12 September 2017

TOXFREE AUSTRALIA PTY LTD

Narangba Incident - Environmental Evaluation Monitoring Plan

Submitted to:
Toxfree Australia Pty Ltd
8-12 Krypton Street
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Report Number. 1780114-013-R-RevA

Distribution:

1 electronic copy to Toxfree Australia Pty Ltd
1 electronic copy to Trevor Lloyd of Lloyd Consulting Pty Ltd

Golder Associates

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1.0 INTRODUCTION

1.1 General

Golder Associates Pty Ltd (Golder) has been engaged by Toxfree Australia Pty Ltd (Toxfree) to provide environmental consultancy services to respond to the requirements of a *Notice to Conduct or Commission and Environmental Evaluation* (the EE Notice), issued by the Department of Environment and Heritage Protection (DEHP), pursuant to Sections 321 to 329 of the *Environmental Protection Act 1994* (the Act).

The EE Notice was issued to Toxfree on 27 September 2017 and amended on 5 October 2017 to acknowledge Toxfree's feedback (Appendix A). The EE Notice relates to a release of hazardous waste into the environment: the incident occurred on 28 April 2017 at Toxfree's facility at 8-12 Crypton Street in Narangba, Queensland, identified as Lot 111 on CP909626.

Approximately 800 L of hazardous liquid waste containing aqueous film forming foam (AFFF) was spilled from an intermediate bulk container (IBC) on the neighbouring property (Lot 112 on CP867909) occupied by Queensland Organics Pty Ltd, an organic fertiliser manufacturer. The spill also affected a nearby waterway, on Lot 535 on SP255151, which flows towards Lagoon Creek.

Under a clean-up notice issued on 12 May 2017, Golder completed and submitted an Investigation Report on the 15 August 2017 (document number 1780114-007-R-Rev0, referred to hereinafter as the '*previous investigation*').

Following receipt of this report, DEHP issued the EE Notice to complete additional, expanded field investigation.

Andrew Howes of Golder is acting as the Suitable Qualified Person (SQP) for this project. Trevor Lloyd of Lloyd Consulting Pty Ltd (Queensland Auditor Certificate No. CLAD05908516) has also been engaged by Toxfree to undertake a critical review of the work undertaken by Golder.

This monitoring plan has been prepared to describe the proposed expanded monitoring programme in fulfilment of the EE Notice.

1.2 Objective

Based on EE Notice requests, the objective of the expanded investigation is to complete an assessment of:

- The nature and extent of environmental harm (including potential harm) caused to receiving waters as a result of the contamination incident. This is to include:
  - The extent of PFAS contamination likely to have been caused by the release to water quality, biota and sediments utilising techniques available to detect trace concentrations of PFAS in the environment.
  - The environmental harm and potential environmental harm caused to the freshwater and estuarine environmental values within the Investigation Area.
  - Determination of PFAS concentrations in water, sediment and potentially affected biota at each of the sampling locations.
  - Testing and analysis for the suite of 20 to 28 standard fluorinated organic compounds by liquid chromatography-mass spectrometry (LC/MS/MS) and total oxidisable precursor (TOP) assay, reported as the analyses for the resulting perfluorinated carboxylates for C4 to C14 carbon chain length (TOP C4-C14).
  - Screening of potential health risks associate with sediment data using field based biota sediment bioaccumulation factors (BAF).
  - Estimation of the risks of exceeding tolerable daily intakes recommended by Food Standards Australia and New Zealand (FSANZ).

The Investigation Area defined for this monitoring plan is upstream from the contamination incident site to the Bruce Highway, and downstream to and inclusive of Hays Inlet to the Houghton Highway road bridge, Clontarf. This Investigation Area in relation to the previous investigation is shown in Figure 1. The matrices for this expanded programme include groundwater, surface water, stream bed-sediments and biota.

Given the primary objective of this monitoring plan relates to the delineation and assessment of risk associated with PFAS contamination delineation, no analysis of non-PFAS contaminants has been included in this proposed analytical plan.

2.0 BACKGROUND INFORMATION

2.1 The Incident

On 28 April 2017 an incident occurred at the Toxfree facility whereby an intermediate bulk container (IBC) of liquid waste, containing approximately 800 L of aqueous film forming foams (AFFF), fell over the northern boundary fence during handling with a forklift. The liquid from the IBC was spilled onto the neighbouring property occupied by an organic fertiliser manufacturer, followed the local topography westwards via surface flow, and affected the north west corner of the Toxfree property and a vegetated area west of the boundary fence.

In the spill location there is a stormwater inspection pit covered with a concrete lid and, at the time, a surface layer of soil. However, based on the observation of foam in the Potassium Street bridge culvert, it appears that some of the liquid flowed through the underground drain pipe and reached the creek in the green corridor to the west of the site, a distance of approximately 80 m from the spill affected area.

Toxfree undertook immediate containment and clean-up activities in the spill area and in the Potassium Street bridge culvert.

2.2 Previous Investigations

Golder, in response to a Clean-Up Notice issued on 12 May 2017 to Toxfree, submitted an Investigation Report on the 18 August (Ref. 1780114-007-R-Rev0, the previous investigation). The extent of this previous investigation was limited to Anzac Avenue as the downstream limit within Saltwater Creek.

