

Off-Site Human Health Risk Assessment July 2016

Executive Summary

RAAF Base Williamtown, Williamtown NSW

Department of Defence

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RAAF Base Williamtown Stage 2B Environmental Investigation

Client: Department of Defence

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Executive Summary

Introduction

As part of the Stage 2B Environmental Investigation (Stage 2B EI), AECOM Services Pty Limited (AECOM) was engaged by the Department of Defence (Defence) to undertake an off-Site human health risk assessment (HHRA) as part of its response to the detection of per and poly-fluorinated alkyl substances (PFAS) contamination associated with historical activities at the Royal Australian Air Force (RAAF) Base Williamtown, New South Wales (NSW) (the Site) (**Figure ES1 – Margin of Safety for all exposure pathways**).

AECOM has also been engaged by Defence to complete the Stage 2B EI (AECOM, 2016a) that has largely informed this HHRA.

The Site has been an active airbase since 1941. The Site is headquarters of the Air Combat Group, which includes several aviation squadrons and support organisations that conduct training and operational activities on the airbase. As part of typical airbase activities, aqueous film forming foam (AFFF) was used at the Site for fire training and emergency response from around 1976. 3M Lightwater™ was the main AFFF product in use until approximately 2004, and is now known to have contained PFAS, including perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA). 3M Lightwater™ was replaced by Ansolite®, which was reported to contain significantly lower concentrations of PFOS and PFOA.

Previous environmental investigations, including the Stage 2B EI, have identified the presence of PFAS, including PFOS and PFOA, on and in the vicinity of the Site in soil, groundwater, surface water, sediment, terrestrial and aquatic biota.

On 3 September 2015, the NSW government defined an area encompassing the Site and surrounds as the 'NSW EPA Investigation Area'. On 4 September 2015, the NSW government by notification under Sections 8 and 9 of the *Fisheries Management Act 1994* issued an *Urgent Fishing Closure* which prohibited the taking of any species of fish from defined areas within Tilligerry Creek and Fullerton Cove. On 2 October 2015, by notification under Sections 8 and 11 of the *Fisheries Management Act 1994* the NSW government revoked the *Urgent Fishing Closure* and replaced it with a *Fishing Closure* which prohibited the taking of any species of fish from defined areas within Tilligerry Creek and Fullerton Cove.

Following review of preliminary data on 8 October 2015, the NSW government extended, as a precautionary measure, the 'NSW EPA Investigation Area' from the Site to the east, to include major surface water drains and creeks between the original investigation area and Tilligerry Creek. Residents within this area were advised by the NSW government to take precautions while further assessments are undertaken, including: *'not drinking or preparing food from private water bores, or water from dams, ponds, creeks or drains (town water is safe), not eating eggs from backyard chickens or drinking milk from cows and goats that have been drinking bore water or surface water in the area; and not eating fish, prawns or wild oysters caught in the nearby area.'*

Context of Risk Assessment

A phased approach to the assessment of risks has been adopted in consultation with the NSW Environment Protection Authority (NSW EPA). It is understood that the NSW EPA has been advised by the Williamtown Contamination Expert Panel (WCEP). The WCEP was established under Division 4 of the *Protection of the Environment Administration Act 1991* for the purpose of providing informed scientific advice to the NSW EPA to assist in developing the NSW government's response to Defence in relation to investigations to characterise and manage the PFAS contamination associated with the Site.

The phases of the risk assessment reporting process are as follows:

- **Preliminary human health risk assessments** previously reported by the NSW government:
 - Preliminary Dietary Exposure Assessment – Seafood – Tilligerry Creek and Fullerton Cove, Williamtown NSW, WCEP dated 3 November 2015 (WCEP, 2015a)
 - Preliminary Dietary Exposure Assessment – Commercial Oysters – Tilligerry Creek and Fullerton Cove, Williamtown NSW, WCEP dated 20 October 2015 (WCEP, 2015b)
 - Preliminary PFOS Risk Assessment for Seafood – Hunter River prawns (WCEP, 2015c).

