FOOD STANDARDS
Australia New Zealand
Te Mana Kounga Kai – Ahitereiria me Aotearoa

Supporting Document 2

Assessment of potential dietary exposure to perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA) and perfluorohexane sulfonate (PFHxS) occurring in foods sampled from contaminated sites

Contents

1   Executive Summary

In June 2016 the Department of Health asked Food Standards Australia New Zealand (FSANZ) to provide a preliminary dietary exposure report on perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA) and perfluorohexane sulfonate (PFHxS).

FSANZ assessed the potential risks related to exposure to these compounds from the diet for the general population and populations living close to contaminated sites. The objective of this work was to provide sufficient information to allow an assessment of the potential risks to public health and safety.

This report complements the first report provided by FSANZ to the Department of Health on health-based guidance values for the three chemicals (Supporting Document 1). It aims to provide information that public health and food regulatory officials can use to develop a response to finding these chemicals in food sourced from or near contaminated sites.

The preliminary dietary exposure assessment identified a number of data deficiencies which meant FSANZ could not do a formal dietary exposure assessment for the general population. However, the limited data available from the 24th Australian Total Diet Study (ATDS) and a review of the literature indicate that dietary exposure from the general food supply is likely to be low.

This report assesses how much of an individual food or food group sourced from contaminated sites that contain PFOS, PFOA and/or PFHxS may be consumed by the Australian population without exceeding the relevant Tolerable Daily Intake (TDI). If a calculated amount for a specified chemical/ food group(s) combination is less than people normally eat then public advice on consuming these foods may be required when they are sourced from or near contaminated sites. In addition, trigger points for investigation have been derived for each food or food group assessed for PFOS + PFHxS combined and PFOA. Public health and/or food regulatory professionals may use the trigger points for investigation of specified chemicals to identify when levels in analysed foods exceed these values and require more research.

The quality of the occurrence data and the high number of non-detects are the major source of uncertainty in the exposure calculations. FSANZ addressed this by using low, middle and upper bound concentration levels for PFOS, PFOA and PFHxS in the different food groups for which data were available. The lower bound median is a 'best case' scenario that assumes for a non-detect result the food is free of the component. The upper bound median is a 'worst case' scenario that assumes for a non-detect result the component is present at the limit of detection (LOD). The middle bound is halfway between the other bounds.

Based on the limited occurrence data for contaminated sites submitted to FSANZ, mean upper bound PFOS concentrations were highest for rabbit meat, finfish livers, cattle meat and mammalian offal. PFOA concentrations were below reporting limits for most samples. Mean upper bound analytical results for foods with PFOA detections were highest for molluscs and freshwater fish. There was less data available on PFHxS analyses than for PFOS or PFOA analyses. Mean upper bound PFHxS concentrations were highest for cattle meat, rabbit meat and eggs.

For PFOA the amount of each 'contaminated site' food that could be consumed before the relevant TDI was exceeded was much greater than amounts usually eaten by high consumers even assuming upper bound median concentrations of PFOA. Usual food consumption patterns were as reported in the 2011-13 Australian Health Survey. PFOS has a lower TDI than PFOA so the outcome of these calculations was different. For PFOS and PFOS + PFHxS combined for the food groups assessed, the amount of foods containing PFOS or PFOS + PFHxS combined at reported levels from contaminated sites that may be consumed without exceeding the relevant TDI was lower than the usual amounts of food consumed. For PFOS this occurred for the whole population with cattle meat, rabbit meat, milk and offal assuming low, middle and upper bound median concentrations. For children aged 2-6 years this applied to cattle meat and milk assuming low, middle and upper bound median concentrations and in addition, at the upper bound median concentration for some vegetables. Occasional exceedances of the TDI from consumption of a specific food on one day or over a short period are not of public health concern.

It is considered extremely unlikely that food consumption of a specific food group over a period would all be from food sourced locally from a contaminated site. This is particularly true for milk and milk products because milk doesn't normally come from one animal but is collected from many animals and several sources, mixed and homogenised and then distributed through retail outlets.

FSANZ developed trigger points for investigation for PFOS + PFHxS combined and PFOA for all the food groups assessed. Trigger points are the maximum concentration level of these chemicals that could be present in individual foods or food groups so even high consumers of these foods would not have dietary exposures exceeding the relevant TDI. For a chemical of interest, the trigger points are lower for those foods that are usually consumed in larger amounts. Proposed trigger points for investigation for PFOS + PFHxS combined are lower for milk (0.4 µg/kg), fruit and vegetables (0.6 and 1.1 µg/kg respectively) than for finfish (5.2 µg/kg), mammalian meat (3.5 µg/kg) and eggs (11 µg/kg). Proposed trigger points for investigation for PFOS + PFHxS combined for other seafood, honey and offal are substantially higher than those proposed for other commodities.

In most commodities, the proposed trigger points for investigation for PFOA are an order of magnitude higher than those for PFOS. Like PFOS, proposed trigger points for investigation are lowest in fruit and vegetables, finfish and meat.

2 Introduction

Per- and poly-fluoroalkyl substances (PFAS) are bioaccumulative in animals and humans. They are very stable organofluorine chemicals that persist for a long time (years) in the environment and in humans (ATSDR 2015, Supporting Document 1). PFAS have been detected in various environmental media and matrices, including food. Unlike other persistent organic pollutants, due to the physical and chemical properties of PFAS they do not accumulate in fatty tissues of animals. Their ability to repel oil, grease and water led to use in carpets, upholstery, paper and cardboard coatings, and as fire-fighting foams.

The PFAS considered in this dietary exposure assessment were perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA) and perfluorohexane sulfonate (PFHxS).

3 Objective

The Department of Health contracted FSANZ to provide a preliminary dietary exposure report (the 'second report') by 28 February 2017 that assessed the potential risks related to exposure to PFOS, PFOA and PFHxS from the diet for the general population and populations living in proximity to contaminated sites. The objective was to provide sufficient information to allow an assessment of the potential risks to public health and safety. The preliminary dietary exposure assessment identified a number of data deficiencies (see section 8.2) which prevented FSANZ undertaking a formal dietary exposure assessment. Therefore, this report assessed the amount of individual foods or food groups sourced from contaminated sites that contain PFOS, PFOA and/or PFHxS that may be consumed by the Australian population without exceeding the relevant Tolerable Daily Intake (TDI)[1]. Assessment was based on the most recent nutrition survey data and occurrence data submitted to FSANZ in response to a call for data. In addition, trigger points for investigation were derived for each food or food group for PFOS + PFHxS combined[2] and PFOA, such that for a high consumer of these foods at this concentration level, dietary exposures would not exceed the relevant TDI.

4 Scope

4.1 Included

- estimates of the amount of individual foods or food groups sourced from contaminated sites that may be safely consumed at reported PFOS, PFOA and PFHxS concentration levels
- trigger points for investigation for PFOA, PFOS + PFHxS combined, the maximum concentration that may be present in individual foods or food groups and be consumed safely, taking account of known food consumption patterns.

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1 A Tolerable Daily Intake is an estimate of the amount of a chemical in food or drinking water, expressed on a body weight basis, that can be ingested daily over a lifetime without appreciable health risk to the consumer (FAO/WHO, 2009)

2 For PFOS the TDI is 20 ng/kg bw/day, for PFOA the TDI is 160 ng/kg bw/day. No separate TDI was recommended for PFHxS as there was not enough toxicological and epidemiological information, the TDI for PFOS is taken to cover PFHxS, effectively meaning that PFHxS and PFOS exposure should be summed for the purpose of risk assessment (Supporting Document 1).

4.2 Excluded

- estimated dietary exposure to PFOS, PFOA and PFHxS for the general population
- overall chronic dietary exposure from dietary sources (food and water) at a contaminated site, noting it is considered unrealistic to assume that all the food and water consumed by populations living in proximity to contaminated sites is sourced from these sites
- exposure from sources other than the diet, including occupational exposure
- calculations for specific identified contaminated sites in the Australian States or Territories.

5   Outline

This Supporting Document provides information for use by public health and food regulatory officials in developing a response to the findings that PFOS, PFOA and PFHxS may occur in food sourced in proximity to contaminated sites. Two different approaches were taken by FSANZ. First, the report describes the dietary exposure calculations to assess the amount of individual foods or food groups from contaminated sites that contain PFOS, PFOA and/or PFHxS that may be consumed by the Australian population without exceeding the relevant TDI. Second, the report describes the derivation of trigger points for investigation for PFOS + PFHxs combined and PFOA.

A discussion of the potential options for overall risk management of the occurrence of PFOS, PFOA and PFHxS in the food supply is found in the Summary Report. Detailed tables showing the key inputs and outputs of the calculations are in the appendices to the report.

A literature review on the occurrence of and dietary exposure to PFOS, PFOA and/or PFHxS in regions other than Australia is in Attachment 1.

A summary of the occurrence data relevant to Supporting Document 2 is in Attachment 2.

6   PFOS, PFOA and PFHxS occurrence and dietary exposure in the Australian general food supply

There was insufficient information to estimate total dietary exposure for the general population as the majority of the data on the amount of PFOS, PFOA and PFHxS in food and water submitted was from contaminated sites. The data available on the general food supply were for PFOS and PFOA from a recent Australian Total Diet Study (ATDS) and data from a survey of imported fish from retail outlets submitted by the New South Wales Food Authority (NSW FA). Both studies are discussed briefly below.

6.1 Australian Total Diet Study

In the 24th ATDS Phase 2 on packaging materials, PFOS and PFOA were analysed; PFHxS was not included in this study (FSANZ 2016). PFOS was reported at low levels in two foods (1.0 µg/kg for fish fillets and 0.2 µg/kg for sausages) out of 50 food types tested for PFOS and PFOA. PFOA was not detected in any foods (see Table 1). Overall, the 24th ATDS indicates levels of PFOS and PFOA in the general food supply are low. The concentrations of PFOS that were reported in two foods, fish fillets and sausages, were in the same range as those reported elsewhere for similar foods (refer to section 4.1 in Attachment 1).