The key findings of the previous investigation were:

Humans

- Risk from exposure to soil impacted from the spill is unlikely.
- Risk from exposure to groundwater impacted by the spill is unlikely.
- Risk from exposure to surface water impacted by the spill is unlikely.
- Risk from exposure to sediment impacted by the spill is unknown but considered unlikely based on the presumed (lack of) recreational activities in the study area. Sediments in the culvert underneath Potassium Street, with the highest concentrations deriving from the spill, have been removed.

Risk from consumption of biota impacted by the spill is likely *if* people consume fish in the areas downstream of the spill. However, we have established that public access to the unnamed creek, Lagoon Creek and upper Saltwater Creek is limited and that the biota sampled, which are likely representative of the icthyofauna, are unlikely to be consumed by humans. In addition, the assessment of risk was based on humans consuming whole organism concentrations which is an over-estimate of potential human exposure.

Furthermore, there is evidence of elevated concentrations of PFAS unrelated to the spill above health standards within the entirety of the study area. Given the likelihood of exposure, the risk from consumption of biota impacted by the spill is considered possible, however given the closest area where recreational fishing or harvesting of marine resources for human consumption may be undertaken is Hays Inlet, which is greater than 9 km downstream of the spill site, the risks from the effects of the spill compared to background levels may be low.

Ecology

- Risk from exposure to soil impacted by the spill is unlikely.
- Risk from exposure to groundwater impacted by the spill is unlikely given the absence of PFAS impact down hydraulic gradient of the spill.
- Risk from exposure to surface water impacted by the spill is likely.
- Risk from exposure to sediment impacted by the spill is unknown.
- Risk to biota impacted by the spill is likely and greatest in the proximity of the spill, however there is evidence of elevated concentrations of PFAS unrelated to the spill above applicable ecological guidelines within the entirety of the study area.

Further investigation was recommended to reduce uncertainties and fill existing data gaps. It was recommended that:

- Additional sampling of all media to confirm if concentrations are stable, reducing or increasing over time and better establish background levels to assess the potential for prevailing offsite sources.
- Additional groundwater sampling to confirm the assumption made in our revised Conceptual Site Model (CSM) that contamination from the spill has not migrated to groundwater, i.e. existing groundwater impacts are due to unrelated activities.
- Additional surface water samples upstream and downstream from the spill site to confirm the assumption made in our revised CSM that:
  - Lagoon and Saltwater Creek surface water has background contamination not attributable to the Toxfree spill.
  - The rainfall event immediately prior to and during sampling would have acted to 'flush' contamination previously contained largely within pooled surface water in the un-named creek adjacent to the spill and that contamination resulting from the spill is no longer a significant contribution to surface water contamination.
- Additional stream bed sediment samples both upstream and downstream from the spill to confirm assumptions made in our revised CSM that:
  - Lagoon and Saltwater Creek stream bed sediments have background contamination not attributable to the Toxfree spill.
  - That the contamination to surface water reported in this report has not led to significant and discernible (above background) contamination of downstream sediments other that those already removed from the Potassium Street culvert.
- Additional biota tissue samples to:
  - Support comparison, where possible, of concentrations of PFAS in the same or similar species at locations upstream (background) and downstream of the spill (for ecological risk assessment).
  - Provide PFAS concentrations in whole-organism samples (used for assessing ecological risk), and edible tissue samples (used for assessing human health risk).
  - Provide greater certainty in the relative contribution from background levels of PFAS to human health exposure (i.e., risks identified are not attributable solely to the Toxfree spill).
- Additional sampling was proposed in Lagoon Creek further upstream, extending up to the crossing with the Bruce Highway and downstream, extending down to the confluence of Kedron Brook and Freshwater Creek, within Hays Inlet, where recreational fishing is more likely.

The requirements contained in the EE Notice are consistent with these recommendations made in the previous investigation report.

3.0 SITE INFORMATION

3.1 Spill affected area

A summary of information regarding the spill affected area is provided in Table 1 below. The spill affected area has an approximate area of 145 m^2.

The spill affected area is bounded to the south, east and north by various industrial properties and a designated green corridor (for overland flow associated with a creek line) along the western boundary (Lot 535 on SP255151).

Table 1: Spill affected area description

Topic	Data			Source
Property Name	**Toxfree plant**	**QLD Organics plant**	**Green Corridor with unnamed waterway**	Personal communication with Toxfree site representative on 2 May 2017)
Land Parcel	Lot 111 on CP909626	Lot 112 on CP867909	Lot 535 on SP255151	QLD Globe accessed on 15 May 2017
Address	8-12 Krypton Street, Narangba	63-71 Potassium Street	n/a	Street directory reviewed on 15 May 2017
Lot Area	7,101 m^2 (approximately 10 m^2 of land affected by potential contamination)	7,507 m^2 (approximately 75 m^2 of land affected by potential contamination)	129.479 ha (approximately 60 m^2 of land and the unnamed waterway flowing into Lagoon Creek affected by potential contamination)	QLD Globe accessed on 15 May 2017
Site use	Liquid and solid hazardous waste treatment facility under the Environmental Permit EPPR00461413	Organic fertilisers manufacturing facility	Vacant land owned by State Government used as flood overflow	Personal communication with Toxfree site representative on 2 May 2017)

