Environment Agency

SANDRINGHAM AVENUE ALLOTMENTS. INTERPRETATIVE SITE INVESTIGATION REPORT

JUNE 2026

CONFIDENTIAL

Environment Agency

SANDRINGHAM AVENUE ALLOTMENTS. INTERPRETATIVE SITE INVESTIGATION REPORT

FINAL ISSUE

CONFIDENTIAL

PROJECT NO. UK-70100310

REPORT REF: UK-70100310/12291

DATE: JUNE 2026

Environment Agency

SANDRINGHAM AVENUE ALLOTMENTS. INTERPRETATIVE SITE INVESTIGATION REPORT

WSP

8 First Street
Manchester
M15 4RP

Phone: +44 161 200 5000

WSP.com

QUALITY CONTROL

Issue/ revision	First issue	Revision 1	Revision 2	Revision 3	Revision 4
Remarks	Draft v1.0	Draft v2.0	Draft v3.0	Draft v4.0	Final Issue
Date	February 2026	February 2026	March 2026	May 2026	June 2026
Prepared by	[redacted]				
Signature					
Checked by					
Signature					
Authorised by					
Signature					
Project number	UK-70100310	UK-70100310	UK-70100310	UK-70100310	UK-70100310
Report number	UK-70100310/12291	UK-70100310/12291	UK-70100310/12291	UK-70100310/12291	UK-70100310/12291

CONTENTS

TABLES

APPENDICES

APPENDIX A

FIGURES

APPENDIX B

GENERAL LIMITATIONS

APPENDIX C

SUPPORTING DATA - RISK ASSESSMENT

APPENDIX C.1

TABLES

APPENDIX C.2

CLEA MODEL RUNS. ALLOTMENTS. CHILD. 4.9 UG/KG PFOA

APPENDIX C.3

CLEA MODEL RUNS. ALLOTMENTS. ADULT. 4.9 UG/KG PFOA

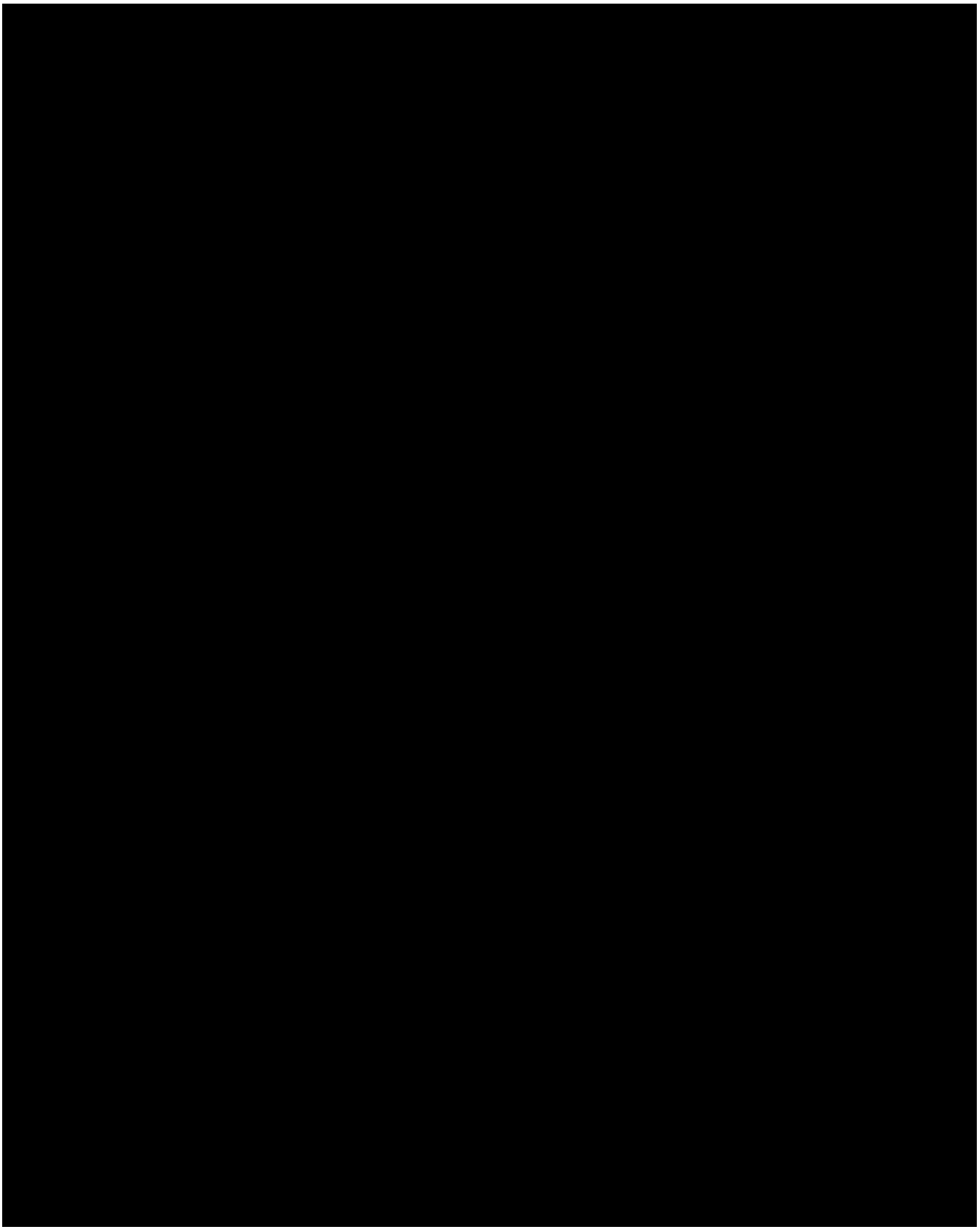
APPENDIX C.4

CLEA MODEL RUNS. RESIDENTIAL NO HG. CHILD. 8.9 UG/KG PFOA

APPENDIX C.5

CLEA MODEL RUNS. RESIDENTAIL NO HG. ADULT. 8.9 UG/KG PFOA

ABOUT THE AUTHORS



NQMS DECLARATION

NQMS SQP Declaration of Document Adequacy

Project

Project Name	Thornton Cleveleys - Sandringham Avenue
Project Address	Sandringham Avenue
NQMS Declaration Reference	0626-K1594

Summary Description of Project / Proposed development
WSP UK Ltd (WSP) has been instructed by the Environment Agency (the 'client') to provide expert
opinion in respect to the status of the allotments located at Sandringham Avenue, Thornton Cleveleys (hereafter the 'site') under Part 2A of the Environmental Protection Act (1990) [1].

As part of the instruction from the Client, WSP was tasked with discussing the findings of the preliminary site investigation works, completed by WSP in January 2025 and the recent (detailed) site investigation works, completed by WSP in October 2025. The purpose of this project is to undertake both generic and detailed quantitative risk assessment and risk evaluation works, to deliver suitably robust conclusions consistent with the decision-making required by the Statutory Guidance and all relevant up-to date good practice for contaminated land investigation and risk assessment.

The purpose of this interpretative report is to provide regulators with the necessary information to
support a decision as to whether the site meets the statutory definition of contaminated land under
Part 2A

Document

Document Title	Sandringham Avenue Allotments. Interpretative Site Investigation Report
Document Type	Interpretative Site Investigation Report
Document Reference	UK-70100310/12291
Document Date	June 2026
Document Author / Publishing Organisation	WSP UK Ltd
Named Client	Environment Agency

Regulator's Contact Details

Local Authority Details

Local Authority Name	N/A
Contact Name	N/A
Contact Telephone	N/A
Contact Email	N/A
Contact Role	N/A

Regulator Details

Regulator	Environment Agency
Contact Name	N/A
Contact Telephone	N/A
Contact Email	N/A
Contact Role	N/A

SQP Details

SQP Name	[redacted]
SQP Registration No.	SQP0077
Telephone	N/A
Email	[redacted]
Organisation	WSP
Address	3 Wellington Place, , Leeds, LS1 4AP
Chartered or Professional Institution	Institution of Environmental Sciences
Chartered or Professional Institution Membership Reference	

Declaration

I, [redacted], confirm that I am the person described in the SQP Details section and hold current valid registration as a Suitably Qualified and Experienced Person Registration No. SQP0077 with the NQMS.

I have reviewed the document described in the Document Details section, in relation to the project and site described in the Site Details section, and I am satisfied that:

1. The assessment has been carried out by appropriately capable people with reference to the Brownfield Skills Framework.
2. That the assessment carried out is, to the best of my knowledge, undertaken with reasonable skill and care, and the information and data reported:
    i. describe an appropriate scope and objectives and
    ii. accord with relevant good practice guidance and standards and
    iii. are based upon appropriately robust science and
    iv. are factually correct and
    v. have been appropriately reviewed.
3. That all specialist aspects have been reviewed by an appropriately qualified/competent person with relevant skills and experience in that specialist area.
4. That the interpretation and conclusions are reasonable.
5. That proposals to mitigate actual, potential, or residual risks are appropriate (where relevant to the report type).
6. I am competent to sign this Declaration and that
    a. I am fully aware of and comply with the SiLC Code of Practice and the Code of Conduct of Institution of Environmental Sciences through which I hold Chartership .
    b. The work of this review and Declaration are within the limits of my knowledge, competence and professional capacity.

Note: The document that has been reviewed was prepared by the organisation named for the benefit of the named Client who has reliance upon it. Any professional liability arising from any proven negligent act or omission by the Company carrying out the work and publishing the document rests with that Company and not with the SQP or the NQMS.

Signed:

0626-K1594

Date:

Name:
[Block capitals]

1

INTRODUCTION

1 INTRODUCTION

1.1 TERMS OF REFERENCE

WSP UK Ltd (WSP) has been instructed by the Environment Agency (the 'client') to provide expert opinion in respect to the status of the allotments located at Sandringham Avenue, Thornton-Cleveleys (hereafter the 'site') under Part 2A of the Environmental Protection Act (1990) [1]. For the location of the site see Figure 1, Appendix A.

As part of the instruction from the Client, WSP was tasked with discussing the findings of the preliminary site investigation works, completed by WSP in January 2025, as reported in January 2026 [2], and the recent (detailed) site investigation works, completed by WSP in October 2025, as reported in January 2026 [3]. The purpose of this project is to undertake both generic and detailed quantitative risk assessment and risk evaluation works, to deliver suitably robust conclusions consistent with the decision-making required by the Statutory Guidance [4] and all relevant up-to-date good practice for contaminated land investigation and risk assessment.

The purpose of this interpretative report is to provide regulators with the necessary information to support a decision as to whether the site meets the statutory definition of contaminated land under Part 2A.

1.2 PROJECT CONTEXT

The investigation findings and risk assessment presented herein form part of a Part 2A inspection focused on legacy emissions from the AGC Chemicals Europe Ltd manufacturing facility (referred to as the 'AGCCE Ltd facility'), which historically formed part of the wider ICI chemical works (referred to as 'ICI Ltd'). The investigation of land in Thornton-Cleveleys is being undertaken through a two tracked, phased and iterative approach, defined as follows:

- Track 1 refers to the wider assessment of contaminant dispersion across the surrounding area.
- Track 2 is the more targeted assessment of specific parcels of land where evidence indicates a potentially unacceptable risk under the Part 2A legislation.

Aerial deposition of perfluorooctanoic acid (PFOA) in soils across the Sandringham Avenue site is likely attributed to legacy aerial emissions from the AGCCE Ltd facility from the 1950s. To date, two phases of shallow soils investigation have been undertaken at the Sandringham Avenue allotments:

- Phase 1 undertaken by WSP in January 2025, comprising part of the Track 1 preliminary investigation. Data obtained is discussed herein and presented within the factual report from the preliminary Sandringham Avenue investigation [2]. This suggested a potential contaminant linkage between legacy aerial deposition of PFOA in shallow soils and users of the Sandringham Avenue site, including those that may consume produce grown at the site, despite not regularly visiting the allotments.
- Phase 2 undertaken by WSP in October 2025, comprising a Track 2 detailed investigation of the allotments. Shallow soil data obtained is discussed herein and presented within the factual report [3].

1.3 SCOPE OF WORK

The scope of works for this interpretative report comprises the following:

- Conceptual Site Model for the Sandringham Avenue site, including site description and consideration of potentially significant contaminant linkages;
- Summary of site investigation works to date including the levels of PFOA, perfluorononanoic acid (PFNA), perfluorohexane sulfonic acid (PFHxS) and perfluorooctane sulfonic acid (PFOS) found in collected soil samples;
- Completion of a risk assessment for PFOA, but also considers PFNA, PFHxS, and PFOS, undertaken in general accordance with the EPA 1990 [1], the Statutory Guidance [4], and relevant up-to-date good practice guidance; and,
- Provision of written advice to the regulators (Environment Agency), based on the outcome of the risk assessment and consideration of the uncertainty, as to whether the Sandringham Avenue site meets the Statutory definition of Contaminated Land under Part 2A of the EPA 1990 [1].

1.4 LEGISLATIVE CONTEXT AND GUIDANCE

This assessment was undertaken in general accordance with the following standards and guidance documents:

- Part 2A of the Environmental Protection Act, 1990 [1];
- Defra, 2012. Contaminated Land Statutory Guidance [4]; and,
- EA, 2025. Land Contamination Risk Management [5].

1.5 LIMITATIONS

Opinion has been limited to the consideration of Contaminated Land and specifically to the assessment of potentially significant risks to human health. Focus has been upon PFOA, PFNA, PFHxS, and PFOS.

The report is addressed to and may be relied upon by the Environment Agency, as “the client” within the meaning given to that phrase within the agreement and subject to the terms and conditions contained therein.

This report has been completed with regard to generally accepted consulting practices and may not be relied upon by any other party without the explicit written agreement of WSP. No other third-party warranty, expressed or implied, is made as to the professional advice included in this report. This report must be used in its entirety.

Unless WSP has actual knowledge to the contrary, WSP has assumed the correctness and completeness of third-party information supplied and shall have no liability in respect of any inaccuracy, defect or omission in any information or materials provided, anecdotally or otherwise, by the Client or any other third party to WSP. WSP does not assume any liability for misrepresentation of information or for items not visible, accessible, present or supplied at the time of the study.

Furthermore, we can accept no liability for misrepresentation of information or for items not visible, accessible, present or supplied at the time of this study. Should further information arise then we reserve the right to update and/or change our opinion. Any comments made of a legal nature must also be considered no more than provisional. Presenting opinion and debating any consideration of responsibility have been excluded.

It should be noted that even a comprehensive sampling and testing programme implemented in accordance with a professional Standard of Care may fail to detect certain conditions. The environmental, geological, geotechnical and hydrogeological conditions that WSP has identified to exist between sampling points may differ from those that actually exist. Passage of time, natural occurrence, and activities near the Site may substantially alter discovered conditions.

In any Conclusions and/or Recommendations section of this report, WSP has set out its key findings and provided a summary and overview of its advice, opinions and recommendations. However, other parts of this report will often indicate the limitations of the information and therefore any advice, opinions or recommendations set out in any Conclusions and Recommendations sections ought not to be relied upon until considered in the context of the whole report. WSP does not provide legal advice, and the advice of lawyers may be required. Furthermore, any Conclusions and Recommendations are only technical advice and may differ from that of the Regulator or other interested parties when wider context is considered.

WSP's General Limitations are included in Appendix B.

2

CONCEPTUAL SITE MODEL

2 CONCEPTUAL SITE MODEL

2.1 INTRODUCTION

The Conceptual Site Model (CSM) is developed at the Preliminary Risk Assessment tier and reviewed and refined during subsequent risk assessment tiers (as defined under the Land Contamination Risk Management, Environment Agency [5]). The CSM represents the characteristics of the site and indicates the possible relationships between contaminants, pathways and receptors, where:

- A contaminant is a substance which is present in, on, or under the land and has the potential to cause harm;
- A receptor is something which could be adversely affected by the contaminant, including the site users, and the allotment-grown produce (representing 'property' in the context of Part 2A, as defined in Section 2.6); and,
- A pathway is a route or means by which a receptor could be exposed to, or affected by, a contaminant.

For a potential risk to exist from a site, all three of the above elements must be present and linked together. In other words, a contaminant has been identified; a receptor is present; and there is an exposure pathway that links the contaminant to the receptor. The term contaminant linkage is introduced in the Statutory Guidance [4] to describe a particular contaminant-pathway-receptor relationship.

2.2 ALLOTMENT SITE DESCRIPTION

Exposure assessments for human health risk assessment are based upon defined exposure scenarios, and the Sandringham Avenue site is currently utilised as an allotment garden. An allotment garden, as described in EA, 2009: SR3 ('Updated technical background to the CLEA model') [6] comprises a number of plots of open space of approximately 250 m^2, made available by the local authority for the growing and consumption of fruit and vegetables by tenants. There are usually several individual plots to a site, and the overall site area may cover more than a hectare.

The key generic assumptions underpinning this scenario are defined as:

- A critical receptor comprising a young, female child (0-6 years);
- An exposure duration of 6 years;
- Exposure pathways comprising of direct soil and dust ingestion, the consumption of allotment produce, the consumption of soil adhering to allotment produce, skin contact with soils and the outdoor inhalation of dusts and vapours; and,
- The lack of any permanent or substantial buildings.

Potential risks have been considered in relation to the current use of the land, as per the Statutory Guidance [4]. Whilst tenants may choose to keep animals at the site, the potential exposure to contaminated meat and eggs is not considered within the generic exposure scenario developed for the initial assessment of land contamination. However, such additional pathways can and should be considered on a site-specific basis.

The Sandringham Avenue site comprises an area of approximately 1,225 m^2 (23 m x 53 m), containing 12 No. allotment plots ranging in size from 61 m^2 to 122 m^2. Plot sizes at the site are

smaller than the generic plot size quoted in SR3, which could potentially result in a lower risk to site users. However, SR3 [6] suggests that the annual household food consumption from an allotment could be met by a growing space of around 133 m^2, which is comparable to the larger allotment plots at the site. The level of risk is also influenced by the types of produce grown and contaminant concentrations in both the soils and plants consumed, so any potential reduction in risk to site users is very difficult to quantify. The locations of the plots are indicated on Figure 2 in Appendix A, and a selection of photographs taken at various points during the Phase 2 works are included within Appendix D of the factual report [3].

Approximately three plots were observed to be heavily overgrown with scrub vegetation at the time of the walkover (January 2025). Strips of grassed marginal land were present between each plot and along a footpath adjacent to the northern and eastern boundaries.

Cultivation of produce was undertaken within in-ground beds. Woodchip cover, bare earth and paving stones was typically noted between tended beds within each plot. Various soil improvement measures were observed, including the addition of compost in some beds whilst covering with cardboard, carpet and polyethylene sheeting was noted to be used as a method of weed suppression. Due to seasonal growing constraints (as noted during the walkover, in January 2025), the presence of observed fruits and vegetables at this time was limited; although, some green and root vegetables were observed (e.g. leek, kale and cabbage) along with unidentified occasional fruit trees. However, no produce samples were collected for analysis during the walkover. Sheds and other fixed infrastructure associated with each plot were typically present along the western boundary.

Based on received questionnaire responses, a wide variety of produce was typically grown in active plots including tubers, green vegetables, root vegetables, herbaceous fruits, shrub fruit and tree fruit. A wide variety of activities were undertaken over the course of each year including planting, watering, harvesting and weeding. A number of soil preparation and improvement methods were observed during the walkover, with most plot holders confirming in their questionnaires that they use a combination of purchased compost, compost created at the allotment, manure or mulches. Three of the six plot holders to respond to the questionnaire stated that they used cardboard, carpet or geotextile plastic as weed suppression measures.

No poultry or other animals were observed to be present onsite, which is consistent with the standard allotment scenario described in SR3 [5].

2.3 THE SOURCE

Deposition from legacy aerial emissions, associated with historical activities undertaken at the AGCCE Ltd facility (formerly operated by ICI Ltd), have likely resulted in PFOA concentrations present in shallow soils and locally grown produce at the Sandringham Avenue site, as discussed in Section 4.

As part of historic operations undertaken by ICI Ltd, and subsequently AGCCE Ltd, the company has estimated that approximately 49 tonnes of PFOA were released to air between the 1950s and 2012. Further details are provided within the desk study [7].

A modelling and dispersion assessment undertaken by the Environment Agency [8] indicated that the historical deposition of PFOA via aerial emissions from a stack located within the curtilage of the current AGCCE Ltd facility had potentially occurred. However, the rate of, and amount of, deposition

was not quantified. The location of the Sandringham Avenue site relative to the AGCCE Ltd facility is indicated on Figure 1 in Appendix A.

A desk study [7] did not identify any other historical sources of PFOA within the Thornton-Cleveleys area that could be used to explain the extent of soil contamination observed in the Track 1 land investigations.

The potential for localised contamination from other sources of PFAS on the allotment site is acknowledged because of their wide-spread use in materials such as polyethylene sheeting and various textiles that may have been used by plot holders to cover the ground as part of typical gardening practices. There is also the potential for possible dilution of contamination, with the addition of other materials to active allotment beds, such as composts and manures, which are generally dug in and consolidated into the soil. However, the findings of the widespread presence of PFOA across the Track 1 area [9], and the general absence of other PFAS compounds at similar concentrations, both support the hypothesis that historical emissions of PFOA to air from the AGCCE Ltd facility - including former site activities - is the most probable primary source of the elevated concentrations detected in offsite shallow soils. The presence of PFOA contamination within shallow soils, based on experience from other similar sites, such as Occupation Road Allotment Gardens [50], is likely to result in measurable PFOA in allotment produce.

2.4 THE PATHWAYS

Based on the usage of the allotments (as described in Section 2.2) and nature of the contaminants under consideration, the relevant exposure pathways for the Sandringham Avenue site include direct exposure pathways (soil and dust ingestion, and dermal contact with soil), the inhalation of dust, and the consumption of allotment produce and attached soil. All pathways are relevant to onsite users, but the consumption of allotment produce and attached soil is largely an off-site activity, as produce will primarily be consumed off-site, and in some cases by individuals who will not have physically visited the allotment gardens.

Plant uptake of soil contamination is typically a passive process through the root zone, and the highest density of roots occurs in the top 0.8 m of the soil profile (as per SR3 [6]). The uptake of contamination from soil represents a relevant exposure pathway for the ‘property’ receptor (allotment-grown produce).

As discussed within the Interim C4SL report for PFAS [10], the volatilisation of PFOA at pH levels above 2.5 is considered negligible[1]. Consequently, exposure to PFOA via vapour migration and inhalation at the allotment is also considered negligible and it has not been modelled. Whilst a number of structures are present at the site including sheds, significant indoor exposure is considered to be unlikely as the buildings are small, well-ventilated and primarily used for storage (as per SR3 [6]).

[1] The majority of PFAS are present in the environment in their involatile dissociated anionic forms. The volatilisation of any structural isomer of PFOA from water will be negligible at environmentally relevant conditions (pH > 2.5) [10].

The tracking back of contamination in soil from the allotment gardens to the home has not been included as a relevant pathway in the CSM for the site and is not considered relevant for an allotment exposure scenario (as per SR3 [6]). Whilst it is accepted that some plot holders may live in close proximity to the Sandringham Avenue site, and / or may have a shed on their plot, this pathway is unlikely to be significant, due to the expected use of reasonable standards of hygiene.

2.5 POTENTIAL RECEPTORS

An important consideration in this exposure scenario is the presence, or absence, of children at the allotment gardens on a regular basis. The standard allotments exposure scenario assumes that children are likely to visit the site infrequently, and in the absence of evidence to the contrary, this is a reasonable assumption for this site. For PFOA, the consumption of homegrown produce, and soil attached to produce, accounts for 98.7% of all soil related exposure for an allotment exposure scenario, assuming default C4SL exposure assumptions [10]. Exposure via this pathway does not require attendance at the site, and all consumers of produce grown at the site are considered to be receptors in the context of the CSM.

The critical human health receptors for the Sandringham Avenue site are therefore:

- A 0-6 year old female child (CLEA age classes AC1-6), in accordance with SR3 [6]; and,
- An adult female (CLEA age class 17), see Section 5 for further discussion.

Part 2A also introduces categories of ‘non-human’ receptors, which include ‘property’, specifically ‘produce grown domestically or on allotments for consumption’, as outlined in Section 4.3, Table 2 of the Statutory Guidance [4].

2.6 POTENTIALLY SIGNFICANT CONTAMINANT LINKAGES

Under Part 2A and in the context of risks to human health, the aim is to consider whether the site is contaminated or not on the grounds of Significant Harm or the Significant Possibility of Significant Harm (SPOSH). As per the Statutory Guidance [4], “contaminated land” is any land which appears to the local authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land that significant harm is being caused or there is a significant possibility of such harm being caused. The following health effects should always be considered to constitute significant harm to human health: death, life threatening diseases, other diseases likely to have serious impacts on health, serious injury, birth defects and impairment of reproductive functions.

Ammonium perfluorooctanoate (AFPO) was used at the adjoining AGCCE Ltd facility (historically operated by ICI Ltd) as a surfactant in the production of fluorotelomer polymers, before it was phased out in 2012. APFO is the ammonium salt of PFOA and readily dissociates in water to give the ammonium and perfluorooctanoate ions, and whilst APFO and PFOA have different properties under certain conditions, it is still considered appropriate to assume that APFO behaves like PFOA in both its toxicity to health and its behaviour on reaching the environment [7].

PFOA is a PFCA (perfluoroalkyl carboxylic acid) with the chemical formula of $C_8HF_{15}O_2$. The health effects identified in humans following exposure to PFOA by authoritative bodies such as the European Food Safety Authority (EFSA), the Agency for Toxic Substances and Disease Registry (ATSDR), Food Standards Australia New Zealand (FSANZ) and the United States Environmental Protection Agency (USEPA) include those in the liver, cardiovascular system, immune system and / or within the developing fetus [11,12,13,14]. It has also been classified as a Group 1 carcinogen

(carcinogenic to humans) by the International Agency for Research on Cancer (IARC) [15]. It can therefore reasonably be concluded that several authoritative organisations have associated human exposure to PFOA with a range of potential adverse effects that meet the definition of a significant health effect as identified in the Statutory Guidance [4].

In the context of risks to property (allotment-grown produce), Part 2A requires the regulator to decide whether or not significant harm is being caused, or if there is considered to be the significant possibility of such harm to the specified property receptor [4]. Produce is considered to be 'significantly harmed' when it is deemed no longer fit for purpose (i.e. consumption), as defined by Section 8(2) of the Food Safety Act 1990 [48], which states that food fails to comply with food safety requirements if it is unsafe within the meaning of Article 14 of Regulation (EC) No. 178/2002 and references to food safety requirements or to food complying with such requirements shall be construed accordingly. Article 14 'Food safety Requirements' Paragraph 5 States: In determining whether any food is unfit for human consumption, regard shall be had to whether the food is unacceptable for human consumption according to its intended use, for reasons of contamination, whether by extraneous matter or otherwise, or through putrefaction, deterioration or decay.

The potentially significant contaminant linkages (SCLs) relating to human health risks at the site, attributed to the aerial deposition of PFOA, are detailed within Table 2-1. The qualitative risk assessment contained within Table 2-1 is based upon the methodology as established within CIRIA C552 [16].

