	0.28	7.04E-01
6	365	365	365	170	365	365	19.0	1.0	0.06	0.10	0.10	19.70	1.1	10.1	0.33	0.26	7.94E-01
7	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	22.10	1.2	12.0	0.22	0.15	8.73E-01
8	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	25.30	1.2	12.0	0.22	0.15	9.36E-01
9	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	27.50	1.3	12.0	0.22	0.15	1.01E+00
10	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	31.40	1.3	12.0	0.22	0.15	1.08E+00
11	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	35.70	1.4	12.0	0.22	0.14	1.19E+00
12	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	41.30	1.4	15.2	0.22	0.14	1.29E+00
13	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	47.20	1.5	15.2	0.22	0.14	1.42E+00
14	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	51.20	1.6	15.2	0.22	0.14	1.52E+00
15	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	56.70	1.6	15.2	0.21	0.14	1.60E+00
16	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	59.00	1.6	15.2	0.21	0.14	1.63E+00
17	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	70.00	1.6	15.7	0.33	0.27	1.78E+00
18	0	0	0	0	0	0	0.0	0.0	0.00	0.00	0.00	70.90	1.6	13.6	0.33	0.27	1.80E+00

Consumption Rates

Consumption rates (g FW kg^{-1} bodyweight day^{-1}) by Produce Group

Age Class	MEAN RATES						90TH PERCENTILE RATES					
	Green veg	Root veg	Tuber veg	Herb. Fruit	Shrub fruit	Tree fruit	Green veg	Root veg	Tuber veg	Herb. Fruit	Shrub fruit	Tree fruit
1							7.12E+00	1.07E+01	1.60E+01	1.83E+00	2.23E+00	3.82E+00
2							6.85E+00	3.30E+00	5.46E+00	3.96E+00	5.40E-01	1.20E+01
3							6.85E+00	3.30E+00	5.46E+00	3.96E+00	5.40E-01	1.20E+01
4							6.85E+00	3.30E+00	5.46E+00	3.96E+00	5.40E-01	1.20E+01
5							3.74E+00	1.77E+00	3.38E+00	1.85E+00	1.60E-01	4.26E+00
6							3.74E+00	1.77E+00	3.38E+00	1.85E+00	1.60E-01	4.26E+00
7							3.74E+00	1.77E+00	3.38E+00	1.85E+00	1.60E-01	4.26E+00
8							3.74E+00	1.77E+00	3.38E+00	1.85E+00	1.60E-01	4.26E+00
9							3.74E+00	1.77E+00	3.38E+00	1.85E+00	1.60E-01	4.26E+00
10							3.74E+00	1.77E+00	3.38E+00	1.85E+00	1.60E-01	4.26E+00
11							3.74E+00	1.77E+00	3.38E+00	1.85E+00	1.60E-01	4.26E+00
12							3.74E+00	1.77E+00	3.38E+00	1.85E+00	1.60E-01	4.26E+00
13							3.74E+00	1.77E+00	3.38E+00	1.85E+00	1.60E-01	4.26E+00
14							3.74E+00	1.77E+00	3.38E+00	1.85E+00	1.60E-01	4.26E+00
15							3.74E+00	1.77E+00	3.38E+00	1.85E+00	1.60E-01	4.26E+00
16							3.74E+00	1.77E+00	3.38E+00	1.85E+00	1.60E-01	4.26E+00
17							2.94E+00	1.40E+00	1.79E+00	1.61E+00	2.20E-01	2.97E+00
18							2.94E+00	1.40E+00	1.79E+00	1.61E+00	2.20E-01	2.97E+00

Top 2 applied? No

Where top 2 method is applied, two produce categories use 90th percentile rates, while the remainder use the mean. Produce categories vary on a chemical-by-chemical basis. Where top 2 method is not used, all produce categories for all chemicals assume 90th percentile rates.