Topic	Data	Source
Adjacent Land Use	■ North: Potassium Street and past Accensi Pty Ltd, crop protection products manufacturer, 60-76 Potassium Street. ■ East: Krypton Street and past Permalog Timbers, timber treatment and preservation, 11-49 Potassium Street, Narangba, QLD, 4504. ■ South: Packer Leather, tannery and factory outlet, 101-107 Boundary Road, Narangba, QLD, 4504. ■ West: State Government property vegetated area and past ACMA Industries polyurethane manufacturer (85-91 Potassium Street) and Alphaline Auto, auto repairer (1-5 Magnesium Street).	Queensland Globe, Queensland Government.
Surrounding Land Use	Industrial.	Google Earth

3.2 Receiving Environment

3.2.1 Lagoon Creek and Saltwater Creek (Freshwater Section)

The unnamed creek adjacent to the spill affected area flows into Lagoon Creek which is located along the southern border of the Freshwater National Park. Lagoon Creek and the surrounding vegetated areas are part of a freshwater palustrine wetland system comprised of coastal/sub-coastal floodplain tree swamps of *Melaleuca spp.* and *Eucalypt spp.* (DEHP 2017). Lagoon Creek flows seasonally depending on rainfall, with intermittent pooling occurring in the low-lying areas. It runs in a south easterly direction for approximately 4 km before continuing into Saltwater Creek.

Saltwater Creek runs south easterly for approximately 8 km before continuing into the Kedron Brook creek and out to Hays Inlet. The upstream section of Saltwater Creek is predominately a continuation of the same palustrine wetland system as Lagoon Creek.

The extensive palustrine wetland that encompasses both Lagoon Creek and Saltwater Creek lies in an alluvial floodplain. The low-lying pools act as nutrient sinks and assist in the retention of floodwaters, thereby protecting other downstream wetland systems (e.g. mangrove swamps) from nutrient run-off and erosion. Additionally, the wetlands provide a favourable habitat for a variety of fauna, such as bats, water mice, flying-foxes, frogs, snakes and fish (DERM 2005).

3.2.2 Saltwater Creek and Hays Inlet

The lower extent of Saltwater Creek is classified as a tidally influenced estuary comprised of mangroves and other associated vegetation (DEHP 2017). Saltwater Creek flows into Kedron Brook which widens in the Hays Inlet, a larger estuary fringed by mangroves, salt flats and salt marsh before entering Bramble Bay.

Hays Inlet and the Moreton Bay are a Ramsar listed high ecological significance wetland, with upstream Hays Inlet a highly protected zone of the Moreton Bay Marine Park, Fish Habitat Area, a Key Coastal Site in the SE Queensland Regional Coastal Management Plan and supporting endangered RE 12.1.1.

3.2.3 Environmental Values

Under the Environmental Protection (Water) Policy 2009 (Water EPP), all Queensland water have prescribed environmental values and water quality objectives. The environmental values for bodies of water which are included in the Investigation Area: Saltwater Creek (both freshwater and tidal sections), Freshwater Creek (tidal sections) Hays Inlet and the North Pine River (tidal sections) are included in Table 2.

Table 2: Environmental Values within the Investigation Area (Pine Rivers and Redcliffe Creeks environmental values and water quality objectives, 2009)

	Environmental Value						
Creek Name	**Aquatic Ecosystems**	**Seagrass**	**Human Consumer**	**Primary Recreation**	**Secondary Recreation**	**Visual Recreation**	**Cultural and Spiritual Values**
Saltwater Creek (Freshwater)	✓	-	-	✓	✓	✓	✓
Saltwater Creek (Tidal)	✓	-	✓	-	✓	✓	✓
Freshwater Creek (Tidal)	✓	-	✓	-	✓	✓	✓
North Pine River (Tidal)	✓	✓	✓	✓	✓	✓	✓
Hays Inlet (Tidal)	✓	✓	✓	✓	✓	✓	✓

4.0 RECEPTOR IDENTIFICATION LITERATURE REVIEW

4.1 Overview

A literature review was undertaken. The purpose of the literature review was to broadly describe the ecological setting, habitats and ecology present in the region of the site. Water quality data found during the review is also summarised in the following sections.

A specific objective of the literature review was to consider the species most likely to be present in the receiving (aquatic) environment downstream of the site, and to identify appropriate species to target during the biota tissue sampling component of the investigation. Specifically, the findings of literature review have been used herein to:

- Identify aquatic ecological receptors potentially present in the area and which may be appropriate for biota tissue sampling.
- Assess whether fish (or other taxa) of recreational value are likely to be targeted and consumed by people accessing Lagoon Creek, Saltwater Creek or downstream in Hays Inlet.