- **Off-Site Human Health Risk Assessment – July 2016**, RAAF Base Williamtown Stage 2B Environmental Investigation (this report), which:
 - represents multiple pathway HHRA to evaluate the potential human health risks to identified receptors within the Off-Site Stage 2B Investigation Area from PFAS contamination
 - includes consideration of direct contact exposures to environmental media (e.g. soil, groundwater, surface water, sediment) as well as secondary exposures via dietary intakes, including seafood and home-grown plant and animal produce
 - assesses potentially complete exposure pathways identified through community surveys.
- **Ecological Risk Assessment**, RAAF Base Williamtown Stage 2B Environmental Investigation (in preparation), which will:
 - assess the potential risk from PFAS contamination to ecological receptors present in habitats in the Stage 2B Investigation Area
 - assess the potential for wider ecosystem impacts to result from the accumulation of PFAS in terrestrial and aquatic organisms exposed to Site-derived contamination.

The areas investigated to inform the risk assessments described above (hereafter referred to as the Stage 2B Investigation Area) include the Site and off-Site areas, both within the NSW EPA Investigation Area and surrounds (refer to **Section 1.3**). For the purposes of this risk assessment, the off-Site Stage 2B Investigation Area has been subdivided into two sections: (1) the Off-Site Stage 2B Investigation Area (excluding the Southern Area), and (2) the Southern Area, which is characterised by higher PFAS concentrations in unsaturated soil groundwater.

This HHRA is based on the data available at the time of preparation and consideration of the uncertainties and limitations of the available data and information. In particular, it is acknowledged that the nature and extent of contamination described in this HHRA is not necessarily a definitive description. Rather, it is a representation of conditions encountered when the samples were taken. Understanding of the nature and extent of contamination will continue to evolve as additional data is collected that expands the spatial coverage and provides an improved understanding of the temporal variability of PFAS concentrations. Where temporal and other forms of variability have been identified that may affect interpretation of data for the purpose of this HHRA, conservative assumptions have been adopted to address the identified uncertainties and minimise the impact on the resultant conclusions.

Objectives of the HHRA

The objective of this HHRA is to quantitatively assess the potential human health risks to identified off-Site receptors associated with exposure to PFAS impacted soil, groundwater, surface water, sediment, terrestrial biota and aquatic biota within the Stage 2B Investigation Area.

HHRA Framework and Methodology

The assessment of potential human health risks associated with environmental contamination has been conducted in accordance with the *National Environment Protection (Assessment of Site Contamination) Measure 1999* (as amended 2013) [ASC NEPM 2013]. The HHRA has been prepared in accordance with the ASC NEPM 2013 and *Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards*, Department of Health and Aging, 2012 Update (enHealth, 2012a).

The use of “Tier 1” assessment criteria for selection of Contaminants of Potential Concern (CoPC) is not considered appropriate for this HHRA because PFAS have the potential to bioaccumulate within the food chain and no published guideline values have been developed that are protective of the potential for bioaccumulation via all potential pathways. The identification of CoPC for the quantitative HHRA was therefore based on the availability of Toxicity Reference Values (TRV) derived in a manner consistent with relevant Australian guidance, for those PFAS detected above the laboratory Limit of Reporting (LOR).

At the time of commencement of this HHRA, there was no published Australian guidance on the toxicological assessment of PFAS. Therefore, AECOM used current toxicological profiles prepared by ToxConsult Pty Ltd (ToxConsult) for the following PFAS to inform this HHRA: PFOS, PFOA, perfluorohexane sulfonic acid (PFHxS), perfluorohexanoic acid (PFHxA), 6:2 fluorotelomer sulfonate (6:2FtS) and 8:2 fluorotelomer sulfonic acid (8:2

FtS). Based on the ToxConsult toxicity profiles, the HHRA has adopted TRV from the European Food Safety Authority (EFSA, 2008) for PFOS, PFOA and PFHxS. ToxConsult also considered the current body of international toxicological research for PFHxA to be sufficient to develop chemical-specific TRV to inform the HHRA.