Table 1. PFOS detections in the 24th ATDS, Phase 2

Chemical	Number of foods analysed	Number of foods with detections	% with detections[1]	Foods with detected values	Concentration range (µg/kg)[2]
PFOS	50	2	0.7 (2/304)	Fish fillets, white fish Sausages, beef	<LOR–1.0 <LOR–0.2

[1] The proportion of total samples analysed. In most cases, each sample analysed was a composite of three individual primary samples with 304 composites from 50 different foods tested for PFOS. For further details refer to FSANZ 2016.

[2] LOR limit of reporting; LOR = 0.4 µg/kg for PFOS in fish fillets and sausages

In the 24th ATDS packaging chemicals were first screened to determine if a more refined dietary exposure estimate was required, by calculating the theoretical maximum daily exposure (TMDE)[3] for each chemical. This screening step is intentionally a conservative approach as it assumes 50% of all foods and beverages consumed contain the chemical of interest at the reported level. In this screening step, the TMDE[4] for PFOS was low in comparison to the TDI of 150 ng/kg bw (33% of TDI), established by the European Food Safety Authority (EFSA). This indicated a negligible public health and safety risk, so that a full dietary exposure assessment for the general population was not deemed necessary.

6.2 NSW Food Authority follow up fish study

Following the publication of the 24th ATDS Phase 2 report, the NSW Food Authority undertook further research on PFOS, PFOA and PFHxS in fish in February 2016, analysing an additional 52 imported fish and prawn samples purchased from Sydney retail outlets (see Table 2). There was only one detection in prawns for PFOS. No further dietary exposure assessment was undertaken.

Table 2. PFOS detections in the NSW Food Authority fish survey

Chemical	Number of foods analysed	Number of foods with detections	% with detections[1]	Foods with detected values	Concentration range (µg/kg)[2]
PFOS	52	1	2	prawns	<LOR–0.39
PFOA	52	0	0		<LOR
PFHxS	52	0	0		<LOR

[1] no detect result is <LOR.

[2] LOR limit of reporting; LOR = 0.3 µg/kg for PFOS, PFOA and PFHxS in fish fillets and prawns

7 PFOS, PFOA and PFHxS occurrence and dietary exposure estimates reported in the literature

The literature on occurrence data and dietary exposure estimates for PFOS, PFOA and PFHxS is reported in Attachment 1 and summarised below.

7.1 Occurrence data outside of Australia

Occurrence data were reported for a number of European countries, with limited data from Canada, Korea, China and Japan, noting different methods of analysis and limits of reporting were applied across different studies. Generally, PFOS, PFOA and PFHxS were present in a similar range of foods and at levels of the same order of magnitude; the major exceptions are described below.

Meat and meat products, and Fish and other seafood food groups had the highest reported levels of PFOS, PFOA and PFHxS. For these two major food groups, reported PFOS levels were of a higher order of magnitude than those for PFOA, which were generally higher than those for PFHxS. Another exception was for cereals and grain-based products where PFOA tended to be reported at higher levels than PFOS.

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3   The TMDE was calculated by summing the theoretical potential exposure from beverages and foods based on maximum physiological levels of food and beverage consumption as derived from the budget method (Hansen 1979), combined with analytical values and comparing it to the relevant health based guidance value.

4   The TMDE for PFOS was 0.00005 mg/kg bw/day (50 ng/kg bw/day) at the maximum concentration detected assuming PFOS was present in 50% of all foods and beverages, 24th Australian Total Diet Study, p34, Table 14 http://www.foodstandards.gov.au/publications/Documents/24th%20Total%20Diet%20Study_Phase%202.pdf

7.2 Dietary exposure estimates outside of Australia

The mean and high consumer (95th percentile) dietary exposure estimates for PFOS, PFOA and PFHxS reported for Europe and other regions of the world were surprisingly similar across countries for each chemical. An exception was those reported for PFOS and PFOA by Cornelis *et al.* (2012) for the Belgian population. However these are likely to be overestimated due to high LODs applied in the derivation of mean concentration levels (Cornelis *et al.* 2012).

Discounting the values reported by Cornelis *et al.* (2012) and noting that estimates were derived in a number of different ways across the studies, reported mean dietary exposure estimates across all studies for PFOS ranged from 0-14 ng/kg bw/day, high dietary exposure (95th percentile) estimates from 0-29 ng/kg bw/day. Reported mean dietary exposure estimates for PFOA ranged from 0-17 ng/kg bw/day, 95th percentile exposure estimates from 0-32 ng/kg bw/day. Reported mean dietary exposure estimates for PFHxS were available for Europe only and ranged from 0-1.22 ng/kg bw/day, 95th percentile exposure estimates from 0-2.25 ng/kg bw/day (refer to section 4.2 in Attachment 1).

Where information was available, dietary exposure estimates for a range of PFAS for infants and young children were higher than for other age groups in the same population, when expressed on a per kilogram bodyweight basis (EFSA 2012, Domingo *et al.* 2012, Klenow *et al.* 2013, Cornelis *et al.* 2012). This is likely a result of higher food consumption per kilogram bodyweight due to growth and maintenance requirements. Estimates of dietary exposure for a range of PFAS were higher for coastal communities in France, including pregnant women, than for the general population, as consumption of fish and other seafood, a major source of PFAS, was reported to be higher in these coastal areas (Yamanda *et al.* 2014).

The literature highlights that estimated dietary exposure to PFAS based on levels found in foods have generally not been considered to be of public health concern for the public.

Reported dietary exposure estimates were all lower than the relevant EFSA TDIs for PFOS (150 ng/kg bw/day) and PFOA (1500 ng/kg bw/day), the health-based guidance values referred to in most of these studies. When evaluated against the TDIs derived by FSANZ for PFOS + PFHxS combined (20 ng/kg bw/day) and PFOA (160 ng/kg bw/day), virtually all dietary exposure estimates would be lower than these health-based guidance values. This is important because it shows that the FSANZ TDI is reasonable and readily achievable for the general population ie. suitable for risk management purposes. The exceptions were the conservative upper bound estimate of high dietary exposure to PFOS for toddlers in Europe (EFSA 2012) and the PFOS estimates reported by Cornelius *et al.* for the Belgian population (Cornelius *et al.* 2012).

8   Dietary exposure calculations for Australian populations consuming foods contaminated by PFOS, PFOA and PFHxS

As it is unknown how much food consumed by populations living near contaminated sites is sourced locally, a total dietary exposure estimate was not undertaken for these populations. The section below describes the calculations undertaken to determine potential risks for populations living in proximity to contaminated sites who may consume local foods, and trigger points for investigation for PFOS + PFHxS combined, and PFOA in foods.

8.1 Methods

Two sets of calculations were undertaken for populations living in proximity to contaminated sites, who may consume locally sourced food:

1. Determination of the amount of individual foods or food groups that could be consumed at the reported concentration levels for PFOS, PFOA and PFHxS without exceeding the relevant TDI derived by FSANZ

2. Establishment of trigger points for investigation for individual foods or food groups for PFOS + PFHxS combined and PFOA, such that for a high consumer of these foods at this concentration level, the relevant TDI would not be exceeded.

8.1.1 Occurrence data

Mean analytical results for PFOS were highest for rabbit meat, finfish livers, cattle meat and mammalian offal. Similarly, median PFOS concentrations were highest for rabbit meat, mammalian offal, cattle meat and finfish livers. PFOA was reported at concentrations below reporting limits for most samples. Analytical results for foods with PFOA detections were highest for molluscs and freshwater fish. There was less data on PFHxS analyses available compared to the other two chemicals. There were no detections for diadromous and marine fish, honey and offal and most fruit and vegetables. Mean PFHxS concentrations were highest for cattle meat, eggs and crustaceans. Details about the occurrence data set are in Attachment 2. The occurrence data used in dietary exposure calculations is set out in Appendix 1 Summary of occurrence data used in dietary exposure calculations.

8.1.1.1 Summary of data call

Only very limited data on the concentration of PFOS, PFOA and PFHxS in Australian foods were made available to FSANZ as inputs into dietary exposure calculations.

On the 8 August 2016, FSANZ undertook a data call seeking any data on the occurrence of PFOS, PFOA and PFHxS in food and water in Australia. FSANZ received 10 data sets in response with most data being environmental samples from contaminated sites. The majority of samples were seafood. All data received were included in a combined data set and, following data cleaning and transformation, used to create a final analytical data set for use in dietary exposure calculations.

There were a number of limitations in the occurrence data. Most data were based on environmental samples and were not foods for retail sale; some animal based food data were estimated from serum measurements. There were major gaps in the data including poultry meat, cereal grains and oils. Some data had poor metadata and were subject to limited auditing or validation prior to submission. A large number of data were non-detect results, with different limits of detection (LOD) and/or limits of quantification (LOQ) and/or limits of reporting (LOR) used to analyse samples.

Foods in the final analytical data set were assigned a food category and food classification. Lower, middle and upper bound median PFOS, PFOA and PFHxS values were calculated from the analysed foods assigned to each food classification (see below, Table 4 for definitions).

8.1.1.2 Management of non-detects

A difficult step in dietary exposure assessment is the handling of occurrence data reported to be below the LOD, LOR or LOQ. These data are known as 'non-detects'. Handling non-detects represents a challenge for collection and statistical analysis of chemical occurrence data. Where a component is not detected there is a high level of uncertainty about its occurrence in the food, for example if the LOD is 5 μg/kg the component may not be present, or may be present somewhere between zero and 5 μg/kg.

The data set contained a large number of non-detects and this issue was addressed by deriving lower, middle and upper bound median concentrations for the contaminants of interest. Lower, middle and upper bound values were assigned to each individual analytical record, based on that record's reported LOR (assigning zero, ½ LOR, LOR respectively), prior to calculating lower, middle and upper bound median concentrations for each food classification. As a result, the lower bound median is a 'best case' scenario and assumes that wherever there is a non-detect the food is free of the component. The upper bound median is a 'worst case' scenario and assumes that wherever there is a non-detect the component is present at the LOR. The middle bound is halfway between the other bounds.

8.1.1.3 Reporting combined occurrence of PFOS and PFHxS

There was insufficient toxicological and epidemiological information to justify establishing a TDI for PFHxS. Effectively this means that PFHxS and PFOS concentrations should be summed for the purposes of a dietary exposure assessment and risk characterisation (refer to Supporting Document 1).