Building No building

Soil Sandy loam

Building footprint (m^2)	0.00E+00
Living space air exchange rate (hr^{-1})	0.00E+00
Living space height (above ground, m)	0.00E+00
Living space height (below ground, m)	0.00E+00
Pressure difference (soil to enclosed space, Pa)	0.00E+00
Foundation thickness (m)	0.00E+00
Floor crack area (cm^2)	0.00E+00
Dust loading factor ($\mu g\ m^{-3}$)	0.00E+00

Porosity, Total ($cm^3\ cm^{-3}$)	5.30E-01
Porosity, Air-Filled ($cm^3\ cm^{-3}$)	2.00E-01
Porosity, Water-Filled ($cm^3\ cm^{-3}$)	3.30E-01
Residual soil water content ($cm^3\ cm^{-3}$)	1.20E-01
Saturated hydraulic conductivity ($cm\ s^{-1}$)	3.56E-03
van Genuchten shape parameter *m* (dimensionless)	3.20E-01
Bulk density ($g\ cm^{-3}$)	1.21E+00
Threshold value of wind speed at 10m ($m\ s^{-1}$)	7.20E+00
Empirical function (F_x) for dust model (dimensionless)	1.22E+00
Ambient soil temperature (K)	2.83E+02
Soil pH	7.00E+00
Soil Organic Matter content (%)	1.00E+00
Fraction of organic carbon ($g\ g^{-1}$)	5.80E-03
Effective total fluid saturation (unitless)	5.12E-01
Intrinsic soil permeability (cm^2)	4.75E-08
Relative soil air permeability (unitless)	6.42E-01
Effective air permeability (cm^2)	3.05E-08

Soil - Vapour Model

Depth to top of source (no building) (cm)	**30**
Depth to top of source (beneath building) (cm)	50
Default soil gas ingress rate?	Yes
Soil gas ingress rate ($cm^3\ s^{-1}$)	0.00E+00
Building ventilation rate ($cm^3\ s^{-1}$)	0.00E+00
Averaging time surface emissions (yr)	6
Finite vapour source model?	No
Thickness of contaminated layer (cm)	200

Air Dispersion Model

Mean annual windspeed at 10m ($m\ s^{-1}$)	5.00
Air dispersion factor at height of 0.8m *	2400.00
Air dispersion factor at height of 1.6m *	0.00
Fraction of site cover ($m^2\ m^{-2}$)	0.75

* Air dispersion factor in $g\ m^{-2}\ s^{-1}$ per $kg\ m^{-3}$

Soil - Plant Model

	Dry weight conversion factor	Homegrown fraction		Soil loading factor	Preparation correction factor
		Average	High		
	$g\ DW\ g^{-1}\ FW$	dimensionless		$g\ g^{-1}\ DW$	dimensionless
Green vegetables	0.096	0.05	0.33	1.00E-03	2.00E-01
Root vegetables	0.103	0.06	0.40	1.00E-03	1.00E+00
Tuber vegetables	0.210	0.02	0.13	1.00E-03	1.00E+00
Herbaceous fruit	0.058	0.06	0.40	1.00E-03	6.00E-01
Shrub fruit	0.166	0.09	0.60	1.00E-03	6.00E-01
Tree fruit	0.157	0.04	0.27	1.00E-03	6.00E-01

Gardener type Average

APPENDIX D

IDG Protocol for Soil Cover Validation
Residential with Consumption of Homegrown Produce

Introduction

Isolation of Made Ground material beneath a cover of "clean" subsoil and topsoil in residential gardens is often recommended where Made Ground is to be left in-situ; most notably when it contains some inorganic and organic contaminants at concentrations above guidance threshold values.

A cover is only required in residential gardens underlain by Made Ground. The soil cover breaks direct contact pollutant linkages between the contaminants in the Made Ground and future residents.