Exposure Assessment

To facilitate preparation of the HHRA a conceptual site model (CSM) was prepared based on the available information to identify the following:

- potential source(s) of PFAS contamination
- potential PFAS contaminant transport and/or migration pathways
- potential human receptors that may be exposed to PFAS contamination via complete exposure pathways.

Where a linkage between a source and receptor via a complete pathway was identified, these were assessed quantitatively in the HHRA.

The focus of this risk assessment is to the identified off-Site receptors only. Therefore, the representative groups of people (receptors) who may be exposed to the PFAS contamination assessed in the HHRA were considered to be:

- residents/low locally sourced seafood consumers
- recreational fishers/moderate locally sourced seafood consumers
- commercial fishers/high locally sourced seafood consumers
- Council worker (who conducts maintenance on surface water drains and maintains below ground services)
- visitors (who frequently visit the Off-Site Stage 2B Investigation Area to conduct boating/swimming activities)
- beef farmers/high local grown beef consumers.

Identification of the potential frequency, extent and duration of exposure to environmental media by the above groups of receptors via identified exposure pathways was based on information gathered from community surveys and from published data from Australian and international sources.

Representative Exposure Point Concentrations (EPC) were identified through evaluation of the available data characterising the environmental media and the current understanding of how off-Site receptors might be exposed to PFAS contamination in the environment.

Conclusions

The following conclusions are provided with respect to the potential for elevated human health risks to identified off-Site human receptors as a result of PFAS concentrations reported in soil, groundwater, surface water, sediment, terrestrial biota and aquatic biota within the Off-Site Stage 2B Investigation Area.

Groundwater and unsaturated soil PFAS concentrations reported from the area immediately south of the Site (referred to as the Southern Area) are not consistent with the groundwater and unsaturated soil PFAS concentrations reported for the broader Off-Site Stage 2B Investigation Area. Therefore, potential risks to human health have been assessed separately in:

1. the Off-Site Stage 2B Investigation Area (excluding the Southern Area)
2. the Southern Area.

The Southern Area is illustrated on **Figure ES2 – Margin of Safety for all selected exposure pathways**. It is important to note that the extent of the Southern Area is preliminary and subject to further refinement based on the collection of additional data.

These conclusions should be read with the data gaps presented in **Section 3.9** and sensitivity assessment presented in **Section 8.0**. A summary of the conclusions is presented in **Table ES1**.

Off-Site Stage 2B Investigation Area (excluding the Southern Area)

- The potential risks to residents (including recreational and commercial fishers), non-resident commercial fishers, non-resident council workers and visitors from exposure to PFAS impact through the following exposure pathways are considered to be low and acceptable:
 - inhalation of dust (from soil irrigated by PFAS impacted groundwater or flooded by PFAS impacted surface water)
 - incidental ingestion of groundwater or surface water as a result of indoor use (excluding drinking water), outdoor use (including swimming pools, dams and surface water bodies) and irrigation
 - dermal contact with groundwater or surface water as a result of indoor use, outdoor use (including swimming pools, dams and surface water bodies) and irrigation
 - incidental ingestion of soil or sediment as a result of outdoor activities
 - dermal contact with soil or sediment as a result of outdoor activities.
- Exposure of residents (including recreational and commercial fishers) to PFAS impact through the following exposure pathways may result in elevated risks under conservative scenarios considered representative of upper level exposure:
 - ingestion of groundwater.
- It is suggested that consideration be given to restricting the following activities within the Off-Site Stage 2B Investigation Area:
 - drinking groundwater, particularly in parts of the Off-Site Stage 2B Investigation Area where elevated PFAS concentrations have been reported in groundwater.