Due to the limited number of PFHxS analyses, there were substantially fewer analyses available to calculate median concentrations based on the sum of PFOS and PFHxS. Reduced numbers of analyses that tested for both compounds resulted in changed distributions of concentrations compared to when PFOS was analysed alone. Changed distributions of the occurrence data affect any subsequent exposure calculations. For some food groups the mean and median concentrations of PFOS + PFHxS combined were markedly higher than those based on PFOS

results only, for example crustaceans and freshwater fish. Consequently, the calculated exposure was higher. For other food groups, for example marine fish and molluscs, mean and median PFOS + PFHxS results were only slightly higher or lower compared with PFOS results only and the exposure calculations were minimally affected.

8.1.2 Consumption data for Australia

Food consumption data were derived for the Australian population from the 2011-12 National Nutrition and Physical Activity Survey (NNPAS) component of the 2011-13 Australian Health Survey, which surveyed 12,153 respondents aged two years and above. Approximately two thirds of the survey respondents (64% or 7735 individuals) were surveyed for two non-consecutive days making it possible to derive two day average food consumption amounts for this sub-set of the population (applying a different set of sample weights to make this survey sub-sample representative of the population).

Consumption amounts were derived for mean and high consumers who had reported consuming the food likely to contain PFOS, PFOA and/or PFHxS on at least one of the two days. The two-day average reflects longer term food consumption patterns and therefore provides a better estimate for use in calculations when the health based guidance value relates to chronic or long term exposures.

Details of the consumption values used as an input into the exposure calculations are set out in Appendix 2: Food consumption from the 2011-12 NNPAS.

8.1.3 Health Based Guidance Values

A TDI is an estimate of the amount of a chemical in food or drinking water expressed on a body weight basis that can be ingested daily over a lifetime without appreciable health risk to the consumer (FAO/WHO, 2009).

FSANZ has established a TDI of 20 ng/kg bw for PFOS and a TDI of 160 ng/kg bw for PFOA. There was insufficient toxicological and epidemiological information to justify establishing a TDI for PFHxS. In the absence of a TDI, it is reasonable to conclude that using the TDI for PFOS is likely to be conservative and protective of public health as an interim measure (Table 3, Supporting Document 1).

No acute health based guidance value has been established, so there is no need for an acute dietary exposure assessment.

Table 3. Health Based Guidance Values used in dietary exposure assessment

Component	Population	ng/kg bw
PFOS*	All ages	20
PFOA	All ages	160

* applied to PFOS + PFHxS combined dietary exposure calculations

8.1.4 Calculating the amount of individual foods or food groups that could be consumed before reaching the TDI at the reported concentration levels

For chronic dietary exposure estimates, results are generally reported for the whole population, that is the mean dietary exposure is derived from data for all survey respondents (eaters and non-eaters of all of the foods of interest), assuming median contamination levels.

Occurrence data submitted to FSANZ in response to a call for data for PFOS, PFOA or PFHxS in the food supply were used for the first set of calculations. As there was a large number of non-detects in the concentration data sets, the lower bound, middle bound and upper bound median concentration values were derived from submitted data on food sourced in proximity to contaminated sites (refer to Table 4 for definitions).

As the TDI for PFOS also applies to PFHxS, concentration values were summed for these compounds for each food as well as undertaking the calculations for PFOS and PFOA alone (refer to Supporting Document 1). The use of the median concentration level reflects the fact that there will always be a distribution of the contaminant in the foods eaten over time or even in one meal, eg. in a plate of a dozen oysters (~150 g). It is unrealistic to expect each food item consumed to be contaminated at the highest reported level on every eating occasion.

Table 4. Concentrations of PFOS, PFOA and PFHxS used in calculations

Concentration level	Measure of central tendency	Characteristic	Description
Lower Bound (LB)	Median	Least conservative	Where a non-detect is reported for a component, the concentration in the food is zero
Middle Bound (MB)	Median	Conservative	Where a non-detect is reported for a component, the concentration in the food is half the LOD
Upper bound (UB)	Median	Highly conservative	Where a non-detect is reported for a component, the concentration in the food is at the LOD

The lower, middle and upper median concentrations for PFOS + PFHxS and PFOA were used for each food category to calculate the amount of food that could be consumed at this level of contamination such that the relevant TDI was not exceeded, assuming background exposure from all other foods was zero.

The calculated food consumption amounts were then compared with mean and high (90th percentile) food consumption amounts reported from the most recent nutrition survey for the Australian population, the 2011-12 National Nutrition and Physical Activity Survey (NNPAS) component of the 2011-13 Australian Health Survey (AHS). Where the calculated amount is less than the usual amount consumed for a specified chemical/ food group(s) combination this indicates public advice may be required on consuming these particular foods when sourced in proximity to contaminated sites.

FSANZ's purpose built analysis platform Harvest was used to extract relevant food consumption data for mean, median or high consumers (90th percentile) of foods reported to contain PFOS, PFOA or PFHxS, based on the 2011-12 NNPAS. As the contaminants of interest predominately occurred in raw commodities, such as fish and vegetables, calculations were made based on consumption data aggregated at a raw commodity level. Consumption data aggregates commodities that are reported as consumed on their own (eg. pork chop, glass of milk, boiled egg) and when used in a mixed food (eg. pork stir-fry, quiche).

As the TDI does not differ by gender, separate assessments were not conducted for Australian males and females and the age groups selected for this assessment were two years and over and 2-6 years. Young children are generally considered separately as they have higher food consumption amounts per kilogram of body weight. This is due to requirements for growth and maintenance and means that their estimated dietary exposure to food chemicals expressed on a per-bodyweight basis is usually higher than that of adults.

8.1.5 Calculating trigger points for investigation for use by public health official for individual foods or food groups

For the second set of calculations the high food consumption amounts (90th percentile, consumer only) derived from the NNPAS were used to determine the *maximum concentration level* of PFOS + PFHxS combined and PFOA that could be present in individual food or food groups without estimated dietary exposures exceeding the relevant TDI. For 'occasionally consumed' foods[5] such as offal, crustaceans and molluscs, the median consumption amount (consumers only) was used. Such foods are not considered staple foods and may be seasonal and therefore unlikely to be consumed every day over a long period of time, even by specific sub population groups such as families of professional or recreational fishers.

Maximum concentration levels form the basis of *trigger points for investigation,* which are selected to be protective of all population groups in a range of consumption scenarios.

Trigger points for investigation are provided to public health and food regulatory officials as an indication that further investigation may be required should analytical results for PFOS, PFOS + PFHxS combined or PFOA in individual foods or food groups, be higher than the trigger points for these chemicals in specified foods or food groups.

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5   The definition of 'occasionally consumed' foods used by FSANZ is that the proportion of respondents consuming the food of interest is ≤10%, based on Day 1 of the 24 hour recall data from a national nutrition survey.

Maximum concentration levels were determined for PFOS, PFOA and PFOS + PFHxS combined for each food classification for which FSANZ received occurrence data for Australian children aged 2-6 years and the Australian population aged 2 years and above.

In order to provide trigger points for investigation for major food groups, the lowest calculated value for PFOA and PFOS + PFHxS combined was selected from either population group for specific food groups ('worst case'). If a food sub-group had a lower calculated level, then this was applied to the whole food group.

8.1.6   Assumptions for dietary exposure calculations for individual foods

8.1.6.1   Consumption

- the food consumption patterns of the population living in proximity to contaminated areas are very similar to the general Australian population
- the ages, gender and bodyweights of the population living in proximity to contaminated areas are very similar to the general Australian population
- foods consumed by the population living in proximity to contaminated areas are sourced locally.

8.1.6.2   Occurrence

- the limited data on concentrations of PFOS, PFOA and PFHxS in Australia available as inputs into dietary exposure estimates adequately reflect occurrence in contaminated areas
- wherever a concentration was assigned to a raw commodity classification, this concentration is present in all foods that are assigned to the classification
- where a raw commodity classification matches no foods in the occurrence data set, the concentration level for those foods is assumed to be zero.

8.2   Limitations and inherent uncertainties in the assessment

FSANZ aims to make as realistic an estimate of dietary exposure as possible. However, where significant uncertainties in the data exist, conservative (or 'worst-case') assumptions are generally used to ensure that exposure estimates are protective of consumers.

According to the guidance provided by EFSA the following sources of uncertainties have been considered: assessment objectives, exposure scenario, exposure model, and model input (parameters) (EFSA 2006). Table 5 summarises a qualitative evaluation of the impact of uncertainties in calculations. For more information on the FSANZ dietary exposure assessment principles, methodology, assumptions and limitations and uncertainties around concentration and food consumption data, see the FSANZ document, *Principles and Practices of Dietary Exposure Assessment for Food Regulatory Purposes* (FSANZ, 2009a).

8.2.1   Assessment objectives

FSANZ was contracted to assess the potential risks related to exposure to PFOS, PFOA and PFHxS from the diet for populations living in proximity to contaminated sites. The uncertainty of the assessment objectives is considered low, however it is noted that FSANZ determined a full dietary exposure assessment for the population could not be undertaken due to deficiencies in the data available.

8.2.2   Occurrence data

It is highly uncertain whether the occurrence data made available to FSANZ in response to its call for data are representative of the contamination of food with PFOS, PFOA and PFHxS. The data received were from a variety of sources for a limited range of foods from contaminated sites or areas in close proximity to such sites. These data provide the most significant limitation in this assessment because there is very limited data on occurrence of PFOS, PFOA AND PFHxS in Australian foods (Attachment 2).

A number of limitations in the occurrence data are described below:

- there is a very high number of records where the chemicals of interest have not been detected; in the case of PFOA and PFHxS this is the majority of records, consequently all calculations are highly sensitive to limits of determination (LOD)
- most data are based on environmental sampling and do not necessarily reflect food as sold to the public (eg. raw milk)
- sampling was targeted (in proximity to contaminated sites) rather than randomised and is unlikely to be representative of the food supply, therefore results are likely to overestimate potential dietary exposure
- most animal data used to estimate occurrence in meat were estimated from blood serum measurements using a conversion factor
- there are major gaps in the data including for poultry meat, cereal grains, oils and fats. None of these foods could be matched to a raw commodity classification where occurrence data were available, hence concentration levels were assumed to be zero
- some of the data included in the database had poor metadata and limited auditing or validation. For example in some cases it is unclear whether the data were duplicates and/or composite samples, and in the latter case how many raw samples were included in each composite.