The focus on aquatic receptors for biota tissue sampling is considered a priority given the spill affected the unnamed creek adjacent to the site, which flows into Lagoon Creek, Saltwater Creek and later into Hays Inlet. However, in addition to aquatic receptors of interest, a number of terrestrial receptor groups (birds, mammals etc.) have been identified as likely present in the area. The potential risk to these taxa will be considered qualitatively based on the proposed predator-prey (trophic level) feeding relationships that will be included in the risk assessment.

The literature review is based on readily available information found via internet searches.

4.2 Water Quality

Limited water quality data was found during the preparation of this plan. The available data for Lagoon Creek and Saltwater Creek was reviewed. One study produced by the (former) Queensland Environmental Protection Authority in 2002 assessed water quality in multiple creeks within the Caboolture Shire. In 2001 samples were collected from nine sites along Saltwater Creek. The study reported that all sites assessed along Saltwater Creek had “poor water quality” with low dissolved oxygen (DO) and high turbidity at most sites. Additionally, both ammonia and total phosphorus were reported above adopted screening values at most sites (based on the regional guidelines provided in EPA (2001) *Draft Queensland Water Quality Guidelines).*

More recent surveys of stream health in the Moreton Bay region have indicated that the health of Saltwater Creek is improving. Historically, Saltwater Creek was classified as Stream Health Class E, which is defined as a polluted system (based on an assessment undertaken in 2007). More recently, Saltwater Creek has been classified as Stream Health Class D along most of its length. This classification is defined as a moderately disturbed system (Nolte 2012).

Hays Inlet, covering an area of approximately 2400 ha is part of a designated Green Zone of the Moreton Bay Marine Park and a declared fish habitat area, with sections of the Inlet being listed under the International Ramsar Convention. The area provides an important nursery for marine species (such as prawns and juvenile fish), as well as roosting and feeding habitat for migratory shorebirds, making it one of the largest and most significant wetland sites in South East Queensland. The Moreton Bay wetland has been subjected to historical high levels of sediment and nutrient runoff from mainland catchment sources due to vegetation clearing (Olley et al., 2015; WetlandCare Australia, n.d.). However, recently, SEQ Healthy Waterways has given an overall grade of ‘B’ to the condition of the western part of Moreton Bay in terms of water quality (turbidity, TN, TP, and chlorophyll-a) (Healthy Waterways, 2016).

4.3 Aquatic Ecological Receptor Groups Potentially Present in the Study Area

Based on the study area walkover and habitat assessment and the findings of the literature review, the following aquatic receptor groups have been identified as being likely present in the area. Aquatic receptors are being targeted during the investigation as these receptors are considered the most likely groups exposed to PFAS following the spill.

4.3.1 Aquatic Invertebrates

Numerous freshwater invertebrates have the potential to occur in Lagoon Creek and the upstream locations along Saltwater Creek. This could include; freshwater shrimp (*Paratya australiensis*), orange-fingered yabby (*Cherax depressus*) and various aquatic insects, including multiple species of non-biting midge (Chironomidae spp.).

The assemblages of aquatic invertebrates are likely to change towards the downstream locations of Saltwater Creek as the waterway transitions from a palustrine environment to an estuarine environment. Grapsid Crabs (*Grapsidae* spp.), fiddler crabs (*Ocypodidae* spp.) and mud crabs (*Scylla serrata*) are known to inhabit the mangrove swamps around Hays Inlet, although it is unknown if their distributions extend up to Saltwater Creek. Other estuarine invertebrates that may be present include aquatic worms (polychaete spp.), molluscs, amphipods, copepods and zooplankton.

4.3.2 Amphibians

Tree swamps provide ideal habitat for numerous frog species, with the slow-moving/pooling water providing ideal habitat for the development of tadpoles. Species with the potential to occur in the vicinity of the site include multiple species of tree frog (*Litoria* spp.), such as the common green tree frog (*Litoria* caerulea), eastern dwarf tree frog (*Litoria falla*), graceful tree frog (*Litoria gracilenta*) and naked tree frog (*Litoria rubella*). Species of conservation concern that may also be present include; wallum froglet (*Crinia tinnula*), wallum rocketfrog (*Litoria freycineti*) and wallum sedgefrog (*Litoria olongburensis*). Tadpoles generally feed on biofilm, detritus and algae and start to feed on small insects as they develop. Due to their dependence on the aquatic environment, all species of frog with the potential to occur in the vicinity of the affected site are considered to be potential receptors.

Given the increasing salinity downstream, it is considered unlikely that, beyond Anzac Avenue, Saltwater Creek and Hays Inlet provide suitable habitat for amphibians.

4.3.3 Fish

The invasive eastern mosquito fish (*Gambusia holbrooki*) is likely to be the dominant species in both Lagoon Creek and Saltwater Creek (Counihan *et al.* 2002). They have been known to outcompete native fish species, especially in poorer water quality and degraded streams. Native gudgeons (*Hypseleotris* spp.) have also been recorded in the upstream areas of Saltwater Creek (Counihan *et al.* 2002).

Larger recreationally targeted fish species are unlikely to occur in the upstream sites of Lagoon Creek and Saltwater Creek. There is the potential for larger species such as bream and mullet to occur towards the southern extent of Saltwater Creek as the waterway transitions to a tidally influenced estuarine environment.