The Local Authority's Environmental Health Department and the NHBC (or other warranty providers) generally require as a condition of planning a validation report be submitted to confirm the thickness and chemical suitability of the cover soils placed in residential garden areas. Validation reports are normally prepared by independent geoenvironmental consultants such as ID Geoenvironmental Limited.

Soil cover validation requires independent assessment of;

- Confirmation of the chemical/physical suitability of the cover soil (i.e. topsoil and subsoil).
- Verification of the thickness of the placed cover soils.

Sources of Cover Soils

Site Won Materials

It is often possible to "win" suitable subsoil and/or topsoil materials from a development site. However, in order to ensure that materials are suitable for use, and remain suitable for use during the development process, careful assessment, segregation and handling of the soil will be required.

Natural clay or sand excavated during site remediation works or during development (such as during the excavation of service trenches or foundations) can often be suitable for use as a subsoil. Topsoil can sometimes be won from landscaped areas of the site during the remediation and preparatory works stages of the development.

Site won materials should be subject to the same validation requirements as for imported materials.

Imported Cover Soils

Imported cover soils can be derived from three different sources;

- Greenfield
- Brownfield
- Recycling Centre

IDG advocates the sampling of cover soils after importation to site. Where soil is sampled at source, additional confirmatory testing may be required following import to site.

Inspection and Sampling of cover soil following import to site by IDG

In most cases, soil is delivered to site prior to sampling and chemical testing. Such soils should be stockpiled in a secure location on site and IDG should be contacted to arrange for visual inspection, sampling and chemical testing. Once the stockpile has been sampled no further material should be added to the stockpile. It is strongly recommended that soils should not be placed in gardens, prior to confirmation of the suitability of the soil by IDG. This normally takes two weeks from initial notification.

Soil Suitability

Physical Suitability

Suitable soil material should:

- Principally comprise natural materials.
- Be clean and free of foreign debris, building waste materials or contaminants.
- Not have a stone content of greater than 20% by visual estimation.
- Have a maximum stone size of 150mm in any one direction.
- 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).

Chemical Suitability

A summary of recommended sampling frequencies and chemical analysis suites for varying sources of cover soils is presented in Table 1 overleaf. In addition further analysis may be required depending on the historical land uses of the sites the cover soils are derived from.

IDG will inspect soil chemical test results provided by the soil supplier or in certain circumstances visit and sample the source location. On receipt of written confirmation from IDG, the Client should instruct his Contractor to commence importation. It is recommended that each imported batch of soil be placed in separate stockpiles whilst chemical test results are awaited.

On importation to site, IDG should inspect the stockpiled material and the Contractor should provide the Client with appropriate haulage notes detailing the source and volume of material imported.

The number of samples to be tested and the chemical analysis suite undertaken will be dependent on the nature of the source and the quantity of material to be imported. Both the testing ratios and chemical analysis suites presented in Table 1 should be agreed with the Local Authority (EHO) before testing is undertaken.

A less frequent sampling rate may be appropriate where large volumes (say >2,000m^3) of soil are imported from a single, relatively homogenous greenfield source.

The Client\Contractor will be notified of the soil's suitability (or otherwise) immediately following receipt of the results (typically taking 7 working days). Chemical assessment criteria for cover soils are presented in Tables 2 and 3 below.

Chemical testing to determine the relative concentrations of determinands present should be supplemented by total organic carbon analysis (TOC). It is widely accepted that soil organic matter contains 58% carbon. Therefore the soil organic matter (SOM) content may be derived by means of the following equation:

$$SOM = TOC / 0.58$$

The appropriate screening criteria presented in Tables 2 and 3 should be relative to the average SOM of the proposed cover soils.