Table 2-1 – Preliminary Conceptual Site Model

Source Pathway Receptor Linkage	Potential Source	Pathway	Receptors	Probability	Consequence	Preliminary Risk Rating
SCL 1	PFOA within shallow soil. (legacy aerial emissions of PFOA associated with historical activities undertaken by the adjacent AGCCE Ltd facility – and former site operators (ICI Ltd)	Soil and dust ingestion, dermal contact with soils. Inhalation of dust, consumption of homegrown produce, and soil attached to homegrown produce.	Human Health – Allotment users, consumers of produce grown at the allotments. Female child, age 0-6 years. Female adult, age 16-65 years.	High Likelihood	Medium	High
SCL 2 ^	PFOA within shallow soil. (legacy aerial emissions of PFOA associated with historical activities undertaken by the adjacent AGCCE Ltd facility – and former site operators (ICI Ltd)	Plant uptake of contamination from soil.	Property – produce grown on allotments	High likelihood	Medium	High

^ Produce sampling was not completed as part of the Sandringham Avenue detailed site investigation works. Therefore, SCL 2 has not been considered further within this Part 2A assessment.

3

SUMMARY OF SITE INVESTIGATION FINDINGS

3 SUMMARY OF SITE INVESTIGATION FINDINGS

3.1 PRELIMINARY INVESTIGATION

As part of a wider (Track 1) site investigation undertaken by WSP in January 2025, the Sandringham Avenue site was subject to limited shallow soil sampling. A total of 24 No. soil samples were obtained between ground level and 0.6 m bgl (below ground level), from 12 No. sample points (referenced LP33-SP201 to LP33-SP212). A maximum sample recovery depth of 0.6 m bgl was selected to account for plausible exposure pathways as identified within the preliminary conceptual site model for the site presented within the desk study [7]. PFOA was recorded above the limit of detection in all samples collected at the Sandringham Avenue site, at concentrations ranging from 1.2 µg/kg dry weight (DW) to 7.3 µg/kg DW (mean 3.6 µg/kg DW). Produce sampling was not undertaken as part of the preliminary investigation.

Soil results are presented and discussed in Section 4, and further details are provided within the factual report for the works [2].

3.2 DETAILED SITE INVESTIGATION

The Track 1 site investigation found PFOA present in soils at the Sandringham Avenue site that potentially indicated the presence of a contaminant linkage under the Part 2A legislation, necessitating the completion of a detailed investigation and assessment. The detailed (Track 2) site investigation was undertaken by WSP in October 2025. An account of the works is provided within the factual report [3], with key information summarised in the following section.

As discussed in Section 2.2, the limited presence of root and green vegetables was noted at the time of the site walkover (January 2025). However, contamination concerns appear to have discouraged most plot users from cultivating produce. Whilst limited produce was observed to be grown within localised areas of the allotments at the time of the detailed site investigation works (October 2025), uncertainty regarding the origin and consistency of the growing media, together with questions over how representative any sampled produce would be, meant that vegetable testing was not considered reliable. As a result, produce sampling was not undertaken as part of the detailed site investigation works.

3.2.1 SOIL SAMPLING

An unbiased sampling strategy was adopted at the Sandringham Avenue site, in accordance with Environment Agency, 2000, R&D Technical Report P5-066/TR [17]. A total of 32 No. sample points were chosen, on a random non-targeted systematic grid spacing of 8 metres. The sample points were randomly positioned using mapping software (ArcGIS) with a minimal allowance set to 3.5 m, which ensured that the locations were positioned within plots. Samples were collected from beds where the random non-targeted location matched with these features. Details are provided within the factual report [3].

For the assessment and control of sampling uncertainty, duplicate sample collection in general accordance with BS:10175 [18] was undertaken at 9 No. randomly selected locations, equivalent to 10% of the proposed sample targets.

To account for the relevant exposure assumptions for allotment users, as described in the standard land use scenario [6], three soil samples were collected at each location, at depths ranging from

ground level to 0.6 m bgl. Samples were collected across this depth range to allow separate characterisation of contaminant concentrations at depths representative of direct soil exposure pathways and the root zone of fruit and vegetables grown on the plots, and to further consider differences in the levels of PFOA with increasing depth.

In total, 96 soil samples were collected (representing 87 No. soil samples and 9 No. sample duplicates), which were all scheduled for analysis. For each of the 9 No. duplicate sampling target locations, a separate hand pit was progressed alongside the target. To account for both sampling and analytical precision, the duplicate sampling resulted in four separate samples being collected in the field for each sample target. Details are provided within the factual report [3].

The soil samples were collected in fully labelled laboratory-supplied containers, relevant to the required suite of analysis, and transported in cooled containers under full chain of custody to a UKAS accredited laboratory (ALS Life Sciences Ltd). Whilst, for the purpose of this investigation, PFOA was identified as the principal contaminant of concern, a wider suite of PFAS analysis was implemented, which offered the lowest method detection limit (MDL) available for PFOA of 0.5 µg/kg DW.

The samples were analysed by liquid chromatography coupled with a triple quadrupole mass spectrometer (LC-MS/MS) (ALS test method TM-4401[2]). The standards used for calibration of PFOS and PFHxS contained both linear and branched components, so all were integrated when quantitating these compounds. All other compounds including PFOA were quantified for the linear component only. Because the analytical testing methodology utilised by ALS Life Sciences Ltd did does not include branched all forms of PFOA, 10 No. soil samples were also submitted to Merieux Nutrisciences Italia as part of the Track 2 investigation [3] for separate analysis for branched and linear forms. The purpose was to check for an under-reporting of total PFOA concentrations within the soils data. The outcome from the additional analysis was that the PFOA linear component was identified to dominate the isomer speciation ratio within samples, with the percentage of linear PFOA ranging between 94.52% and 99.36% (5.48% to 0.64% branched PFOA). Therefore, any general underreporting was considered to be less than 5%.

Soil results are presented and discussed in Section 4. Full laboratory results are included within the factual report [3].

[2] https://www.alsenvironmental.co.uk/media-uk/method_statements/hawarden/contaminated-land-organics/tm440---pfas-in-soils.pdf

4

RESULTS - SOIL DATASET

4 RESULTS - SOIL DATASET

4.1 SOIL DATA

As discussed within Section 3, as part of the Track 1 site investigation works undertaken by WSP in 2025, 24 No. soil samples were collected at the Sandringham Avenue site, and submitted for a suite of PFAS analysis ('PFAS Broad Suite') at ALS Life Sciences Ltd. Following the subsequent completion of detailed (Track 2) investigation works at the site, a further 96 No. soil samples were collected, and submitted to the same laboratory for the same analytical suite. The resultant soil dataset comprises a total of 120 No. soils samples, collected using an unbiased (non-targeted) sampling strategy.

Although the principal contaminant of concern for this assessment is PFOA, each of the soil samples scheduled for testing was analysed for a total of 52 No. separate PFAS compounds. Current good practice for the assessment of risks to health from exposure to PFAS compounds in contaminated soils (as discussed in Section 5) is based upon combined exposure to the sum of PFOA, PFOS, PFHxS and PFNA. As a result, soil results for these four PFAS are discussed in more detail below.

4.1.1 PFOA

4.1.1.1 PFOA Depth Profile

Soil PFOA concentrations at the site were reported in excess of the MDL of 0.5 µg/kg DW in 119 No. of the 120 No. samples (a frequency of detection of 99%), at concentrations ranging from 0.8 to 19.3 µg/kg DW. Table 4-1 below summarises the depth profile for reported PFOA concentrations within the dataset.

Table 4-1 – PFOA Depth Profile, Sandringham Avenue Soils

Depth Range (m bgl)	No. of Samples	Mean Concentration (µg/kg DW)	80% Confidence Intervals (µg/kg DW)	95% Confidence Intervals (µg/kg DW)
0.0-0.1	24	3.8	3.1 – 4.6	2.6 – 5.0
0.1-0.2	17	4.2	3.5 – 5.0	3.0 – 5.4
0.2-0.3	21	4.7	3.9 – 5.5	3.5 – 5.9
0.3-0.4	19	3.7	3.0 – 4.3	2.7 – 4.7
0.4-0.5	21	3.8	3.3 – 4.4	2.9 – 4.7
0.5-0.6	18	6.3	5.5 – 7.7	4.2 – 8.5

To consider whether the representative concentration of PFOA in the soils collected at the Sandringham Avenue site changed with depth, further statistical analysis was carried out. The sample populations presented in Table 4-1 have been assessed using the Mann-Whitney U Test, to establish if they are statistically different. This is a nonparametric statistical test used to compare differences between two independent populations. It is particularly useful when the data is not normally distributed or when sample sizes are small (n < 30), such as for the dataset above separated by depth. The 0.0 – 0.1 m bgl dataset has been assessed against the 0.1 – 0.6 m bgl datasets to provide an indication of whether the PFOA results for surface soils are statistically comparable to those recorded in sub-surface soils (soils collected below a depth of 0.1 m bgl).

The Mann-Whitney U test has been performed as a two-sided test. The null and alternative hypotheses (H) are:

H_0: The two populations are equal i.e. they have the same mean PFOA concentration.

H_a: The two populations are not equal and are therefore independent of one another.

The output of the test is a p-value which is compared against a pre-defined significance level (in this instance 0.05). For the comparison of the surface soils to sub-surface materials, the p-value of the test is larger than our significance level of 0.05, and therefore we cannot reject the null hypothesis, indicating that the surface soil results are statistically similar to the sub-surface material. Mann-Whitney U Test results are provided within Table C1 (Appendix C).

The above statistical analysis does not present justification in splitting the full PFOA soil dataset of 120 No. samples into two subsets. As such, the full dataset (0-0.6m bgl) has been used in the risk assessment going forward.

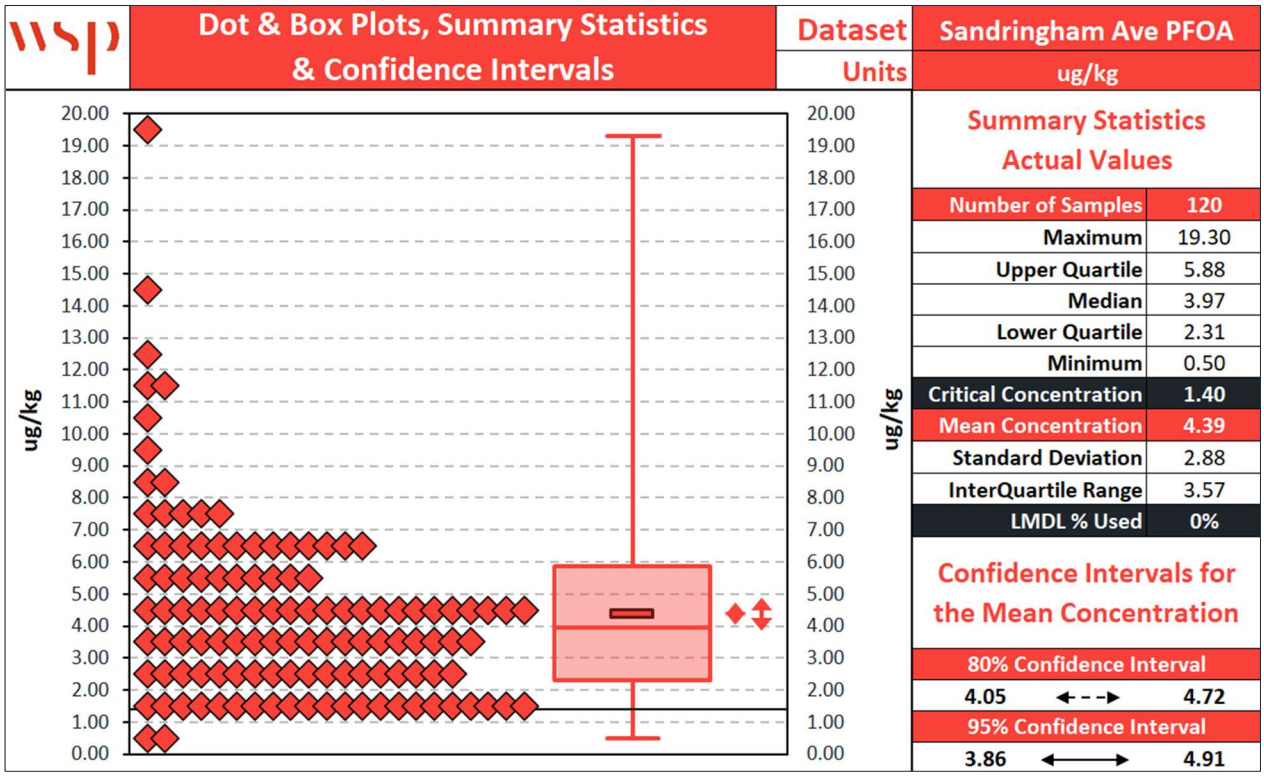
4.1.1.2 Soil Dataset

The PFOA results for the soil dataset of 120 No. soils, collected between 0.0 and 0.6 m bgl, are presented below in Figure 4-1. The soil dataset is observed to be log-symmetric, with a mean concentration of 4.4 µg/kg DW and a median concentration of 4.0 µg/kg DW.

Confidence intervals for the mean concentration are:

- 4.1 – 4.7 µg/kg DW (80% confidence interval around the mean value); and
- 3.9 – 4.9 µg/kg DW (95% confidence interval around the mean value).

Figure 4-1 - PFOA Soil Dataset (0.0 – 0.6 m bgl)



4.1.1.3 Soil Results Plot-by Plot

The sampling strategy was not intended to facilitate a detailed assessment of the site on a plot-by-plot basis. Nevertheless, a minimum of 2 No. and a maximum of 14 No. samples were collected from each of the 12 No. allotment plots.

A total of 87 No. soil samples were collected from within individual allotment plots, with a further 33 No. samples collected on grassed paths and communal land between the plots.

The soil dataset for each plot is summarised below in Table 4-2.

Table 4-2 – PFOA Results by Plot

Plot Number	No. of Samples	Mean Concentration (µg/kg DW)	80% Confidence Intervals (µg/kg DW)	95% Confidence Intervals (µg/kg DW)
PL-01A	8	6.8	5.5 – 8.1	4.7 – 9.0
PL-01B	4	8.0	6.1 – 9.9	4.2 – 11.7
PL-02A	5	4.5	3.8 – 5.2	3.3 – 5.8
PL-02B	11	3.8	3.1 – 4.6	2.7 – 5.0
PL-03	5	4.5	4.0 – 5.0	3.6 – 5.4
PL-04A	7	2.2	1.5 – 2.9	1.0 – 3.4

Plot Number	No. of Samples	Mean Concentration (µg/kg DW)	80% Confidence Intervals (µg/kg DW)	95% Confidence Intervals (µg/kg DW)
PL-04B	3	3.5	1.2 – 5.8	0.0 – 8.8
PL-05	11	4.5	2.3 – 6.7	0.9 – 8.0
PL-06	8	3.2	2.5 – 3.9	2.0 – 4.4
PL-07A	2	1.8	0.4 – 3.1	0.0 – 7.3
PL-07B	9	3.7	3.0 – 4.4	2.5 – 4.8
PL-08	14	4.3	3.3 – 5.4	2.7 – 6.0

Upper 95th percentile confidence intervals of the arithmetic mean PFOA concentration for individual plots range from 3.4 µg/kg DW (plot 04A) to 11.7 µg/kg DW (plot 01B). Where six or more soil samples have been collected from an individual plot, the reported 95th percentile confidence intervals in Table 4-2 are broadly comparable. However, due to the small sample population sizes for each plot, the soil dataset is considered to be insufficient to identify any notable differences in PFOA concentrations between the 12 No. plots sampled at the site.

4.1.2 PFOS

A total of 31 of the 120 No. samples contained PFOS above the MDL of 0.6 µg/kg DW (a frequency of detection of 26%). The minimum, maximum and median reported total PFOS concentrations (branched and linear) are <0.6 µg/kg DW, 12.1 µg/kg DW and 0.60 µg/kg DW, respectively.

4.1.3 PFHXS

Concentrations within all 120 No. samples were reported below the MDL of 0.5 µg/kg DW.

4.1.4 PFNA

Concentrations within all 120 No. samples were reported below the MDL of 0.5 µg/kg DW.

5

RISK EVALUATION – HUMAN HEALTH

5 RISK EVALUATION – HUMAN HEALTH

5.1 INTRODUCTION

This section outlines the purpose of risk assessment in the context of Part 2A and details the methodology applied to the risk evaluation process. This has been used to inform the potential determination of whether Significant Contaminant Linkages (SCLs) to human health exist at the site, as defined under Part 2A of the Environmental Protection Act 1990 [1,4]. It is important to note that the soil at a site can be contaminated by polluting substances, but the level of contamination may not meet the legal definition of contaminated land based on the level of risk it poses to site users and the wider environment.

In April 2012, the Department of Environment, Food and Rural Affairs (Defra) published updated Statutory Guidance, which introduced a four-category approach to determining whether land in England and Wales is contaminated or not on the grounds of significant possibility of significant harm [4]. The categories are as follows:

- **Category 1:** Human Health cases result when the local authority considers there to be an unacceptably high probability, supported by robust, science-based evidence, that significant harm would occur if no action is taken to stop it;
- **Category 2:** Human Health cases result where the local authority concludes that the land poses a 'significant possibility of significant harm', on the basis that there is a strong case for considering that the risks from the land are of sufficient concern;
- **Category 3:** Human Health cases result if the authority concludes that the strong case described above does not exist, and therefore the legal test for 'significant possibility of significant harm' is not met; and,
- **Category 4:** Human Health cases result when the local authority considers there to be no risk, or that the risk is low.

Part 2A takes a risk-based approach to identifying contaminated land as outlined in the Statutory Guidance [4]. This often starts with a preliminary risk assessment based on a desk study and site walkover, moving onto a generic quantitative risk assessment and various stages of more detailed quantitative risk assessment [4,5]. At each stage, more site-specific information is used to reduce uncertainties and conservatism incorporated into the risk assessment. For land to proceed to the next stage of risk assessment, there should be evidence that an unacceptable risk could reasonably exist, with the assessment process continuing until sufficient information is available for the local authority to make an informed decision on:

a) Whether there is insufficient evidence that the land might be contaminated land to justify further inspection and assessment; and / or

b) whether or not the land is contaminated land.

In accordance with the Statutory Guidance [4], the decision-making process for this assessment follows the following steps:

1. Initial qualitative decision on Category 1 in case of an obvious or urgent significant risk to health or the environment,

2. Decision on Category 4 using primarily Tier 2 generic quantitative risk assessment (GQRA) and consideration of what constitutes normal background concentrations [5]. If the site cannot be allocated to Category 4: Human Health, then,

3. Refine decision between Categories 1, 2 and 3 using GQRA, Tier 3 detailed quantitative risk assessment (DQRA) and other evidence [5].

In all steps of the investigation and assessment, whether the evidence points to the need for urgent action should be kept under review.

This report presents the evidence collected at each stage, utilising the results of the GQRA, DQRA and/or other evidence (as applicable) to support the decision-making process. The preliminary risk assessment for the Sandringham Avenue site concluded that there was no obvious or urgent risk to human health, and this report continues the risk evaluation process at step 2.

5.2 DECISION ON CATEGORY 4

A Tier 2 GQRA forms step 2 in the risk assessment process and is a systematic approach used to evaluate risks through the screening of site concentrations against appropriate criteria [5]. This method allows for a more quantitative understanding of risks compared to qualitative assessments alone. For this assessment, the GQRA has been undertaken using published, generic soil assessment criteria, supported by qualitative considerations around normal levels of PFOA to assess whether the Sandringham Avenue site represents Category 4: Human Health. When undertaking the GQRA, the technical approach outlined in good practice guidance has been followed [5].

5.2.1 SELECTION OF ASSESSMENT CRITERIA

Category 4 Screening Levels (C4SL) are screening criteria derived to help local authorities (and others) to decide when a site falls within Category 4 (Human Health) in the context of Part 2A of the Environmental Protection Act (1990) [1]. C4SLs are intended to be more pragmatic than other generic assessment criteria, such as the older soil guideline values, whilst remaining strongly precautionary.

C4SL values are contaminant concentrations in soil below which the risk to public health from exposure for a standard land-use scenario is considered low [10]. They do not mark the boundary between land contamination and contaminated land and exceeding them is not necessarily an indicator of unacceptable risk. However, if a C4SL is not exceeded by a representative soil concentration, the land should normally be placed in Category 4: Human Health, and no further inspection and assessment is required. A site placed in Category 4 does not meet the legal definition of contaminated land. Where a C4SL is exceeded by a representative soil concentration, other factors should be considered such as normal levels of contamination (see Section 5.2.3), and the appropriate categorisation of the site (in either Category 1, 2, 3, or 4) further evaluated.

The Interim C4SL Report for PFAS [10] presents individual assessment criteria for four individual PFAS compounds including PFOA, PFOS, PFNA and PFHxS, as shown in Table 5-1. However, the interim C4SL for PFOA [10] has been used alone to assess whether the Sandringham Avenue site should be placed in Category 4 under the Part 2A regime. The reasoning for this is that PFOA is present more consistently and at higher levels than any of the other three PFAS. Notably, PFNA and PFHxS were always reported below the analytical MDL in soil samples collected from the

Sandringham Avenue site. The C4SL value for PFOA has been compared with a representative soil concentration of PFOA calculated from the site investigation data described in Section 4.1.1.

Table 5-1 - Interim C4SL for PFAS [10] – Allotments (µg/kg DW)

Land Use	PFOA	PFOS	PFHxS	PFNA
Allotments	1.4	2.7	1.5	1.3

According to the C4SL report [10] itself, “The label "interim" has been used throughout this report to reflect the fact that further work by COT [Committee on the Toxicity of Chemicals in Food, Consumer Products, and the Environment] and others may result in the need for the LLTC and the resulting C4SL values to be updated”.

5.2.2 THE OBSERVED DATA

As discussed in Section 4.1.1, the full PFOA soil dataset of 120 No. samples has been taken forward for assessment. Soil results are considered representative of the levels of contamination at the Sandringham Avenue site from surface to a depth of 0.6m bgl.

Reported PFOA concentrations ranged from 0.5 to 19.3 µg/kg DW, with a 95th percentile LCL of 3.9 µg/kg DW. The LCL of 3.9 µg/kg DW exceeds the interim C4SL for PFOA of 1.4 µg/kg DW.

The results of the assessment for the soils dataset are included in Table C2 (Appendix C).

5.2.3 NORMAL PRESENCE OF CONTAMINANTS

As per the Statutory Guidance [4], ‘normal’ levels of contaminants in soil should not be considered to cause land to meet the definition of contaminated land, unless there is a particular reason to consider otherwise. Normal levels of contaminants in soil can arise from natural presence (i.e. underlying geology) or low-level diffuse pollution from residential and municipal activities (such as transport emissions or domestic heating using coal or wood).

Limited soil data is available for levels of PFOA in English soils. An Environment Agency initiated pilot study to assess PFAS background in soils (Beriro et al. 2025 [19]) analysed a range of archived and contemporary soil samples from across England. They reported the mean level of PFOA as 0.27 and 0.60 µg/kg DW for archived and contemporary samples, respectively. PFOA was detected in 24 of 25 No. archived soils and all nine contemporary soils. Beriro et al. noted that the PFAS levels found in their study were similar to other surveys conducted at regional, national, and international scales. The mean PFOA levels found in soils at the Sandringham Avenue site, 4.4 µg/kg DW, are around an order of magnitude higher.

The Track 1 evidence [9] indicated widespread local PFOA contamination in soil with levels ranging from 0.7 to 144 µg/kg DW and a mean of 4.2 µg/kg DW, from a dataset of 291 No. samples. The soil contamination found at the Sandringham Avenue site is broadly consistent with these earlier findings. While these might be considered normal levels of contamination caused by low level diffuse pollution from a regional perspective, it is important to note that the Statutory Guidance (para. 3.23) [4] excludes contamination arising from specific industrial processes. As noted in Section 1.2, the source of PFOA contamination in this area is considered to be the AGCCE Ltd facility, which historically formed part of the wider ICI Ltd chemical works. It is therefore concluded that elevated local soil levels are not a relevant comparator for normal levels of contamination.

5.2.4 OUTCOME OF STEP 2 – DECISION OF CATEGORY 4

Two criteria were used to evaluate whether the Sandringham Avenue site should be placed in Category 4 of the Statutory Guidance for Part 2A on the basis of PFOA contamination [4]:

- Whether representative levels of PFOA in soil were less than the C4SL for PFOA for an appropriate land-use scenario [10]; and
- Whether the levels of PFOA found were consistent with local or national widespread levels as a result of low-level diffuse pollution.

Representative soil concentrations at the Sandringham Avenue site exceeded the C4SL by up to a factor of 2.8. While data on ambient levels of PFOA in English soils is limited, indicative evidence suggests that local levels in the Thornton-Cleveleys area are higher. As a result, it is concluded that the Sandringham Avenue site cannot be placed in Category 4 based on the outcome of the GQRA, and further assessment in accordance with the LCRM guidance [5] and Statutory Guidance [4] is required.

5.3 DECISION ON CATEGORY 1, 2 AND 3

5.3.1 INTRODUCTION

In Section 5.2, an assessment concluded that there was insufficient evidence to place the Sandringham Avenue site in Category 4 for risks to Human Health under the Part 2A regime [4]. The interim C4SL for PFOA [10] was key evidence used in that assessment. However, as noted in the Statutory Guidance [4], generic assessment criteria such as C4SL represent cautious estimates of levels in soil that suggest a potential risk to health, and they should not be used as direct indicators of whether a significant possibility of significant harm (SPOSH) exists. They also do not describe the boundary between Categories 2 and 3 for risks to Human Health under the Part 2A regime. In the context of Part 2A, land only meets the definition of Contaminated Land if the authority considers it falls within Categories 1 or 2.

In this section, evidence is presented to assist the authority in deciding whether the Sandringham Avenue site potentially falls within Categories 1, 2, or 3 with respect to risks to Human Health under the Part 2A regime.

The evaluation is split into three sections:

- Estimates of human exposure to PFOA based on modelling and supported by site information;
- Comparison of estimated exposures with available evidence from epidemiological and animal studies of PFOA to consider the likelihood and significance of risk to human health; and,
- Evidence from land with similar circumstances. The Occupation Road site is a nearby allotment gardens that has already gone through this assessment process. Consequently, the findings and conclusions of that assessment will prove important in the evaluation of Sandringham Avenue.
- Other considerations to contextualise the evidence presented for site exposures to PFOA, including comparison with other examples of environmental contamination found internationally, such as via food and drinking water, and decisions taken by other authorities at similar sites, albeit under different jurisdictions.

These are considered the multiple lines of evidence needed to support any regulatory decision.

5.3.2 CONSIDERATIONS AROUND EXPOSURE

This sub-section provides estimates of human exposure to PFOA for the two critical human health receptors (female adult, female child), as defined in Table 2-1, which can be used to further evaluate the potential risks to human health. It incorporates information and tasks available during a Tier 3 DQRA, which is the step beyond a Tier 2 GQRA. A Tier 2 assessment relies primarily on generic assessment criteria [5] and is considered insufficient to further determine the significance of any risk to human health under the Statutory Guidance [4].

These exposure estimates for children and adults are based on forward modelling using the CLEA model [20]. The parameterisation of the model is supported by lines of evidence, including a questionnaire circulated to the allotment users to gather further information on how they use their individual plots (included within the factual report [3]). This is followed by a further discussion of the uncertainties in the exposure estimates, and whether these likely lead to an under- or over-estimation of exposure by using the conceptual model for an allotment scenario in the model.

5.3.2.1 Estimates of Human Exposure

Estimates of human exposure for a generic adult and child were made using the CLEA model [20] operating in forward (ratio) mode using the default C4SL allotment scenario (Environment Agency [6], CL:AIRE [21]). Where available, site specific data was used to update the default parameters from the derivation of the interim C4SL for PFOA (CL:AIRE [10]).

An updated oral MDI of 0.0142 µg/d has been used in all subsequent estimates of exposure in this report. It incorporates drinking water data for the Thornton area, as provided by United Utilities (2023 – 2025 period), which reported a lower bound PFOA concentration of 0.002 µg/l. This is a higher concentration than the one used in the derivation of the original oral MDI of 0.0128 µg/d used in the C4SL values, which was based on European drinking water data.