The oxleyan pygmy perch (*Nannoperca oxleyana*), which is classified as endangered under the *Environment Protection and Biodiversity Act 1999* and vulnerable under the Queensland *Nature Conservation Act 1992,* has the potential to occur although it is considered unlikely to be encountered during the field program due to their limited distribution in the region. Another species of conservation significance that may be present is the honey blue eye (*Pseudomugil mellis*). Species of conservation significance will not be targeted in the biota tissue sampling assessment.

Aside from those species of fish described as being more resident in the area, Hays Inlet is also an important nursery ground for many species of fish that inhabit the wider Moreton Bay region. Commercially and recreationally valued marine species utilise the range of available habitats as nurseries and include, amongst others, Mud Crabs (*Scylla serrata*) and Blue Swimmer Crabs (*Portunus armatus*), a variety of prawn species, Flathead species (*Platycephalus spp.*), Whiting species (*Sillago spp.*) and Saucer Scallops (*Amusium balotti*) (Beumer et al., 2012).

4.3.4 Aquatic birds

Hays Inlet forms part of the Moreton Bay Marine Park and includes the Hays Inlet Conservation Park. It is significant to many species of marine birds as a breeding ground, haven and roosting site. The Inlet is home to a diversity of aquatic and migratory shorebirds including the nationally threatened Greater Sand Plover (*Charadrius leschenaultia*), Lesser Sand Plover (*Charadrius mongolus*), and the migratory Western Alaskan Bar-Tailed godwit (*Limosa lapponica bauera*) (Queensland Government, 2017).

The importance of Hays Inlet continues to grow as South East Queensland's population growth drives up coastal development, thus impacting upon areas that were once suitable for aquatic and migratory species to inhabit (Jones *et al*., 1999).

4.4 Potential for Fishing or Harvesting of Marine Resources for Human Consumption

During the literature review, commercial and recreational fishing was not identified as being undertaken in Lagoon Creek or Saltwater Creek. This is consistent with the observations made during the previous investigation. The stagnant, pooled water along much of the mid to upper reaches of Saltwater Creek and Lagoon Creek is unlikely to support species which would be targeted recreationally. Instead, hardy pest species such as cane toads and mosquito fish dominate.

The lower extent of the Investigation Area including Saltwater Creek downstream of Anzac Avenue, Freshwater Creek and North Pine River are all within either a Marine National Park Zone or Conservation Park Zone of Moreton Bay. As such, commercial fishing is not permitted within the expanded Investigation Area although does occur beyond the Houghton Highway. The Conservation Park Zone of Hays Inlet is however a major recreational fishing ground. Targeted species include: Australian bass, Bream, Blue salmon, Estuary cod, Flathead, Garfish, Jewfish, Mangrove Jack, Mullet, Mud and sand crabs and Banana and Eastern King prawns.

5.0 DATA QUALITY OBJECTIVES

As per *Schedule B2 (Guideline on Site Characterisation)* of the NEPM "*a systematic planning process is used for defining the objectives of a site assessment and to develop a sampling plan for the collection and evaluation of representative data to achieve those objectives. Without systematic planning, the site assessment may be ambiguous or inconclusive, which may lead to additional sampling requirements, resulting in increased costs and project delays*".

In its simplest form, the planning process outlined in the NEPM should consider:

- The overall objective of the site assessment.
- The decision(s) to be made on the basis of the site assessment findings.
- The constraints on the assessment (financial, time and logistical).
- The degree of flexibility to conduct follow-up investigations.

This project level information can then be used to identify the specific site information needed to address the assessment objectives.

The Data Quality Objectives (DQO) process is used to define the type, quantity and quality of data needed to support decisions relating to the environmental condition of a site. The seven step DQO/data quality indicator (DQI) process is identified in *Schedule B2* of the NEPM as one example of a suitable systematic planning approach for site investigations.

The DQO process involves the seven steps as follows:

- Step 1: State the problem.
- Step 2: Identify the decision or goal of the investigation.
- Step 3: Identify the information inputs.
- Step 4: Define the site boundaries.
- Step 5: Develop the analytical approach.
- Step 6: Specify performance or acceptance limits.
- Step 7: Develop the plan for obtaining data.

The DQO process will be applied as described below, to ensure that data collection activities are appropriate and achieve the stated objectives.

5.1 Step 1: State the problem

The driver for the investigation is that following the spill of 800 L of waste containing AFFF, the subsequent emergency clean-up activities and the previous investigation reported in August 2017, the extent of migration downstream and the associated risk to human health and the environment are not fully understood.

The data gap identified is the assessment of the presence of PFAS in groundwater, sediment, surface water and biota downstream or down gradient of the spill affected area – including within the expanded area beyond that investigated in the previous investigation – that is, downstream in extent to Anzac Avenue.

The monitoring plan has also been designed to address the requirements of the EE Notice issued to Toxfree.

5.2 Step 2: Identification of the decision or goal of the investigation

The primary objective is to assess the risk to human health and environmental receptors downstream of the site of the spill of approximately 800 L of AFFF waste.