As occurrence data are a significant input into dietary exposure estimates this is a major source of uncertainty in this assessment. The overall uncertainty in the model estimations due to the quality of the occurrence data is therefore considered to be high. The use of the UB median levels in calculations is very conservative as a high proportion of results for PFOS, PFOA and PFHxS were non-detects (< LOR).

8.2.3   Consumption data

Regarding food consumption, the FSANZ raw commodity food consumption model is well established and validated. The overall uncertainty in the calculations from food consumption data is ranked as low.

Table 5. Summary of qualitative evaluation of the impact of uncertainties in calculations

Sources of uncertainty	Direction
Uncertainty of analytical measurements	+/-
Sampling strategy (random/targeted)	+
Analytical strategy (individual/composite samples)	+/-
Occurrence data available from a limited number of sites	++/--
Limited occurrence data, missing data for some food groups	--
Use of lower bound (LB) median level in estimates	-
Use of middle bound (MB) median level in estimates	+
Use of upper bound (UB) median level in estimates	++
Food consumption data	+/-

8.3 Results

8.3.1   Amount of individual foods or food groups that could be consumed at the reported concentration levels

For PFOS and PFOS + PFHxS combined there were a range of food groups where the amount of contaminated site food that could be consumed before the TDI was reached (at the upper or middle bound median concentration) was less than the 90th percentile (or mean) food consumption amounts derived from the 2011-12 NNPAS. In these circumstances, consumers of a contaminated food may exceed the TDI when they consume their usual amounts of that food. This has been summarised in Figure 1. Occasional exceedances of the TDI from consumption of a specific food on one day or over a short period of time are not of public health concern.

However, it should be noted that it is considered extremely unlikely that food consumption of a specific food group, for example meat, over a period would all be from food sourced locally near a contaminated site. This is particularly true for milk and milk products where milk is not normally sourced from one animal but is collected from many animals and several sources, mixed and homogenised and then distributed through retail outlets.

8.3.1.1   PFOS

For the whole population (older than 2 years) Table 6 shows in bold where the amounts of food sourced from contaminated sites that may be consumed before the TDI for PFOS is reached are less than the 90th percentiles of consumption for the whole population aged 2 years and over. Consumption amounts to reach the TDI that are less than the mean consumption of that food are also shaded in grey.

For PFOS, for the whole population, amounts of cattle meat, rabbit meat, cattle milk and mammalian offal that could be consumed before the TDI for PFOS is reached are less than the 90th percentile and mean consumption amounts reported for these foods in the 2011-12 NNPAS.

In Table 7, the same information is presented for children aged 2-6 years. For this population amounts of cattle meat, milk, cattle milk and pome fruits (at the upper bound median concentration) that can be consumed before reaching the TDI for PFOS are less than the 90th percentile and mean consumption amounts reported for these foods. In addition, at the upper bound the amount of some vegetables that may be consumed before reaching the TDI is less that the 90th percentile consumption for those foods reported in the 2011-12 NNPAS, but more than the reported mean consumption.

More detailed results for all the commodities for which data were available for PFOS are provided in Appendix 3. Amounts of food that can be consumed to reach the TDI for the whole population are set out in Table 14 and for children 2-6 years of age in Table 15.

8.3.1.2   PFOS + PFHxS combined

For PFOS + PFHxS combined, additional food groups to those discussed above for PFOS were identified as having amounts of food that could be consumed before reaching the TDI which were greater than their 90th percentile and mean consumption amounts reported in the NNPAS (Table 6, Table 7).

For the whole population and for children, the amount of freshwater fish that may be consumed before reaching the TDI for PFOS + PFHxS combined (all bounds) was less than the mean consumption of freshwater fish reported in the 2011-12 NNPAS.

For the whole population, berries and other small fruits consumption amounts to reach the TDI at the middle bound as well as the upper bound were less than 90th percentile consumption. Finally, the amount of citrus, pome fruits, root and tuber vegetables consumed to reach the TDI at the upper bound was less than the 90th percentile consumption of these foods.

For children aged 2-6 citrus, other fruiting and root and tuber vegetable consumption to reach the TDI was less than the 90th percentile consumption reported for these foods at the middle bound, and less than their reported mean consumption at the upper bound.

More detailed results for all of the commodities for which data were available for PFOS + PFHxS combined are provided in Appendix 3: Amount of food at median PFOS, PFOA, PFHxS levels to reach TDI. Amounts of food that can be consumed to reach the TDI for the whole population are set out in Table 18 and for children 2-6 years of age in Table 19.

8.3.1.3   PFOA

PFOA has a higher TDI (160 ng/kg/bw/day) than PFOS. Consequently, the amount of each 'contaminated site' food group (at the median upper bound median PFOA concentration) that could be consumed before the TDI was reached was much higher than the 90th percentile usual food consumption amounts for all food groups assessed for both children aged 2-6 years and the populations aged 2 years and above (Table 16, Table 17).

Table 6. Food groups* where amount of food group consumed by the whole population (2 years and above) at median PFOS and/or PFOS+PFHxS combined concentration to reach the TDI are less than mean (shaded) or 90th percentile food consumption (bold) derived from the 2011-12 NNPAS

Food Group	Amount of food (grams/day) that can be consumed to reach TDI (20 ng/kg bw/day)^						Food consumption 2011-12 NNPAS (grams/day)	
	PFOS median concentration			PFOS+PFHxS median concentration			Consumers only	
	Lower Bound	Middle Bound	Upper Bound	Lower Bound	Middle Bound	Upper Bound	P90	Mean
Population aged 2 years and above (mean body weight = 70 kg)								
Freshwater fish	406	406	406	**33**	**33**	32	143	56
Berries and other small fruits		933	**467**			467	233	526	166
Citrus fruits		933	467		467	**233**	354	129
Pome fruits		933	467		467	**233**	321	147
Meat mammalian (all)	**153**	**153**	**153**	**113**	**113**	**113**	221	106
Cattle meat	**26**	**26**	**26**	22	22	22	163	71
Rabbit meat	**21**	**21**	**21**	19	19	19	-	364
Milk	**483**	**483**	**483**	**483**	444	412	1295	693
Cattle milk	**591**	**591**	**591**	**591**	533	485	1295	692
Offal mammalian	**23**	**23**	**23**	23	23	23	84	32
Root and tuber vegetables		933	467		467	**233**	273	123

* Consumption amounts not provided where median PFAS concentration was <LOR and calculated as zero; - insufficient consumers to derive P90 consumption

^ For each food group it is assumed that background exposure from all other foods is zero

Table 7. Food groups* where amount of food group consumed by children aged 2-6 years at median PFOS and or/ PFOS + PFHxS combined concentration to reach the TDI are less than mean (shaded) or 90th percentile (bold) food consumption derived from the 2011-12 NNPAS

Food Group	Amount of food (grams/day) that can be consumed to reach TDI (20 ng/kg bw/day)^						Food consumption 2011-12 NNPAS (grams/day)	
	PFOS median concentration			PFOS+PFHxS median concentration			Consumers only	
	Lower Bound	Middle Bound	Upper Bound	Lower Bound	Middle Bound	Upper Bound	P90	Mean
Children Aged 2-6 years (Mean body weight =19 kg)								
Freshwater fish	110	110	110	9	9	9	72	28
Berries and other small fruits		253	127		127	63	108	38
Citrus fruits		253	127		127	63	246	88
Pome fruits		253	127		127	63	361	171
Meat mammalian (all)	41	41	41	31	31	31	108	47
Cattle meat	7	7	7	6	6	6	85	33
Milk	131	131	131	131	121	112	1097	679
Cattle milk	160	160	160	160	145	132	1097	678
Poultry eggs	53	53	53	48	41	35	36	13
Other fruiting vegetables		253	127		127	63	151	73
Root and tuber vegetables		253	127		127	63	164	66

* Consumption amounts not provided where median PFAS concentration was <LOR and calculated as zero

^ For each food group it is assumed that background exposure from all other foods is zero