In forward mode, the CLEA model estimates the average daily exposure (ADE) to a soil-borne chemical in mg chemical/kg body weight/day for a defined receptor and land-use scenario, for a specified soil concentration. The exposure pathways assumed by the allotment scenario have been previously described in Section 2.2. While the interim C4SL for PFOA assumes the most sensitive receptor is a young child (age from birth to six years), which is consistent with the likelihood of increased soil exposure relative to body weight, some potential adverse effects from exposure to PFOA are relevant to adult women of child-bearing age (see Section 5.3.3). Table 5-2 presents estimated exposure using the CLEA model for the Sandringham Avenue site for both a young female child (age classes 1 to 6 in the CLEA model, total exposure duration of six years) and a female adult (age class 17, total exposure duration of 49 years).

One of the key parameters for forward modelling using the CLEA model is the choice of a representative soil concentration. In the technical background to the CLEA model (Environment Agency [6]), the contamination depth assumed by the default conceptual model is 0 – 0.6 m. The importance of the concentration of contamination with depth depends on the exposure pathway. In the case of direct soil ingestion, skin contact with soil, and wind-blown dust, the soil nearer the surface (0 – 0.1 m) is likely to have the greater influence on exposure, compared to soil at greater depths. However, for the consumption of allotment produce, plant uptake is often a passive process throughout the soil rootzone. The updated technical background to the CLEA model (Environment Agency [6]) noted that for many crop plants, root depths were as deep as 1 – 2 m bgl; although, the highest density occurred in the top 0.8 m. Many root vegetables need around 0.4 – 0.6 m of soil to

establish their roots [22]. As noted in Section 4.1.1, the statistical analysis of soil samples taken at the Sandringham Avenue site did not indicate a statistical difference between the PFOA concentrations in surface soils (0.0 – 0.1 m bgl) and those taken at depth (0.1 – 0.6 m bgl). Therefore, the full PFOA dataset, collected between ground level and 0.6 m BGL, has been used in the estimation of site receptor exposure to PFOA.

Table 5-2 presents estimated exposure to PFOA using the CLEA model for the Sandringham Avenue site for both a young child (age classes 1 to 6 in the CLEA model) and an adult (age class 17). The initial soil concentration of PFOA used for this estimate is 4.9 µg/kg DW, which is the 95th percentile upper confidence limit of the mean for the soil dataset (0.0 – 0.6 m bgl), as calculated from the site investigation data in Section 4.1.1.

Table 5-2 - Estimated ADE of PFOA in mg/kg bw/d For an Adult and a Child *

Receptor	Soil ADE (contribution to total ADE)	Background (non-soil) ADE (oral and inhalation)	Total ADE
Adult	4.85E-07 (69%)	2.18E-07	7.03E-07
Child	1.10E-06 (56%)	8.62E-07	1.97E-06

** using forward modelling in the CLEA model [45] and the standard C4SL allotment scenario, chemical parameters for PFOA from the interim C4SL for PFAS report, and a representative site soil concentration of 4.9 µg/kg DW PFOA.*

It can be noted from Table 5-2 that the ADE for a child is higher than the ADE for an adult. In both cases, the major contributor to the total ADE is the site itself (comprising 56% of exposure for a child and 69% for an adult, respectively).

5.3.2.2 Site Specific Lines of Evidence for Exposure Estimates

It has been previously noted that the consumption of allotment grown produce is the most important exposure pathway for PFOA using the standard C4SL allotment scenario in the CLEA model. The basis for estimating the soil-derived ADE via this pathway is set out in Chapter 7 of SR3 (Environment Agency [6]) and depends on the following parameters, as described in Equation 7-16 in SR3:

- The soil concentration;
- The soil-to-plant concentration factor (CF) for each produce group;
- The average amount of each produce group consumed daily; and,
- The fraction of each produce group considered to come from the allotment.

This section discusses the results of a questionnaire for the Sandringham Avenue plot holders, and the application of the CFs from Occupation Road to the Sandringham Avenue site.

As part of the detailed site investigation works, WSP produced a questionnaire to be distributed to all allotment plot holders (see further details in factual report [3]). The aim was to collect a wide range of information on the activities undertaken by plot holders including the types of produce grown and any soil conditioning undertaken, to provide site-specific background and context. Responses were only received from six of the 12 No. plot holders, and consequently the results of this survey may not be representative of the behaviours of all allotment users.

Table 5-3 compares a summary of the responses with the CLEA model defaults.

Two of the six plot holders to respond to the questionnaire stated that they had not consumed any produce grown at the allotments, choosing to wait until the results of this assessment were made public. A third plot holder only provided a high level response, stating that 95% of all produce consumed from each of the six individual groups was store purchased.

Table 5-3 - Comparison of Default Homegrown Fraction by Produce Group With Representative Data Collected From Responses to an Allotment Questionnaire.

Produce Group	Homegrown Fraction (dimensionless) [6]	
	Default	Questionnaire Responses
Green vegetables	0.33	Three respondents (3 of 6) reported consuming green vegetables grown at the site. Estimates of the proportion of the diet for this produce group range from 20 – 80% (mean 60% or a fraction of 0.60).
Root vegetables	0.40	Three respondents (3 of 6) reported consuming root vegetables grown at the site. Estimates of the proportion of the diet for this produce group range from 5 – 100% (mean 62% or a fraction of 0.62).
Tuber vegetables	0.13	Three respondents (3 of 6) reported consuming tuber vegetables grown at the site. Estimates of the proportion of the diet for this produce group range from 0 – 85% (mean 30% or a fraction of 0.30).
Herbaceous fruit	0.40	Three respondents (3 of 6) reported consuming herbaceous fruit grown at the site. Estimates of the proportion of the diet for this produce group range from 5 – 80% (mean 55% or a fraction of 0.55).
Shrub fruit	0.60	Three respondents (3 of 6) reported consuming shrub fruit grown at the site. Estimates of the proportion of the diet for this produce group range from 5 – 90% (mean 43% or a fraction of 0.43).
Tree fruit	0.27	Three respondents (3 of 6) reported consuming tree fruit grown at the site. Estimates of the proportion of the diet for this produce group range from 5 – 50% (mean 25% or a fraction of 0.25).

Although only a minority of plot holders (around a quarter) responded in adequate detail to the questionnaire, their evidence suggests that some site users consumed a greater proportion of allotment grown produce for most produce groups (green, root and tuber vegetables, herbaceous fruit) and less for others (shrub and tree fruit) than that assumed by the CLEA model. However, interpretation of the results is difficult with some respondents providing incomplete responses or not specifying the individual categories.

It is a challenge to quantitatively interpret the questionnaire data in the context of the overall estimate of exposure using the CLEA model. However, it suggests that intakes may be underestimated, most notably in the consumption of vegetables, where the default values for the

proportion of home grown produce in the diet appear to have been underestimated from the site data. The consumption of shrub and tree fruits is also a potential area where the predicted intakes have been underestimated. These two produce categories are not considered at all within the standard C4SL allotment land-use scenario for PFOA because of a lack of available chemical data on plant uptake (CL:AIRE [10]); although, they were reported to be grown for consumption by most plot holders on the Sandringham Avenue site.

As discussed in Section 3.2, produce sampling was not undertaken as part of the detailed site investigation works at the Sandringham Avenue allotments. However, limited produce sampling was undertaken as part of the nearby Occupation Road assessment [49, 50]. The empirical data, collected in December 2025 from Occupation Road, was used to calculate CFs for green vegetables, root vegetables and tuber vegetables in mg/g FW plant to mg/g DW soil.

Table 5-4 – Comparison of default soil-to-plant concentration factors for PFOA by produce group, with representative data from samples taken from the Occupation Road allotments.

Produce Group	Soil-to-plant concentration factors (mg/g FW plant over mg/g DW soil)	
	Default	Site Observed Values geometric mean (minimum and maximum values)
Green vegetables	0.0871	0.0506 (0.0008 – 0.3993)
Root vegetables	0.0532	0.0554 (0.0135 – 0.5452)
Tuber vegetables	0.00223	0.0176 (0.0166 – 0.0184)
Herbaceous fruit	0.0214	No data
Shrub fruit	Not modelled	No data
Tree fruit	Not modelled	No data

PFOA was reported in plant samples at concentrations above the method detection limit (MDL) of 0.001 µg/kg FW in 24 of the 25 No. produce samples submitted for testing from Occupation Road. This provided clear evidence of an exposure pathway for PFOA from soil to site users.

Interpretation of the Occupation Road data indicated that, although concentrations across different produce groups varied by up to three orders of magnitude (a pattern commonly observed in such datasets), the geometric mean soil-to-plant CFs measured at the Occupation Road site were consistently within an order of magnitude of the default CFs used in the derivation of the interim C4SL for PFOA [10]. While the timing of sampling limited the availability of data for a broader range of crops, the results provide a robust qualitative line of evidence demonstrating that the default CF parameters are appropriate and not unduly conservative. Although equivalent produce data are not available for the Sandringham Avenue site, the close similarity between the two sites in terms of contamination source, soil PFOA concentrations and conceptual site model provides a strong basis for extrapolation. On this basis, material differences in CF values between the two sites are not expected.

In conclusion, the limited evidence collected to support the risk evaluation suggests that the use of the default approach in the CLEA model to estimate human exposure due to the consumption of allotment grown produce is not unreasonable and unlikely to be overly precautionary. Unfortunately, no data was available to update the consumption rates for the produce groups, which would require

plot holders to keep some form of food diary for most of the year to reflect the availability of seasonal produce. This remains an important and significant uncertainty.

5.3.2.3 Other Considerations for Site-based Exposure Estimates

The estimated total ADE reported in Table 5-2 is the sum of soil-derived ADE and ADE from other sources, including the general diet, drinking water and ambient air ('background exposure'). This section considers several other challenges to the estimated exposures from the Sandringham Avenue site.

The first possible issue to consider is whether PFOA exposure is overestimated due to double counting from the consumption of allotment produce and from the dietary contribution from root and leafy vegetables and tubers to the non-soil background intake. As noted in Section 5.3.2.2, several plot holders grow a significant proportion of their consumed produce at the allotment and therefore dietary contributions from non-site sources would be expected to be reduced. However, for most plot holders and most produce categories, the majority of consumed fruit and vegetables is not expected from the site.

The assumptions for non-soil (background) ADE are taken from the interim C4SL PFAS report [10], though the oral MDI has been updated with regional drinking water data, obtained from United Utilities (as detailed within Section 5.3.2.1, resulting in a revised oral MDI of 0.0142 µg/d). The inhalation MDI of 0.00104 µg/d is based on measured concentrations of PFOA within indoor and outdoor air, taken from four studies (CL:AIRE [10]).

The non-soil ADE estimated from these values is shown in Table 5-5.

Table 5-5- Key Assumptions For the Non-soil (Background) ADE for PFOA in mg/kg Body Weight/Day for an Adult and a Young Child.

Non-soil ADE	Adult (% of total non-soil ADE)	Child (% of total non-soil ADE)
Oral non-soil ADE in mg/kg body weight/day	2.03E-07 (93.1%)	7.99E-07 (92.7%)
Inhalation non-soil ADE in mg/kg body weight/day	1.49E-08 (6.9%)	6.30E-08 (7.3%)
Total non-soil ADE in mg/kg body weight/day	2.18E-07	8.62E-07

For the inhalation MDI, there is considered to be a very low risk of double counting with site exposures, as ambient air levels were measured from a wide variety of sources and are likely a baseline for site levels.

With regards to the oral MDI, no double counting is expected from the component from drinking water, as this is not considered by the allotment scenario in the CLEA model. Mean dietary intakes were estimated from the lower bound estimates of intake from the UK National Diet and Nutrition Survey for the period 2008 to 2011 (Table A5 of Annex A, EFSA [11]). By examining the supplementary data in Table A6 of Annex A (EFSA [11]), which identified the main contributing food categories from a number of dietary surveys across different age categories, double counting of up to of 10 - 15% of the oral MDI is possible within the non-soil (background) ADE.

Consequently, reducing the oral non-soil ADE by 15% would result in a revised total non-soil ADE of 7.42E-07 and 1.87E-07 mg/kg body weight/day for a child and an adult, respectively.

The representative PFOA soil concentration used to predict the ADE reported in Table 5-2 is 4.9 µg/kg DW, which was based on chemical analysis of all soil samples collected from the Sandringham Avenue site (see also Section 4.1.1). However, the testing method used by the analytical laboratory was based on a linear PFOA reference sample (that is, a PFOA molecule without significant branched alkyl groups) and that branched PFOA present in the sample may have been under reported. Testing undertaken on a limited number of samples from the Sandringham Avenue site for both linear and branched PFOA has identified that linear PFOA dominates the isomer speciation ratio within samples. Linear PFOA accounts for between 94.5% and 99.4% of the PFOA recorded in the soil samples (5.5% to 0.6% of branched PFOA). Taking this into account and since there is a linear relationship between the representative soil concentration and predicted soil ADE by the CLEA model, this suggests that increasing the representative soil concentration by 5.5% to 5.2 µg/kg DW would result in an increased soil ADE of 1.16E-06 and 5.12E-07 mg/kg body weight/day for a child and adult, respectively.

The outcome of the Track 1 investigation of the area surrounding the AGCCE Ltd facility reported the ubiquitous presence of PFOA in surface soils [9]. In terms of human exposure, this indicates that users of the Sandringham Avenue site and family members that consume produce from the allotment (who may not otherwise visit the site) may also be exposed to soil contamination from other sites, such as residential gardens and recreational public open space. While it is challenging to estimate this additional off-site soil exposure, it can be illustrated through forward modelling using the CLEA model. For example, if we assume that the allotment plot holder and their family live within the surrounding area then additional PFOA exposure can be estimated by using the CLEA model with the C4SL land use scenario for a residential property (without homegrown consumption) and a representative soil concentration estimated from the Track 1 study.

Table 6-1 in the factual report for the Track 1 works [9] reported that the mean PFOA soil levels found at seven individual locations within 500 m of the AGCCE Ltd facility ranged from 4.1 to 11.6 µg/kg DW, with a mean value of 8.9 µg/kg DW for the full dataset. Assuming a representative PFOA soil concentration of 8.9 µg/kg DW, the soil ADE for a C4SL residential scenario using the CLEA tool (Environment Agency [6], CL:AIRE [10,21]) would be 6.91E-08 and 9.99E-09 mg/kg body weight/day for a child and adult, respectively (CLEA model output reports are included within Appendix C). This represents an additional soil ADE of only 6% for a child and 2% for an adult, suggesting that the majority of soil exposure would come from the Sandringham Avenue site.

In summary, as indicated in Table 5-6, possible changes in soil ADE are mostly offset by potential double counting in non-soil ADE. Off-site sources contribute minimally to total PFOA ADE, so all these factors are unlikely to significantly affect this assessment's conclusions.

Table 5-6 - Comparison of the Original Estimate of Total ADE for PFOA in for an Adult and a Young Child with an Adjusted Total Taking into Account Potential Double Counting for Non-Soil ADE, Testing Method for Chemical Analysis, and Potential Contributions to Soil Exposure from Other Sites.

Receptor		ADE (mg/kg body weight/day)			
		Soil ADE	Off-site Soil ADE	Non-soil ADE	Total ADE
Adult	Original	4.85E-07	-	2.18E-07	7.03E-07
	Revised	5.12E-07	9.99E-09	1.87E-07	7.09E-07
Child	Original	1.10E-06	-	8.62E-07	1.97E-06
	Revised	1.16E-06	6.91E-08	7.42E-07	1.97E-06

5.3.3 CONSIDERATIONS AROUND POTENTIAL HEALTH EFFECTS

As introduced in Section 5.2.1, the use of generic assessment criteria including the C4SLs are useful to indicate when land presents a low risk, meaning it is highly unlikely to pose a significant possibility of significant harm to human health (SPOSH). As the Statutory Guidance [4] makes clear, such assessment criteria should not be used as direct indicators of whether a significant possibility of significant harm exists, or to mark the boundary between Category 2 and Category 3.

In Section 2.6, the term ‘significant harm’ was introduced, along with an overview of the potential adverse health effects that have been attributed to exposure to PFOA by numerous authoritative bodies. The toxicological effects of PFOA and its potential impacts on public health have been widely reviewed in recent years; although, many uncertainties in the interpretation of epidemiological and animal studies remain.

To evaluate the significance of estimated exposures to PFOA for users of the Sandringham Avenue site (and consumers of its allotment-grown produce), data has been collated from a number of authoritative reviews on the toxicology of PFOA. The purpose of this review is to ensure that a broad range of evidence, and not just the health-based guidance value that underpins the C4SL, is used to inform any decision on whether the land meets the definition of Contaminated Land (that is, it should be placed in Category 1 or 2, and not Category 3 in accordance with the Statutory Guidance [4]).

Collating and presenting a broad evidence base provides a clearer understanding of the underlying toxicological uncertainty and ensures that this is considered as part of any robust decision-making process. The review is not a detailed evaluation or authoritative review of the available data, which is the subject of on-going work by the Expert Committee on the Toxicity of Chemicals in Food, Consumer Products, and the Environment (COT).

The approach taken here is consistent with a margin of exposure approach (EFSA [24]), which is a tool used by risk assessors to assess safety concerns in a range of different scenarios, including food safety. Firstly, the assessor identifies one or more points of departure (POD) from relevant epidemiological and toxicological studies. PODs include no observed adverse effect levels (NOAELs), low observed adverse effect levels (LOAELs), and lower confidence limits of the benchmark dose (BMDLs) for relevant adverse effects from a relevant study. Secondly, the

assessor estimates an exposure for a specific population – in this case, the estimated exposures for allotment plot holders at the Sandringham Avenue site, as presented in Table 5-2. The ratio of the POD to the estimated exposure level is calculated, with a lower ratio indicating a greater concern for public health. EFSA [24] noted that for a thresholded adverse effect, a margin equal to or greater than 100 for a POD derived from an animal study would not be considered a concern to public health. Margins much lower than 100 may still not represent a concern, if the POD is derived from an epidemiological study or the POD from an animal study is adjusted to take into account some of the interspecies differences. For example, a POD adjusted to a human equivalent dose (HED) from an animal study (a POD-HED), already accounts for some of the toxicokinetic differences between the animal species and humans and therefore margins of exposure equal to or greater than 25 would not be considered a concern to public health. Further information on the basic principles of chemical risk assessment can be found in the Environment Agency report SR2 'Human health toxicological assessment of contaminants in soil' [25].

While there is very little toxicological data on many PFAS, PFOA is one of the most studied with respect to adverse health effects. Authoritative reviews have been published in recent years by:

- Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail (ANSES) [26];
- Agency for Toxic Substances and Disease Registry [12];
- European Food Safety Authority [11,27];
- Food Safety Commission of Japan [28];
- Health Canada [29];
- Food Standards Australia New Zealand [13];
- National Health and Medical Research Council / Australian Drinking Water Guidelines [30];
- Office of Environmental Health Hazard Assessment for State of California [31]; and,
- United States Environmental Protection Agency [14].

POD-HEDs shortlisted as candidates for health-based guidance values by these authoritative organisations were collated from their review documents and are shown in Table 5-7. These were primarily derived using physiologically based pharmacokinetic (PBPK) modelling from a blood concentration of PFOA in animals or humans to an equivalent dietary human intake.

Table 5-7 - Summary Table of POD-HED Identified by Authoritative Organisations with Details Provided on Overall Effect Classification, The Specific Endpoint of Concern From The Study, The Model (Animal or Human), and The Type of POD Reported.

Authoritative Body	End Point	Detail	Study	Model	POD Type	POD-HED (mg/kg bw/d)
Health Canada 2018 [29]	Carcinogenicity	Incidence of Leydig cell tumours	Butenhoff et al. 2012	Rat	NOAEL	7.60E-02[3]
SLR / NHMRC 2024 [30]	Carcinogenicity	Neoplastic: Pancreatic acinar adenomas & adenocarcinomas	NTP (2023)	Rat	$BMDL_{10RD}$	1.90E-03[4]
EFSA 2018 [27]	Cardiovascular Effects	Increased serum total cholesterol	Steenland et al. (2009)	Human	$BMDL_{5}$	8.00E-07
EFSA 2018 [27]	Cardiovascular Effects	Increased serum total cholesterol	Eriksen et al. (2013)	Human	$BMDL_{5}$	8.00E-07
US EPA 2024 [14]	Cardiovascular Effects	Increased serum total cholesterol	Dong et al. (2019)	Human	$BMDL_{5RD}$	2.75E-07
US EPA 2024 [14]	Cardiovascular Effects	Increased serum total cholesterol	Steenland et al. (2009)	Human	$BMDL_{5RD}$	5.10E-07

[3] Health Canada 2018 concluded that tumours were not likely to have been caused by a non-thresholded mechanism. The weight of evidence suggests that PFOA is not genotoxic.
[4] SLR/NHMRC 2024 concluded that tumours were not likely to have been caused by a non-thresholded mechanism. The weight of evidence suggests that PFOA is not genotoxic.

Authoritative Body	End Point	Detail	Study	Model	POD Type	POD-HED (mg/kg bw/d)
ATSDR 2021 [12]	Developmental Effects	Skeletal alterations in adult offspring	Koskela et al. (2016)	Mouse	LOAEL	8.21E-04
ATSDR 2021 [12]	Developmental Effects	Neurodevelopmental effects (increased horizontal and vertical activity and decreased resting activity)	Sobolewski et al. (2014)	Mouse	LOAEL	2.21E-04
ATSDR 2021 [12]	Developmental Effects	Neurodevelopmental effects (decreased number of inactive periods, altered novelty induced activity)	Onishchenko et al. (2011)	Mouse	LOAEL	8.21E-04
ATSDR 2021 [12]	Developmental Effects	Decreased number of successful births	Ngo et al. (2014)	Mouse	NOAEL	2.41E-04
ATSDR 2021 [12]	Developmental Effects	Reduced ossification of proximal phalanges and advanced preputial separation	Lau et al. (2006)	Mouse	LOAEL	3.88E-03
ATSDR 2021 [12]	Developmental Effects	Increased ambulatory activity	Goulding et al. (2017)	Mouse	NOAEL	1.24E-03
ATSDR 2021 [12]	Developmental Effects	Reduced weight gain and delayed eye opening	Wolf et al. (2007)	Mouse	LOAEL	8.40E-03

Authoritative Body	End Point	Detail	Study	Model	POD Type	POD-HED (mg/kg bw/d)
EFSA 2018 [27]	Developmental Effects	Low birth weight	Fei et al. (2007)	Human	$BMDL_5$	1.00E-06
EFSA 2018 [27]	Developmental Effects	Low birth weight	Whitworth et al. (2012)	Human	$BMDL_5$	4.00E-07
Food Safety Commission of Japan 2025 [28]	Developmental Effects	Reduced number of ossification sites in proximal phalanges of forelimbs and hindlimbs of foetuses, acceleration of sexual maturation in male offspring	Lau et al. (2006)	Mouse	LOAEL	5.30E-03
FSANZ 2017 [13]	Developmental Effects	Decreased pup body weight gain	Lau et al. (2006)	Mouse	NOAEL	4.90E-03
SLR / NHMRC 2024 [30]	Developmental Effects	Decreased pre-weaning growth rate in pups	Lau et al. (2006)	Mouse	NOAEL	4.90E-03
SLR / NHMRC 2024 [30]	Developmental Effects	Decreased pup survival	Abbott et al. (2007)	Mouse	NOAEL	2.40E-03
SLR / NHMRC 2024 [30]	Developmental Effects	Decreased pup survival	Song et al. (2018)	Mouse	$BMDL_{0.5SD}$	1.50E-03
US EPA 2024 [14]	Developmental Effects	Low birth weight	Sagiv et al. (2018)	Human	$BMDL_{5RD}$	1.21E-06
US EPA 2024 [14]	Developmental Effects	Low birth weight	Wikström et al. (2020)	Human	$BMDL_{5RD}$	2.92E-07

Authoritative Body	End Point	Detail	Study	Model	POD Type	POD-HED (mg/kg bw/d)
US EPA 2024 [14]	Developmental Effects	Decreased offspring survival	Song et al. (2018)	Mouse	$BMDL_{0.5SD}$	6.40E-04
US EPA 2024 [14]	Developmental Effects	Delayed time to eye opening	Lau et al. (2006)	Mouse	$BMDL_{1SD}$	4.17E-04
FSANZ 2017 [13]	General Effects	Decreased maternal body weight gain	Lau et al. (2006)	Mouse	NOAEL	2.76E-02
FSANZ 2017 [13]	General Effects	Decreased mean body weight	Perkins et al. (2004)	Rat	NOAEL	1.30E-02
ANSES 2017 [26]	Hepatic Effects	Hepatocellular hypertrophy in male animals	Perkins et al. (2004)	Rat	NOAEL	6.25E-04
ATSDR 2021 [12]	Hepatic Effects	Increased severity of chronic inflammation in liver of offspring aged 18 months	Filgo et al. (2015a and 2015b)	Mouse	NOAEL	1.24E-03
ATSDR 2021 [12]	Hepatic Effects	Increased liver weight, hepatocellular hypertrophy, and necrosis	Butenhoff et al. (2004)	Rat	NOAEL	1.35E-02

Authoritative Body	End Point	Detail	Study	Model	POD Type	POD-HED (mg/kg bw/d)
DMOE 2015 [32]	Hepatic Effects	Increased hepatic palmitoyl CoA oxidase activity, increased relative liver weights, and hepatocellular hypertrophy and necrosis of liver cells	Palazzolo (1993)	Rat	LOAEL	4.50E-03
DMOE 2015 [32]	Hepatic Effects	Increased hepatic palmitoyl CoA oxidase activity, increased relative liver weights, and hepatocellular hypertrophy and necrosis of liver cells	Palazzolo (1993)	Rat	$BMDL_{10}$	3.00E-03
EFSA 2018 [27]	Hepatic Effects	Increased serum alanine transferase (ALT)	Gallo et al. (2012)	Human	$BMDL_5$	2.00E-06
FSANZ 2017 [13]	Hepatic Effects	Clinical signs, decreased body weight and hepatic toxicity	Butenhoff et al. (2002)	Monkey	NOAEL	1.40E-02
Health Canada 2018 [29]	Hepatic Effects	Hepatocellular hypertrophy in male animals	Perkins et al. (2004)	Rat	$BMDL_{10}$	5.21E-04
OEHHA 2024 [31]	Hepatic Effects	Increased serum ALT	Gallo et al. (2012)	Human	NOAEC	2.70E-06

Authoritative Body	End Point	Detail	Study	Model	POD Type	POD-HED (mg/kg bw/d)
SLR / NHMRC 2024 [30]	Hepatic Effects	Microscopic anatomic pathological evidence of hepatotoxicity & Leydig cell tumours	Butenhoff et al. (2012)	Rat	$BMDL_{4RD}$	4.75E-03
SLR / NHMRC 2024 [30]	Hepatic Effects	Non-neoplastic: Hepatocellular necrosis	NTP (2023)	Rat	$BMDL_{10RD}$	3.40E-03
US EPA 2024 [14]	Hepatic Effects	Increased serum ALT	Gallo et al. (2012)	Human	$BMDL_{5RD}$	2.15E-06
US EPA 2024 [14]	Hepatic Effects	Increased serum ALT	Darrow et al. (2016)	Human	$BMDL_{5RD}$	7.92E-06
US EPA 2024 [14]	Hepatic Effects	Increased serum ALT	Nian et al. (2019)	Human	$BMDL_{5RD}$	4.51E-07
US EPA 2024 [14]	Hepatic Effects	Necrosis	NTP (2020)	Rat	$BMDL_{10RD}$	3.23E-03
ATSDR 2021 [12]	Immune Effects	Reduced response to dinitrophenyl-ficoll (DNP) antigen	DeWitt et al. (2016)	Mouse	NOAEL	1.21E-03
ATSDR 2021 [12]	Immune Effects	Reduced response to sheep red blood cells (SRBC)	DeWitt et al. (2008)	Mouse	NOAEL	3.32E-03