5.3 Step 3: Identify the information inputs

For the investigation the major inputs are:

- Information received from Toxfree about the incident involving the spill.
- Desktop information on environmental conditions and potential receptors (geology/hydrogeology, ecology, nearby surface water bodies, etc.).
- Existing investigations reports including the previous investigation report.
- Identification of nearby and downstream receptors within the Investigation Area.
- Publically available historical information including:
  - Historic Aerial Photographs.
  - Topographical, soil and geological maps.
  - Environmental Values.
- Collection of representative sediment, surface water, groundwater and biota samples, and laboratory analysis of the samples at down gradient locations.

5.4 Step 4: Define the investigation boundaries

The Investigation Area extends from the spill affected area to the nearby surface water bodies and up to approximately 15 km downstream, including Saltwater Creek and Hays Inlet to the downstream most extent delineated by the Houghton Highway at Clontarf. The Investigation Area of this expanded investigation relative to the previous investigation is shown in Figure 1

The vertical boundaries of the study area are:

- Groundwater - the groundwater level immediately underlying the study area is up to 5 m deep, however it is expected to be seasonally variable.
- Surface water – unnamed creek in the green corridor flowing into Lagoon Creek and Saltwater Creek then into Hays Inlet including the other systems that drain into Hays Inlet.
- Sediments - in unnamed creek, Lagoon Creek, Saltwater Creek and Hays Inlet to a depth of 0.15 m below bed surface.

Sampling of target biota is proposed in the identified water bodies: unnamed creek, Lagoon and Saltwater Creek and Hays Inlet, where a complete pathway between the PFAS spill affected area to receptors downstream may be present.

5.5 Step 5: Develop the analytical approach

The purpose of this step is to define the parameters of interest, specify action levels and combine the outputs of the previous DQO steps to develop a series of options if certain trigger events occur.

A decision on the acceptance of the analytical data will be made on the basis of the DQI (Section 0 and Section 6.0).

The results of analytical data will be compared with the adopted guidelines (Section 9.0) to assess the presence of and associated risk of PFAS downstream from the site.

5.6 Step 6: Specify performance or acceptance limits

Data Quality Indicators (DQI) are developed based on the following PARCC parameters including:

- P - Precision: A quantitative measure of the variability (or reproducibility) of data;
- A - Accuracy: A quantitative measure of the closeness of reported data to the "true" value;
- R - Representativeness: The confidence (expressed qualitatively) that data are representative of each media present on site;
- C - Completeness: A measure of the amount of useable data from a data collection activity, and whether it is all the data required to enable the objectives to be met; and
- C - Comparability: The confidence (expressed qualitatively) that data may be considered to be equivalent for each sampling and analytical event.

The measures/criteria employed to enable review of these parameters are described below and detailed in Section 6.0.

Precision

Field precision will be monitored through the use of Golder's Standard Operating Procedures (SOPs) and ensuring that these are complied with throughout the sampling event(s). Suitable performance indicators for assessment of laboratory precision include performance of intra-laboratory and inter-laboratory duplicate sample sets through calculation of Relative Percentage Differences (RPD).

Accuracy (Bias)

Accuracy in the field activities will be monitored through the use of SOPs and ensuring that these are complied with throughout the sampling event(s).

The closeness of the reported data to the "true" value is assessed through review of performance of:

- Method blanks, which are analysed for the analytes targeted in the primary samples.
- Matrix spike sample sets.
- Surrogate spikes.
- Laboratory control samples.

Representativeness

To ensure representativeness of the field data, all appropriate media will be sampled as identified in this report.

To ensure the data produced by the laboratory is representative of conditions encountered in the field, the following steps will be taken:

- Blank samples will be run at the laboratory in parallel with field samples to confirm there are no unacceptable instances of laboratory artefacts.
- Review of RPD values for field and laboratory duplicates to provide an indication that the samples are generally homogeneous, with no unacceptable instances of significant sample matrix heterogeneities.
- The appropriateness of collection methodologies, handling, storage and preservation techniques will be assessed to ensure/confirm there was minimal opportunity for sample interference.

To ensure that PFAS results after total oxidisable precursor (TOP) assay are representative of the potential future breakdown of "dark matter compounds", the oxidation performance is evaluated with the presence of the fluorotelemer compounds post TOP oxidation. In the event residual fluorotelomer is observed, sample extracts are re-oxidized at dilution to further breakdown and assess pre-cursor presence. Both fluorotelemer and sulphonamides (typically not present in environment if AFFF is the primary source) should not show presence post TOPA oxidation.

Completeness

In assessing the completeness of the field data the following is considered:

- All critical locations and depths are sampled.
- Representative samples are collected.
- An appropriately experienced sampling team is engaged in the investigation program.

In validating the degree of completeness of the analytical data sets acquired during the program the following is considered:

- Whether SOPs for sampling protocols have been adhered to.
- Copies of all project chain of custody (CoC) documentation are reviewed and presented.

It can therefore be considered whether the proportion of "useable data" generated in the data collection activities is sufficient for the purposes of the assessment.