Southern Area

- The potential risks to residents (including recreational and commercial fishers), non-resident commercial fishers and non-resident council workers from exposure to PFAS impact through the following exposure pathways are considered to be low and acceptable:
 - inhalation of dust (from soil irrigated by PFAS impacted groundwater or flooded by PFAS impacted surface water)
 - incidental ingestion of surface water as a result of indoor use (excluding drinking water), outdoor use (including swimming pools, dams and surface water bodies) and irrigation
 - dermal contact with groundwater or surface water as a result of indoor use, outdoor use (including swimming pools, dams and surface water bodies) and irrigation
 - incidental ingestion of soil or sediment as a result of outdoor activities
 - dermal contact with soil or sediment as a result of outdoor activities.
- Exposure of residents (including recreational and commercial fishers) to PFAS impact through the following exposure pathways may result in elevated risks under conservative scenarios considered representative of upper level exposure:
 - ingestion of groundwater
 - incidental ingestion of groundwater as a result of indoor use, outdoor use and irrigation, specifically:
 - showering and bathing using extracted groundwater
 - filling swimming pools and children's wading pools with extracted groundwater
 - sprinkler play with extracted groundwater.
- It is suggested that consideration be given to restricting the following activities within the Southern Area:
 - drinking groundwater
 - showering and bathing using extracted groundwater
 - filling swimming pools and children's wading pools with extracted groundwater
 - sprinkler play with extracted groundwater.

Exposure of infants to breast milk

- The increased risk from exposure to PFAS impact reported in environmental media to children and adults exposed to PFAS impact from breastmilk over a childhood (6 years) and lifetime (35 years) does not result in a meaningful increase to potential risk over a lifetime.

Locally sourced food (aquatic biota and terrestrial biota)

- The potential risks to residents (including recreational and commercial fishers) from exposure to PFAS impact through the following food pathways are considered to be low and acceptable:
 - consumption of honey
 - consumption of locally sourced seafood (including finfish, prawns, crabs and oysters)
 - consumption of locally grown fruit and vegetables
 - consumption of beef from cattle grown in the Off-Site Stage 2B Investigation Area (excluding the Southern Area) and exposed to surface water (or groundwater) from within the Off-Site Stage 2B Investigation Area (excluding the Southern Area) as their primary drinking water supply.
- Exposure of residents (including recreational and commercial fishers) to PFAS impact through the following food pathways may result in elevated risks under conservative scenarios considered representative of upper level exposure:
 - consumption of eggs from backyard chickens that are exposed to surface water or groundwater as their primary drinking water supply
 - consumption of beef from cattle grown in the Southern Area and exposed to surface water or groundwater from within the Southern Area as their primary drinking water supply
 - consumption of milk from dairy cows that are exposed to surface water from the Off-Site Stage 2B Investigation Area (by children) or groundwater from within the Southern Area (by children and adults) as their primary drinking water supply.
- It is suggested that consideration be given to restricting consumption of the following food pathways:
 - eggs from backyard chickens that are exposed to surface water or groundwater as their primary source of drinking water
 - milk from dairy cows that exposed to surface water or groundwater from within the Southern Area as their primary source of drinking water
 - beef from cattle grown in the Southern Area and exposed to surface water or groundwater from within the Southern Area as their primary source of drinking water.