Figure 1. Food groups where amounts that can be consumed at median PFOS and or/ PFOS + PFHxS combined concentration to reach the TDI are less than the 90th percentile food consumption derived from the 2011-12 NNPAS
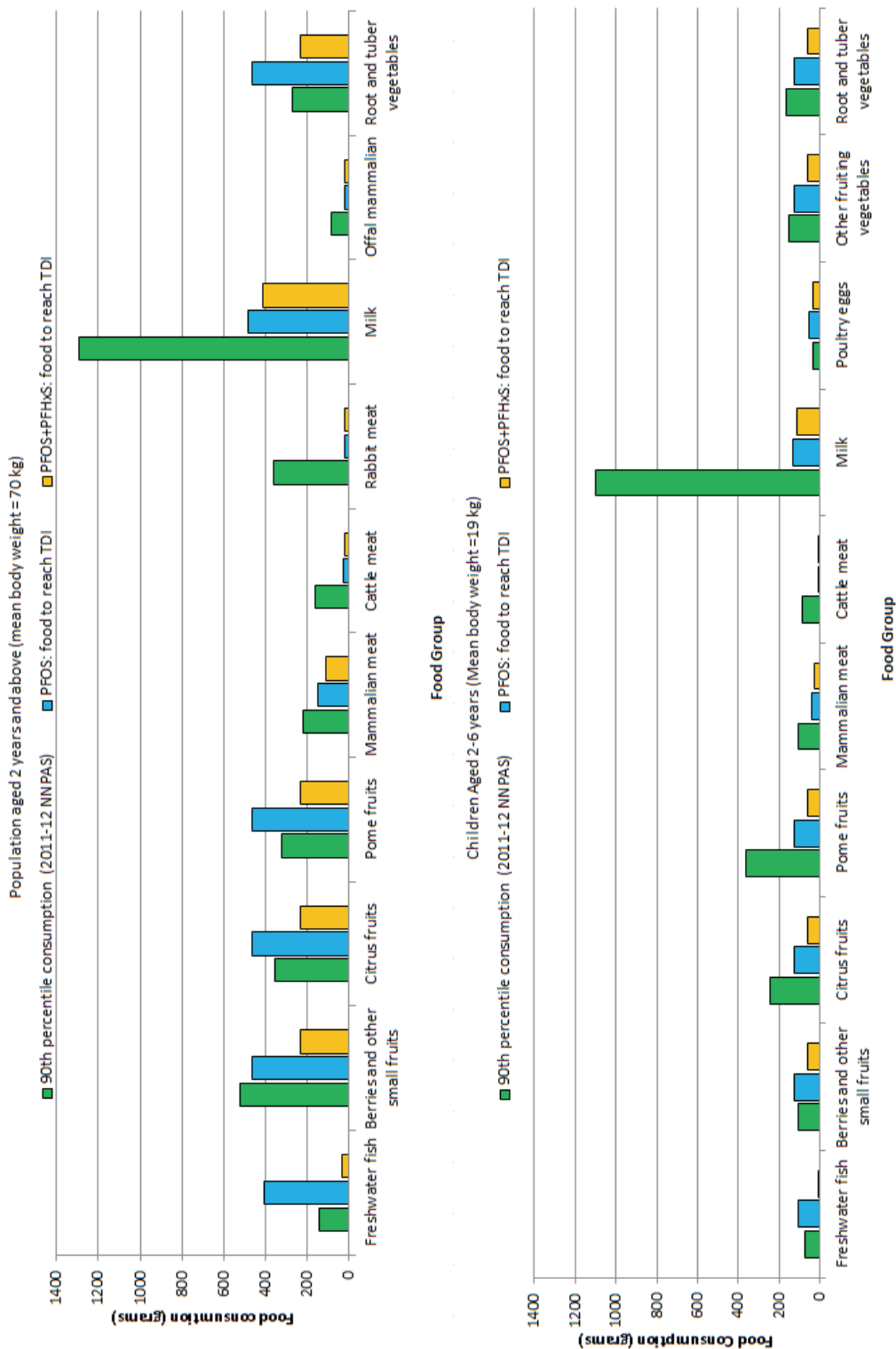
8.3.2 Proposed trigger points for investigation for individual foods or food groups

The proposed trigger points for investigation are summarised in Table 8. Maximum concentration levels form the basis of the trigger points and are selected to be protective of all population groups in a range of consumption scenarios. For a chemical of interest, there will be lower trigger points with higher usual consumption amounts of food as derived from the national nutrition survey. The maximum concentrations for all commodities and contaminants are set out in Table 20; the data used to derive the trigger points are in bold. Trigger points for investigation have not been derived for drinking water in this report.

8.3.2.1 PFOS and PFOS + PFHxS combined

Proposed trigger points for investigation are lower for milk (0.4 µg/kg), fruit and vegetables (0.6 and 1.1 µg/kg respectively) than for finfish (5.2 µg/kg), mammalian meat (3.5 µg/kg) and eggs (11 µg/kg). Proposed trigger points for investigation for other seafood, fish liver, honey and mammalian offal are substantially higher than those proposed for other commodities.

In reviewing the results of the 24th ATDS against the proposed trigger points for investigation, there were two detected values: the first one was for PFOS detected in fish fillets at 1.0 µg/kg, which is below the proposed trigger points for investigation for finfish of 5.2 µg/kg. The second was in beef sausages at a concentration of 0.2 µg/kg, which is below the proposed trigger points for investigation for mammalian meat of 3.5 µg/kg. PFHxS was not analysed in the 24th ATDS.

8.3.2.2 PFOA

In most commodities, proposed PFOA trigger points for investigation are an order of magnitude higher than those for PFOS. Like PFOS, levels are lowest in milk, fruit and vegetables, finfish and meat.

Table 8. Proposed trigger points for investigation

Food	Food classification	Proposed trigger points for investigation (µg/kg)		Derivation
		PFOS, PFOS+ PFHxS combined	**PFOA**	
Fish and Seafood	Crustaceans and Molluscs#	65	520	Children 2-6 years, median consumption
	Finfish (all)	5.2	41	Children 2-6 years, P90 consumption
	Fish liver#	280	2240	Population 2+ years, median consumption assumed to be 5 g (weight of one liver)*
Animal Products	Meat mammalian	3.5	28	Children 2-6 years, P90 consumption
	Milk	0.4 or LOD if higher	2.8	Children 2-6 years, P90 consumption
	Honey	33	264	Children 2-6 years, P90 consumption
	Offal mammalian#	96	765	Population 2+ years, median consumption
	Poultry eggs	11	85	Children 2-6 years, P90 consumption
Fruits and vegetables	Fruit (all)	0.6 or LOD if higher	5.1	Children 2-6 years, P90 consumption
	Vegetables (all)	1.1 or LOD if higher	8.8	Children 2-6 years, P90 consumption

occasionally consumed food, trigger points for investigation for crustaceans applied to molluscs due to small number of consumers of molluscs.

* no food consumption data available, source: FSANZ report on Edith River, Northern Territory 2013,
  https://dpir.nt.gov.au/__data/assets/pdf_file/0006/260187/TraceElementsNTFish.pdf

9   Conclusions

1. There were very little data on the occurrence of PFOS, PFOA and PFHxS from the general food supply; therefore, it was not possible to estimate dietary exposure to these chemicals for the general Australian population. However, the limited data available from the 24th ATDS and a review of the literature indicate that exposure to PFOS, PFOA and PFHxS from the general food supply is likely to be low.

2. Based on the limited occurrence data from foods from contaminated areas, mean and median concentrations were calculated. PFOS mean upper bound concentrations were reported to be highest for rabbit meat, finfish livers, mammalian offal and cattle meat. Similarly, median upper bound concentrations were highest for rabbit meat, finfish livers and cattle meat.

3. PFOA was reported at concentrations below reporting limits for most samples. Mean upper bound concentrations for foods with detections were highest for molluscs and freshwater fish.

4. There was less PFHxS analytical data available than for PFOS and PFOA. There were no detections for diadromous and marine fish, honey and offal and most fruit and vegetables. Mean upper bound concentrations were highest for cattle meat, eggs and crustaceans.

5. It should be noted that concentrations of contaminants in mammalian meat were both measured directly and estimated from serum concentrations using a conversion factor, creating uncertainty in the values of these occurrence data.

6. Creating a dataset for the sum of PFOS + PFHxS combined resulted in changed distributions of concentrations, in particular for crustaceans and freshwater fish, marine fish and molluscs as this information was not available for all samples where detections of PFOS were reported.

7. As occurrence data are a significant input into estimates, their quality is a major source of uncertainty in this assessment. The overall uncertainty in the model estimations due to the quality of the occurrence data is considered to be high. The use of the upper bound median levels in calculations to determine the amount of contaminated food that can be consumed at reported concentration levels is very conservative as a high proportion of results for PFOS, PFOA and PFHxS were non-detects.

8. For PFOS and PFOS + PFHxS combined, there was a range of food groups where the amount of food that could be consumed before the TDI was reached was less than the high consumption (90th percentile) or mean food consumption amounts for the whole population amounts derived from the latest nutrition survey, the 2011-12 NNPAS.

9. For PFOS exposure in the whole population, the amounts of cattle meat, rabbit meat, milk and offal that can be consumed before the TDI was reached were less than the mean consumption amounts of these foods. For children aged 2-6 years this applied to cattle meat and milk and in addition, at the upper bound to citrus and some vegetables.

10. For PFOS + PFHxS combined, additional food groups were identified as having amounts of food that could be consumed before the TDI was reached that were lower than the 90th percentile or mean consumption amounts of those foods.

11. PFOA has a higher TDI than PFOS. Consequently, the amount of each 'contaminated site' food that could be consumed before the TDI was reached is much higher than the 90th percentile usual food consumption amounts for all food groups and populations.

12. It is considered extremely unlikely that food consumption of a specific food group over a period would all be from food sourced locally near a contaminated site. This is particularly true for milk and milk products where milk is not normally sourced from one animal but is collected from many animals and several sources, mixed and homogenised and then distributed through retail outlets.

13. Proposed trigger points for investigation for PFOS + PFHxS combined are lowest for milk (0.4 µg/kg). Proposed trigger points for investigation are lower for fruit and vegetables (0.6 and 1.1 µg/kg respectively) than for finfish (5.2 µg/kg), mammalian meat (3.5 µg/kg) and eggs (11 µg/kg). Trigger points for investigation for other seafood, honey and offal are substantially higher than those proposed for other commodities.

14. In most commodities, proposed trigger points for investigation for PFOA are an order of magnitude higher than those for PFOS. Like PFOS, levels are lowest in fruit and vegetables, finfish and meat.

10 References

Agency for Toxic Substances and Disease Registry (ATSDR) 2015. Public Health Statement: Perfluoroalkyls, EPA, https://www.atsdr.cdc.gov/phs/phs.asp?id=1115&tid=237 (accessed Jan 2017).

Cornelis C, D'Hollander W, Roosens L, Covaci A, Smolders R, Van Den Heuvel R, Govarts E, Van Campenhout K, Reynders H, Bervoets L 2012. First assessment of population exposure to perfluorinated compounds in Flanders, Belgium, *Chemosphere;* **86**: 308-314.

European Food Safety Authority (EFSA) 2006. Guidance of the Scientific Committee on a request from EFSA related to Uncertainties in Dietary Exposure Assessment, The EFSA Journal; 438:1-54.

European Food Safety Authority (EFSA) 2008. Perfluorooctanoic acid (PFOA) and their salts, Opinion of the Scientific Panel on Contaminants in the Food Chain, The EFSA Journal; 53:1–131.

European Food Safety Authority (EFSA) 2012. Scientific Report of EFSA Perfluoroalkylated substances in food: occurrence and dietary exposure, The EFSA Journal; 10(6): 2743-2798.

FAO/WHO (2009) Principles and methods for the risk assessment of chemicals in food. Environmental Health Criteria 240.