Authoritative Body	End Point	Detail	Study	Model	POD Type	POD-HED (mg/kg bw/d)
EFSA 2020 [11]	Immune Effects	Decreased serum anti-diphtheria antibody concentration in children	Abrahams et al. (2020)	Human	$BMDL_{10}$	6.30E-07[5]
SLR / NHMRC 2024 [30]	Immune Effects	Decreased IgM response to SRBC	DeWitt et al. (2008)	Mouse	NOAEL	5.40E-03
US EPA 2024 [14]	Immune Effects	Decreased serum anti-tetanus antibody concentration in children	Budtz-Jørgensen and Grandjean (2018)	Human	$BMDL_{05SD}$	3.05E-07
US EPA 2024 [14]	Immune Effects	Decreased serum anti-tetanus antibody concentration in children	Timmerman et al. (2021)	Human	$BMDL_{05SD}$	3.34E-07
US EPA 2024 [14]	Immune Effects	Decreased serum anti-diphtheria antibody concentration in children	Budtz-Jørgensen and Grandjean (2018)	Human	$BMDL_{05SD}$	2.92E-07

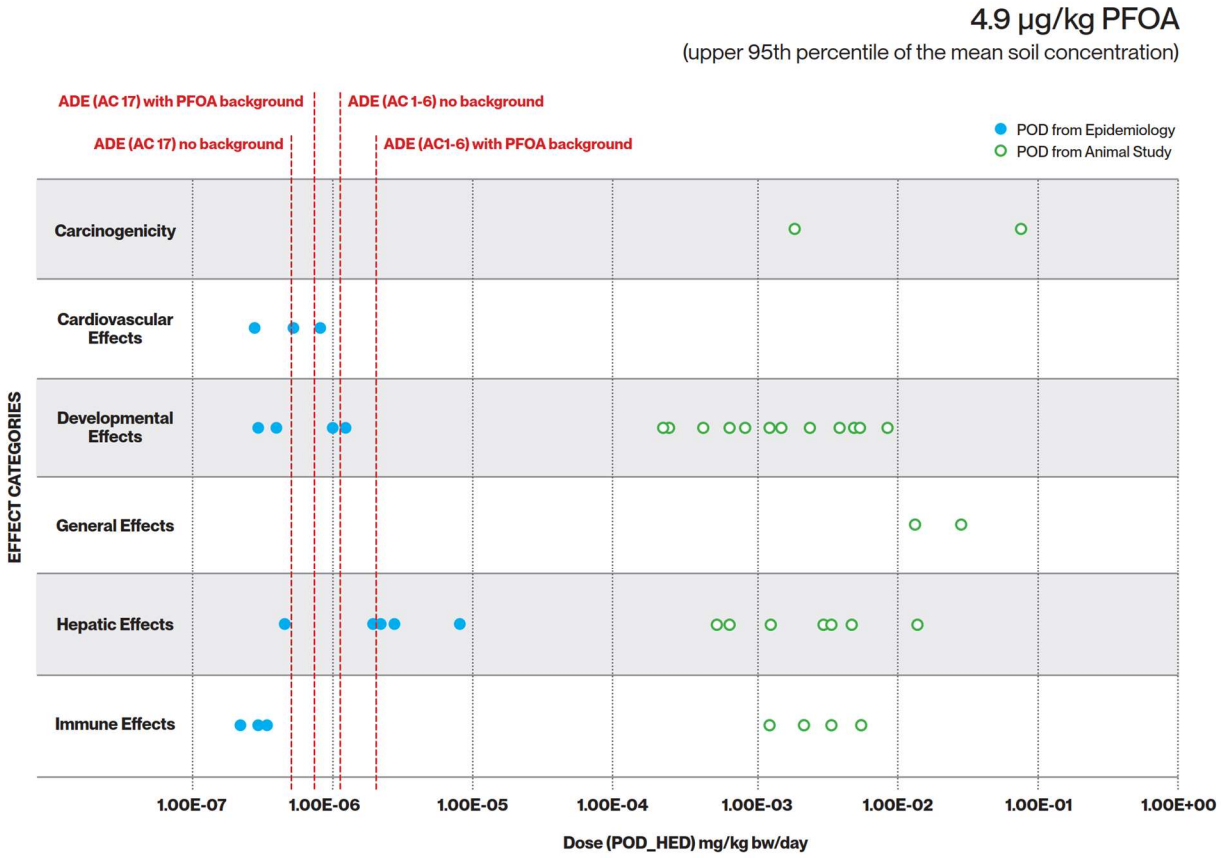
[5] Applies to the sum of exposure to PFOA, PFOS, PFNA, and PFHxS.

Authoritative Body	End Point	Detail	Study	Model	POD Type	POD-HED (mg/kg bw/d)
US EPA 2024 [14]	Immune Effects	Decreased serum anti-diphtheria antibody concentration in children	Timmerman et al. (2021)	Human	$BMDL_{05SD}$	2.20E-07
US EPA 2024 [14]	Immune Effects	Decreased IgM response to SRBC	Dewitt et al. (2008)	Mouse	$BMDL_{1SD}$	2.18E-03

In total, 50 No. POD-HED were identified from authoritative reviews; although, a small number of these values were duplicates for the same endpoint from the same study. The values were grouped into six different effect categories (see the following subsections for a description and discussion of each category).

Figure 5-1 below presents the POD-HED graphically, alongside the estimated soil ADE (no background) and total ADE (from Table 5-2) for both the child (AC 1-6) and adult (AC 17) receptors. It can be seen that these estimates of exposure generally are much lower than the POD-HED derived from animal studies but are within the range of values observed in epidemiological studies. This is the focus of further discussion within this section.

Figure 5-1 - Child (AC 1-6) and Adult (AC 17) ADE Plotted Against POD-HED Data.



In the interpretation of the margins of exposure used in this report, the authors have used the approach described in Table 5-8. As noted in sections 5.3.3.1 to 5.3.3.6, the biological and clinical relevance, and adverse health effects of biomarkers and other endpoints observed in epidemiological studies is not clearly understood and there remain critical differences of opinion and interpretation between authoritative bodies. Therefore, the statement of a possibility of a potential effect adopted in this report applies to a specific study endpoint (such as changes in cholesterol levels) and not necessarily to the occurrence of clinical symptoms of disease.

Table 5-8 - Overview of The Categorisation and Terminology Used For The Margin of Exposure Assessment in this Risk Evaluation.

Margin of Exposure		Category
Animal Studies	Human Studies	
≥ 25	≥ 10	A very low possibility of a potential effect on the endpoint(s) in question
1 – 25	1 – 10	A low to moderate possibility of a potential effect on the endpoint(s) in question
≤ 1	≤ 1	A moderate to high possibility of a potential effect on the endpoint(s) in question

5.3.3.1 Carcinogenicity

PFOA is classified as carcinogenic to humans (Group 1) by the International Agency for Research on Cancer (IARC Monographs Volume 135 [15]). They noted in the Group 1 evaluation that "…*based on the combination of sufficient evidence for cancer in experimental animals and strong mechanistic evidence of key characteristics of carcinogens in exposed humans*."

Several authoritative organisations do not consider PFOA to be a genotoxic carcinogen, and that carcinogenicity has a threshold (EFSA [11,27], NHMRC [30]). The NHMRC reported in 2025 [33] that no evidence for genotoxicity had been identified by the IARC [15] and that evidence from animal studies had not reported genotoxicity at non-cytotoxic concentrations (ATSDR [12]). Although the USEPA [14] have derived cancer slope factors from epidemiological studies that assumed a non-threshold behaviour, the NHMRC [33] noted that the USEPA had acknowledged a lack of information to support a mutagenic mode of action.

Two POD-HED for carcinogenic effects were identified from authoritative reviews. Health Canada [29] reported a NOAEL for the incidence of Leydig tumours and NHRMC [30] reported a $BMDL_{10}$ for the incidence of pancreatic tumours, both in rat studies. The margin of exposure from the lowest of these two POD-HED is 2,703 and 964, for adult and child exposures, respectively, indicating a very low possibility of a potential effect on the incidence of tumours.

5.3.3.2 Cardiovascular Effects

All of the POD-HED chosen by authoritative bodies for cardiovascular effects were derived from epidemiological studies in the adult human population (EFSA [27], USEPA [14]).

The European Food Safety Authority concluded in 2018 [27] that a likely association between blood serum PFOA levels and blood serum cholesterol levels, observed in epidemiological studies, was causal, and that an increase in cholesterol levels was considered adverse. They derived two POD-HED as $BMDL_5$ values, based upon epidemiological studies (Steenland et al. 2009, Eriksen et al. 2013). In their updated Opinion on PFAS in 2020 [11], EFSA revised their view on this endpoint. In the executive summary, they stated that although "… *the association with increased cholesterol was observed in a large number of studies, the CONTAM panel now considers the uncertainty regarding causality to be larger. This is primarily due to a postulated biological process around the enterohepatic cycling of both PFASs and bile acids, the latter affecting serum cholesterol levels. This should be further investigated*."

The USEPA concluded in 2024 [14] that the available evidence indicated that PFOA exposure is likely to cause cardiovascular effects in humans, given sufficient exposure conditions (e.g., at measured levels in humans as low as 1.1 to 5.2 ng/mL, and at administered doses in animals as low as 0.3 to 1.0 mg/kg/day). They proposed that the primary evidence supporting cardiovascular effects was increased blood serum lipid levels in humans and alterations to lipid homeostasis in animals. POD-HED as $BMDL_5$ values were proposed as candidates for the derivation of a health-based guidance value from two medium confidence epidemiological studies (Steenland et al. 2009, Dong et al. 2019). The USEPA [14] commented that even a small increase in serum cholesterol was clinically relevant when extrapolated to the overall population, because this could "… *shift the distribution of serum cholesterol in the overall population relative to the clinical cut-off, leading to an increased number of individuals at risk for cardiovascular disease*."

The SLR addendum to the NHMRC review [30] identified significant limitations in the epidemiological study by Dong et al. 2019 (as cited by the USEPA [14]) and did not recommend using the POD-HED determined by the USEPA [14] as a basis for the Australian drinking water guideline. The SLR addendum to the NHMRC review [30] noted that the clinical significance of the findings by Dong et al. 2019 were unclear.

The margin of exposure from these four POD-HED ($BMDL_5$ values) range from 0.4 to 1.1 for adult exposure, and from 0.1 to 0.4 for child exposure. This suggests a moderate to high possibility of a potential effect on cholesterol levels for children. For the adults, two of the four POD-HEDs also suggests a moderate to high possibility, with the remaining two showing a low to moderate possibility of a potential effect on cholesterol. However, there is considerable uncertainty amongst authoritative bodies on the clinical relevance and significance of this endpoint. The four POD-HED were derived from studies of the general adult population and therefore may not have accounted for susceptibility in children.

5.3.3.3 Developmental Effects

A total of 14 No. POD-HED based on developmental effect endpoints in mice studies were identified by authoritative bodies with seven proposed by ATSDR [12]. A range of specific endpoints were identified including skeletal alterations, reduced ossification of proximal phalanges and advanced preputial separation, neurodevelopmental effects, decreased pup growth rates, and decreased pup survival rates. Four POD-HED were also proposed by authoritative bodies for developmental effects derived from epidemiological studies (EFSA [27], USEPA [14]). The critical effect was considered in all cases to be low birth weight.

In all cases, the margin of exposure from POD-HED derived from animal studies were much greater than 25. This indicates a low possibility of a potential impact for the different endpoints, and no detailed discussion of the animal studies is required.

In 2018, EFSA [27] reviewed 13 No. prospective and four cross-sectional epidemiological studies that examined associations between PFOA and/or PFOS and birth weight. Relatively modest but consistent inverse associations with birth weight were observed for both compounds, although this may have been partly confounded by physiological changes in pregnancy (Committee on Toxicity Statement, 2022 [34]). In 2020, EFSA [11], after review of eight additional studies, concluded that "*there may well be a causal association between PFOS and PFOA [exposure] and birth weight*." EFSA [27] proposed two POD-HED based on the $BMDL_5$ values from two studies (Fei et al. 2007, Whitworth et al. 2012). Fei et al. (2007) reported a significant inverse association between maternal

blood serum concentrations (n = 1,400) of PFOA (mean 5.6 ng/mL) and birth weight with a modest reduction of 5 g in birth weight per 1 ng/mL increase in maternal concentrations (corresponding to around 50–60 g reduction in birth weight over the effective exposure range). Whitworth et al. (2012) reported a borderline significant inverse association between maternal concentrations of PFOA (median 2.2 ng/mL, n = 901) of 106 g comparing the highest to lowest quartile of exposure. EFSA [27] concluded that the "… *biological relevance of an inverse association with birth weight on its own was unclear. Whether a modest reduction in birth weight was an indication of some adverse events that will become apparent later cannot, however, be excluded. Overall, despite relatively consistent inverse associations being observed, some uncertainty about the causality of these findings remains*." EFSA [11] reinforced this view by observing that "… *the decrease in birth weight after adjusting for confounders is not large and the potential longer term consequences of this decrease are unclear*."

The USEPA [14] concluded that for developmental effects, the primary evidence was decreased birth weight in human infants and decreased offspring survival, decreased fetal and pup weight, delayed time to eye opening, and related pre- and postnatal effects in animal studies. The USEPA [14] noted that decreases in birth weight "… *even at smaller magnitudes at the individual level, are clinically relevant when extrapolated to the overall population. This is because, at the population level, even small magnitude decreases in birthweight could shift the distribution of birthweight in the overall population relative to the clinical cut-off, leading to an increased number of individuals at risk for decreased birthweight and subsequent effects related to decreased birthweight*." They derived $BMDL_5$ values for decreases in body weight observed in two epidemiological studies with cohorts of mothers and infants (Sagiv et al. 2018, Wikstrom et al. 2020). A BMR of 5% was selected because decreased birth weight was considered a sensitive developmental effect. The SLR addendum to the NHMRC review [30] commented that there was no statistically significant difference between birth weight and PFOA in the Sagiv et al. 2018 study, after correction for confounders. In the case of Wikstrom et al. 2020, the SLR addendum to the NHMRC review [30] acknowledged that low PFOA doses appeared to be associated with decreased birth weight, but they concluded that the data on dose response was not considered sufficiently reliable for use as a key study for derivation of the Australian drinking water guideline.

Given this endpoint is based on maternal blood serum concentrations, the exposure estimates for adults (females of childbearing age) are considered more relevant for any margin of exposure assessment. The margins of exposure calculated from these four POD-HED ($BMDL_5$ values) range from 0.4 to 1.7. This suggests, for two of these four POD-HEDs, there is a moderate to high possibility of a potential effect on birth weight, although there is considerable uncertainty amongst authoritative bodies on the clinical relevance and significance of this endpoint. For the remaining two POD-HEDs, there is a low to moderate possibility of a potential effect on birth weight.

5.3.3.4 General Effects

Two POD-HED were derived from animal studies for decreases in mean body weight (Lau et al. 2006, Perkins et al. 2004). The margin of exposure from the lowest of these two POD-HED is 18,492 for an adult and 6,599 for a child, indicating a very low possibility of a potential effect on body weight. There are no further considerations.

5.3.3.5 Hepatic Effects

In experimental studies, the liver was the target organ in rodents (EFSA [27]). Ten POD-HED based on hepatic effect endpoints in rodent studies were identified by authoritative bodies with specific endpoints including hepatocellular hypertrophy and necrosis, liver inflammation, and increases in liver weight. The lowest POD-HED values were from a study by Perkins et al. 2004, which were used by Health Canada [29] and ANSES [26] in the derivation of health-based guidance values. The margin of exposure from the lowest of these two POD-HED is 741 and 264, for adult and child exposures, respectively. This indicates a very low possibility of a potential impact for the different endpoints.

Five POD-HED were derived from epidemiological studies by three different authoritative organisations (EFSA [27], OEHAA [31] and USEPA [14]). The specific endpoint identified in all derivations was increased blood serum levels of alanine transferase (ALT).

EFSA [27] noted that epidemiological studies provided support for a causal association between exposure to PFOA and increased serum levels of the liver enzyme ALT. However, on further review, EFSA [11] commented that the "… *magnitude of the associations was small (~ 3%), however, and few studies found associations with ALT outside the reference range, and there were no associations with liver disease*." EFSA [27] proposed a POD-HED based on a $BMDL_5$ value from the study by Gallo et al. 2012, who investigated associations between PFOA and biomarkers of liver function in a cross-sectional study of 47,000 adults. The study adjusted for common causes of elevated liver enzymes such as ALT including obesity (BMI) and high alcohol consumption.

OEHHA [31] commented that the current epidemiological literature provided consistent evidence that PFOA can cause hepatotoxicity in humans, and in particular, increases in liver enzyme levels. However, they also noted that consistent evidence for overt liver diseases had not been seen. OEHHA [31] proposed a POD-HED derived from a NOAEL value from the study by Gallo et al. 2012. They described this endpoint as representative of an increased risk of liver toxicity, as indicated by elevated ALT levels that exceeded clinically based reference levels used by the International Federation of Clinical Chemistry and Laboratory Medicine. OEHHA [31] also noted that "… *These fairly small effect sizes raise concerns that they may be due to relatively small amounts of residual confounding or bias. Importantly though, the fact that associations were seen across a number of different study populations and the fact that results changed only slightly after adjustments for potential confounders in several studies are evidence that this is not the case*." In terms of the significance of the effect, OEHHA [31] concluded that the "… *relatively small effect sizes reported in most of the studies of PFOA and liver enzymes might also raise concerns about their clinical relevance. These effect sizes are generally lower than what might be seen with overt hepatitis or other severe liver disease. Regardless, as shown for lead and other prevalent exposures, small effect sizes like this, which might have only minor or unnoticeable effects in an otherwise healthy individual, can have very important impacts on a population basis or in particularly susceptible people especially for very common exposures like PFOA. A good example of this has been shown for thyroid hormones, and the same principles apply to hepatotoxicity*."

The USEPA [14] concluded that there was "… *moderate evidence for an association between PFOA exposure and hepatic effects in humans based on associations with liver biomarkers, especially ALT, in several medium confidence studies*." They proposed three POD-HED derived from $BMDL_5$ values from three medium confidence epidemiological studies (Gallo et al. 2012, Darrow et al. 2016, Nian et al. 2019). The two largest studies of PFOA and ALT in adults (Gallo et al. 2012 and Darrow

et al. 2016) were both conducted in over 30,000 adults. The third study by Nian et al. 2019 examined a large population of adults in Shenyang (one of the largest fluoropolymer manufacturing centres in China). The USEPA [14] concluded that the POD-HED based on Gallo et al. 2012 was the preferred candidate value for derivation of a health-based guidance value because (a) unlike Nian et al. 2019, the predominant exposure was from PFOA and not PFOS and (b) unlike Darrow et al. 2016, the serum ALT levels were measured and not modelled. The SLR addendum to the NHMRC review [30] reviewed the three studies selected by USEPA [14] and concluded that the dose response data from these studies were not considered sufficiently reliable for use as a key study for derivation of the Australian drinking water guideline.

The margin of exposure from these five POD-HED (four $BMDL_5$ values and a NOAEL value) range from 0.6 to 11.3 and from 0.2 to 4.0 for adult and child exposures, respectively. This suggests, for four of the five of these POD-HEDs, a low to moderate possibility of a potential effect on serum ALT levels, although there is considerable uncertainty amongst authoritative bodies on the clinical relevance and significance of this endpoint. For the remaining POD-HED, there is a moderate to high possibility of a potential effect on serum ALT levels.

5.3.3.6 Immune System Effects

In animal studies, PFOA has been shown to cause a reduced response to vaccination (T-cell-dependent antibody response) (EFSA [11]). Four POD-HED based on immune system effects in mice studies were identified by authoritative bodies with specific endpoints including reduced response to dinitrophenyl-ficoll (DNP) antigen and reduced response to sheep red blood cells (SRBC). The margin of exposure from the lowest of these POD-HED is 1,721 and 614, for adult and child exposures, respectively. This indicates a very low possibility of a concern.

EFSA [11] considered the findings of a decreased immune response to be robust, since they were consistently observed for PFOA in rodents and in humans. They derived a POD-HED for the combined effect of PFOS, PFOA, PFNA, and PFHxS from a derived $BMDL_{10}$ for decreased serum anti-diphtheria antibody concentration in predominantly breastfed children (around one year old) from an epidemiological study by Abrahams et al. 2021. Using a PBPK model, and assuming 12 months of breastfeeding, EFSA [11] estimated that the $BMDL_{10}$ in infants corresponded to a dietary intake by the mother of 0.63 ng/kg bw per day for the sum of four PFAS. Although they noted that a decreased vaccination response was considered a risk factor for disease rather than a disease, EFSA [11] concluded that when antibody titres were diminished, the level of protection from vaccines might be compromised. In their 2022 statement [34], COT commented that it was not clear what decrease in antibody levels might cause such an effect, and that there were natural fluctuations in vaccine titres over time.

The COT [34] agreed that on the basis of the information reviewed by EFSA [11], qualitatively the appropriate endpoint had been identified, but quantitatively, they questioned the calculations. COT noted that overall "*there were some reservations about the choice of the critical study (Abraham et al. 2020) and the specific effect selected. However, the COT agreed that the critical study was the best available. It was not unreasonable that this study was selected, and in the absence of more appropriate studies, its use was understandable*." They had "… *significant reservations about the model used, including the BMD [benchmark dose] approach, and the TWI [tolerable weekly intake] which had been established, due to the uncertainties and the caveats involved*."

The USEPA [14] observed that the primary evidence for immunotoxicity was developmental immunosuppression in humans, specifically decreased antibody response to vaccination against tetanus and diphtheria in children, and evidence of immunosuppression and other types of immunotoxicity in studies of adult animals, including decreased IgM response to sheep red blood cells (SBRC), reduced spleen and thymus weights, changes in immune cell populations, and decreased splenic and thymic cellularity. They derived four POD-HED from $BMDL_{0.5SD}$ values for decreased serum anti-diphtheria and anti-tetanus antibody concentrations from two medium confidence epidemiological studies (Budtz-Jørgensen and Grandjean 2018, Timmermann et al. 2021). However, ultimately the USEPA [14] concluded that the response observed in 7-year-old Faroese children in a cohort study (Budtz-Jørgensen and Grandjean 2018) was more robust than that reported by the cross-sectional study by Timmermann et al. 2021. They also noted that "*no biological rationale has been identified as to whether one particular time period or duration of exposure or outcome measurement is more sensitive to an overall immune response to PFOA exposure*."

The USEPA [14] used a novel PBPK model to convert an internal dose metric (serum concentration) to an external exposure. They concluded that this approach "… *explicitly models PFOA exposure to infants during nursing who are undergoing rapid development, including growth, through childhood and who do not reach steady state until near adulthood. This allows for a more accurate estimation of exposures associated with either serum levels in children or dose metric from developmental animal toxicological studies*."

The SLR addendum to the NHMRC review [30] reviewed the Timmermann et al. 2021 study selected by the USEPA [14] and reported a number of potential confounders not accounted for in the epidemiological study, including the presence of other chemicals and the time to last vaccination. They also found it difficult to reconcile the large difference between markers of immunosuppression in mice studies (for example, mean PFOA levels of ~73,100 ng/mL, with no effects at 45,300 ng/mL) with the human serum PFOA concentrations in Timmermann et al. 2021 for which statistical associations were found with antibody concentrations (that is, a median of 2.28 ng/mL for PFOA). The SLR addendum to the NHMRC review [30] concluded that this "… *indicates there is still marked uncertainty in terms of the appropriateness of using epidemiological data to define the threshold and dose response of effects potentially caused by PFOS and PFOA exposure*." The SLR addendum to the NHMRC review [30] concluded that the dose response data from these studies were not considered sufficiently reliable for use as a key study for derivation of the Australian drinking water guideline.

A margin of exposure was not determined for the EFSA [11] POD-HED because of the complexity in interpreting the results from PFOA alone. The margin of exposure for the four POD-HED for PFOA ($BMDL_{0.5SD}$) derived by the USEPA [30] ranged from 0.3 to 0.5 and from 0.11 to 0.17 for adult and child exposures, respectively. In respect of the Budtz-Jørgensen and Grandjean 2018 study, the margins were 0.4 for adult exposures and from 0.11 to 0.17 for child exposures. This suggests a moderate to high possibility of a potential effect on antibody titres in response to vaccination, although there is considerable uncertainty amongst authoritative bodies on the clinical relevance and significance of this endpoint. It is unclear to what extent the concerns raised by the COT [34] about the derivation of the POD-HED by EFSA [11] are also applicable to the derivations by the USEPA [14]. However, the COT statement [34] suggests that their reservations concerning this endpoint are applicable here.

5.3.3.7 Summary of Consideration of Health Impacts

A wide range of potential hazards to human health from long-term exposure to PFOA have been identified by authoritative bodies. A margin of exposure approach, comparing estimated soil exposures for adults and children from the Sandringham Avenue site with POD-HED values for a range of different effects reported in animal and epidemiological studies, has been undertaken.

In order to conclude that land is Contaminated Land for the purpose of the Part 2A regime, the regulator must consider whether there is a **significant** possibility of **significant** harm to human health (SPOSH), based on the available evidence and taking into account the uncertainty. Within the review above, the likelihood of exposure and the significance of the potential effects identified have been considered separately, and the results are summarised below.

In total, 50 POD-HED were identified from authoritative organisations, although a small number of values were duplicates for the same endpoint from the same study. These values were grouped into six different effects categories (see Figure 5-1).

Across all six effect categories, the margin of exposure for POD-HED from animal studies were considered to present a very low possibility of a potential effect for a wide range of study endpoints. Categories that included only POD-HED values from animal studies (that is, carcinogenicity and general toxicity effects) are not considered to meet SPOSH on the basis of the evidence presented.

Margins of exposure for POD-HED values from epidemiological studies were much lower, sometimes less than one. On this basis alone, it is considered that for most study endpoints, there is a moderate to high possibility of potential effects across the four categories (cardiovascular effects, developmental effects, hepatic effects, and immune effects). However, while this addresses the question of a significant possibility of an effect, a further question needs to be asked about whether the markers and endpoints seen in the epidemiology studies constitute significant harm. In all cases, there are differences of opinion between authoritative organisations as to the significance of the endpoints reported in epidemiological studies in terms of biological and clinical relevance and adverse effect on health.

The lowest POD-HED values have been derived from vaccine response data. Whilst the USEPA [14] and EFSA [11] consider these endpoints to be relevant to public health, other authorities such as the NHMRC [30] and the Food Safety Commission of Japan [28] have considered the uncertainties to be too large, and they have subsequently recommended guidelines based upon animal data. In their 2022 statement, the COT [34] did not object to the choice of endpoint but expressed concerns about how the POD-HED used by EFSA [11] had been derived. Although the COT has not yet reviewed the approach taken by the USEPA (2024, [14]), their statement [34] suggests that there would still be reservations regarding the biological significance of this endpoint. There is therefore considerable uncertainty as to whether the endpoints selected from epidemiological studies constitute appropriate markers for significant harm.

The outcome of this assessment is that for four categories (cardiovascular effects, developmental effects, hepatic effects, and immune effects), there is considered to be a significant possibility of potential effects on various epidemiological markers including cholesterol levels, birth weight, serum ALT levels, and antibody titres in response to vaccination. The question of SPOSH requires the regulator to take either a precautionary view of the evidence or to seek additional technical advice on interpretation of the evidence from a relevant authoritative body.