Table ES1 Summary of HHRA Conclusions

Exposure Pathway	Receptor/Exposed Community	Potential Risk – Off-Site Stage 2B Investigation Area ³		Potential Risk - Southern Area		Suggested Precautions
		Upper ⁶	Typical ⁷	Upper ⁶	Typical ⁷	
Groundwater						
Ingestion of groundwater	Residents ¹	Elevated	Low & Acceptable	Elevated ⁴	Elevated ⁴	Restrict the use of groundwater for drinking
Incidental ingestion of groundwater as a result of indoor use (excluding drinking water), outdoor use (including swimming pools, dams and surface water bodies) and irrigation	Residents ¹ , non-resident council workers and visitors ²	Low & Acceptable	Low & Acceptable	Elevated	Low & Acceptable	Restrict the use of groundwater for: showering and bathing; filling swimming pools and children's wading pools; and, sprinkler play.
Dermal contact with groundwater as a result of indoor use, outdoor use (including swimming pools, and dams) and irrigation	Residents ¹ , non-resident council workers and visitors ²	Low & Acceptable	Low & Acceptable	Low & Acceptable	Low & Acceptable	None Advised
Surface Water						
Incidental ingestion of surface water as a result of outdoor use (including swimming pools, dams and surface water bodies) and irrigation	Residents ¹ , non-resident commercial fishers, non-resident council workers and visitors ²	Low & Acceptable	Low & Acceptable	Low & Acceptable	Low & Acceptable	None Advised
Dermal contact with surface water as a result of outdoor use (including swimming pools, dams and surface water bodies) and irrigation	Residents ¹ , non-resident commercial fishers, non-resident council workers and visitors ²	Low & Acceptable	Low & Acceptable	Low & Acceptable	Low & Acceptable	None Advised
Soil and Sediment						
Incidental ingestion of soil and sediment as a result of outdoor activities	Residents ¹ , non-resident commercial fishers, non-resident council workers and visitors ²	Low & Acceptable	Low & Acceptable	Low & Acceptable	Low & Acceptable	None Advised
Dermal contact with soil and sediment as a result of outdoor activities	Residents ¹ , non-resident commercial fishers, non-resident council workers and visitors ²	Low & Acceptable	Low & Acceptable	Low & Acceptable	Low & Acceptable	None Advised
Inhalation of Dust as a result of indoor and outdoor activities (from soil irrigated by PFAS impacted groundwater or flooded by PFAS impacted surface water)	Residents ¹ , non-resident commercial fishers, non-resident council workers and visitors ²	Low & Acceptable	Low & Acceptable	Low & Acceptable	Low & Acceptable	None Advised

Exposure Pathway	Receptor/Exposed Community	Potential Risk – Off-Site Stage 2B Investigation Area ³		Potential Risk - Southern Area		Suggested Precautions
		Upper ⁶	Typical ⁷	Upper ⁶	Typical ⁷	
Locally sourced food						
Consumption of locally sourced seafood (including finfish, prawns, crabs and oysters)	Residents ¹ , non-resident commercial fishers	Low & Acceptable	Low & Acceptable	Low & Acceptable	Low & Acceptable	None Advised
Consumption of locally grown fruit and vegetables	Residents ¹	Low & Acceptable	Low & Acceptable	Low & Acceptable	Low & Acceptable	None Advised
Consumption of honey	Residents ¹	Low & Acceptable	Low & Acceptable	Low & Acceptable	Low & Acceptable	None Advised
Consumption of beef from locally grown cattle and exposed to surface water as their primary drinking water supply	Residents ¹	Low & Acceptable	Low & Acceptable	Elevated	Low & Acceptable	Restrict consumption of beef from cattle grown in the Southern Area and exposed to surface water (or groundwater ⁵) from within the Southern Area as their primary drinking water source
Consumption of eggs from locally grown backyard chicken that are exposed to groundwater as their primary drinking water supply	Residents ¹	Elevated	Low & Acceptable	Elevated ⁴	Elevated ⁴	Restrict consumption of eggs from backyard chickens exposed to surface water or drinking water within the Stage 2B Investigation Area
Consumption of milk from locally grown dairy cows that are exposed to surface water as their primary drinking water supply	Residents ¹	Elevated	Low & Acceptable	Elevated	Low & Acceptable	Restrict consumption of milk from dairy cows exposed to surface water (or groundwater from within the Southern Area ⁵) as their primary drinking water source

Notes

- Residents includes recreational fishers/moderate locally sourced seafood consumers and commercial fishers/high locally sourced seafood consumers
- Visitors were not assessed in the Southern Area
- Stage 2B Investigation Area excludes the Site and the Southern Area
- Risk estimates were not calculated based on the assumption that as a result of the elevated groundwater concentrations reported in the Southern Area, the current management action advising against the drinking of groundwater and eating eggs from backyard chickens who have groundwater as the primary drinking water source within the Off-Site Stage 2B Investigation Area will remain in place for the Southern Area