Food Standards Australia New Zealand (FSANZ) 2009. Principles and Practices of Dietary Exposure Assessment for Food Regulatory Purposes. http://www.foodstandards.gov.au/publications/Pages/Principles-and-Practices-of-Dietary.aspx

Food Standards Australia New Zealand (FSANZ) 2016. 24th Australian Total Diet Study Phase 2. http://www.foodstandards.gov.au/publications/Pages/24th-ATDS-Phase-2.aspx

Hansen S 1979. Conditions for the use of food additives based on a budget method for an acceptable daily intake, *Journal of Food Protection* 42(5): 429-434.

List of Tables

Appendix 1: Summary of occurrence data used in dietary exposure calculations

Table 9. Median lower, middle and upper bound PFOS, PFOA and PFHxS concentrations (µg/kg) by food classification

Food Category	Food Classification	PFOS			PFOA			PFHxS			PFOS+PFHxS		
		Lower Bound	Middle Bound	Upper Bound	Lower Bound	Middle Bound	Upper Bound	Lower Bound	Middle Bound	Upper Bound	Lower Bound	Middle Bound	Upper Bound
Fish and Seafood	Crustaceans of all species	2.6	2.6	2.6	0	0.15	0.3	1.95	1.95	1.95	16.1	16.1	16.1
	Finfish (all)	2.3	2.3	2.3	0	0.15	0.3	0	0.5	1	4.35	4.6	4.85
	Diadromous fish	5	5	5	0	0.15	0.3	0	0.5	1	5	5.5	6
	Freshwater fish	3.45	3.45	3.45	0	0.15	0.3	0	0.5	1	42.5	43	43.5
	Marine fish of all species	1.95	1.95	1.95	0	0.15	0.3	0	0.25	0.5	1.1	1.35	1.6
	Finfish – Liver only	39.5	39.5	39.5	0	0.2	0.32	2.55	2.55	2.55	41.2	41.2	41.2
	Molluscs	1.05	1.05	1.05	0	0.22	0.3	0	0.25	0.5	1.5	1.75	1.86
Animal products	Meat mammalian (all)	9.17	9.17	9.17	0	0.02	0.04	2.83	2.83	2.83	12.42	12.42	12.42
	Cattle meat	54.17	54.17	54.17	0	0.03	0.04	9.08	9.08	9.08	63.67	63.67	63.67
	Rabbit meat	66.5	66.5	66.5	0	1	2	4.43	4.43	4.43	75.13	75.13	75.13
	Sheep meat	4.92	4.92	4.92	0	0.02	0.04	0.34	0.5	1.0	5.8	5.8	5.8
	Milk (all)	2.9	2.9	2.9	0	0.26	0.52	0	0.26	0.52	2.9	3.15	3.4
	Cattle milk	2.37	2.37	2.37	0	0.26	0.52	0	0.26	0.52	2.369	2.627	2.884
	Sheep milk	2.9	2.9	2.9	0	0.26	0.52	0	0.26	0.52	2.9	3.15	3.4
	Honey[1]	0	1.5	3.00	0	1.5	3	0	1.5	3	0	3	6
	Offal mammalian	60.4	60.4	60.4	0	0.75	1.5	0	0.75	1.5	60.4	61.15	61.9
	Poultry eggs	7.15	7.15	7.15	0	1.5	3	0.85	2.5	5	8	9.25	10.8

ASSESSMENT OF POTENTIAL DIETARY EXPOSURE TO PERFLUOROOCTANE SULFONATE (PFOS), PERFLUOROOCTANOIC ACID (PFOA) AND PERFLUOROHEXANE SULFONATE (PFHxS) OCCURRING IN FOODS SAMPLED FROM CONTAMINATED SITES

Food Category	Food Classification	PFOS			PFOA			PFHxS			PFOS+PFHxS		
		Lower Bound	Middle Bound	Upper Bound	Lower Bound	Middle Bound	Upper Bound	Lower Bound	Middle Bound	Upper Bound	Lower Bound	Middle Bound	Upper Bound
Fruit and vegetables	*Vegetables (all)*												
	Cucurbits	0	0.5	1	0	1	2	0	0.5	1	0	1	2
	Herbs[1]	0	1.5	3	0	1.5	3	0	1.5	3	0	3	6
	Leafy vegetables	0	0.5	1	0	1	2	0	0.5	1	0	1	2
	Other fruiting vegetables	0	1.5	3	0	1.5	3	0	1.5	3	0	3	6
	Root and tuber vegetables	0	1.5	3	0	1.5	3	0	1.5	3	0	3	6
	Spices[1]	0	1.5	3	0	1.5	3	0	1.5	3	0	3	6
	Stalk and stem vegetables	3.85	3.85	3.85	0	1	2	1.25	1.25	1.25	4.75	4.75	4.95
	Fruit (all)												
	Berries and other small fruits[1]	0	1.5	3	0	1.5	3	0	1.50	3.00	0	3	6
	Citrus fruits	0	1.5	3	0	1.5	3	0	1.5	3	0	3	6
	Pome fruits[2]	0	1.5	3	0	1.5	3	0	1.50	3	0	3	6
	Tropical fruit - edible peel	0	0.5	1	0	0.5	1	0	0.5	1	0	1	2

[1] single value only, no mean or median calculated, [2] mean is used, insufficient samples to derive median value (n <3)

Appendix 2: Food consumption from the 2011-12 NNPAS

Table 10. Food consumption amounts (grams/day) for food groups for Australians aged 2 years and above

Food Category	Food classification	No. consumers	% consumers to respondents	Mean all respondents	P90 consumers only	Mean consumers only
Fish and seafood	*Crustaceans of all species*	1096	14%	3	63	21
	Finfish (all)	3679	48%	21	123	45
	Diadromous fish	839	11%	5	119	50
	Freshwater fish	685	9%	5	143	56
	Marine fish of all species	5438	70%	15	76	22
	Molluscs	1063	14%	1	30	9
Animal products	*Meat mammalian (all)*	7016	91%	96	221	106
	Cattle meat	6217	80%	57	163	71
	Rabbit meat	3	0%	0	-	364
	Sheep meat	4332	56%	12	85	22
	Milk (all)[1]	7718	100%	692	1295	693
	Cattle milk	7718	100%	691	1295	692
	Sheep milk	1681	22%	3	31	13
	Honey	3089	40%	2	14	5
	Offal mammalian	52	1%	0	84	32
	Poultry eggs	6520	84%	19	59	23
Fruit and vegetables	*Vegetables (all)*	7734	100%	314	570	314
	Cucurbits	5866	76%	27	96	35
	Herbs	5791	75%	1	4	2
	Leafy vegetables	6005	78%	17	48	22
	Other fruiting vegetables	7724	100%	104	205	104
	Root and tuber vegetables	7479	97%	119	273	123
	Spices	7261	94%	2	5	2
	Stalk and stem vegetables	4641	60%	4	15	7
	Fruit (all)	7522	97%	371	861	381
	Berries and other small fruits	5023	65%	108	526	166
	Citrus fruits	5981	77%	100	354	129
	Pome fruits	5166	67%	98	321	147
	Tropical fruit - edible peel	3374	44%	2	10	5

[1] *Slight difference between consumer and respondent consumption amounts may occur because of rounding*

Table 11. Food consumption amounts (grams/day) for food groups for Australians aged 2-6 years

Food category	Food classification	No. consumers	% consumers to respondents	Mean all respondents	P90 consumers only	Mean consumers only
Fish and seafood	*Crustaceans of all species*	21	4%	<1	21	8
	Finfish (all)	173	36%	9	73	24
	Diadromous fish	17	4%	1	60	34
	Freshwater fish	33	7%	2	72	28
	Marine fish of all species	321	67%	7	40	10
	Molluscs	32	7%	<1	4	2
Animal products	*Meat mammalian (all)*	425	89%	42	108	47
	Cattle meat	382	80%	27	85	33
	Rabbit meat	NC	NC	NC	NC	NC
	Sheep meat	284	59%	5	36	9
	Milk (all)	479	100%	679	1097	679
	Cattle milk	479	100%	678	1097	678
	Sheep milk	88	18%	1	10	5
	Miscellaneous animal foods	220	46%	2	12	5
	Offal mammalian	1	0%	-	-	-
	Poultry eggs	385	80%	11	36	13
Fruit and vegetables	*Vegetables (all)*	479	100%	188	346	188
	Cucurbits	329	69%	24	115	35
	Herbs	297	62%	1	2	1
	Leafy vegetables	264	55%	5	26	9
	Other fruiting vegetables	478	100%	73	151	73
	Root and tuber vegetables	460	96%	64	164	66
	Stalk and stem vegetables	207	43%	2	7	4
	Spices	437	91%	1	2	1
	Fruit (all)	476	99%	312	592	314
	Berries and other small fruits	375	78%	30	108	38
	Citrus fruits	367	77%	68	246	88
	Pome fruits	427	89%	152	361	171
	Tropical fruit - edible peel	176	37%	2	10	5

NC – not consumed, - insufficient consumers to derive consumption amounts.