5.3.4 OTHER CONSIDERATIONS

The purpose of this section of the report is to summarise evidence from other locations where land has been contaminated with PFOA internationally, the soil and produce levels observed, and the views / actions taken subsequently by regulators. In addition, it considers situations where environmental contamination with PFOA (not necessarily of soil) has resulted in measured or estimated exposures to the general public, and the view taken by regulatory authorities in a broader context.

This information helps to contextualise the findings reported here for the Sandringham Avenue site and can be used as supporting information in decision-making. This is consistent with advice in paragraphs 4.19 (a) and (b), and 4.21 (d) of the Statutory Guidance [4].

5.3.4.1 Similar Experiences of Land Contamination with PFOA

As part of the current Part 2A inspection, investigation and assessment has been undertaken at Occupation Road allotments, which is located closer to the AGCCE Ltd facility than Sandringham Avenue allotments. In addition, two relevant examples were identified in the published literature: the DuPont / Chemours site in Dordrecht, the Netherlands and the DuPont Washington Works, Parkersburg, West Virginia, the USA. These similar case studies are discussed below.

Occupation Road allotments, Thornton-Cleveleys

The Occupation Road allotments border the AGCCE Ltd facility, and are located approximately 630m to the north east of the Sandringham Avenue allotments [49]. The site has been subject to investigation as part of both Track 1 and Track 2 investigation works, with soil and locally grown produce being tested from the site.

The shallow soil results have identified a mean sub-surface soil PFOA concentration at the Occupation Road allotments of 6.7 µg/kg DW, which 1.5x higher than the mean soil PFOA concentration at the Sandringham Avenue allotments of 4.4 µg/kg DW [50].

Deposition from legacy aerial emissions, associated with historical activities undertaken at the AGCCE Ltd facility (formerly operated by ICI Ltd), have likely resulted in the elevated PFOA concentrations present in the soil profile at both sites. The marginally higher reported PFOA concentrations at the Occupation Road site are to be expected, due to the proximity of the allotments to the AGCCE Ltd facility, and are in line with the predictions of the modelling and dispersion assessment undertaken by the Environment Agency [8].

The Occupation Road allotments assessment used a margin of exposure approach, comparing soil exposures to POD-HED values for various reported effects. Four categories, cardiovascular, developmental, hepatic, and immune effects, were identified as potentially significant, affecting markers like cholesterol, birth weight, serum ALT, and antibody titres. Table 5-9 illustrates that margins of exposure for POD-HED values for these categories are similar between Sandringham Avenue and Occupation Road allotments, although the former are slightly higher (reflecting the lower mean soil concentration).

Table 5-9 – Comparison of Margins of Exposure for POD-HED values for Sandringham Avenue and Occupation Road Allotments.

Effect Category	MoE – Child		MoE – Adult	
	Sandringham Avenue	Occupation Road	Sandringham Avenue	Occupation Road
Cardiovascular Effects (epidemiology)	0.1 – 0.4	0.1 – 0.3	0.4 – 1.1	0.3 – 0.9
Developmental Effects (epidemiology)	0.1 – 0.6	0.1 – 0.5	0.4 – 1.7	0.3 – 1.3
Hepatic Effects (epidemiology)	0.2 – 4.0	0.2 – 3.3	0.6 – 11.3	0.5 – 8.6
Immune Effects (epidemiology)	0.11 – 0.17	0.09 – 0.14	0.3 – 0.5	0.2 – 0.7

Twenty-five produce samples were collected from six accessible plots at the Occupation Road allotments, and analysed on a fresh weight (FW) basis [49]. PFOA was detected above the method detection limit in 24 of 25 No. samples, with concentrations ranging from 0.0135 to 2.11 µg/kg FW. The highest concentrations were observed in beetroot (up to 2.11 µg/kg FW), chard (1.5 µg/kg FW), cavolo nero (1.07 µg/kg FW) and green cabbage leaves (1.04 µg/kg FW) [49].

As part of the Occupation Road allotments investigation, paired sampling of produce and corresponding root-zone soils enabled calculation of soil-to-plant CFs for key produce groups [49]. The geometric mean CFs derived from site data were within an order of magnitude of the default values used in the CLEA-based interim C4SL derivation, supporting an active and plausible plant uptake pathway and indicating that generic uptake assumptions are not obviously inconsistent with the observed scenario at the Occupation Road allotments [50].

The Occupation Road site produce dataset was compared with EFSA's collated data for the 'vegetables and vegetable products' category [50]. The mean PFOA concentration across the Occupation Road samples (0.431 µg/kg FW) exceeded EFSA's reported upper-bound mean (0.160 µg/kg FW) by more than a factor of two (2.7x), and the site median (0.166 µg/kg FW) was also slightly higher than EFSA's upper-bound mean. This indicates the site produce concentrations were elevated relative to typical EU survey data [50].

The FSA reviewed the produce dataset and, while noting the limited number of samples and the likelihood that some root vegetables retained residual soil, concluded that PFOA concentrations in both green and root vegetables were elevated relative to expected background levels. In the absence of UK health screening values for produce, reliance was placed on EU thresholds – specifically the EFSA TWI values. The TWI is the maximum intake of substances in food that can be consumed weekly over a lifetime without risking adverse health effects (noting the uncertainty with regard the derivation of the TWI and ongoing research). On an indicative basis, the FSA advised that regular consumers eating substantial quantities of these vegetables could exceed the EFSA TWI by approximately 3–4 times, increasing to 7–8 times when typical background dietary exposure

is included [50]. The FSA further noted that adverse effects from the estimated exposures were possible; however, they emphasised that more definitive conclusions could not be reached until the COT completes its ongoing evaluation of PFAS.

Based on the above findings, in 2026 WSP recommended to Wyre Council that there was sufficient evidence to justify taking regulatory action on a precautionary basis and placing the Occupation Road site into **Category 2: Human Health**. The site was also considered to meet the conditions for a significant contaminant linkage - **a significant possibility of significant harm to produce grown domestically**.

DuPont / Chemours fluoropolymers factory in Dordrecht, The Netherlands

At the DuPont / Chemours fluoropolymers factory in Dordrecht, The Netherlands, PFOA was used as a dispersant in the polymer preparation of Teflon and other fluoropolymer products [35]. Atmospheric emissions of PFOA occurred from 1970 to 2012, and land investigations confirmed in 2000 that PFOA had been deposited over a 50 km radius from the factory [35]. Residential properties were located in close proximity to the factory, within both the Dordrecht and Sliedrecht areas.

The National Institute for Public Health and the Environment (RIVM) has conducted research into possible health risks for the local residents as a result of this long-term exposure. An assessment reported in 2016 [36] comprised the estimation of exposure from air, drinking water and food around the factory, on the basis of emission data only. This assessment did not account for the consumption of homegrown fruit and vegetables. Nevertheless, RIVM concluded that in the past, long-term exceedances of the health-based limit value for PFOA in blood serum of 89 ng/mL[6] probably occurred, leading to possible adverse effects on the liver.

In 2018, RIVM undertook an assessment to characterise PFOA (and GenX) concentrations in vegetable crops grown in the area surrounding the Dordrecht factory (reported in 2021) [37]. RIVM reported sum concentrations of GenX and PFOA in a range of produce types, expressed as PFOA equivalent concentrations[7]. Concentrations ranged from 0.07 to 2.65 µg/kg FW. Their initial conclusions were that vegetable garden crops grown within 1 km of the factory could be consumed, though not too often, and not in large quantities. Similar precautionary behavioural advice had previously been issued by Wyre Council for the Sandringham Avenue allotments. Wyre Council are now in the process of closing the allotments[8].

Following the publication of the revised (stricter) tolerable weekly intake by EFSA in 2020 [11], RIVM updated their assessment, using the original produce data collected in 2017; and as a result, advised local residents not to eat homegrown produce grown within 1 km of the Dordrecht factory.

[6] The blood serum concentration of 89 ng/mL was selected by RIVM in 2016 as a health-based limit value for long term exposure to PFOA. As a comparison, albeit for a different endpoint (immunotoxicity and not hepatic) the EFSA TWI is based upon a blood serum concentration of 17.5 ng/mL, based upon the sum of PFOS, PFOA, PFNA and PFHxS.
[7] The relative potency factors used by RIVM [10] are 0.06 for GenX and 1 for PFOA.
[8] https://www.bbc.co.uk/news/articles/c5y4909np13o accessed on 14.05.2026

DuPont Washington Works, Parkersburg, WV. USA

The DuPont Washington Works, located approximately 10 miles south-west of Parkersburg, WV, is a well-known case study, following its depiction in the 2019 motion picture 'Dark Waters'. Established in the 1940s, the site used APFO as a surfactant in some of its fluoropolymer production processes between 1951 and 2003.

Releases of APFO to the atmosphere and the subsequent deposition to soil, in addition to releases to surface water, were the principal sources of the detected PFOA within local drinking water supplies (Paustenbach et al., 2007 [38]). The highest off-site PFOA impacts were predicted around 1 mile from the facility, where representative surface soil concentrations of PFOA were estimated to be 11 µg/kg (moderately elevated compared to mean soil PFOA concentrations at the Sandringham Avenue site of 4.4 µg/kg DW).

In August 2001, a class action lawsuit was filed against DuPont on behalf of approximately 70,000 people in West Virginia and Ohio, due to PFOA-contaminated drinking water supplies linked to the Washington Works.

Between 2005 and 2013, an independent scientific panel (the C8 Science Panel) carried out exposure and health studies on the residents of the Mid-Ohio Valley communities potentially affected by the PFOA emissions from the Washington Works plant [39]. The panel then assessed the links between PFOA exposure and a number of diseases, and concluded that there was a probable link between PFOA exposure and the following health effects:

- Diagnosed high cholesterol;
- Ulcerative colitis;
- Thyroid disease;
- Testicular cancer;
- Kidney cancer; and,
- Pregnancy-induced hypertension.

With regards to the DuPont Washington Works, modelled PFOA concentrations within off-site drinking water (1951 to 2003) are 4 µg/l [38]. Assuming a 70 kg adult drinks 2 litres of water per day, this results in a daily exposure of 1.1E-04 mg/kg body weight/day PFOA. Calculated soil exposures for an adult receptor at the Sandringham Avenue allotments, as discussed in Section 5.3.2, range from 5.1E-07 to 6.1-07 mg/kg bw/d PFOA. Estimated exposures from this case study are therefore considered to be orders of magnitude higher than those predicted from the Sandringham Avenue site.

5.3.4.2 Similar Experiences of Environmental Pollution with PFOA

Three potentially relevant examples were identified in the literature. Studies of water pollution in Jersey [40,47] and the Veneto region in Italy [41,42,43], and a study of contaminated composts and sludges applied to agricultural fields in Germany [44,45,46]. However, sufficient data for a comparison with the Sandringham Avenue site was not available for any of the three case studies.

5.3.4.3 Other Significant Sources of Exposure to PFOA

The major source of exposure to PFOA in the general UK population is through the diet including foodstuffs (79.7%) and drinking water (20.3%) (CL:AIRE [10]). In their 2020 report, EFSA [11] collated data on the concentrations of PFAS including PFOA in a wide range of foodstuffs; although, most of the data was provided by Norway, France, and Germany.

The mean daily intake (MDI) used in the derivation of the interim C4SL for PFOA [10] is 0.0128 µg/d. The drinking water intake is based upon the reported lower bound PFOA concentration in drinking water in Europe of 0.0013 µg/l [10]. Drinking water data for the Thornton area, as provided by United Utilities (2023 – 2025 period) has been reviewed, and the lower bound PFOA concentration is 0.002 µg/l. The United Utilities data has been used in the derivation of PFOA ADE values for child and adult receptors (as summarised within Appendix C), resulting in a revised oral MDI or 0.0142 µg/d. Using this site specific drinking water data results in revised contributions to PFOA exposure in the Thornton area of 71.8% for foodstuffs and 28.2% for drinking water.

In their 2022 statement, the COT [34] commented that UK specific data for the sum of the four PFAS included in the tolerable weekly intake (that is, PFOA, PFOS, PFNA, and PFHxS) were within and towards the lower end of the range of data reported by EFSA.

5.3.4.4 Comparison of Dietary Exposure with Estimates of Site Exposure

EFSA [11] undertook an exposure assessment for PFAS in the diet using produce data collected by 19 No. European countries including the UK. For PFOA, the survey highlighted that fish, egg and egg products, livestock meat, drinking water, fruit and fruit products, vegetables and vegetable products contained relatively high levels, considering their significant contribution to the diet. Overall, EFSA [11] noted that left-censored data (that is, levels below the LOQ for the test method) was above 90% for all PFAS with the exception of PFOS, and that as a result, the "… *chronic dietary survey cannot be performed accurately*."

As noted in sub-section 5.3.4.3, EFSA [11] calculated a lower and an upper bound mean for dietary exposure across various age categories. Exposure is likely to be underestimated with the lower bound approach and overestimated with the upper bound approach. EFSA [11] concluded that these values prove only a "*rough indication*" and that interpretation of these exposures should be approached with caution. CL:AIRE [10] commented that EFSA considered the lower bound estimates to be more realistic.

Table 5-10 summarises the lower bound mean dietary intakes of PFOA according to different age groups as presented by EFSA [11] in Tables 6, 7, 8, and 10 of the main report. Estimated site only exposures for an adult and a child (see Table 5-2) from the Sandringham Avenue site are three times higher than the median lower bound mean dietary intakes estimated by EFSA for an adult and toddler. Although part of the difference may be explained by differences in the assumed consumption patterns between an allotment holder (modelled at a higher rate) and the general population, exposure from the site is still considered to be moderately elevated compared to dietary data.

Table 5-10 - Comparison of The Estimated Intakes for PFOA From Dietary Sources Against Estimates of Exposure From The Site Only*

Receptor Group	Lower Bound Mean (mg/kg body weight/day)			Site Exposures from Soil (mg/kg body weight/day)
	Minimum	Median	Maximum	
Infants	1.1E-07	1.9E-07	3.9E-07	1.10E-06
Toddlers	2.5E-07	4.1E-07	5.9E-07	

Receptor Group	Lower Bound Mean (mg/kg body weight/day)			Site Exposures from Soil (mg/kg body weight/day)
	Minimum	Median	Maximum	
Other Children	1.6E-07	3.0E-07	6.3E-07	
Adults	1.3E-07	1.8E-07	2.8E-07	4.85E-07

**Comparison of the estimated lower bound mean dietary intakes for PFOA from dietary sources as presented in Tables 6, 7, 8, and 10 of EFSA (2020 [11]) for infants (<1 year), toddlers (1-3 years), other children (3-10 years), and adults (18-65 years). They are compared with the estimates of exposure from the site only for a child and adult from the Sandringham Avenue allotments as presented in Table 5-2. All exposure data is presented in mg/kg body weight/day.*

The COT [34] reviewed other sources of exposure including drinking water, dust and soil, and indoor air, but some of the data was presented for total PFAS only (the sum of PFOS, PFOA, PFNA, and PFHxS). Nonetheless, the Sandringham Avenue site exposures to PFOA only, as presented in Table 5-2, were higher when compared with these intakes. For example, chronic mean exposures from drinking water, assuming a reasonably conservative PFAS concentration of 0.01 µg/l, were estimated to be 2.5E-07 and 8.1E-08 mg/kg body weight/day for toddlers and older adults (aged >65), respectively. Estimated Sandringham Avenue site exposures are between a factor of 4 and 6 higher than these estimates for PFOA alone. Exposures to PFOA in indoor dust were estimated by the COT [34] to be 3.7E-07 and 2.1E-09 mg/kg body weight/day for infants and adults (aged up to 65), respectively. Estimated Sandringham Avenue site exposures were higher for infants (by a factor of 3) and for adults (by a factor of more than 100), compared to exposures from indoor dust.

5.4 SUMMARY AND INITIAL RECOMMENDATIONS

5.4.1 SUMMARY

A risk evaluation for the Sandringham Avenue site has been completed in accordance with LCRM [5] and the Statutory Guidance [4]. The risk evaluation serves to inform the potential determination of whether SCLs to human health exist at the site, as defined under Part 2A of the Environmental Protection Act 1990 [1].

In order to consider whether the land at Sandringham Avenue is in Category 2 or Category 3 of the Statutory Guidance [4], it is important to compare the available evidence here with that previously considered at Occupation Road. The Occupation Road allotments border the AGCCE Ltd facility and are located approximately 630m to the north east of the Sandringham Avenue allotments. Both sites share the same conceptual exposure model and reported PFOA concentrations in soils at both sites are elevated compared to the interim C4SL for PFOA. In their 2026 assessment [50], WSP recommended to Wyre Council that there was sufficient evidence to justify taking regulatory action on a precautionary basis and placing the Occupation Road site into **Category 2: Human Health**. The site was also considered to meet the conditions for a significant contaminant linkage - **a significant possibility of significant harm to produce grown domestically**.

- The mean sub-surface soil PFOA concentration at the Occupation Road allotments (6.7 µg/kg DW) is 1.5x higher than the mean soil PFOA concentration at the Sandringham Avenue allotments (4.4 µg/kg) [50].

- Total ADE values for PFOA of 1.97E-06 and 7.03E-07 mg/kg bodyweight/day have been calculated for a female 0-6 year old child and a 16-65 year old adult, respectively, at the Sandringham Avenue allotments. For the Occupation Road site, the calculated values are comparable to Sandringham Avenue, at 2.43E-06 and 9.21E-07 mg/kg bodyweight/day.
- Margins of exposure for both sites are very similar, though the values for Sandringham Avenue are slightly higher, with a significant possibility of potential effects being identified for four categories (cardiovascular effects, developmental effects, hepatic effects, and immune effects).
- Produce samples were collected at the Occupation Road allotments site. Although no produce sampling was carried out at Sandringham Avenue allotments, it is reasonable to expect similar PFOA levels in produce to those found at Occupation Road allotments due to their comparable conditions and close geographic proximity. However, the lack of produce data from Sandringham Avenue allotments is acknowledged to add uncertainty to any subsequent decision on the Part 2A status of the site.

Further work was undertaken to evaluate one of the key parameters used by the CLEA model to estimate exposure via the consumption of allotment grown produce pathway, with the evidence suggesting that the use of the default approach in the CLEA model to estimate human exposure via the consumption of allotment grown produce is not unreasonable, and unlikely to be overly precautionary. However, the lack of site-specific consumption rates, and the unavailability of any produce samples for collection and analysis, remain important and significant uncertainties.

In total, 50 No. POD-HED were identified, grouped into six different effect categories. Estimates of human exposure to PFOA were calculated for the two critical human health receptors using a representative soil concentration of 4.9 µg/kg DW, the 95th percentile UCL of the mean for the soil dataset (0.0 – 0.6 m bgl). The estimated PFOA exposure for both receptors were much lower than the POD-HED derived from animal studies, which were therefore considered to represent a very low possibility of a potential effect on a wide range of study endpoints, but within the range of values observed in epidemiological studies. Margins of exposure for POD-HED values from epidemiological studies were sometimes less than one, and for most study endpoints, there is considered to be a moderate to high possibility of potential effects on various epidemiological markers including cholesterol level, birth weight, serum ALT level, and antibody titres in response to vaccination. However, there remain important differences of opinion between authoritative organisations as to the significance of the endpoints reported in epidemiological studies, in terms of both biological and clinical relevance, and the potential for an adverse effect on health. This represents a key uncertainty in the assessment.

The published literature was also reviewed for similar experiences of land contamination and environmental pollution with PFOA outside of the UK. Whilst study sites from the Netherlands, USA, Germany, Italy and Jersey have been identified where the land has been contaminated with PFOA, the DuPont / Chemours fluoropolymers factory in Dordrecht, the Netherlands, is the only identified site to share a comparable conceptual model to the Sandringham Avenue site. Unfortunately, soil data to enable a direct comparison with the Sandringham Avenue site was not available for the Dordrecht factory.

Site only PFOA exposures for an adult and a child were compared against PFAS dietary intakes across 19 No. European countries (including the UK), as collected by EFSA [11]. Site exposures were 3 and 6 times higher than the median lower bound mean dietary intakes estimated by EFSA for a toddler and an adult, respectively [11]. Exposure from the site is therefore considered to be

moderately elevated, compared to EU dietary data. This is again similar to Occupation Road allotments, where site exposures are reported to be between a factor of 4 and 9 higher than the median lower bound mean dietary intakes estimated by EFSA for a toddler and an adult, respectively [50].

5.4.2 INITIAL RECOMMENDATIONS

The question is, based upon the above lines of evidence, does the Sandringham Avenue site meet the requirements for Category 1, 2, or 3 with respect to Human Health, as defined within the Statutory Guidance [4], as summarised above in Section 5.1.

Category 1

Evidence from the Occupation Road allotments is relevant and important in the assessment of whether the site could fall within Category 1. This is due to the Occupation Road allotments being directly comparable with Sandringham Avenue, being influenced by the same contamination source and having the same conceptual site model.

In their 2026 assessment [50], WSP recommended to Wyre Council that there was insufficient evidence to place the Occupation Road site into Category 1: Human Health under Part 2A. However, there was sufficient evidence to justify taking regulatory action on a precautionary basis and placing the Occupation Road site into Category 2: Human Health. However, the site is yet to be formally Determined as Contaminated Land, in accordance with Part 2A of the Environmental Protection Act 1990 [1].

Based on the above, as per section 4.19 of the Statutory Guidance [4], there is no evidence that similar degrees of PFOA exposure have led to significant harm at similar sites and therefore the site is not deemed to fall into Category 1: Human Health.

Category 2 / 3

The key remaining question is whether the site should be categorised as Category 2: Human Health or Category 3: Human Health, in accordance with the Statutory Guidance [4]?

It is important to compare the available evidence here with that previously considered at Occupation Road. Although mean sub-surface PFOA concentrations at the Occupation Road allotments are 1.5x higher than PFOA concentrations at the Sandringham Avenue site, the calculated margins of exposure for both sites are similar, with a significant possibility of potential effects being identified for four categories (cardiovascular effects, developmental effects, hepatic effects, and immune effects).

Produce sampling was not undertaken at the Sandringham Avenue site, and consequently there is less clear evidence for a contaminant linkage at this site between levels of PFOA in soil and in produce. However, whilst produce sampling was not undertaken, it is reasonable to expect similar results to those from the Occupation Road allotments, due to their comparable conditions and close geographical proximity, although this is acknowledged as adding uncertainty to any decision on the Part 2A status of the site.

The estimated PFOA exposures for adult and child receptors at the Sandringham Avenue site are considered reasonable based on the evidence available and to represent a moderate to high possibility of potential effects on various epidemiological markers including cholesterol levels, birth weight, serum ALT levels, and antibody titres in response to vaccination. There are differences of opinion between authoritative organisations as to the significance of the endpoints reported in

epidemiological studies in terms of biological and clinical relevance and adverse effect on health. Therefore, there remains uncertainty as to whether the biomarker effects of PFOA observed at comparable exposures in epidemiological studies are consistent with significant harm.

Due to the stated uncertainties in the risk assessment, the regulator may wish to seek additional technical advice from a relevant authoritative body, such as the COT, to clarify the biological and clinical relevance of the endpoints seen in epidemiology studies, which could help to support a decision on whether the effects constitute significant harm under Part 2A. However, the timeframes for the completion of such an authoritative review by the COT are unknown[9].

The soil at the Sandringham Avenue site is contaminated with PFOA. However, is the level of contamination sufficient to place the site in Category 2 (that is, does it meet the definition of Contaminated Land)? If the regulator wishes to conclude the categorisation without delay, for example, to avoid further public uncertainty and concern, there is considered to be sufficient evidence for it to take action on a precautionary basis and place the Sandringham Avenue site into Category 2: Human Health.

(Category 2: Human Health as defined in Section 4.25 of the Statutory Guidance: There is a strong case for considering that the risks from the land are of sufficient concern, that the land poses a significant possibility of significant harm, with all that this might involve and having regard to Section 1. Category 2 may include land where there is little or no direct evidence that similar land, situations or levels of exposure have caused harm before, but nonetheless the authority considers on the basis of the available evidence, including expert opinion, that there is a strong case for taking action under Part 2A on a precautionary basis.)

[9] FSA evidence provided to the Environmental Audit Committee (EAC) earlier in 2025 indicated that further COT evaluation and outputs on this topic were not expected for at least 2 years.

6

CONCLUSIONS AND RECOMMENDATIONS

6 CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

6.1.1 BACKGROUND

WSP UK Ltd (WSP) was instructed by the Environment Agency to provide expert opinion in respect to the status of the allotments located at Sandringham Avenue, Thornton-Cleveleys under Part 2A of the Environmental Protection Act (1990) [1]. As part of the instruction from the Client, WSP was tasked with discussing the findings of the preliminary site investigation works, completed by WSP in January 2025 [2], and recent site investigation works, completed by WSP in October 2025 [3].

The purpose of this project is to undertake both Tier 2 generic and Tier 3 detailed quantitative risk assessment and risk evaluation works, to deliver suitably robust conclusions consistent with the decision-making required by the Statutory Guidance [4] and all relevant up-to-date good practice for contaminated land investigation and risk assessment.

6.1.2 CONCEPTUAL SITE MODEL

The Sandringham Avenue site is currently utilised as an allotment garden, and deposition from legacy aerial emissions, associated with historical activities undertaken at the adjacent (off-site) AGCCE Ltd facility (formerly operated by ICI Ltd), have likely resulted in PFOA concentrations present in shallow soils at the allotments site.

For PFOA, the consumption of homegrown produce, and soil attached to produce, accounts for 98.7% of all soil related exposure for an allotment exposure scenario. Exposure via this pathway does not require attendance at the site, and all consumers of produce grown at the site are considered to be receptors in the context of the CSM. The critical human health receptors for the Sandringham Avenue site are therefore a 0-6 year old female child and an adult female.

6.1.3 SITE INVESTIGATION WORKS

Following the completion of preliminary and detailed investigation works at the site [2,3], a total of 120 No. soils samples were collected, using an unbiased (non-targeted) sampling strategy. Soil PFOA concentrations at the site were reported in excess of the MDL of 0.5 µg/kg DW in 119 of the 120 No. samples, at concentrations ranging from 0.8 to 19.3 µg/kg DW.

A statistical assessment confirmed the absence of a depth profile to the PFOA concentrations. The soil dataset was observed to be log-symmetric, with a mean concentration of 4.4 µg/kg DW and a median concentration of 4.0 µg/kg DW. The 95th percentile LCL and UCL of the mean PFOA concentrations were 3.9 and 4.9 µg/kg DW.

No produce samples were collected as part of either phase of investigation works.

6.1.4 RISK EVALUATION

A risk evaluation for the Sandringham Avenue site was completed in accordance with LCRM [5] and the Statutory Guidance [4], to inform the potential determination of whether SCLs to human health exist at the site, as defined under Part 2A of the Environmental Protection Act 1990 [1]. Estimates of human exposure to PFOA were calculated for the two critical human health receptors (a female

adult and a female child, aged 0-6 years) using a representative soil concentration of 4.9 µg/kg DW, the 95th percentile UCL of the mean for the soil dataset (0.0 – 0.6 m bgl).

In order to consider whether the land at Sandringham Avenue is in Category 2 or Category 3 of the Statutory Guidance [4], it is important to compare the available evidence here with that previously considered at Occupation Road. The Occupation Road allotments border the AGCCE Ltd facility and are located approximately 630m to the north east of the Sandringham Avenue allotments. Both sites share the same conceptual exposure model and reported PFOA concentrations in soils at both sites are elevated compared to the interim C4SL for PFOA. In their 2026 assessment [50], WSP recommended to Wyre Council that there was sufficient evidence to justify taking regulatory action on a precautionary basis and placing the Occupation Road site into **Category 2: Human Health**. The site was also considered to meet the conditions for a significant contaminant linkage - **a significant possibility of significant harm to produce grown domestically**.