5. Risk estimates for consumption of beef and milk were assessed based on the assumption that the cattle were exposed to surface water as their primary source of drinking water. However, the groundwater concentrations reported in the Southern Area is greater than those reported in the surface water. Therefore, if the risk estimate was based on the groundwater concentrations, the risk estimates for consumption of beef and milk would also be elevated
6. Upper exposure scenario – is intended to be protective of a reasonable maximum exposure (RME) and provide an assessment of potential risk from exposure that is reflective of the upper/high end of the range of exposure frequency and exposure concentrations. The upper exposure scenario would be expected to apply to only a small percentage of the population.
7. Typical exposure scenario – is intended to be protective of the average exposure and provide an assessment of potential risk from exposure that is reflective of typical exposure frequency and exposure concentrations. The typical exposure scenario would be expected to apply to the majority of the population.

Margin of Safety

It is understood that the multiple-pathway combinations included in the various scenarios presented in this HHRA may not be applicable to all off-Site stakeholders within the Off-Site Stage 2B Investigation Area. Therefore, a margin of safety (MoS) tool has been developed to assist individual stakeholders to develop an understanding the potential risks associated with their individual circumstances. It is anticipated that the MoS tool will also inform consideration of future risk management actions that might be taken by Defence and/or the NSW government. The MoS tool is presented in **Section 7.6** of this HHRA and summarised in the following figures.

Using the MoS tool, an individual can estimate their potential risk by summing the percentage for each exposure pathway applicable to their circumstance and comparing the cumulative sum against a target value of 100%. If the cumulative sum is less than 100%, it can be concluded that the risk associated with the selected cumulative exposure pathways is likely to be low and acceptable. If the cumulative sum is greater than 100%, the risk associated with the selected exposure pathways is likely to warrant either:

- consideration of further refinement of the risks associated with their individual circumstances based on the information in this HHRA
- consideration of a change in current exposure practices that may change or limit individual exposure and risk.

The values presented in the MoS are based on the Hazard Index (HI) calculated as part of this HHRA using upper exposure scenario assumptions for the Off-Site Stage 2B Investigation Area (excluding Southern Area).

Future Considerations

The results of this HHRA provide an improved understanding of the potential human health risks to identified off-Site receptors associated with exposure to PFAS impacted soil, groundwater, surface water, sediment, terrestrial biota (fruit and vegetables, eggs, beef and milk) and aquatic biota (finfish, crabs, prawns and oysters) within the NSW EPA Investigation Area.

It is understood Defence will undertake further assessment to address important limitations in current understanding of PFAS contamination arising from RAAF Base Williamtown within the NSW EPA Investigation Area and its understanding of associated risks to the community. It is understood the outcomes of Stage 2B EI and this HHRA will inform these further assessments and will also inform ongoing environmental monitoring and future management decisions in relation to PFAS contamination arising from RAAF Base Williamtown. The further assessments and ongoing monitoring programs of work will be developed in consultation with the NSW government and the NSW EPA Accredited Site Auditor.

Within this context, it is suggested that consideration be given to:

- further groundwater investigations within the Off-Site Stage 2B Investigation Area to improve characterisation of the extent of the Southern Zone and the distribution of PFAS contamination in shallow groundwater
- further investigation to improve understanding of the potential for PFAS exposure through eggs, milk and beef food pathways.

Depending on the outcome of these additional investigations, it may be necessary to revise this HHRA to quantify changes to currently identified potential human health risks.

Finally, it is possible that the regulatory guidelines within Australia relating to PFAS contamination may change in the future. In the event that regulatory guidelines change, particularly in relation to the toxicological values on which this HHRA is based, it may be necessary to revise this HHRA.