	Table 1 – Sampling Frequency and Chemical Analysis Suites Summary Table				
	Nature of Source Material	**Sampled**	**Sampling Frequency**	**Minimum Testing Suite**	**Sampling Requirements**
Site Won Material	Greenfield	On site	1:100m³ - Topsoil	pH, metals, speciated PAH, Total Organic Carbon	Minimum of 3 samples to be tested from each designated stockpile. No further material to be added to the stockpile once it has been sampled.
			1:250m³ - Subsoil		
	Brownfield		1:50m³ - Topsoil	pH, metals, speciated PAH, Banded TPH, BTEX, Total Organic Carbon & Asbestos Screen	Minimum of 3 samples to be tested from each designated stockpile. No further material to be added to the stockpile once it has been sampled.
			1:100m³ - Subsoil		
Imported Cover Soils	Greenfield	At source	1:100m³ - Topsoil	pH, metals, speciated PAH, Total Organic Carbon	Two sampling methodolgies can be used; • Sampling from stockpile. Minimum of 3 samples to be tested from each designated stockpile. No further material to be added to the stockpile once it has been sampled. • In-situ sampling of cover soils on a grid pattern across a designated area of the site. An adequate number of samples should be taken to satisfy the sampling frequency.
			1:250m³ - Subsoil		
		Following delivery to site	1:100m³ - Topsoil	pH, metals, speciated PAH, Total Organic Carbon	Minimum of 3 samples to be tested from each imported batch of stockpiled material. No further material to be added to the stockpile once it has been sampled.
			1:250m³ - Subsoil		
	Brownfield	At source	1:50m³ - Topsoil	pH, metals, speciated PAH, Banded TPH, BTEX, Total Organic Carbon & Asbestos Screen	Minimum of 3 samples to be tested from each designated stockpile. No further material to be added to the stockpile once it has been sampled.
			1:100m³ - Subsoil		
		Following delivery to site	1:50m³ - Topsoil	pH, metals, speciated PAH, Banded TPH, BTEX, Total Organic Carbon & Asbestos Screen	Minimum of 3 samples to be tested from each imported batch of stockpiled material. No further material to be added to the stockpile once it has been sampled.
			1:100m³ - Subsoil		
	Recycling Centre	At recycling centre	1:50m³ – Topsoil & Subsoil	pH, metals, speciated PAH, Banded TPH, BTEX, cyanide, phenols, Total Organic Carbon & Asbestos Screen	Minimum of 3 samples to be tested from each designated stockpile. No further material to be added to the stockpile once it has been sampled.
		Following delivery to site	1:50m³ – Topsoil & Subsoil	pH, metals, speciated PAH, Banded TPH, BTEX, cyanide, phenols, Total Organic Carbon & Asbestos Screen	Minimum of 3 samples to be tested from each imported batch of stockpiled material. No further material to be added to the stockpile once it has been sampled.

Hard to Excavate Layers

Cover layers can often include a "difficult to dig" or capillary break layer of coarse natural or recycled aggregate. Where this aggregate is sourced from recycled materials (such as crushed demolition arisings) asbestos screening tests should also be undertaken.

Table 2 - Common Inorganic Determinands

Contaminant	Assessment Concentration (mg/kg)			Source
	% Soil Organic Matter			
	1%	2.5%	6%	
pH	>6 to <8			Initial assessment only
Arsenic	37			S4UL LQM/CIEH 2015
Cadmium	11			S4UL LQM/CIEH 2015
Chromium	910			S4UL LQM/CIEH 2015 value for Chromium III
	6			S4UL LQM/CIEH 2015 value for Chromium VI
Copper	2,400			S4UL LQM/CIEH 2015
Lead	200			SP1010: Development of C4SLs for Assessment of Land Affected by Contamination-Policy Companion Document, December 2014.
Mercury	40			S4UL LQM/CIEH 2015
Nickel	130			S4UL LQM/CIEH Revised Aug 2015
Selenium	250			S4UL LQM/CIEH 2015
Zinc	3,700			S4UL LQM/CIEH 2015
Asbestos	Not Detected			UKAS accredited asbestos screen