- The mean sub-surface soil PFOA concentration at the Occupation Road allotments (6.7 µg/kg DW) is 1.5x higher than the mean soil PFOA concentration at the Sandringham Avenue allotments (4.4 µg/kg) [50].
- Total ADE values for PFOA of 1.97E-06 and 7.03E-07 mg/kg bodyweight/day have been calculated for a female 0-6 year old child and a 16-65 year old adult, respectively, at the Sandringham Avenue allotments. For the Occupation Road site, the calculated values are comparable to Sandringham Avenue, at 2.43E-06 and 9.21E-07 mg/kg bodyweight/day.
- Margins of exposure for both sites are very similar, though the values for Sandringham Avenue are slightly higher, with a significant possibility of potential effects being identified for four categories (cardiovascular effects, developmental effects, hepatic effects, and immune effects).
- Produce samples were collected at the Occupation Road allotments site. Although no produce sampling was carried out at Sandringham Avenue allotments, it is reasonable to expect similar PFOA levels in produce to those found at Occupation Road allotments due to their comparable conditions and close geographic proximity. However, the lack of produce data from Sandringham Avenue allotments is acknowledged to add uncertainty to any subsequent decision on the Part 2A status of the site.

Further work indicated that the key parameters used by the CLEA model to estimate exposure via the consumption of allotment grown produce pathway were not unreasonable, and unlikely to be overly precautionary. However, the lack of site-specific consumption rates, and the unavailability of any produce samples for collection and analysis, remain important and significant uncertainties.

Total ADE values for PFOA of 1.97E-06 and 7.03E-07 mg/kg bodyweight/day were calculated for a female 0-6 year old child and a 16-65 year old adult, respectively. To help evaluate the significance of these estimated exposures, data was collated from a number of authoritative reviews on the toxicology of PFOA. The lack of a UK authoritative review (the subject of on-going work by the COT) represented an uncertainty in the assessment. Nevertheless, in total, 50 No. POD-HED were identified and grouped into six different effect categories. The estimated PFOA exposure for both receptors were much lower than the POD-HED derived from animal studies, which were therefore considered to represent a very low possibility of a potential effect on a wide range of study endpoints, but within the range of values observed in epidemiological studies. Margins of exposure for POD-HED values from epidemiological studies were sometimes less than one, and for most study endpoints, there was considered to be a moderate to high possibility of potential effects on various epidemiological markers including cholesterol level, birth weight, serum ALT level, and

antibody titres in response to vaccination. However, there remain important differences of opinion between authoritative organisations as to the significance of the endpoints reported in epidemiological studies, in terms of both biological and clinical relevance, and the potential for an adverse effect on health. This represents a key uncertainty in the assessment.

The published literature was also reviewed for similar experiences of land contamination and environmental pollution with PFOA outside of the UK. Whilst study sites from the Netherlands, USA, Germany, Italy and Jersey have been identified where the land has been contaminated with PFOA, the DuPont / Chemours fluoropolymers factory in Dordrecht, the Netherlands, is the only identified site to share a comparable conceptual model to the Sandringham Avenue site. Unfortunately, soil data to enable a direct comparison with the Sandringham Avenue site was not available for the Dordrecht factory.

Site only PFOA exposures for an adult and a child were compared against PFAS dietary intakes across 19 No. European countries (including the UK), as collected by EFSA [11]. Site exposures were 3 and 6 times higher than the median lower bound mean dietary intakes estimated by EFSA for a toddler and an adult, respectively [11]. Exposure from the site is therefore considered to be moderately elevated, compared to EU dietary data. This is again similar to Occupation Road allotments, where site exposures are reported to be between a factor of 4 and 9 higher than the median lower bound mean dietary intakes estimated by EFSA for a toddler and an adult, respectively [50].

6.2 RECOMMENDATIONS

6.2.1 HUMAN HEALTH

In the context of Part 2A and potential human health risk, land only meets the definition of Contaminated Land if the authority considers it falls within Categories 1 or 2 as defined in the Statutory Guidance [4]. The following lines of evidence are presented in order to assist the authority in deciding whether the Occupation Road site potentially falls within Categories 1, 2, or 3 with respect to risks to Human Health under the Part 2A regime

Category 1 Evidence

Based on the findings of the risk evaluation and fact that Occupation Road allotments was not deemed to fall under Category 1: Human Health, there is insufficient evidence to classify Sandringham Avenue allotments as Category 1: Human Health.

Category 2 / 3 Lines of Evidence

The key remaining question is whether the site should be categorised as Category 2: Human Health or Category 3: Human Health, in accordance with the Statutory Guidance [4]?

Uncertainties have been identified within the Tier 2 and 3 quantitative risk assessments, and the authority may choose to seek additional advice from a relevant authoritative body to clarify the biological and clinical relevance of the endpoints seen in the epidemiology studies, which could help to support a decision on whether the effects constitute significant harm. However, as stated within the 2012 Statutory Guidance [4], **Category 2 may include land where there is little or no direct evidence that similar land, situations or levels of exposure have caused harm before, but nonetheless the authority considers on the basis of the available evidence, including expert opinion, that there is a strong case for taking action under Part 2A on a precautionary basis.**

It is important to compare the available evidence here with that previously considered at Occupation Road. Although mean sub-surface PFOA concentrations at the Occupation Road allotments are 1.5x higher than mean PFOA soil concentrations at the Sandringham Avenue site, the calculated margins of exposure for both sites are similar, with a significant possibility of potential effects being identified for four categories (cardiovascular effects, developmental effects, hepatic effects, and immune effects).

Produce sampling was not undertaken at the Sandringham Avenue site, and consequently there is less clear evidence for a contaminant linkage at this site between levels of PFOA in soil and in produce. However, whilst produce sampling was not undertaken, it is reasonable to expect similar results to those from the Occupation Road allotments, due to their comparable conditions and close geographical proximity. Although this is acknowledged as adding uncertainty (and precaution) to a Category 2 decision on the Part 2A status of the site, the estimated PFOA exposures for adult and child receptors at the Sandringham Avenue site are considered reasonable based on the evidence available and to represent a moderate to high possibility of potential effects on various epidemiological markers including cholesterol levels, birth weight, serum ALT levels, and antibody titres in response to vaccination. There are differences of opinion between authoritative organisations as to the significance of the endpoints reported in epidemiological studies in terms of biological and clinical relevance and adverse effect on health. Therefore, there remains uncertainty as to whether the biomarker effects of PFOA observed at comparable exposures in epidemiological studies are consistent with significant harm.

The soil at the Sandringham Avenue site is contaminated with PFOA. However, is the level of contamination sufficient to place the site in Category 2 (that is, does it meet the definition of Contaminated Land)? If the regulator wishes to conclude the categorisation without delay, for example, to avoid further public uncertainty and concern, there is considered to be sufficient evidence for it to take action on a precautionary basis and place the Sandringham Avenue site into Category 2: Human Health.

*(**Category 2: Human Health** as defined in Section 4.25 of the Statutory Guidance: There is a strong case for considering that the risks from the land are of sufficient concern, that the land poses a **significant possibility of significant harm**, with all that this might involve and having regard to Section 1. Category 2 may include land where there is little or no direct evidence that similar land, situations or levels of exposure have caused harm before, but nonetheless the authority considers on the basis of the available evidence, including expert opinion, that there is a strong case for taking action under Part 2A on a precautionary basis.)*

7

REFERENCES

7 REFERENCES

1. Part 2A of the Environmental Protection Act, 1990.
2. WSP UK Ltd, 2026. Sandringham Avenue Allotments, Thornton-Cleveleys. Factual and Semi-Interpretative Report from Preliminary Investigation.
3. WSP UK Ltd, 2026. Sandringham Avenue Allotments, Thornton-Cleveleys. Factual Report from Detailed Investigation.
4. Defra, 2012. Contaminated Land Statutory Guidance.
5. Environment Agency, 2025. Land Contamination Risk Management.
6. Environment Agency, January 2009. Science Report – Updated Technical Background to the CLEA Model. SC050021/SR3.
7. WSP UK Ltd, 2025. Desk Study: AGC Chemicals Europe Ltd Facility, Thornton-Cleveleys. Specification for PFAS Risk Screening - Phase 4 (Ref 70100310-12157(5)).
8. Environment Agency, 2023. PFOA Dispersion - Air dispersion and deposition modelling study (ref: AQMAU-C2478-RP02).
9. WSP UK Ltd, 2024. Land at Thornton-Cleveleys, Factual Report from Preliminary Phase of Offsite Soils Investigation.
10. CL:AIRE, 2024. Interim Category 4 Screening Levels for per- and polyfluoroalkyl substances (PFAS): perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA), perfluorohexane sulfonic acid (PFHxS) and perfluorooctane sulfonic acid (PFOS).
11. EFSA, 2020. Risk to human health related to the presence of perfluoroalkyl substances in food. EFSA Journal 2020, 18(9), 6223.
12. ATSDR, 2021. Table A8. Toxicological Profile for Perfluoroalkyls.
13. FSANZ, 2017. Table 31. Hazard assessment report – Perfluorooctane Sulfonate (PFOS), Perfluorooctanoic Acid (PFOA), Perfluorohexane Sulfonate (PFHxS). Food Standards Australia New Zealand.
14. US EPA, 2024. Table 4-11. Human Health Toxicity Assessment for Perfluorooctanoic Acid (PFOA) and Related Salts. EPA Document No. 815R24006.
15. International Agency for Research on Cancer Monographs Volume 135: Perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS).
16. CIRIA C552 Contaminated land risk assessment. A guide to good practice. 2001.
17. Environment Agency, 2000. Secondary Model Procedure for the Development of Appropriate Soil Sampling Strategies for Land Contamination Development. R&D Technical Report P5-066/TR.
18. BS 10175:2011+A2:2017 Investigation of potentially contaminated sites. Code of practice.
19. Beriro D.J., Bearcock J.M., Vane C.H., Marchant B., Martin I., Haslam A., Pickering H., Hughes M., James A., 2025. A comparative analysis of PFAS in archive and fresh soil

samples in England and implications for large-scale surveys. Environmental Pollution, 379, art no. 126401.

20. Contaminated land exposure assessment (CLEA) tool - GOV.UK [Last updated 07 September 2015].
21. CL:AIRE, 2013. Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination (SP1010).
22. https://www.growveg.co.uk/guides/vegetable-root-depths-revealed-use-this-guide-to-make-smarter-planting-decisions (accessed 15.10.25).
23. Schulz et al., Distribution and effects of branched versus linear isomers of PFOA, PFOS, and PFHxS: A review of recent literature. Science of the Total Environment Volume 733, 1 September 2020, 139186.
24. https://www.efsa.europa.eu/en/topics/topic/margin-exposure (accessed on 16.10.25).
25. Environment Agency, January 2009. Science Report - Human Health Toxicological Assessment of Contaminants in Soil. SC050021/SR2.
26. ANSES, 2017. Tableau XVIII. Avis de l'Anses relatif à l'évaluation des risques sanitaires d'alkyls per- et polyfluorés dans les eaux destinées à la consommation humaine (Saisine no. 2015-SA-0105). Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail (Maisons-Alfort).
27. EFSA, 2018. Table 28. Risk to human health related to the presence of perfluorooctane sulfonic acid and perfluorooctanoic acid in food. EFSA Journal 2018, 16(12), 5194
28. Food Safety Commission of Japan, 2025. Per- and Poly-fluoroalkyl Substances (PFAS) (Chemicals and Contaminants). Food Safety 2025; Vol. 13, No. 1, 19-21.
29. Health Canada, 2018. Guidelines for Canadian Drinking Water Quality Guideline Technical Document Perfluorooctanoic Acid (PFOA). Ottawa: Health Canada.
30. SLR Consulting Australia, 2024. Table 6-4. Addendum to PFAS Evidence Evaluation for Australian Drinking Water Guidelines Chemical Fact Sheets. Work undertaken for and published by the National Health and Medical Research Council.
31. OEHHA, 2024. Public Health Goals. Perfluorooctanoic Acid and Perfluorooctane Sulfonic Acid in Drinking Water. Office of Environmental Health Hazard Assessment at California Environmental Protection Agency.
32. DMOE, 2015. Table 5-3. Perfluoroalkylated substances: PFOA, PFOS and PFOSA Evaluation of health hazards and proposal of a health based quality criterion for drinking water, soil and ground water. Environmental project No. 1665, 2015. Danish Ministry of the Environment.
33. National Health and Medical Research Council. Australian Drinking Water Guidelines 6 2011 Version 4.0 Updated June 2025.
34. Committee on Toxicity. Statement on the EFSA Opinion on the risks to human health related to the presence of perfluoroalkyl substances (PFASs) in food (2022).

35. Gerardu et al., Accumulation and transport of atmospherically deposited PFOA and PFOS in undisturbed soils downwind from a fluoropolymers factory. Environmental Advances 11 (2023) 100332.
36. RIVM, 2016. Risk assessment of PFOA emissions for local residents. Location: DuPont/Chemours, Dordrecht, The Netherlands. RIVM Letter Report 2016-0049.
37. RIVM, 2021. Revision of the risk assessment of GenX and PFOA in vegetable crops in Dordrecht, Papendrecht and Sliedrecht. RIVM Letter Report 2021-0064.
38. Paustenbach et al., A Methodology for Estimating Human Exposure to Perfluorooctanoic Acid (PFOA): A Retrospective Exposure Assessment of a Community (1951-2003). Journal of Toxicology and Environmental Health, Part A, 70: 28-57 (2007).
39. C8 Science panel website. http://www.c8sciencepanel.org/ (accessed on 30.09.25).
40. Government of Jersey, 2024, A rapid assessment of potatoes grown within St Ouen's Bay, Jersey to explore the presence of per- and polyfluoroalkyl substances (PFAS), 15 March 2024.
41. Giglioli, S. Colombu, L. Azzellino, A. 2023, Cluster and multivariate analysis to study the diffuse contamination of emerging per- and polyfluroalkyl substances (PFAS) in the Veneto Region plant (North-eastern Italy), Chemosphere, 319.
42. Ingeliod, A, M. Abballe, A. Gemma, S. Dellatte, E. Lacovella, N. De Angelis, G. Zampaglioni, F. Marra, V. Miniero, R. Valentini, S. Russo, F. Vazzoler, M. Testai, E and De Felip, E. 2018, Biomonitoring of perfluorinated compounds in adults exposed to contaminated drinking water in the Veneto Region, Italy, Environment International, 110, 149-159
43. Ingeliod, A, M. Abballe, A. Gemma, S. Dellatte, E. Lacovella, N. De Angelis, G. Marra, V. Russo, F. Vazzoler, M. Testai, E and De Felip, E. 2020, Serum concentrations of perfluorinated alkyl substance in farmers living in areas affected by water contamination in the Veneto Region (Northern Italy), Environment International, 136, 105435
44. Rohler et al., Long-term behaviour of PFAS in contaminated agricultural soils in Germany. Journal of Contaminant Hydrology 241 (2021) 103812
45. https://www.umweltbundesamt.de/sites/default/files/medien/2875/dokumente/pfas_krakau_final.pdf (accessed on 20.10.25)
46. https://rpk.baden-wuerttemberg.de/abt5/referat-52-gewaesser-und-boden/stabsstelle-pfas/pfc-problematik-mittelbaden-mannheim/ (accessed on 20.10.25)
47. PFAS Testing Protocol – Informing Report Four by the Independent PFAS Scientific Panel. https://www.gov.je/SiteCollectionDocuments/Planning%20and%20building/PFAS%20Testing%20Protocol.pdf (accessed on 20.10.25)
48. Food Safety Act, 1990
49. WSP UK Ltd, 2025. Occupation Road Allotments, Thornton-Cleveleys. Factual Report from Detailed Investigation
50. WSP UK Ltd, 2025. Occupation Road Allotments, Thornton-Cleveleys. Interpretative Site Investigation Report

8

GLOSSARY AND ABBREVIATIONS

8 GLOSSARY AND ABBREVIATIONS

The following terms and abbreviations have been used throughout the enclosed statement. All may be considered as common terms used on an everyday basis by Contaminated Land professionals, their definitions are presented to assist the reader and avoid ambiguity.

Ammonium Perfluorooctanate (APFO). APFO is the ammonium salt of perfluorooctanoic acid (PFOA) and readily dissociates in water to give the ammonium and perfluorooctanoate ions. Whilst APFO and PFOA have subtly different properties it considered appropriate to assume APFO = 100% PFOA once it reaches the environment.

Average Daily Exposure (ADE). The average daily amount of a contaminant per kg bodyweight, which a critical human receptor might take in over the duration of exposure.

Below Ground Level (BGL).

Committee on Toxicity (COT). The Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment (COT) is an independent scientific committee that provides advice to the Food Standards Agency, the Department of Health and Social Care, and other Government Departments and Agencies on matters concerning the toxicity of chemicals.

Concentration Factor (CF).

Contaminated Land: Applications In Real Environments (CL:AIRE).

Conceptual Site Model (CSM). A representation of the characteristics of the site in diagrammatic or written form that shows the possible Pollutant linkages between Contaminants, Pathways and Receptors.

Contaminant. A substance that is in, on or under the land and that has the potential to cause harm or to cause pollution to the water environment.

Contaminant Linkage. The relationship between a contaminant, pathway and receptor, which is identified by developing the conceptual site model ('CSM'). See also source-pathway-receptor linkage.

Contaminant of Concern (CoC). Contaminants that pose an unacceptable risk to human health and the environment, as identified in the risk assessments.

Contaminated Land. Contaminated Land: defined in Section 78A(2) of the Environmental Protection Act [8] as: 'any land which appears to the local authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land, that - '(a) significant harm is being caused or there is a significant possibility of such harm being caused, or; '(b) pollution of controlled waters is being, or is likely to be, caused.' OR with respect to radioactive contamination defined in Section 78A(2)(as modified) as 'any land which appears to the local authority in whose area it is situated to be in such a condition, by reasons of substances in, on or under the ground, that: (a) harm is being caused, or (b) there is a significant possibility of such harm being caused.'

Critical Receptor. The individuals or subgroup of the population most likely to be exposed and/or susceptible to the presence of soil contamination.

Cytotoxic. Toxic to cells.

Detailed Quantitative Risk Assessment (DQRA).

European Food Safety Authority (EFSA).

Excess Lifetime Cancer Risk (ELCR).

Food Standards Agency (FSA).

Generic Quantitative Risk Assessment (GQRA).

Genotoxic. A chemical capable of causing damage to genetic material.

Harm. This means adverse impacts on the health of living organisms or other interference with the ecological systems of which they form a part and, in the case of man, includes harm to property. (Defined in Section 78A(4) of the Environmental Protection Act 1990)

Hazard. A property or situation that in particular circumstances could lead to harm or pollution.

Hazard Index (HI).

Hazard Index Approach for PFAS. The hazard index approach requires that a hazard quotient (HQ) is first calculated for each of the four PFAS for each soil sample. The hazard quotient is the ratio of the measured soil concentration to the relevant C4SL. The hazard index (HI) for the soil sample is then the sum of the hazard quotients for the four PFAS: HI = HQPFOA + HQPFOS + HQPFHxS + HQPFNA. A hazard quotient or index of greater than 1 (again, subject to consideration of uncertainties) signifies that further assessment or consideration of the risk is required.

Hazard Quotient (HQ). See Hazard Index approach for PFAS.

Human Equivalent Dose (HED).

IARC. The International Agency for Research on Cancer is the specialized cancer agency of the World Health Organisation (WHO).

LLTC (Low Level of Toxicological Concern). An LLTC should represent an intake of low concern that remains suitably protective of health, and definitely does not approach an intake level that could be defined as SPOSH.

LOD or Limit of Detection. The lower limit achievable detection as reported by the smallest amount (concentration) that can be detected with reasonable certainty using a specific analytical procedure.

Margin of Exposure (MoE).

Method Detection Limit (MDL). The minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero.

Part 2A. Part 2A of the Environmental Protection Act 1990.

Pathway. A route or means by which a receptor could be, or is exposed to, or affected by a Contaminant.

Per- and polyfluoroalkyl substances (PFAS). A group of synthetic organofluorine chemical compounds that have multiple fluorine atoms attached to an alkyl chain.

- Perfluorooctanesulfonic acid (PFOS)
- Perfluorooctanoic acid (PFOA)
- Perfluorononanoic acid (PFNA)

- Perfluorohexane sulfonate (PFHxS)

Plausible Contaminant Linkage. A contaminant linkage that may plausibly be significant but requires further quantification or investigation to confirm or refute in the context of Part 2A.

Point of Departure. The dose or concentration selected from a toxicity or epidemiology study as the basis for the derivation of a health criteria value or a margin of exposure.

Receptor. In general terms, something that could be adversely affected by contamination (e.g., people, an ecological system, property or a water body).

Risk. A combination of the probability, or frequency of occurrence of a defined hazard and the magnitude of the consequences of the occurrence.

Risk Assessment. The formal process of identifying, assessing and evaluating the health and environmental risks that may be associated with a hazard.

Site Investigation (SI). The collection and analysis of soil, surface water, groundwater, soil gas and other media as a means of further understanding the condition of the site and to inform the risk assessment. This investigation may be undertaken in a single stage, or a number of successive stages.

Significant Contaminant Linkage (SCL). A contaminant linkage that gives rise to a level of risk sufficient to justify a piece of land being determined as Contaminated Land.

Significant Possibility of Significant Harm (SPOSH) (a formal term within Part 2A Legislation). The following health effects should always be considered to constitute significant harm to human health: death; life threatening diseases (e.g., cancers); other diseases likely to have serious impacts on health; serious injury; birth defects; and impairment of reproductive functions. Other health effects may be considered by the local authority to constitute significant harm. For example, a wide range of conditions may or may not constitute significant harm (alone or in combination) including physical injury; gastrointestinal disturbances; respiratory tract effects; cardio-vascular effects; central nervous system effects; skin ailments; effects on organs such as the liver or kidneys; or a wide range of other health impacts. In deciding whether or not a particular form of harm is significant harm, the local authority should consider the seriousness of the harm in question: including the impact on the health, and quality of life, of any person suffering the harm; and the scale of the harm.

Tolerable Weekly Intake (TWI).

United Kingdom Health Security Agency (UKHSA).

Unacceptable Risk. A risk of such a nature that it would give grounds for land to be considered Contaminated Land under Part 2A.

Uncertainty. A lack of knowledge about specific factors in a risk or exposure assessment, including parameter uncertainty, model uncertainty and scenario uncertainty. Parameter uncertainty refers to the uncertainty in the model parameter values, which can be due to uncertainties in the data available. Model uncertainty is uncertainty due to imperfections and idealizations made in the physical model formulation. Scenario uncertainty is uncertainty in the actual conceptual model being assumed for example in the actual exposure duration and frequency of a receptor on a site.

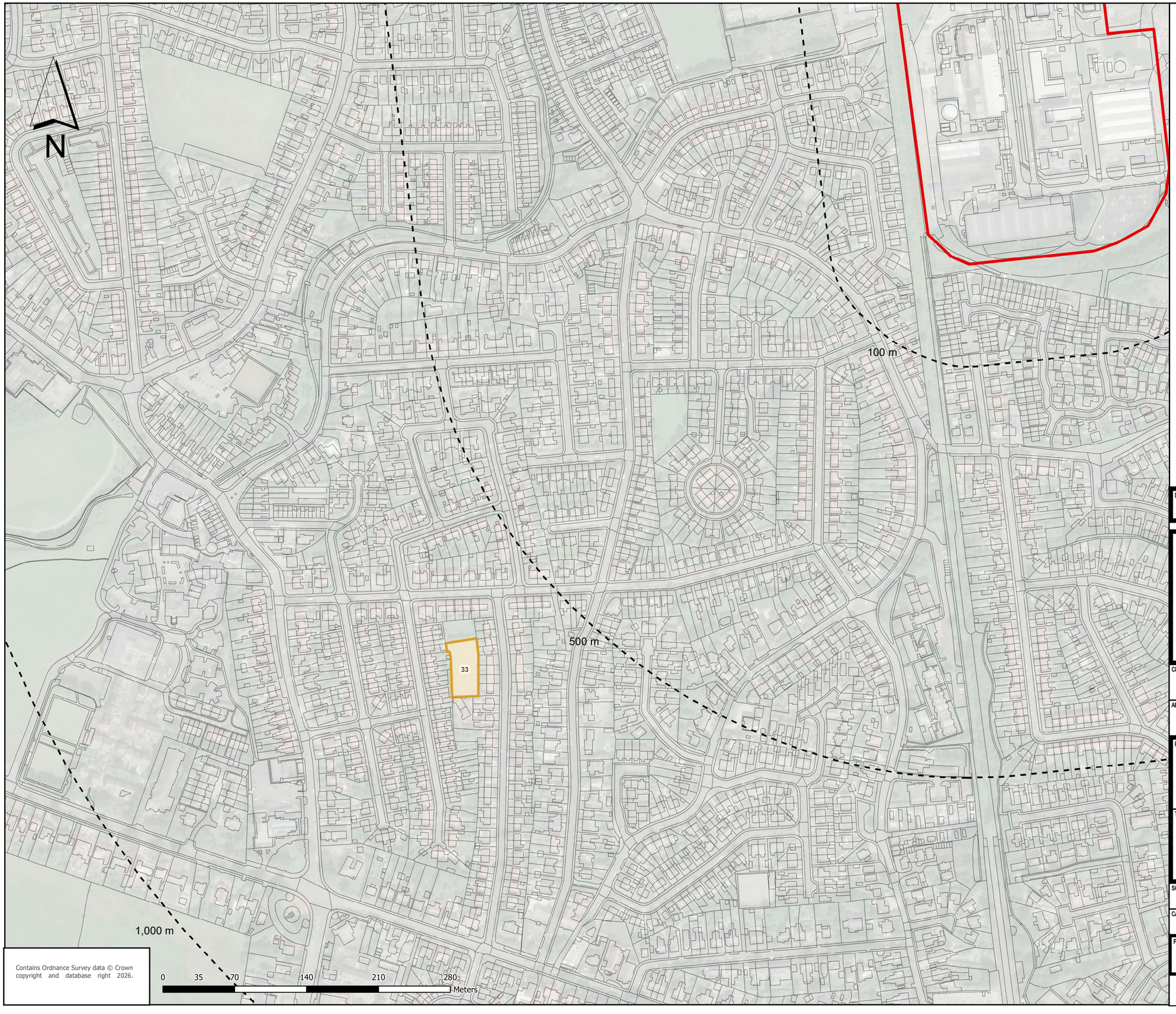
United States Environmental Protection Agency (USEPA).

Upper Confidence Limit (UCL).