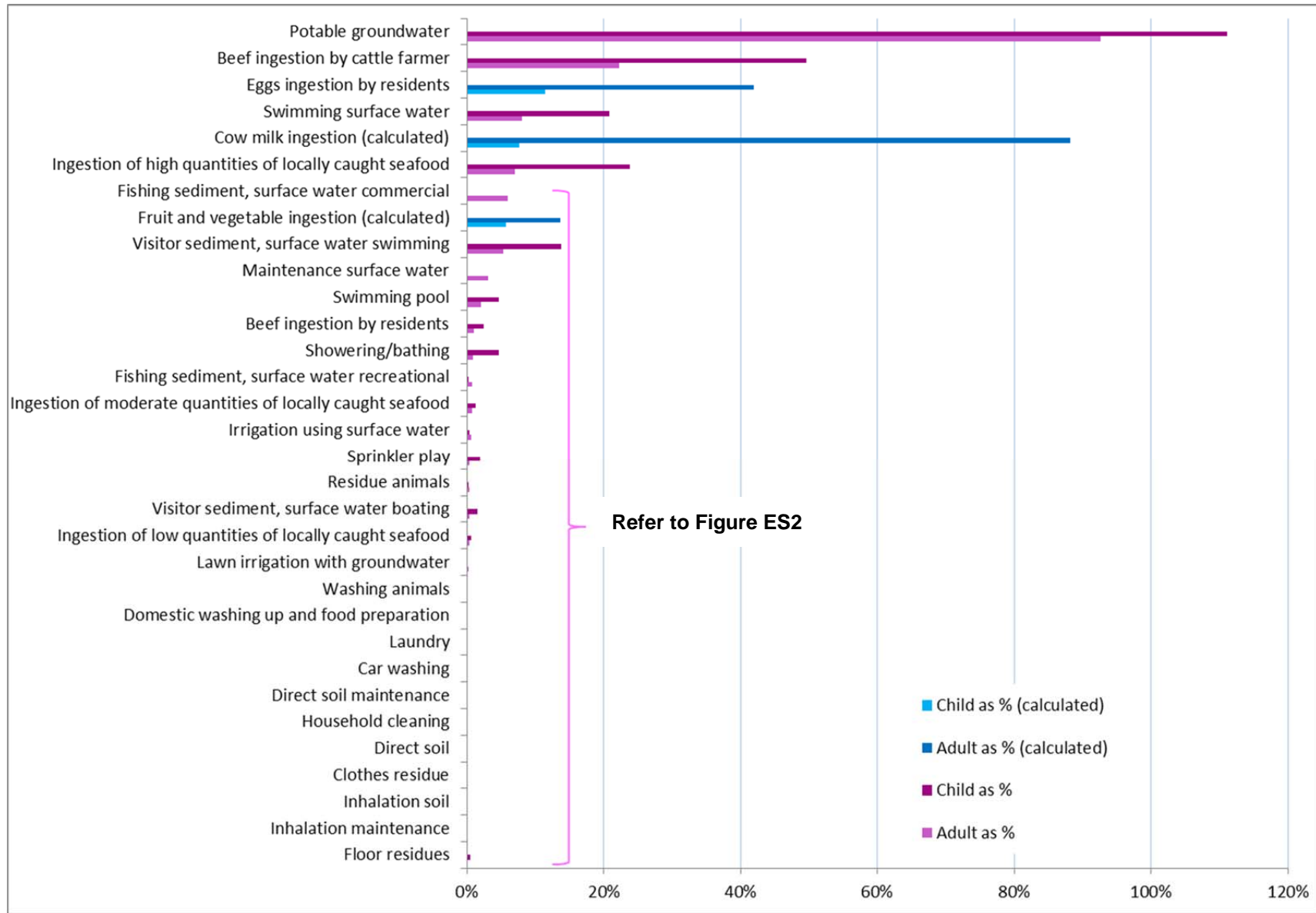


Figure ES1 Margin of Safety for all exposure scenarios