Comparability

In the event that the reported data sets are comprised of data sets from separate sampling events, issues of comparability between data sets are reduced through adherence to the same SOPs on each data gathering activity.

In addition the data will be collected by experienced samplers and National Association of Testing Authorities, Australia (NATA) accredited laboratory methodologies, where available, will be employed in all laboratories.

5.7 Step 7: Develop the plan for obtaining data

Sample locations have been selected based on the observed site conditions and project objectives. The broader sampling strategy will be as presented in Table 3. Proposed sampling locations are shown in Figure 2.

Table 3: Receptor and Pathway Sampling

Pathway/Receptor	Media	Sampling Strategy and Access/Limitations
Unnamed Creek	Surface water/sediment/biota	2 locations in two parallel streams of the creek approximately 100 m up gradient the spill area to provide background context to downstream samples. 3 locations down gradient in the section before confluence into Lagoon Creek. At each location, collection of 1 surface water and 1 sediment sample (in total 4 sediment and 4 surface water samples). Target biota, including the sampling methodology and locations are discussed in Section 7.4
Lagoon Creek and Saltwater Creek	Surface water/sediment/biota	4 locations upstream of the confluence of un-named creek and Lagoon Creek. These locations are to provide a background context to the downstream samples. 12 locations down to the intersection with Anzac Avenue. Target biota, including the sampling methodology are discussed in Section 7.4

Pathway/Receptor	Media	Sampling Strategy and Access/Limitations
Hays Inlet and tidal system	Surface water/sediment/biota	11 locations in total, including: ■ 6 locations in Saltwater Creek/Kedron Brook downstream of Anzac Avenue ■ 1 location in the North Pine River to provide context to additional potential contaminant fluxes into Hays Inlet ■ 2 location in Freshwater Creek to provide context to additional potential contaminant fluxes into Hays Inlet ■ 2 locations adjacent to the Houghton Highway at the seaward margin of Hays Inlet. Target biota, including the sampling methodology are discussed in Section 7.4
Burpengary Creek	Surface water/sediment/biota	1 location within the tidally influenced zone. This sample is considered to be **outside** of the Investigation Area but is intended to provide context to samples within the Investigation Area.

6.0 GENERAL QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

6.1 Field QA/QC

Standard QA/QC procedures will be adopted during the assessment process including those for sample collection, management and handling.

Specific requirements will include the use of laboratory prepared containers, decontamination of sampling equipment between locations, collection of an appropriate number of quality control samples, preservation of samples in ice chests and transport to laboratories under chain of custody documentation within holding times.

Calibration of all field measurement equipment will be carried out by the supplier and the calibration certificates retained by the field engineer/scientist. Records for equipment requiring daily calibration will be included into field notes.

6.2 Field Quality Control Samples

The following field quality control (QC) samples will be collected and analysed as part of this investigation:

- Intra-laboratory field duplicates (blind replicates): the intra-laboratory field duplicates and corresponding primary samples will collected from the same location, preserved, stored, transported, prepared and analysed in an identical manner by the primary laboratory however, the duplicate sample will be blind coded. Intra-laboratory field duplicates provide an indication of the precision or reproducibility of the field sampling techniques and analytical results. Intra-laboratory field duplicates will be collected at a frequency of 5% or greater. Intra-laboratory field duplicate results will be assessed by calculating the Relative Percentage Differences (RPDs). For this project, one intra-laboratory field duplicate will be collected every twenty primary samples and tested for both soil/sediment and groundwater/surface water samples.
- Inter-laboratory field duplicates (field triplicate/split sample): individual samples will be split in the field and placed in two separate containers. One sample will be sent to the primary laboratory and the duplicate sent to an independent check laboratory. Inter-laboratory field duplicates provide an indication of the precision or reproducibility of the analytical results, and will be analysed at a frequency of 5% or greater. Inter-laboratory field duplicate results will also be assessed by calculating the RPDs. For this project, one inter-laboratory field triplicate will be collected every twenty primary samples and tested for both soil/sediment and groundwater/surface water samples. For biota, one duplicate sample will be prepared for the three species analysed for PFAS (where three species are available for collection). The duplicates will be split in the primary laboratory following compositing and homogenisation of biota samples and sent to the secondary laboratory for analysis.
- Rinsate blanks: are used to detect contamination originating from field equipment. Rinsate samples will be collected of single use equipment prior to use to confirm the equipment is not contributing to the contamination detected in the samples. Rinsate samples will also be collected after an item of equipment has been decontaminated to confirm that the decontamination procedures are adequate. For this project, one rinsate blank per stage of fieldwork mobilisation will be collected and tested.
- Field blanks: are used to confirm the water for rinsate blanks and decontamination as well as the sample containers provided by the laboratory are not a source of PFAS. One field blank for the field program will be analysed.

6.3 Assessment of Duplicates

The primary, duplicate and triplicate samples are submitted to a laboratory for analysis. The primary and the duplicate go to the primary laboratory to determine the intra laboratory accuracy. The triplicate is dispatched to a separate laboratory to determine the inter laboratory accuracy.