Table 3 - Common Organic Determinands

Contaminant	Assessment Concentration (mg/kg)			Source
	% Soil Organic Matter			
	1%	2.5%	6%	
Benzene	0.21	0.23	0.49	IDG Assessment criteria based on S4UL parameters and C4SL exposures for residential with homegrown produce **without indoor inhalation pathway**
Toluene	280	337	770	
Ethyl Benzene	200	253	580	
Xylenes (p-xylene)	360	454	1000	
**Benzo(a)pyrene (as surrogate marker)	1.6	1.95	2.14	
Acenaphthene	222	528	1,150	
Acenaphthylene	180	431	954	
Anthracene	2,390	5,440	10,900	
Benz(a)anthracene	9.15	12.3	14.3	
Benzo(a)pyrene	2.25	2.74	3.00	
Benzo(b)fluoranthene	2.63	3.33	3.71	
Benzo(g,h,i)perylene	318	340	349	
Benzo(k)fluoranthene	78	93	101	

Contaminant	Assessment Concentration (mg/kg)			Source
	% Soil Organic Matter			
	1%	2.5%	6%	
Chrysene	15.3	22.3	27.1	
Dibenzo(a,h)anthracene	0.25	0.29	0.31	
Fluoranthene	286	561	898	
Fluorene	173	409	880	
Indeno(1,2,3-cd)pyrene	27.7	36.4	41.4	
Naphthalene	27	64.4	147	
Phenanthrene	97	221	442	
Pyrene	622	1,250	2,040	
GRO C_5-C_6	90*	180*	380*	IDG Assessment criteria based on S4UL parameters and C4SL exposures for residential with homegrown produce **without indoor inhalation pathway**
GRO C_6-C_8	150*	340*	770*	
GRO C_8-C_{10}	58	130	300	
DRO C_{10}-C_{12}	83	190	420	
DRO C_{12}-C_{16}	150	330	670	
DRO C_{16}-C_{21}	270	550	940	
LRO C_{21}-C_{35}	1,100	1500	1,700	
Phenol	152	278	535	

* BTEX compounds must also be assessed with Aromatic C5-C7, Aromatic C7-C8, GRO C5-C6 and TPH C6-C8 bandings
**Benzo(a)pyrene assessed as surrogate marker for genotoxic PAH. Oral HCV based on minimal risk value (CLAIRE 2014, Appendix E Table 2.2) ID_{Oral} of 0.021 ug/kgBW/day compared to oral, dermal and inhalation exposures and ID_{Inhal} og 0.0003 ug/kgBW/day compared to inhalation exposure.

Placed Thickness Validation

Thickness can only be checked after placement, but should be done before turfing, fencing etc. Thickness will be checked via the excavation of an appropriate number of inspection trial pits. Typically one trial pit for every two gardens will be required.

The thickness of cover is dependent on the nature and degree of contamination (and often the Local Authority whose area the site lies within), but typically between 600mm and 1,000mm is required. Where underlying materials do not contain contaminants above critical concentrations but contains materials generally considered undesirable as a near-surface material in garden areas (i.e. construction rubble) then a 300mm thick cover, in accordance with NHBC Standards, Chapter 9.2, should be adequate.

Soil cover is usually placed many weeks after completion of the preparatory\remedial works, and issue of the associated Verification Report. Consequently, site visits, to generate supplementary letter reports, are typically required after soil cover has been placed in the gardens of each plot, or set of plots.

Issue of Soil Cover Validation Reports

Validation reports will be issued by IDG following the confirmation of the placed thickness within each plot, or set of plots. Each report will contain the following information;

- Details of the provenance of the subsoil and topsoil.
- Chemical test data.
- An interpretation of the chemical data indicating whether the soils are suitable for use in a clean cover layer.
- Photographs of the excavated trial pits confirming the thickness of placed soils.
- A data table indicating the thickness of cover soils within each trial pit excavated.

Soil Cover Validation Reports will be issued to the Client, Local Authority and to the NHBC by email.