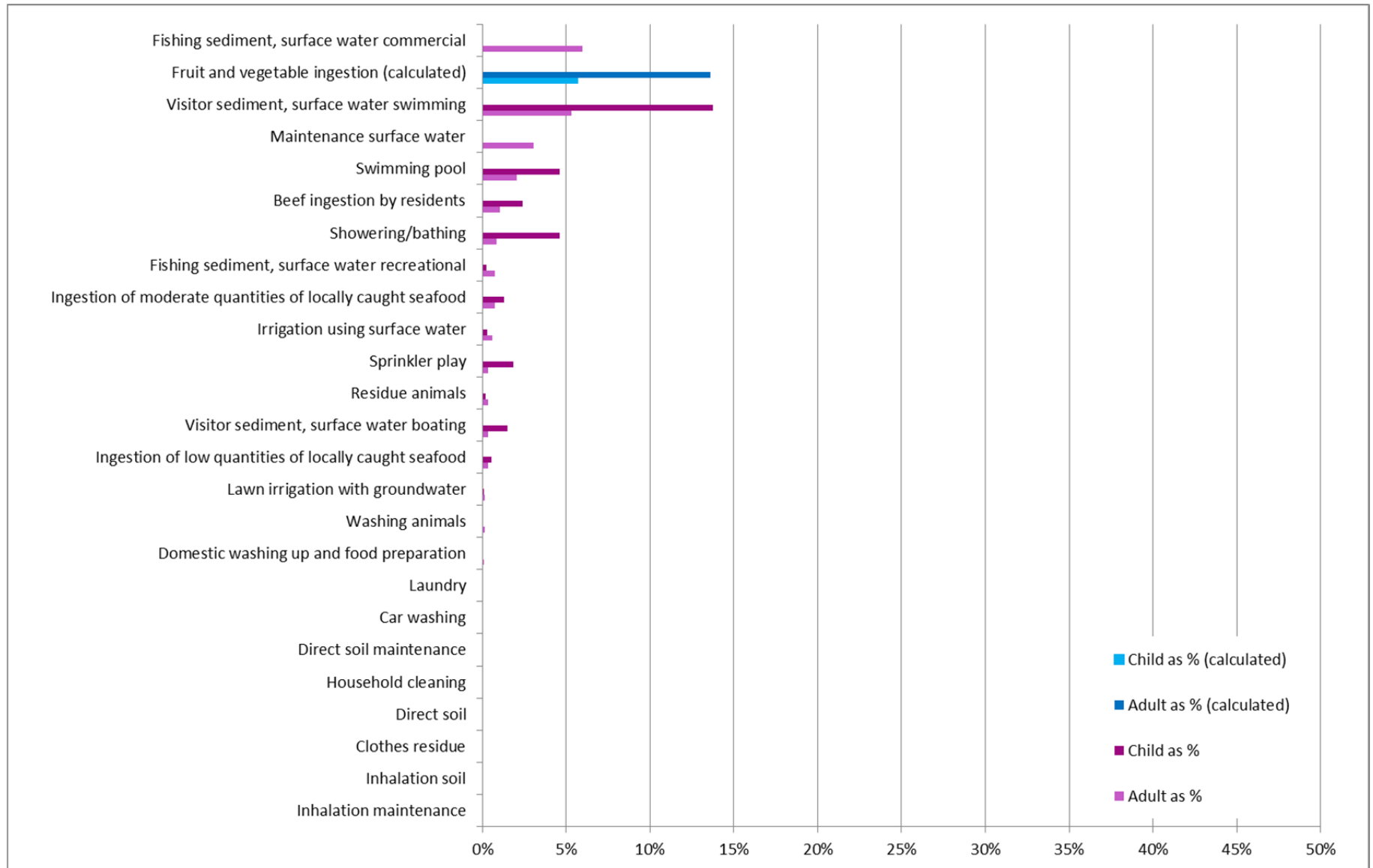


Figure ES2 Margin of Safety for selected exposure scenarios