Appendix 3: Amount of food at median PFOS, PFOA, PFHxS levels to reach TDI

Table 12. Amount of food* (grams/day) at median PFHxS concentration to reach the TDI for the population aged 2 years and above

Food category	Food classification	Amount of food that can be consumed before reaching PFHxS TDI			Food consumption derived from 2011-12 NNPAS	
		Lower Bound	Middle Bound	Upper Bound	P90 consumers only	Mean consumers only
Fish and seafood	*Crustaceans of all species*	718	718	718	63	21
	Finfish (all)		2800	1400	123	45
	Diadromous fish		2800	1400	119	50
	Freshwater fish		2800	1400	143	56
	Marine fish of all species		5600	2800	76	22
	Molluscs		5600	2800	30	9
Animal products	*Meat mammalian (all)*	494	494	494	221	106
	Cattle meat	154	154	154	163	71
	Rabbit meat	316	316	316	-	364
	Sheep meat	4098	2800	1400	85	22
	Milk (all)		5437	2718	1295	693
	Cattle milk		5437	2718	1295	692
	Sheep milk		5437	2718	31	13
	Miscellaneous foods (honey)		933	467	14	5
	Offal mammalian		1867	933	84	32
	Poultry eggs	1647	560	280	59	23
Fruit and vegetables	*Vegetables (all)*				570	314
	Cucurbits		2800	1400	96	35
	Herbs		933	467	4	2
	Leafy vegetables		2800	1400	48	22
	Other fruiting vegetables		933	467	205	104
	Root and tuber vegetables		933	467	273	123
	Spices		933	467	5	2
	Stalk and stem vegetables	1120	1120	1120	15	7
	Fruit (all)				861	381
	Berries and other small fruits		933	467	526	166
	Citrus fruits		933	467	354	129
	Pome fruits		933	467	321	147
	Tropical fruit - edible peel		2800	1400	10	5

* *Consumption amounts not provided where median PFAS concentration was <LOR and calculated as zero; - insufficient consumers to derive P90 consumption*

Table 13. Amount of food* (grams/day) at median PFHxS concentration to reach the TDI for the population aged 2-6 years

Food category	Food classification	Amount of food that can be consumed before reaching PFHxS TDI			Food consumption derived from 2011-12 NNPAS	
		Lower Bound	Middle Bound	Upper Bound	P90 consumers only	Mean consumers only
Fish and seafood	*Crustaceans of all species*	195	195	195	21	8
	Finfish (all)		760	380	73	24
	Diadromous fish		760	380	60	34
	Freshwater fish		760	380	72	28
	Marine fish of all species		1520	760	40	10
	Molluscs		1520	760	4	2
Animal product	*Meat mammalian (all)*	134	134	134	108	47
	Cattle meat	42	42	42	85	33
	Sheep meat	1112	760	380	36	9
	Milk (all)		1476	738	1097	679
	Cattle milk		1476	738	1097	678
	Sheep milk		1476	738	10	5
	Miscellaneous foods (honey)		253	127	12	5
	Offal mammalian		507	253	-	-
	Poultry eggs	447	152	76	36	13
Fruit and vegetables	*Vegetables (all)*				346	188
	Cucurbits		760	380	115	35
	Herbs		253	127	2	1
	Leafy vegetables		760	380	26	9
	Other fruiting vegetables		253	127	151	73
	Root and tuber vegetables		253	127	164	66
	Spices		253	127	2	1
	Stalk and stem vegetables	304	304	304	7	4
	Fruit (all)				592	314
	Berries and other small fruits		253	127	108	38
	Citrus fruits		253	127	246	88
	Pome fruits		253	127	361	171
	Tropical fruit - edible peel		760	380	10	5

* Consumption amounts not provided where median PFAS concentration was <LOR and calculated as zero; - Not consumed

Table 14. Amount of food* (grams/day) at median PFOS concentration to reach the TDI for the population aged 2 years and above

Food category	Food classification	Amount of food that can be consumed before reaching PFOS TDI			Food consumption derived from 2011-12 NNPAS	
		Lower Bound	Middle Bound	Upper Bound	P90 consumers only	Mean consumers only
Fish and seafood	*Crustaceans of all species*	538	538	538	63	21
	Finfish (all)	609	609	609	123	45
	Diadromous fish	280	280	280	119	50
	Freshwater fish	406	406	406	143	56
	Marine fish of all species	718	718	718	76	22
	Molluscs	1333	1333	1333	30	9
Animal products	*Meat mammalian (all)*	153	153	153	221	106
	Cattle meat	26	26	26	163	71
	Rabbit meat	21	21	21	-	364
	Sheep meat	285	285	285	85	22
	Milk (all)	483	483	483	1295	693
	Cattle milk	591	591	591	1295	692
	Sheep milk	483	483	483	31	13
	Miscellaneous foods (honey)		933	467	14	5
	Offal mammalian	23	23	23	84	32
	Poultry eggs	196	196	196	59	23
Fruit and vegetables	*Vegetables (all)*				570	314
	Cucurbits		2800	1400	96	35
	Herbs		933	467	4	2
	Leafy vegetables		2800	1400	48	22
	Other fruiting vegetables		933	467	205	104
	Root and tuber vegetables		933	467	273	123
	Spices		933	467	5	2
	Stalk and stem vegetables	364	364	364	15	7
	Fruit (all)				861	381
	Berries and other small fruits		933	467	526	166
	Citrus fruits		933	467	354	129
	Pome fruits		933	467	321	147
	Tropical fruit - edible peel		2800	1400	10	5

* *Consumption amounts not provided where median PFAS concentration was <LOR and calculated as zero; - insufficient consumers to derive P90 consumption*

Table 15. Amount of food* (grams/day) at median PFOS concentration to reach the TDI for the population aged 2-6 years

Food category	Food classification	Amount of food that can be consumed before reaching PFOS TDI			Food consumption derived from 2011-12 NNPAS	
		Lower Bound	Middle Bound	Upper Bound	P90 consumers only	Mean consumers only
Fish and seafood	*Crustaceans of all species*	146	146	146	21	8
	Finfish (all)	165	165	165	73	24
	Diadromous fish	76	76	76	60	34
	Freshwater fish	110	110	110	72	28
	Marine fish of all species	195	195	195	40	10
	Molluscs	362	362	362	4	2
Animal products	*Meat mammalian (all)*	41	41	41	108	47
	Cattle meat	7	7	7	85	33
	Sheep meat	77	77	77	36	9
	Milk (all)	131	131	131	1097	679
	Cattle milk	160	160	160	1097	678
	Sheep milk	131	131	131	10	5
	Miscellaneous foods (honey)		253	127	12	5
	Offal mammalian	6	6	6	-	-
	Poultry eggs	53	53	53	36	13
Fruit and vegetables	*Vegetables (all)*				346	188
	Cucurbits		760	380	115	35
	Herbs		253	127	2	1
	Leafy vegetables		760	380	26	9
	Other fruiting vegetables		253	127	151	73
	Root and tuber vegetables		253	127	164	66
	Spices		253	127	2	1
	Stalk and stem vegetables	99	99	99	7	4
	Fruit (all)				592	314
	Berries and other small fruits		253	127	108	38
	Citrus fruits		253	127	246	88
	Pome fruits		253	127	361	171
	Tropical fruit - edible peel		760	380	10	5

* Consumption amounts not provided where median PFAS concentration was <LOR and calculated as zero

Table 16. Amount of food* (grams/day) at median PFOA concentration to reach the TDI for the population aged 2 years and above

Food category	Food classification	Amount of food that can be consumed before reaching PFOA TDI			Food consumption derived from 2011-12 NNPAS	
		Lower Bound	Middle Bound	Upper Bound	P90 consumers only	Mean consumers only
Fish and seafood	*Crustaceans of all species*		74,667	37,333	63	21
	Finfish (all)		74,667	37,333	123	45
	Diadromous fish		74,667	37,333	119	50
	Freshwater fish		74,667	37,333	143	56
	Marine fish of all species		74,667	37,333	76	22
	Molluscs		52,093	37,333	30	9
Animal products	*Meat mammalian (all)*		537,600	268,800	221	106
	Cattle meat		448000	268800	163	71
	Rabbit meat		11,200	5,600	-	364
	Sheep meat		537,600	268,800	85	22
	Milk (all)		43,495	21,748	1,295	693
	Cattle milk		43,495	21,748	1,295	692
	Sheep milk		43,495	21,748	31	13
	Miscellaneous foods (honey)		7,467	3,733	14	5
	Offal mammalian		14,933	7,467	84	32
	Poultry eggs		7,467	3,733	59	23
Fruit and vegetables	*Vegetables (all)*				570	314
	Cucurbits		11,200	5,600	96	35
	Herbs		7,467	3,733	4	2
	Leafy vegetables		11,200	5,600	48	22
	Other fruiting vegetables		7,467	3,733	205	104
	Root and tuber vegetables		7,467	3,733	273	123
	Spices		7,467	3,733	5	2
	Stalk and stem vegetables		11,200	5,600	15	7
	Fruit (all)				861	381
	Berries and other small fruits		7,467	3,733	526	166
	Citrus fruits		7,467	3,733	354	129
	Pome fruits		7,467	3,733	321	147
	Tropical fruit - edible peel		22,400	11,200	10	5

* Consumption amounts not provided where median PFAS concentration was <LOR and calculated as zero; - insufficient consumers to derive P90 consumption

Table 17. Amount of food* (grams/day) at median PFOA concentration to reach the TDI for the population aged 2-6 years

Food category	Food classification	Amount of food that can be consumed before reaching PFOA TDI			Food consumption derived from 2011-12 NNPAS	
		Lower Bound	Middle Bound	Upper Bound	P90 consumers only	Mean consumers only
Fish and seafood	*Crustaceans of all species*		20,267	10,133	21	8
	Finfish (all)		20,267	10,133	73	24
	Diadromous fish		20,267	10,133	60	34
	Freshwater fish		20,267	10,133	72	28
	Marine fish of all species		20,267	10,133	40	10
	Molluscs		14,140	10,133	4	2
Animal products	*Meat mammalian (all)*		145,920	72,960	108	47
	Cattle meat		121600	72,960	85	33
	Sheep meat		145,920	72,960	36	9
	Milk (all)		11,806	5,903	1,097	679
	Cattle milk		11,806	5,903	1,097	678
	Sheep milk		11,806	5,903	10	5
	Miscellaneous foods (honey)		2,027	1,013	12	5
	Offal mammalian		4,053	2,027	-	-
	Poultry eggs		2,027	1,013	36	13
Fruit and vegetables	*Vegetables (all)*				346	188
	Cucurbits		3,040	1,520	115	35
	Herbs		2,027	1,013	2	1
	Leafy vegetables		3,040	1,520	26	9
	Other fruiting vegetables		2,027	1,013	151	73
	Root and tuber vegetables		2,027	1,013	164	66
	Spices		2,027	1,013	2	1
	Stalk and stem vegetables		3,040	1,520	7	4
	Fruit (all)				592	314
	Berries and other small fruits		2,027	1,013	108	38
	Citrus fruits		2,027	1,013	246	88
	Pome fruits		2,027	1,013	361	171
	Tropical fruit - edible peel		6,080	3,040	10	5

* Consumption amounts not provided where median PFAS concentration was <LOR and calculated as zero

Table 18. Amount of food* (grams/day) at median PFOS+PFHxS combined concentration to reach the TDI for the population aged 2 years and above