Appendix A

FIGURES

Drawn By: UKDXK032



DO NOT SCALE

Legend

- Sandringham Avenue Allotments (LP33)
- AGCCE Ltd. Permit Boundary

DRAWING STATUS: FINAL

wsp
8 First Street
Manchester
Tel: +44 (0)161 200 500
Website: www.wsp.com

CLIENT: ENVIRONMENT AGENCY

ARCHITECT: WSP UK LIMITED

PROJECT: 70100310 LAND AT THORNTON-CLEVELEYS SANDRINGHAM AVENUE ALLOTMENTS (LP33)

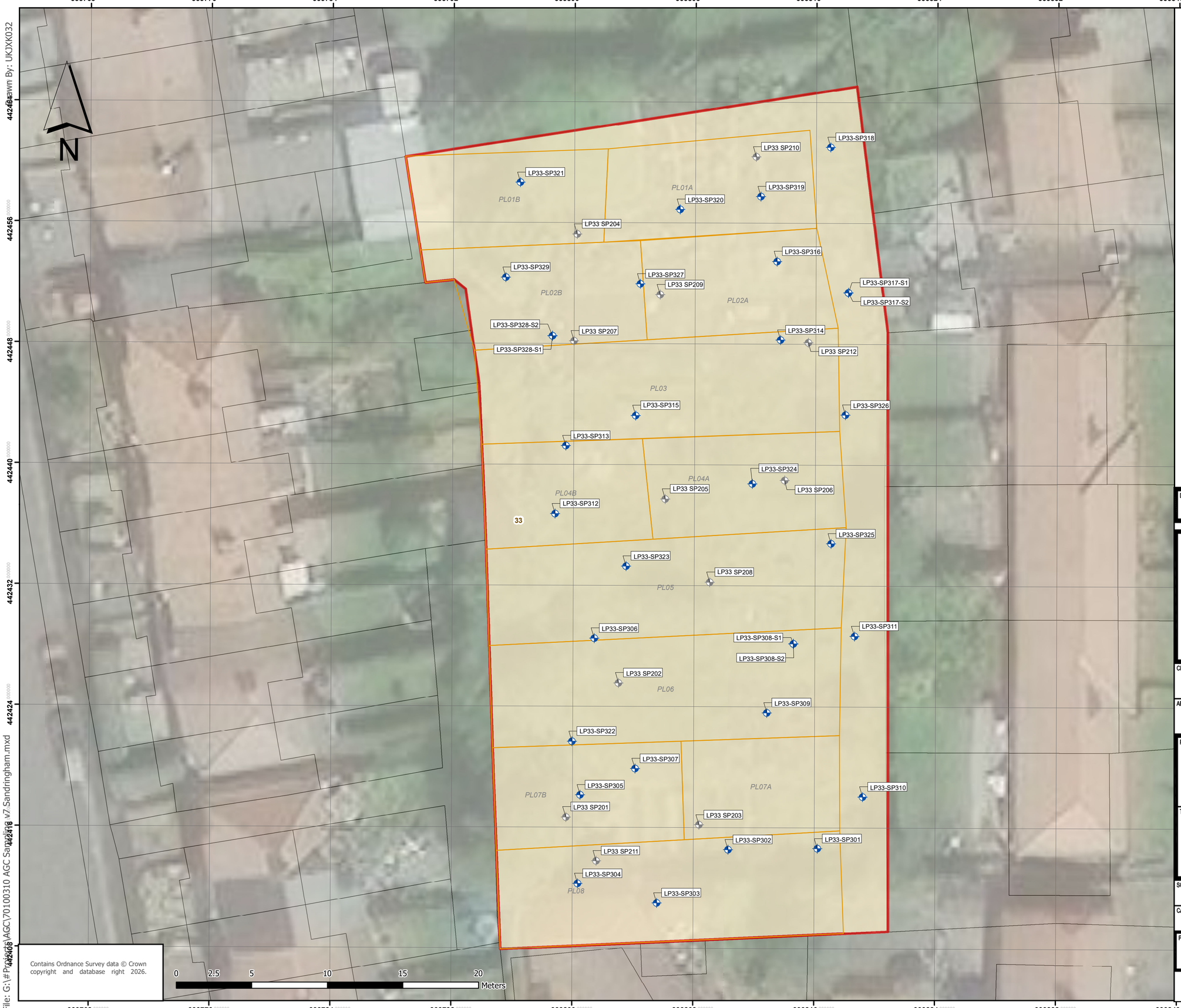
TITLE:

FIGURE 1
SITE LOCATION PLAN

SCALE @ A	CHECKED:	APPROVED:
1:0	KG	HDL
CAD FILE:	**DESIGN-DRAWN:**	**DATE:**
WSP - A3 Landscape	WG	JAN 26

PROJECT No:	DRAWING No:	REV:
70100310	70100310/P3 -01	

File: G:\#Projects\AGC\70100310 AGC Sampling v7 Sandringham.mxd



Contains Ordnance Survey data © Crown copyright and database right 2026.

File: G:\#Projects\AGC\70100310 AGC Sandringham v7.Sandringham.mxd

Drawn By: UKDXK032

DO NOT SCALE

Legend

Sample Points

- Track 2 Sample Points
- Track 1 Sample Points
- Sandringham Avenue Allotments
- Allotment Plots

DRAWING STATUS: FINAL

8 First Street
Manchester
Tel: +44 (0)161 200 500
Website: www.wsp.com

CLIENT: ENVIRONMENT AGENCY

ARCHITECT: WSP UK LIMITED

PROJECT: 70100310 LAND AT THORNTON-CLEVELEYS SANDRINGHAM AVENUE ALLOTMENTS (LP33)

TITLE: FIGURE 2 SAMPLE POINT LOCATION PLAN

SCALE @ A	CHECKED:	APPROVED:
1:0	KG	HDL
CAD FILE: WSP - A3 Landscape	DESIGN-DRAWN: WG	DATE: JAN 26
PROJECT No: 70100310	DRAWING No: 70100310/P3 -02	REV:

Appendix B

GENERAL LIMITATIONS

REPORT LIMITATIONS - GROUND AND WATER

GENERAL

1. WSP UK Limited has prepared this report solely for the use of the Client and those parties with whom a warranty agreement has been executed, or with whom an assignment has been agreed and outlined in the body of the report.

2. Unless explicitly agreed otherwise, in writing, this report has been prepared under WSP UK Limited standard Terms and Conditions as included within our proposal to the Client.

3. Project specific appointment documents may be agreed at our discretion and a charge may be levied for both the time to review and finalise appointments documents and also for associated changes to the appointment terms. WSP UK Limited reserves the right to amend the fee should any changes to the appointment terms create an increase risk to WSP UK Limited.

4. The report needs to be considered in the light of the WSP UK Limited proposal and associated limitations of scope. The report needs to be read in full and isolated sections cannot be used without full reference to other elements of the report and any previous works referenced within the report.

PHASE 1 GEO ENVIRONMENTAL AND PRELIMINARY RISK ASSESSMENTS

Coverage: *This section covers reports with the following titles or combination of titles: phase 1; desk top study; geo environmental assessment; development appraisal; preliminary environmental risk assessment; constraints report; due diligence report; geotechnical development review; environmental statement; environmental chapter; project scope summary report (PSSR), program environmental impact report (PEIR), geotechnical development risk register; and, baseline environmental assessment.*

5. The works undertaken to prepare this report comprised a study of available and easily documented information from a variety of sources (including the Client), together with (where appropriate) a brief walk over inspection of the Site and correspondence with relevant authorities and other interested parties. Due to the short timescales associated with these projects responses may not have been received from all parties. WSP UK Limited cannot be held responsible for any disclosures that are provided post production of our report and will not automatically update our report.

6. The opinions given in this report have been dictated by the finite data on which they are based and are relevant only for the purpose for which the report was commissioned. The information reviewed should not be considered exhaustive and has been accepted in good faith as providing true and representative data pertaining to site conditions. Should additional information become available which may affect the opinions expressed in this report, WSP UK Limited reserves the right to review such information and, if warranted, to modify the opinions accordingly.

7. It should be noted that any risks identified in this report are perceived risks based on the information reviewed. Actual risks can only be assessed following intrusive investigations of the site.

8. WSP UK Limited does not warrant work / data undertaken / provided by others.

REPORT LIMITATIONS - GROUND RISK AND REMEDIATION

INTRUSIVE INVESTIGATION REPORTS

Coverage: *The following report titles (or combination) may cover this category of work: geo environmental site investigation; geotechnical assessment; GIR (Ground Investigation reports); preliminary environmental and geotechnical risk assessment; and, geotechnical risk register.*

9. The investigation has been undertaken to provide information concerning either:

- **i.** The type and degree of contamination present at the site in order to allow a generic quantitative risk assessment to be undertaken; or
- **ii.** Information on the soil properties present at the site to allow for geotechnical development constraints to be considered.

10. The scope of the investigation was selected on the basis of the specific development and land use scenario proposed by the Client and may be inappropriate to another form of development or scheme. If the development layout was not known at the time of the investigation the report findings may need revisiting once the development layout is confirmed.

11. For contamination purposes, the objectives of the investigation are limited to establishing the risks associated with potential contamination sources with the potential to cause harm to human health, building materials, the environment (including adjacent land), or controlled waters.

12. For geotechnical investigations the purpose is to broadly consider potential development constraints associated with the physical property of the soils underlying the site within the context of the proposed future or continued use of the site, as stated within the report.

13. The amount of exploratory work, soil property testing and chemical testing undertaken has necessarily been restricted by various factors which may include accessibility, the presence of services; existing buildings; current site usage or short timescales. The exploratory holes completed assess only a small percentage of the area in relation to the overall size of the Site, and as such can only provide a general indication of conditions.

14. The number of sampling points and the methods of sampling and testing do not preclude the possible existence of contamination where concentrations may be significantly higher than those actually encountered or ground conditions that vary from those identified. In addition, there may be exceptional ground conditions elsewhere on the site which have not been disclosed by this investigation and which have therefore not been taken into account in this report.

15. The inspection, testing and monitoring records relate specifically to the investigation points and the timeframe that the works were undertaken. They will also be limited by the techniques employed. As part of this assessment, WSP UK Limited has used reasonable skill and care to extrapolate conditions between these points based upon assumptions to develop our interpretation and conclusions. The assumption made in forming our conclusions is that the ground and groundwater conditions (both chemically and physically) are the same as have been encountered during the works undertaken at the specific points of investigation. Conditions can change between investigation points and these interpretations should be considered indicative.

16. The risk assessment and opinions provided are based on currently available guidance relating to acceptable contamination concentrations; no liability can be accepted for the retrospective effects of any future changes or amendments to these values. Specific assumptions associated

with the WSP UK Limited risk assessment process have been outlined within the body or associated appendix of the report.

17. Additional investigations may be required in order to satisfy relevant planning conditions or to resolve any engineering and environmental issues.

18. Where soil contamination concentrations recorded as part of this investigation are used for commentary on potential waste classification of soils for disposal purposes, these should be classed as indicative only. Due consideration should be given to the variability of contaminant concentrations taken from targeted samples versus bulk excavated soils and the potential variability of contaminant concentrations between sampling locations. Where major waste disposal operations are considered, targeted waste classification investigations should be designed.

19. The results of the asbestos testing are factually reported and interpretation given as to how this relates to the previous use of the site, the types of ground encountered and site conceptualisation. This does not however constitute a formal asbestos assessment. These results should be treated cautiously and should not be relied upon to provide detailed and representative information on the delineation, type and extent of bulk ACMs and / or trace loose asbestos fibres within the soil matrix at the site.

20. If costs have been included in relation to additional site works, and / or site remediation works these must be considered as indicative only and must be confirmed by a qualified quantity surveyor.

EUROCODE 7: GEOTECHNICAL DESIGN

21. On 1st April 2010, BS EN 1997-1:2004 (Eurocode 7: Geotechnical Design – Part 1) became the mandatory baseline standard for geotechnical ground investigations.

22. In terms of geotechnical design for foundations, slopes, retaining walls and earthworks, EC7 sets guidance on design procedures including specific guidance on the numbers and spacings of boreholes for geotechnical design, there are limits to methods of ground investigation and the quality of data obtained and there are also prescriptive methods of assessing soil strengths and methods of design. Unless otherwise explicitly stated, the work has not been undertaken in accordance with EC7. A standard geotechnical interpretative report will not meet the requirements of the Geotechnical Design Report (GDR) under Eurocode 7. The GDR can only be prepared following confirmation of all structural loads and serviceability requirements. The report is likely to represent a Ground Investigation Report (GIR) under the Eurocode 7 guidance.

DETAILED QUANTITATIVE RISK ASSESSMENTS AND REMEDIAL STRATEGY REPORTS

23. These reports build upon previous report versions and associated notes. The scope of the investigation, further testing and monitoring and associated risk assessments were selected on the basis of the specific development and land use scenario proposed by the Client and may not be appropriate to another form of development or scheme layout. The risk assessment and opinions provided are based on currently available approaches in the generation of Site Specific Assessment Criteria relating to contamination concentrations and are not considered to represent a risk in a specific land use scenario to a specific receptor. No liability can be accepted for the retrospective effects of any future changes or amendments to these values, associated models or associated guidance.

24. The outputs of the Detailed Quantitative Risk Assessments are based upon WSP UK Limited manipulation of standard risk assessment models. These are our interpretation of the risk assessment criteria.

25. Prior to adoption on site they will need discussing and agreeing with the Regulatory Authorities prior to adoption on site. The regulatory discussion and engagement process may result in an alternative interpretation being determined and agreed. The process and timescales associated with the Regulatory Authority engagement are not within the control of WSP UK Limited. All costs and programmes presented as a result of this process should be validated by a quantity surveyor and should be presumed to be indicative.

GEOTECHNICAL DESIGN REPORT (GDR)

26. The GDR can only be prepared following confirmation of all structural loads and serviceability requirements. All the relevant information needs to be provided to allow for a GDR to be produced.

MONITORING (INCLUDING REMEDIATION MONITORING REPORTS)

27. These reports are factual in nature and comprise monitoring, normally groundwater and ground gas and data provided by contractors as part of an earthworks or remedial works.

28. The data is presented and will be compared with assessment criteria.

Appendix C

SUPPORTING DATA - RISK ASSESSMENT

Appendix C.1

TABLES

Table C1: Mann-Whitney U Test Results

Depth (m bgl)	No. of Samples	Mean PFOA (µg/kg)	80% CI	95% CI
0.0-0.1	24	3.8	4.6	5
0.1-0.6	96	4.5	4.9	5.1

0.0-0.1	0.1-0.6	0.0-0.1 ranks	0.1-0.6 ranks
4.89	1.74	81.5	16
1.99	1.71	24	15
14.3	4.63	119	76
5.55	1.55	88	10.5
4.48	2.46	72.5	35.5
3.86	4.14	59	66.5
1.9	1.34	20.5	7
2.19	4.84	29	80
6	4.22	94.5	70
4.49	7.73	74	111
2.89	4.34	41	71
6.45	9.94	99	114
2.88	5.09	40	84
0.829	3.97	2	61
0.5	3.07	1	45
2.44	3.49	34	54
4.66	7.3	77	108.5
1.93	2.38	22	32
2.18	1.68	28	13
6	3.09	94.5	46
1.21	6.2	4	97
3.64	1.28	56	5
1.43	2.4	9	33
5.44	2.46	87	35.5
	6.23		98
	4.71		79
	5.96		93
	6.14		96
	7.3		108.5
	11.6		117
	10.1		115
	1.55		10.5
	5.26		86
	3.41		53
	4.48		72.5
	3.62		55
	4.14		66.5
	4.96		83
	6.53		101
	5.72		89
	1.7		14
	2.33		31
	1.9		20.5
	6.96		106
	3.11		47
	4.08		64
	1.39		8
	5.87		90
	1.6		12
	1.8		18
	2.5		37
	8.26		113
	4.15		68
	2.05		25
	4.07		63
	2.12		27
	3.26		52
	7.05		107
	3.85		58
	6.64		102
	1.87		19
	5.95		92
	3.96		60
	4.13		65
	2.23		30
	7.59		110
	4.89		81.5
	1.97		23
	2.61		38
	6.81		104
	3.13		49
	2.1		26
	3.03		44
	2.99		42
	3		43
	1.31		6
	1.78		17
	3.24		51
	6.93		105
	11.2		116
	6.52		100
	1.16		3
	4.6		75
	4		62
	12.6		118
	2.83		39
	3.77		57
	4.19		69
	8.11		112
	5.89		91
	19.3		120
	5.23		85
	3.16		50
	4.7		78
	6.74		103
	3.12		48

R1	1256.5
R2	6003.5
N1	24
N2	96
U1	1347.5
U2	956.5
U	956.5
z	-1.2826361
p	0.1996196

The null hypothesis of the test states that the two groups have the same mean PFOA concentration. Since the p-value of the test is (0.199) is greater than our significance level of 0.05, we cannot reject the null hypothesis.

TABLE C2: GENERIC QUANTITATIVE RISK ASSESSMENT - ALL SOILS. HAZARD INDEX CALCULATIONS - INTERIM ALLOTMENTS C4SL
SANDRINGHAM AVENUE ALLOTMENTS. DECEMBER 2025.

All results µg/kg																								
Sample ID	LP33-SP302	LP33-SP304	LP33-SP308-S1	LP33-SP308-S1	LP33-SP308-S2	LP33-SP308-S2	LP33-SP310	LP33-SP312	LP33-SP314	LP33-SP316	LP33-SP318	LP33-SP320	LP33-SP322	LP33-SP323	LP33-SP324	LP33-SP326	LP33-SP328-S1	LP33-SP201	LP33-SP203	LP33-SP204	LP33-SP205	LP33-SP209	LP33-SP211	LP33-SP212
Depth (m BGL)	0.00-0.10	0.00-0.10	0.00-0.10	0.00-0.10	0.00-0.10	0.00-0.10	0.00-0.10	0.00-0.10	0.00-0.10	0.00-0.10	0.00-0.10	0.00-0.10	0.00-0.10	0.00-0.10	0.00-0.10	0.00-0.10	0.00-0.10	0.00-0.10	0.00-0.10	0.00-0.10	0.00-0.10	0.00-0.10	0.00-0.10	0.00-0.10
PFOA	4.89	1.99	14.3	5.55	4.48	3.86	1.9	2.19	6	4.49	2.89	6.45	2.88	0.829	<0.500	2.44	4.66	1.93	2.18	6	1.21	3.64	1.43	5.44
HQ (PFOA)	3.49	1.42	10.21	3.96	3.20	2.76	1.36	1.56	4.29	3.21	2.06	4.61	2.06	0.59		1.74	3.33	1.38	1.56	4.29	0.86	2.60	1.02	3.89
PFHxS	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
HQ (PFHxS)																								
PFNA	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
HQ (PFNA)																								
Total PFOS	<0.600	<0.600	1.93	<0.600	<0.600	<0.600	<0.600	1.74	2.44	<0.600	0.768	<0.600	<0.600	2.69	0.989	12.1	1.52	<0.600	<0.600	<0.600	2.15	1.19	<0.600	2.41
HQ (PFOS)			0.71					0.64	0.90		0.28			1.00	0.37	4.48	0.56				0.80	0.44		0.89
Hazard Index	**3.49**	**1.42**	**10.93**	**3.96**	**3.20**	**2.76**	**1.36**	**2.21**	**5.19**	**3.21**	**2.35**	**4.61**	**2.06**	**1.59**	**0.37**	**6.22**	**3.89**	**1.38**	**1.56**	**4.29**	**1.66**	**3.04**	**1.02**	**4.78**

Sample ID	LP33-SP301	LP33-SP303	LP33-SP305	LP33-SP306	LP33-SP307	LP33-SP309	LP33-SP311	LP33-SP313	LP33-SP315	LP33-SP317-S1	LP33-SP319	LP33-SP321	LP33-SP325	LP33-SP327	LP33-SP329	LP33-SP206	LP33-SP210	LP33-SP301	LP33-SP304	LP33-SP305	LP33-SP308-S1	LP33-SP309	LP33-SP312	LP33-SP313
Depth (m BGL)	0.10-0.20	0.10-0.20	0.10-0.20	0.10-0.20	0.10-0.20	0.10-0.20	0.10-0.20	0.10-0.20	0.10-0.20	0.10-0.20	0.10-0.20	0.10-0.20	0.10-0.20	0.10-0.20	0.10-0.20	0.10-0.20	0.10-0.20	0.20-0.30	0.20-0.30	0.20-0.30	0.20-0.30	0.20-0.30	0.20-0.30	0.20-0.30	0.20-0.30
PFOA	1.74	1.71	4.63	1.55	2.46	4.14	1.34	4.84	4.22	7.73	4.34	9.94	5.09	3.97	3.07	3.49	7.3	2.38	1.68	3.09	6.2	1.28	2.4	2.46
HQ (PFOA)	1.24	1.22	3.31	1.11	1.76	2.96	0.96	3.46	3.01	5.52	3.10	7.10	3.64	2.84	2.19	2.49	5.21	1.70	1.20	2.21	4.43	0.91	1.71	1.76
PFHxS	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
HQ (PFHxS)																								
PFNA	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
HQ (PFNA)																								
Total PFOS	<0.600	<0.600	<0.600	<0.600	<0.600	<0.600	<0.600	10	2.52	1.1	<0.600	<0.600	1.42	<0.600	<0.600	8.34	<0.600	<0.600	<0.600	<0.600	<0.600	<0.600	1.25	1.95
HQ (PFOS)								3.70	0.93	0.41			0.53			3.09							0.46	0.72
Hazard Index	**1.24**	**1.22**	**3.31**	**1.11**	**1.76**	**2.96**	**0.96**	**7.16**	**3.95**	**5.93**	**3.10**	**7.10**	**4.16**	**2.84**	**2.19**	**5.58**	**5.21**	**1.70**	**1.20**	**2.21**	**4.43**	**0.91**	**2.18**	**2.48**

Sample ID	LP33-SP316	LP33-SP317-S1	LP33-SP317-S1	LP33-SP317-S2	LP33-SP317-S2	LP33-SP320	LP33-SP321	LP33-SP324	LP33-SP325	LP33-SP328-S1	LP33-SP201	LP33-SP208	LP33-SP209	LP33-SP212	LP33-SP302	LP33-SP303	LP33-SP306	LP33-SP307	LP33-SP310	LP33-SP311	LP33-SP314	LP33-SP315	LP33-SP318	LP33-SP319
Depth (m BGL)	0.20-0.30	0.20-0.30	0.20-0.30	0.20-0.30	0.20-0.30	0.20-0.30	0.20-0.30	0.20-0.30	0.20-0.30	0.20-0.30	0.20-0.30	0.20-0.30	0.20-0.30	0.20-0.30	0.30-0.40	0.30-0.40	0.30-0.40	0.30-0.40	0.30-0.40	0.30-0.40	0.30-0.40	0.30-0.40	0.30-0.40	0.30-0.40
PFOA	6.23	4.71	5.96	6.14	7.3	11.6	10.1	1.55	5.26	3.41	4.48	3.62	4.14	4.96	6.53	5.72	1.7	2.33	1.9	6.96	3.11	4.08	1.39	5.87
HQ (PFOA)	4.45	3.36	4.26	4.39	5.21	8.29	7.21	1.11	3.76	2.44	3.20	2.59	2.96	3.54	4.66	4.09	1.21	1.66	1.36	4.97	2.22	2.91	0.99	4.19
PFHxS	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
HQ (PFHxS)																								
PFNA	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
HQ (PFNA)																								
Total PFOS	<0.600	1.01	0.947	<0.600	<0.600	<0.600	<0.600	5.97	1.08	0.982	<0.600	4.09	<0.600	0.82	<0.600	<0.600	<0.600	<0.600	<0.600	<0.600	<0.600	4.95	<0.600	<0.600
HQ (PFOS)		0.37	0.35					2.21	0.40	0.36		1.51		0.30								1.83		
Hazard Index	**4.45**	**3.74**	**4.61**	**4.39**	**5.21**	**8.29**	**7.21**	**3.32**	**4.16**	**2.80**	**3.20**	**4.10**	**2.96**	**3.85**	**4.66**	**4.09**	**1.21**	**1.66**	**1.36**	**4.97**	**2.22**	**4.76**	**0.99**	**4.19**

Sample ID	LP33-SP322	LP33-SP323	LP33-SP326	LP33-SP327	LP33-SP329	LP33-SP202	LP33-SP206	LP33-SP207	LP33-SP211	LP33-SP302	LP33-SP304	LP33-SP308-S1	LP33-SP310	LP33-SP312	LP33-SP314	LP33-SP316	LP33-SP318	LP33-SP320	LP33-SP322	LP33-SP323	LP33-SP324	LP33-SP326	LP33-SP328-S1	LP33-SP328-S1
Depth (m BGL)	0.30-0.40	0.30-0.40	0.30-0.40	0.30-0.40	0.30-0.40	0.30-0.40	0.30-0.40	0.30-0.40	0.30-0.40	0.40-0.50	0.40-0.50	0.40-0.50	0.40-0.50	0.40-0.50	0.40-0.50	0.40-0.50	0.40-0.50	0.40-0.50	0.40-0.50	0.40-0.50	0.40-0.50	0.40-0.50	0.40-0.50	0.40-0.50	0.40-0.50
PFOA	1.6	1.8	2.5	8.26	4.15	2.05	4.07	2.12	3.26	7.05	3.85	6.64	1.87	5.95	3.96	4.13	2.23	7.59	4.89	1.97	2.61	6.81	3.13	2.1
HQ (PFOA)	1.14	1.29	1.79	5.90	2.96	1.46	2.91	1.51	2.33	5.04	2.75	4.74	1.34	4.25	2.83	2.95	1.59	5.42	3.49	1.41	1.86	4.86	2.24	1.50
PFHxS	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
HQ (PFHxS)																								
PFNA	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
HQ (PFNA)																								
Total PFOS	<0.600	<0.600	3.37	<0.600	<0.600	<0.600	3.25	<0.600	<0.600	<0.600	<0.600	<0.600	<0.600	<0.600	<0.600	<0.600	<0.600	<0.600	<0.600	<0.600	2.92	3.69	<0.600	<0.600
HQ (PFOS)			1.25				1.20														1.08	1.37		
Hazard Index	**1.14**	**1.29**	**3.03**	**5.90**	**2.96**	**1.46**	**4.11**	**1.51**	**2.33**	**5.04**	**2.75**	**4.74**	**1.34**	**4.25**	**2.83**	**2.95**	**1.59**	**5.42**	**3.49**	**1.41**	**2.95**	**6.23**	**2.24**	**1.50**

Sample ID	LP33-SP328-S2	LP33-SP328-S2	LP33-SP201	LP33-SP203	LP33-SP205	LP33-SP207	LP33-SP301	LP33-SP303	LP33-SP305	LP33-SP306	LP33-SP307	LP33-SP309	LP33-SP311	LP33-SP313	LP33-SP315	LP33-SP317-S1	LP33-SP319	LP33-SP321	LP33-SP325	LP33-SP327	LP33-SP329	LP33-SP202	LP33-SP208	LP33-SP210
Depth (m BGL)	0.40-0.50	0.40-0.50	0.40-0.50	0.40-0.50	0.40-0.50	0.40-0.50	0.50-0.60	0.50-0.60	0.50-0.60	0.50-0.60	0.50-0.60	0.50-0.60	0.50-0.60	0.50-0.60	0.50-0.60	0.50-0.60	0.50-0.60	0.50-0.60	0.50-0.60	0.50-0.60	0.50-0.60	0.50-0.60	0.50-0.60	0.50-0.60
PFOA	3.03	2.99	3	1.31	1.78	3.24	6.93	11.2	6.52	1.16	4.6	4	12.6	2.83	3.77	4.19	8.11	5.89	19.3	5.23	3.16	4.7	6.74	3.12
HQ (PFOA)	2.16	2.14	2.14	0.94	1.27	2.31	4.95	8.00	4.66	0.83	3.29	2.86	9.00	2.02	2.69	2.99	5.79	4.21	13.79	3.74	2.26	3.36	4.81	2.23
PFHxS	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
HQ (PFHxS)																								
PFNA	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
HQ (PFNA)																								
Total PFOS	<0.600	<0.600	<0.600	<0.600	<0.600	<0.600	<0.600	<0.600	<0.600	<0.600	<0.600	<0.600	<0.600	<0.600	<0.600	<0.600	<0.600	<0.600	<0.600	<0.600	<0.600	<0.600	0.914	<0.600
HQ (PFOS)																							0.34	
Hazard Index	**2.16**	**2.14**	**2.14**	**0.94**	**1.27**	**2.31**	**4.95**	**8.00**	**4.66**	**0.83**	**3.29**	**2.86**	**9.00**	**2.02**	**2.69**	**2.99**	**5.79**	**4.21**	**13.79**	**3.74**	**2.26**	**3.36**	**5.15**	**2.23**