Food category	Food classification	Amount of food that can be consumed before reaching PFOS+PFHxS TDI			Food consumption derived from 2011-12 NNPAS	
		Lower Bound	Middle Bound	Upper Bound	P90 consumers only	Mean consumers only
Fish and seafood	*Crustaceans of all species*	87	87	87	63	21
	Finfish (all)	322	304	289	123	45
	Diadromous fish	280	255	233	119	50
	Freshwater fish	33	33	32	143	56
	Marine fish of all species	1,273	1,037	875	76	22
	Molluscs	933	800	753	30	9
Animal products	*Meat mammalian (all)*	113	113	113	221	106
	Cattle meat	22	22	22	163	71
	Rabbit meat	19	19	19	-	364
	Sheep meat	241	241	241	85	22
	Milk (all)	483	444	412	1,295	693
	Cattle milk	591	533	485	1,295	692
	Sheep milk	483	444	412	31	13
	Miscellaneous foods (honey)		467	233	14	5
	Offal mammalian	23	23	23	84	32
	Poultry eggs	175	151	130	59	23
Fruit and vegetables	*Vegetables (all)*				570	314
	Cucurbits		1,400	700	96	35
	Herbs		467	233	4	2
	Leafy vegetables		1,400	700	48	22
	Other fruiting vegetables		467	233	205	104
	Root and tuber vegetables		467	233	273	123
	Spices		467	233	5	2
	Stalk and stem vegetables	295	295	283	15	7
	Fruit (all)				861	381
	Berries and other small fruits		467	233	526	166
	Citrus fruits		467	233	354	129
	Pome fruits		467	233	321	147
	Tropical fruit - edible peel		1,400	700	10	5

* Consumption amounts not provided where median PFAS concentration was <LOR and calculated as zero; - insufficient consumers to derive P90 consumption

Table 19. Amount of food* (grams/day) at median PFOS+PFHxS combined concentration to reach the TDI for the population aged 2-6 years

Food category	Food classification	Amount of food that can be consumed before reaching PFOS+PFHxS TDI			Food consumption derived from 2011-12 NNPAS	
		Lower Bound	Middle Bound	Upper Bound	P90 consumers only	Mean consumers only
Fish and seafood	*Crustaceans of all species*	24	24	24	21	8
	Finfish (all)	87	83	78	73	24
	Diadromous fish	76	69	63	60	34
	Freshwater fish	9	9	9	72	28
	Marine fish of all species	345	281	238	40	10
	Molluscs	253	217	204	4	2
Animal products	*Meat mammalian (all)*	31	31	31	108	47
	Cattle meat	6	6	6	85	33
	Sheep meat	66	66	66	36	9
	Milk (all)	131	121	112	1,097	679
	Cattle milk	160	145	132	1,097	678
	Sheep milk	131	121	112	10	5
	Miscellaneous foods (honey)		127	63	12	5
	Offal mammalian	6	6	6	-	-
	Poultry eggs	48	41	35	36	13
Fruit and vegetables	*Vegetables (all)*				346	188
	Cucurbits		380	190	115	35
	Herbs		127	63	2	1
	Leafy vegetables		380	190	26	9
	Other fruiting vegetables		127	63	151	73
	Root and tuber vegetables		127	63	164	66
	Spices		127	63	2	1
	Stalk and stem vegetables	80	80	77	7	4
	Fruit (all)				592	314
	Berries and other small fruits		127	63	108	38
	Citrus fruits		127	63	246	88
	Pome fruits		127	63	361	171
	Tropical fruit - edible peel		380	190	10	5

* Consumption amounts not provided where median PFAS concentration was <LOR and calculated as zero

Appendix 4: Maximum concentrations and trigger points for investigation

Table 20. PFOS, PFOA and PFHxS concentration (µg/kg) at median or 90th percentile consumption (consumers only) to reach TDI*. Trigger points are shaded and bolded.

Food category	Food Classification	Population: 2-6 years				Population: 2 years +			
		PFHxS	PFOS	PFOA	PFOS+PFHxS	PFHxS	PFOS	PFOA	PFOS+PFHxS
Fish and seafood	Crustaceans of all species	**65***	**65***	**520***	**65***	183*	183*	1463*	183*
	Finfish (all)	**5.2**	**5.2**	**41**	**5.2**	11	11	91	11
	Diadromous fish	22*	22*	177*	22*	37*	37*	296*	37*
	Freshwater fish	20*	20*	158*	20*	33*	33*	267*	33*
	Marine fish of all species	10	10	77	10	18	18	147	18
	Molluscs	29272*	29272*	234178*	29272*	35948*	35948*	287587*	35948*
Animal products	Meat mammalian (all)	**3.5**	**3.5**	**28**	**3.5**	6.3	6.3	51	6.3
	Cattle meat	4.5	4.5	36	4.5	8.6	8.6	69	8.6
	Rabbit meat	-	-	-	-	3.0*	3.0*	24*	3.0*
	Sheep meat	11	11	85	11	17	17	132	17
	Milk (all)	0.4	0.4	2.8	0.4	1.1	1.1	8.7	1.1
	Cattle milk	**0.4**	**0.4**	**2.8**	**0.4**	1.1	1.1	8.7	1.1
	Sheep milk	38	38	306	38	45	45	361	45
	Honey	**33**	**33**	**264**	**33**	98	98	783	98
	Offal mammalian	-	-	-	-	**96***	**96***	**765***	**96***
	Poultry eggs	**11**	**11**	**85**	**11**	24	24	192	24

ASSESSMENT OF POTENTIAL DIETARY EXPOSURE TO PERFLUOROOCTANE SULFONATE (PFOS), PERFLUOROOCTANOIC ACID (PFOA) AND PERFLUOROHEXANE SULFONATE (PFHxS) OCCURRING IN FOODS SAMPLED FROM CONTAMINATED SITES

Food category	Food Classification	Population: 2-6 years				Population: 2 years +			
		PFHxS	PFOS	PFOA	PFOS+PFHxS	PFHxS	PFOS	PFOA	PFOS+PFHxS
Fruit and vegetables	Vegetables (all)	1.1	1.1	8.8	1.1	2.5	2.5	20	2.5
	Cucurbits	3.3	3.3	26	3.3	15	15	117	15
	Herbs	172	172	1380	172	349	349	2794	349
	Leafy vegetables	15	15	119	15	29	29	232	29
	Other fruiting vegetables	2.5	2.5	20	2.5	6.8	6.8	55	6.8
	Root and tuber vegetables	2.3	2.3	19	2.3	5.1	5.1	41	5.1
	Spices	185	185	1478	185	282	282	2257	282
	Stalk and stem vegetables	52	52	412	52	96	96	771	96
	Fruit (all)	0.6	0.6	5.1	0.6	1.6	1.6	13	1.6
	Berries and other small fruits	3.5	3.5	28	3.5	2.7	2.7	21	2.7
	Citrus fruits	1.5	1.5	12	1.5	4.0	4.0	32	4.0
	Pome fruits	1.1	1.1	8.4	1.1	4.4	4.4	35	4.4
	Tropical fruit - edible peel	38	38	304	38	145	145	1163	145

- Not consumed

* Median food consumption used to calculate maximum concentration as infrequently consumed food (infrequently consumed foods are those food groups consumed by ≤10% of the population on day 1 of the nutrition survey). Trigger points for investigation for crustaceans applied to molluscs due to small numbers of consumers of molluscs, particularly for children 2-6 years. Derivation of consumption of molluscs also included consumers of oyster sauce (oyster as an ingredient) leading to a low median consumption figure for consumers not considered appropriate for use to derive a trigger point for investigation.

Appendix 5: Dietary exposure assessments at FSANZ

A dietary exposure assessment is the process of estimating how much of a food chemical a population, or population sub group, consumes. Dietary exposure to food chemicals is estimated by combining food consumption data with food chemical concentration data. The process of doing this is called 'dietary modelling'.

$$Dietary\ exposure\ =\ food\ chemical\ concentration\ x\ food\ consumption$$

FSANZ's approach to dietary modelling is based on internationally accepted procedures for estimating dietary exposure to food chemicals (FSANZ 2009). Different dietary modelling approaches may be used depending on the assessment, the type of food chemical, the data available and the risk assessment questions to be answered. In the majority of assessments FSANZ uses the food consumption data from each person in the national nutrition surveys to estimate their individual dietary exposure, adjusted for individual bodyweight where appropriate. Population summary statistics such as the mean exposure or a high percentile exposure are derived from the distribution of individual person's exposures from the nutrition survey.

An overview of how dietary exposure assessments are conducted and their place in the FSANZ Risk Analysis Process is provided on the FSANZ website at http://www.foodstandards.gov.au/science/riskanalysis/Pages/default.aspx.

FSANZ has developed a custom-built computer program 'Harvest' to calculate dietary exposures. Harvest is a newly built program and replaces the program 'DIAMOND' that had been used by FSANZ for many years. Harvest has been designed to replicate the calculations that occurred within DIAMOND using a different software package. Further detailed information on conducting dietary exposure assessments at FSANZ is provided in *Principles and Practices of Dietary Exposure Assessment for Food Regulatory Purposes* (FSANZ 2009), available at http://www.foodstandards. gov.au/science/exposure/documents/Principles%20_%20practices%20exposure%20assessment%202009.pdf.

Food consumption data used

The most recent food consumption data available for the Australian population from the 2011-12 Australian National Nutrition and Physical Activity Survey (2011-12 NNPAS) component of the 2011-13 Australian Health Survey undertaken by the Australian Bureau of Statistics was used in this assessment.

The 2011–12 NNPAS includes information on dietary patterns of a sample of 12,153 Australians aged from 2 years and above. The survey used a 24-hour recall method for all respondents, with 64% of respondents also completing a second 24-hour recall on a second, non-consecutive day. The data were collected from May 2011 to June 2012 (with no enumeration between August and September 2011 due to the Census). Day 1 and Day 2 24-hour recall data for a subset of respondents were used for this assessment. These data were weighted for use in the calculations of food consumption amounts for food or food groups. Consumption and respondent data from the survey were incorporated into the Harvest program from the Confidentialised Unit Record Files (CURF) data set (ABS 2014).

Further information on the national nutrition surveys used to conduct dietary exposure assessments is available on the FSANZ website at http://www.foodstandards.gov.au/science/exposure/Pages/dietaryexposureandin4438.aspx.