Appendix C.2

CLEA MODEL RUNS. ALLOTMENTS. CHILD. 4.9 UG/KG PFOA

CLEA Software Version 1.071

Report generated 16-May-25

Report title Sandringham Avenue Allotments. Child. 4.9 ug/kg PFOA

Created by WSP UK Ltd

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	PFOA (updated PFOA oral MDI)	0.00E+00	0.00E+00	0.00E+00	3.51	NR	NR	#DIV/0!	Yes	No	Yes	Yes	Yes	No	No	0	0
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	
13																	
14																	
15																	
16																	
17																	
18																	
19																	
20																	

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																
22																
23																
24																
25																
26																
27																
28																
29																
30																

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	PFOA (updated PFOA oral MDI)	11.3	88.7	0.0	100.0	4.90E-03	0.00E+00	NA	8.34E-11	0.00E+00	NA	NA	NA	4.27E-04	2.61E-04	1.09E-05	1.05E-04	0.00E+00	0.00E+00
2																			
3																			
4																			
5																			
6																			
7																			
8																			
9																			
10																			
11																			
12																			
13																			
14																			
15																			
16																			
17																			
18																			
19																			
20																			

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
21																		
22																		
23																		
24																		
25																		
26																		
27																		
28																		
29																		
30																		

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	PFOA (updated PFOA oral MDI)	9.78E-09	1.09E-06	4.87E-09	3.98E-12	0.00E+00	7.99E-07	6.30E-08	0.50	55.41	0.25	0.00	0.00	0.00	40.64	3.21
2																
3																
4																
5																
6																
7																
8																
9																
10																
11																
12																
13																
14																
15																
16																
17																
18																
19																
20																

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)
21															
22															
23															
24															
25															
26															
27															
28															
29															
30															

Environment Agency

		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)
1	PFOA (updated PFOA oral MDI)	TDI	0.00063	NR	0	0.0142	0.00104	0.00E+00	0.00E+00	0.00E+00	0	0	0.1	0.5	1	1	1
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	
13																	
14																	
15																	
16																	
17																	
18																	
19																	
20																	

Environment Agency

	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)
21																
22																
23																
24																
25																
26																
27																
28																
29																
30																

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	PFOA (updated PFOA oral MDI)	3.48E-02	0.00E+00	4.14E+03	0.0871 fw	0.0532 fw	0.00223 fw	0.0214 fw	0.00E+00	0.00E+00
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										

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)
21									
22									
23									
24									
25									
26									
27									
28									
29									
30									

CLEA Software Version 1.071

Report generated	16/05/2025
Report title	Sandringham Avenue Allotments. Child. 4.9 ug/kg PFOA
Created by	WSP UK Ltd

Environment Agency

BASIC SETTINGS

Land Use	Allotments (C4SL)						
Building	No building						
Receptor	Female (allot)	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	✗

Land Use Allotments (C4SL)

Receptor Female (allot)

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	25	180	0	25	0	25	0.0	3.0	0.00	1.00	0.10	5.60	0.7	10.3	0.32	0.26	3.43E-01
2	130	365	0	130	0	130	0.0	3.0	0.00	1.00	0.10	9.80	0.8	18.8	0.33	0.26	4.84E-01
3	130	365	0	130	0	130	0.0	3.0	0.00	1.00	0.10	12.70	0.9	20.7	0.32	0.25	5.82E-01
4	130	365	0	130	0	130	0.0	3.0	0.00	1.00	0.10	15.10	0.9	19.1	0.35	0.28	6.36E-01
5	65	365	0	65	0	65	0.0	3.0	0.00	1.00	0.10	16.90	1.0	21.3	0.35	0.28	7.04E-01
6	65	365	0	65	0	65	0.0	3.0	0.00	1.00	0.10	19.70	1.1	24.9	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	17.6	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	20.2	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	21.8	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	25.0	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	28.4	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	19.8	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	22.7	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	24.5	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	27.2	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	28.3	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	27.4	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	25.4	0.33	0.27	1.80E+00

Consumption Rates

Environment Agency

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	3.47E+00	5.22E+00	9.22E+00	8.90E-01	1.07E+00	1.87E+00	7.12E+00	1.07E+01	1.60E+01	1.83E+00	2.23E+00	3.82E+00
2	3.34E+00	1.61E+00	3.14E+00	1.93E+00	2.60E-01	5.84E+00	5.87E+00	2.83E+00	6.60E+00	3.39E+00	4.60E-01	1.03E+01
3	3.34E+00	1.61E+00	3.14E+00	1.93E+00	2.60E-01	5.84E+00	5.87E+00	2.83E+00	6.60E+00	3.39E+00	4.60E-01	1.03E+01
4	3.34E+00	1.61E+00	3.14E+00	1.93E+00	2.60E-01	5.84E+00	5.87E+00	2.83E+00	6.60E+00	3.39E+00	4.60E-01	1.03E+01
5	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
6	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
7	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
8	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
9	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
10	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
11	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
12	1.03E+00	4.90E-01	1.60E+00	5.10E-01	4.00E-02	1.18E+00	1.87E+00	8.90E-01	3.05E+00	9.30E-01	8.00E-02	2.13E+00
13	1.03E+00	4.90E-01	1.60E+00	5.10E-01	4.00E-02	1.18E+00	1.87E+00	8.90E-01	3.05E+00	9.30E-01	8.00E-02	2.13E+00
14	1.03E+00	4.90E-01	1.60E+00	5.10E-01	4.00E-02	1.18E+00	1.87E+00	8.90E-01	3.05E+00	9.30E-01	8.00E-02	2.13E+00
15	1.03E+00	4.90E-01	1.60E+00	5.10E-01	4.00E-02	1.18E+00	1.87E+00	8.90E-01	3.05E+00	9.30E-01	8.00E-02	2.13E+00
16	1.03E+00	4.90E-01	1.60E+00	5.10E-01	4.00E-02	1.18E+00	1.87E+00	8.90E-01	3.05E+00	9.30E-01	8.00E-02	2.13E+00
17	1.26E+00	6.00E-01	1.18E+00	6.90E-01	9.00E-02	1.27E+00	2.36E+00	1.12E+00	2.35E+00	1.29E+00	1.80E-01	2.38E+00
18	1.35E+00	6.40E-01	1.25E+00	7.40E-01	1.00E-01	1.36E+00	2.34E+00	1.12E+00	2.36E+00	1.28E+00	1.80E-01	2.37E+00

Top 2 applied? Yes

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 (%)	6.00E+00
Fraction of organic carbon ($g\ g^{-1}$)	3.48E-02
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)	0
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 *	120.00
Air dispersion factor at height of 1.6m *	0.00
Fraction of site cover ($m^2\ m^{-2}$)	0.5

* 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 High

Appendix C.3

CLEA MODEL RUNS. ALLOTMENTS. ADULT. 4.9 UG/KG PFOA

CLEA Software Version 1.071

Report generated 16-May-25

Report title Sandringham Avenue Allotments. Adult. 4.9 ug/kg PFOA

Created by WSP UK Ltd

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	PFOA (updated PFOA oral MDI)	0.00E+00	0.00E+00	0.00E+00	1.18	NR	NR	#DIV/0!	No	No	Yes	Yes	Yes	No	No	0	0
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	
13																	
14																	
15																	
16																	
17																	
18																	
19																	
20																	

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																
22																
23																
24																
25																
26																
27																
28																
29																
30																

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	PFOA (updated PFOA oral MDI)	11.3	88.7	0.0	100.0	4.90E-03	0.00E+00	NA	8.34E-11	3.58E-11	NA	NA	NA	4.27E-04	2.61E-04	1.09E-05	1.05E-04	0.00E+00	0.00E+00
2																			
3																			
4																			
5																			
6																			
7																			
8																			
9																			
10																			
11																			
12																			
13																			
14																			
15																			
16																			
17																			
18																			
19																			
20																			

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
21																		
22																		
23																		
24																		
25																		
26																		
27																		
28																		
29																		
30																		

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	PFOA (updated PFOA oral MDI)	2.47E-09	4.80E-07	2.38E-09	1.24E-12	0.00E+00	2.03E-07	1.49E-08	0.35	68.34	0.34	0.00	0.00	0.00	28.85	2.11
2																
3																
4																
5																
6																
7																
8																
9																
10																
11																
12																
13																
14																
15																
16																
17																
18																
19																
20																

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)
21															
22															
23															
24															
25															
26															
27															
28															
29															
30															

Environment Agency

		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)
1	PFOA (updated PFOA oral MDI)	TDI	0.00063	NR	0	0.0142	0.00104	0.00E+00	0.00E+00	0.00E+00	0	0	0.1	0.5	1	1	1
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	
13																	
14																	
15																	
16																	
17																	
18																	
19																	
20																	

Environment Agency

	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)
21																
22																
23																
24																
25																
26																
27																
28																
29																
30																

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	PFOA (updated PFOA oral MDI)	3.48E-02	0.00E+00	4.14E+03	0.0871 fw	0.0532 fw	0.00223 fw	0.0214 fw	0.00E+00	0.00E+00
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										

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)
21									
22									
23									
24									
25									
26									
27									
28									
29									
30									

CLEA Software Version 1.071

Report generated	16/05/2025
Report title	Sandringham Avenue Allotments. Adult. 4.9 ug/kg PFOA
Created by	WSP UK Ltd

Environment Agency

BASIC SETTINGS

Land Use	Allotments (lifetime exposure C4SL)						
Building	No building						
Receptor	Female (allot)	Start age class	17	End age class	17	Exposure Duration	49 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	✗

Environment Agency

Land Use Allotments (lifetime exposure C4SL)

Receptor Female (allot)

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	25	180	0	25	0	25	0.0	3.0	0.00	1.00	0.10	5.60	0.7	10.3	0.32	0.26	3.43E-01
2	130	365	0	130	0	130	0.0	3.0	0.00	1.00	0.10	9.80	0.8	18.8	0.33	0.26	4.84E-01
3	130	365	0	130	0	130	0.0	3.0	0.00	1.00	0.10	12.70	0.9	20.7	0.32	0.25	5.82E-01
4	130	365	0	130	0	130	0.0	3.0	0.00	1.00	0.10	15.10	0.9	19.1	0.35	0.28	6.36E-01
5	65	365	0	65	0	65	0.0	3.0	0.00	1.00	0.10	16.90	1.0	21.3	0.35	0.28	7.04E-01
6	65	365	0	65	0	65	0.0	3.0	0.00	1.00	0.10	19.70	1.1	24.9	0.33	0.26	7.94E-01
7	65	365	0	65	0	65	0.0	3.0	0.00	1.00	0.10	22.10	1.2	17.6	0.22	0.15	8.73E-01
8	65	365	0	65	0	65	0.0	3.0	0.00	1.00	0.10	25.30	1.2	20.2	0.22	0.15	9.36E-01
9	65	365	0	65	0	65	0.0	3.0	0.00	1.00	0.10	27.50	1.3	21.8	0.22	0.15	1.01E+00
10	65	365	0	65	0	65	0.0	3.0	0.00	1.00	0.10	31.40	1.3	25.0	0.22	0.15	1.08E+00
11	65	365	0	65	0	65	0.0	3.0	0.00	1.00	0.10	35.70	1.4	28.4	0.22	0.14	1.19E+00
12	65	365	0	65	0	65	0.0	3.0	0.00	1.00	0.10	41.30	1.4	19.8	0.22	0.14	1.29E+00
13	25	365	0	25	0	25	0.0	3.0	0.00	0.30	0.05	47.20	1.5	22.7	0.22	0.14	1.42E+00
14	25	365	0	25	0	25	0.0	3.0	0.00	0.30	0.05	51.20	1.6	24.5	0.22	0.14	1.52E+00
15	25	365	0	25	0	25	0.0	3.0	0.00	0.30	0.05	56.70	1.6	27.2	0.21	0.14	1.60E+00
16	25	365	0	25	0	25	0.0	3.0	0.00	0.30	0.05	59.00	1.6	28.3	0.21	0.14	1.63E+00
17	258	365	0	258	0	258	0.0	3.0	0.00	0.30	0.05	70.00	1.6	27.4	0.33	0.27	1.78E+00
18	258	365	0	258	0	258	0.0	3.0	0.00	0.30	0.05	70.90	1.6	25.4	0.33	0.27	1.80E+00

Consumption Rates

Environment Agency

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	3.47E+00	5.22E+00	9.22E+00	8.90E-01	1.07E+00	1.87E+00	7.12E+00	1.07E+01	1.60E+01	1.83E+00	2.23E+00	3.82E+00
2	3.34E+00	1.61E+00	3.14E+00	1.93E+00	2.60E-01	5.84E+00	5.87E+00	2.83E+00	6.60E+00	3.39E+00	4.60E-01	1.03E+01
3	3.34E+00	1.61E+00	3.14E+00	1.93E+00	2.60E-01	5.84E+00	5.87E+00	2.83E+00	6.60E+00	3.39E+00	4.60E-01	1.03E+01
4	3.34E+00	1.61E+00	3.14E+00	1.93E+00	2.60E-01	5.84E+00	5.87E+00	2.83E+00	6.60E+00	3.39E+00	4.60E-01	1.03E+01
5	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
6	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
7	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
8	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
9	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
10	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
11	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
12	1.03E+00	4.90E-01	1.60E+00	5.10E-01	4.00E-02	1.18E+00	1.87E+00	8.90E-01	3.05E+00	9.30E-01	8.00E-02	2.13E+00
13	1.03E+00	4.90E-01	1.60E+00	5.10E-01	4.00E-02	1.18E+00	1.87E+00	8.90E-01	3.05E+00	9.30E-01	8.00E-02	2.13E+00
14	1.03E+00	4.90E-01	1.60E+00	5.10E-01	4.00E-02	1.18E+00	1.87E+00	8.90E-01	3.05E+00	9.30E-01	8.00E-02	2.13E+00
15	1.03E+00	4.90E-01	1.60E+00	5.10E-01	4.00E-02	1.18E+00	1.87E+00	8.90E-01	3.05E+00	9.30E-01	8.00E-02	2.13E+00
16	1.03E+00	4.90E-01	1.60E+00	5.10E-01	4.00E-02	1.18E+00	1.87E+00	8.90E-01	3.05E+00	9.30E-01	8.00E-02	2.13E+00
17	1.26E+00	6.00E-01	1.18E+00	6.90E-01	9.00E-02	1.27E+00	2.36E+00	1.12E+00	2.35E+00	1.29E+00	1.80E-01	2.38E+00
18	1.35E+00	6.40E-01	1.25E+00	7.40E-01	1.00E-01	1.36E+00	2.34E+00	1.12E+00	2.36E+00	1.28E+00	1.80E-01	2.37E+00

Top 2 applied? Yes

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 (%)	6.00E+00
Fraction of organic carbon ($g\ g^{-1}$)	3.48E-02
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)	0
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)	49
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 *		120.00
Air dispersion factor at height of 1.6m *		280.00
Fraction of site cover ($m^2\ m^{-2}$)		0.5

* 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 High

Appendix C.4

CLEA MODEL RUNS. RESIDENTIAL NO HG. CHILD. 8.9 UG/KG PFOA

CLEA Software Version 1.071

Report generated	16-May-25
Report title	Sandringham Avenue. Residential. ADE. Child.8.9 ug/kg PFOA
Created by	WSP UK Ltd

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	PFOA (only PFOA MDI)	0.00E+00	0.00E+00	0.00E+00	0.22	NR	NR	#DIV/0!	Yes	No	Yes	Yes	Yes	No	No	0	0
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	
13																	
14																	
15																	
16																	
17																	
18																	
19																	
20																	

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																
22																
23																
24																
25																
26																
27																
28																
29																
30																

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	PFOA (only PFOA MDI)	11.3	88.7	0.0	100.0	8.90E-03	0.00E+00	4.45E-03	3.79E-12	0.00E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA
2																			
3																			
4																			
5																			
6																			
7																			
8																			
9																			
10																			
11																			
12																			
13																			
14																			
15																			
16																			
17																			
18																			
19																			
20																			

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
21																		
22																		
23																		
24																		
25																		
26																		
27																		
28																		
29																		
30																		

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	PFOA (only PFOA MDI)	6.60E-08	0.00E+00	2.94E-09	1.47E-10	0.00E+00	7.20E-07	6.30E-08	7.74	0.00	0.35	0.02	0.00	0.00	84.50	7.40
2																
3																
4																
5																
6																
7																
8																
9																
10																
11																
12																
13																
14																
15																
16																
17																
18																
19																
20																

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)
21															
22															
23															
24															
25															
26															
27															
28															
29															
30															

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	PFOA (only PFOA MDI)	TDI	0.00063	NR	0	0.0128	0.00104	0.00E+00	0.00E+00	0.00E+00	0	0	0.1	0.5	1	1	1
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	
13																	
14																	
15																	
16																	
17																	
18																	
19																	
20																	

Environment Agency

	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)
21																
22																
23																
24																
25																
26																
27																
28																
29																
30																

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	PFOA (only PFOA MDI)	3.48E-02	0.00E+00	4.14E+03	0.0871 fw	0.0532 fw	0.00223 fw	0.0214 fw	0.00E+00	0.00E+00
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										

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)
21									
22									
23									
24									
25									
26									
27									
28									
29									
30									

CLEA Software Version 1.071

Report generated 16/05/2025

Report title Sandringham Avenue. Residential. ADE. Child.8.9 ug/kg PFOA

Created by WSP UK Ltd

BASIC SETTINGS

Land Use Residential without 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	✖

Environment Agency

Land Use Residential without 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	0	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	0	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	0	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	0	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	0	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	0	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

Environment Agency

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	3.47E+00	5.22E+00	9.22E+00	8.90E-01	1.07E+00	1.87E+00	7.12E+00	1.07E+01	1.60E+01	1.83E+00	2.23E+00	3.82E+00
2	3.34E+00	1.61E+00	3.14E+00	1.93E+00	2.60E-01	5.84E+00	5.87E+00	2.83E+00	6.60E+00	3.39E+00	4.60E-01	1.03E+01
3	3.34E+00	1.61E+00	3.14E+00	1.93E+00	2.60E-01	5.84E+00	5.87E+00	2.83E+00	6.60E+00	3.39E+00	4.60E-01	1.03E+01
4	3.34E+00	1.61E+00	3.14E+00	1.93E+00	2.60E-01	5.84E+00	5.87E+00	2.83E+00	6.60E+00	3.39E+00	4.60E-01	1.03E+01
5	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
6	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
7	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
8	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
9	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
10	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
11	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
12	1.03E+00	4.90E-01	1.60E+00	5.10E-01	4.00E-02	1.18E+00	1.87E+00	8.90E-01	3.05E+00	9.30E-01	8.00E-02	2.13E+00
13	1.03E+00	4.90E-01	1.60E+00	5.10E-01	4.00E-02	1.18E+00	1.87E+00	8.90E-01	3.05E+00	9.30E-01	8.00E-02	2.13E+00
14	1.03E+00	4.90E-01	1.60E+00	5.10E-01	4.00E-02	1.18E+00	1.87E+00	8.90E-01	3.05E+00	9.30E-01	8.00E-02	2.13E+00
15	1.03E+00	4.90E-01	1.60E+00	5.10E-01	4.00E-02	1.18E+00	1.87E+00	8.90E-01	3.05E+00	9.30E-01	8.00E-02	2.13E+00
16	1.03E+00	4.90E-01	1.60E+00	5.10E-01	4.00E-02	1.18E+00	1.87E+00	8.90E-01	3.05E+00	9.30E-01	8.00E-02	2.13E+00
17	1.26E+00	6.00E-01	1.18E+00	6.90E-01	9.00E-02	1.27E+00	2.36E+00	1.12E+00	2.35E+00	1.29E+00	1.80E-01	2.38E+00
18	1.35E+00	6.40E-01	1.25E+00	7.40E-01	1.00E-01	1.36E+00	2.34E+00	1.12E+00	2.36E+00	1.28E+00	1.80E-01	2.37E+00

Top 2 applied? Yes

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 (%)	6.00E+00
Fraction of organic carbon ($g\ g^{-1}$)	3.48E-02
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)	0
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 None

Appendix C.5

CLEA MODEL RUNS. RESIDENTAIL NO HG. ADULT. 8.9 UG/KG PFOA

CLEA Software Version 1.071

Report generated 16-May-25

Report title Sandringham Avenue. Residential. ADE. Adult.8.9 ug/kg PFOA

Created by WSP UK Ltd

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	PFOA (only PFOA MDI)	0.00E+00	0.00E+00	0.00E+00	0.02	NR	NR	#DIV/0!	No	No	Yes	Yes	Yes	No	No	0	0
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	
13																	
14																	
15																	
16																	
17																	
18																	
19																	
20																	

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																
22																
23																
24																
25																
26																
27																
28																
29																
30																

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	PFOA (only PFOA MDI)	11.3	88.7	0.0	100.0	8.90E-03	0.00E+00	4.45E-03	3.79E-12	4.78E-13	NA	NA	NA	NA	NA	NA	NA	NA	NA
2																			
3																			
4																			
5																			
6																			
7																			
8																			
9																			
10																			
11																			
12																			
13																			
14																			
15																			
16																			
17																			
18																			
19																			
20																			

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
21																		
22																		
23																		
24																		
25																		
26																		
27																		
28																		
29																		
30																		

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	PFOA (only PFOA MDI)	6.36E-09	0.00E+00	3.60E-09	3.38E-11	0.00E+00	1.83E-07	1.49E-08	3.06	0.00	1.73	0.02	0.00	0.00	88.04	7.15
2																
3																
4																
5																
6																
7																
8																
9																
10																
11																
12																
13																
14																
15																
16																
17																
18																
19																
20																

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)
21															
22															
23															
24															
25															
26															
27															
28															
29															
30															

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	PFOA (only PFOA MDI)	TDI	0.00063	NR	0	0.0128	0.00104	0.00E+00	0.00E+00	0.00E+00	0	0	0.1	0.5	1	1	1
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	
13																	
14																	
15																	
16																	
17																	
18																	
19																	
20																	

Environment Agency

	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)
21																
22																
23																
24																
25																
26																
27																
28																
29																
30																

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	PFOA (only PFOA MDI)	3.48E-02	0.00E+00	4.14E+03	0.0871 fw	0.0532 fw	0.00223 fw	0.0214 fw	0.00E+00	0.00E+00
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										

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)
21									
22									
23									
24									
25									
26									
27									
28									
29									
30									

CLEA Software Version 1.071

Report generated	16/05/2025
Report title	Sandringham Avenue. Residential. ADE. Adult.8.9 ug/kg PFOA
Created by	WSP UK Ltd

Environment Agency

BASIC SETTINGS

Land Use	Residential (lifetime exposure C4SL)						
Building	Small terraced house						
Receptor	Female (res C4SL)	Start age class	17	End age class	17	Exposure Duration	49 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	✗

Environment Agency

Land Use Residential (lifetime exposure 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	365	365	365	170	365	365	19.0	1.0	0.06	0.10	0.10	22.10	1.2	12.0	0.22	0.15	8.73E-01
8	365	365	365	170	365	365	19.0	1.0	0.06	0.10	0.10	25.30	1.2	12.0	0.22	0.15	9.36E-01
9	365	365	365	170	365	365	19.0	1.0	0.06	0.10	0.10	27.50	1.3	12.0	0.22	0.15	1.01E+00
10	365	365	365	170	365	365	19.0	1.0	0.06	0.10	0.10	31.40	1.3	12.0	0.22	0.15	1.08E+00
11	365	365	365	170	365	365	19.0	1.0	0.06	0.10	0.10	35.70	1.4	12.0	0.22	0.14	1.19E+00
12	365	365	365	170	365	365	19.0	1.0	0.06	0.10	0.10	41.30	1.4	15.2	0.22	0.14	1.29E+00
13	365	365	365	170	365	365	15.0	1.0	0.06	0.30	0.05	47.20	1.5	15.2	0.22	0.14	1.42E+00
14	365	365	365	170	365	365	15.0	1.0	0.06	0.30	0.05	51.20	1.6	15.2	0.22	0.14	1.52E+00
15	365	365	365	170	365	365	15.0	1.0	0.06	0.30	0.05	56.70	1.6	15.2	0.21	0.14	1.60E+00
16	365	365	365	170	365	365	15.0	1.0	0.06	0.30	0.05	59.00	1.6	15.2	0.21	0.14	1.63E+00
17	365	365	365	170	365	365	16.0	1.0	0.06	0.30	0.05	70.00	1.6	15.7	0.33	0.27	1.78E+00
18	365	365	365	170	365	365	16.0	1.0	0.06	0.30	0.05	70.90	1.6	13.6	0.33	0.27	1.80E+00

Consumption Rates

Environment Agency

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	3.47E+00	5.22E+00	9.22E+00	8.90E-01	1.07E+00	1.87E+00	7.12E+00	1.07E+01	1.60E+01	1.83E+00	2.23E+00	3.82E+00
2	3.34E+00	1.61E+00	3.14E+00	1.93E+00	2.60E-01	5.84E+00	5.87E+00	2.83E+00	6.60E+00	3.39E+00	4.60E-01	1.03E+01
3	3.34E+00	1.61E+00	3.14E+00	1.93E+00	2.60E-01	5.84E+00	5.87E+00	2.83E+00	6.60E+00	3.39E+00	4.60E-01	1.03E+01
4	3.34E+00	1.61E+00	3.14E+00	1.93E+00	2.60E-01	5.84E+00	5.87E+00	2.83E+00	6.60E+00	3.39E+00	4.60E-01	1.03E+01
5	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
6	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
7	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
8	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
9	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
10	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
11	2.54E+00	1.20E+00	2.65E+00	1.25E+00	1.10E-01	2.89E+00	4.53E+00	2.14E+00	4.95E+00	2.24E+00	1.90E-01	5.16E+00
12	1.03E+00	4.90E-01	1.60E+00	5.10E-01	4.00E-02	1.18E+00	1.87E+00	8.90E-01	3.05E+00	9.30E-01	8.00E-02	2.13E+00
13	1.03E+00	4.90E-01	1.60E+00	5.10E-01	4.00E-02	1.18E+00	1.87E+00	8.90E-01	3.05E+00	9.30E-01	8.00E-02	2.13E+00
14	1.03E+00	4.90E-01	1.60E+00	5.10E-01	4.00E-02	1.18E+00	1.87E+00	8.90E-01	3.05E+00	9.30E-01	8.00E-02	2.13E+00
15	1.03E+00	4.90E-01	1.60E+00	5.10E-01	4.00E-02	1.18E+00	1.87E+00	8.90E-01	3.05E+00	9.30E-01	8.00E-02	2.13E+00
16	1.03E+00	4.90E-01	1.60E+00	5.10E-01	4.00E-02	1.18E+00	1.87E+00	8.90E-01	3.05E+00	9.30E-01	8.00E-02	2.13E+00
17	1.26E+00	6.00E-01	1.18E+00	6.90E-01	9.00E-02	1.27E+00	2.36E+00	1.12E+00	2.35E+00	1.29E+00	1.80E-01	2.38E+00
18	1.35E+00	6.40E-01	1.25E+00	7.40E-01	1.00E-01	1.36E+00	2.34E+00	1.12E+00	2.36E+00	1.28E+00	1.80E-01	2.37E+00

Top 2 applied? Yes

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 (%)	6.00E+00
Fraction of organic carbon ($g\ g^{-1}$)	3.48E-02
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)	0
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)	49
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 *		19000.00
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

8 First Street
Manchester
M15 4RP

wsp.com