The duplicate and triplicate sample results are compared with primary sample results using Relative Percentage Differences (RPDs). RPDs are calculated according to the following formula:

$$\%RPD = \left|\frac{A - B}{A + B}\right| \times 200$$

Where: A is the concentration of the primary laboratory result per analyte and B is the corresponding duplicate or triplicate result.

RPD values can lie in a range from 0% (indicating perfect correlation between results) to 200% (indicating a large divergence in results).

In calculating RPD values, the following protocols have been adopted according to the particular circumstance:

- Where the laboratory has reported results below the detection limit for both the primary sample and duplicate or triplicate sample for a particular analyte, the RPD will not be calculated.
- Where the laboratory has reported results below the detection limit for either the primary, duplicate or triplicate sample, a RPD will be calculated. This is performed by using the laboratory limit for the undetected sample, and comparing that to the concentration of the detected sample.
- Where the laboratory reports detectable amounts of a contaminant in both the primary sample and duplicate sample or primary sample and triplicate sample a RPD will be calculated and tabulated.
- In accordance with the Australian Standard (AS4482.1-2005), acceptably precise results are indicated by better than +/- 50% RPD between inter and intra laboratory, with the following consideration of laboratory limit of reporting (LOR):

  Acceptable RPDs:

Analysis Results:	RPDs
>20 * LOR	30%
10-20 * LOR	50%
<10 * LOR	No Limit

  For data that fell outside acceptable limits of precision and accuracy, the data integrity will be evaluated based on the nature and degree of the non-compliance.

6.4 Laboratory QA/QC

The primary and secondary laboratory selected for the chemical analysis of soil, sediment, surface water, groundwater and biota samples will be Eurofins MGT Pty Ltd (Eurofins) and Australian Laboratory Services Pty Ltd (ALS) in Brisbane.

Both laboratories are certified by NATA for the required analyses (with the exception of biota analyses for PFAS, for which accreditation for both laboratories are pending). Laboratory analysis will be conducted in accordance with the standard test methods outlined in Schedule B(3) of the NEPM (NEPC 2013), US EPA, APHA or equivalent modified methods supported by adequate quality control.

Laboratory QA/QC for the assessment includes accreditation of laboratories providing analytical services, and their internal QA/QC procedures and documentation. Laboratory QA/QC will comprise internal duplicates, blanks, controls, spikes and surrogates. The laboratory QA/QC results will be considered by comparison with the laboratory generated control limits. The internal QA/QC results will be reviewed and discussed. The results of the internal blank samples will be evaluated to demonstrate minimal interference.

The following internal laboratory quality control (QC) samples will be reviewed as part of this investigation:

- Internal Laboratory Duplicates: are prepared by the laboratory by dividing a field sample into two or more aliquots, which is analysed separately to provide an indication of the effect of sample matrix variability on precision. These are assessed through the calculation of RPDs. Acceptance criteria for duplicates and splits are presented in Section 6.3.
- Method Blanks: are contaminant free samples analysed by the laboratory to assess the level of contamination that exists in the laboratory analytical system. Results are evaluated by comparison to reporting limits.
- Laboratory Control Samples (LCS): are samples spiked with known concentrations of specific analytes to assess the laboratory performance on sample preparation and the analysis procedure.

Results are assessed in terms of accuracy by calculating a percent recovery between the observed and spiked concentrations.

- Matrix Spikes: are field samples spiked with known concentrations of specific analytes to assess the effects of the sample matrix on the accuracy and precision of analyses. Like laboratory control samples, matrix spike sample accuracy is evaluated in terms of a percent recovery between the observed and expected spiked compound concentrations.
- Surrogates: are organic compounds of similar chemical composition, extraction, and chromatography to analytes of interest, but which are not normally found in field samples spiked into sample aliquots prior to preparation and analysis. Surrogates provide an indication of analytical accuracy and potential matrix effects. Percentage recoveries are calculated for each surrogate.

6.5 Data Validation

The objective of the data validation process is to ensure that the data reported can be used to achieve the project objectives.

The validity of all analytical data reported will be assessed by a critical review of the QC check sample results. The validation process is based upon the following data validation guidance documents:

- *National Environment Protection (Assessment of Site Contamination) Measure 1999* (NEPC 2013);
- *USEPA Contract Laboratory Program National Functional Guidelines for Superfund Inorganic Data Review* (US EPA 2010); and
- *USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review* (US EPA 2008).

Accuracy and precision measurements from the appropriate QC check samples will be compared with the analytical DQIs to assess the quality of the analytical data. Should data be found to fall outside acceptable limits of precision and accuracy, appropriate corrective actions will be investigated.

The data will also be evaluated to assess the reproducibility, comparability and completeness of the data. Upon review of the DQIs, an assessment as to whether the data can be relied upon for the purposes of the investigation will be made.

7.0 SAMPLING QUALITY PLAN

7.1 Objectives

The sampling plan has been developed with consideration of the DEHP issued EE Notice and available information.

The proposed sampling program is to obtain data with respect to the nature and extent of environmental harm (including potential harm) caused to receiving waters and biota as a result of the contamination incident. Targeted sampling (as outlined in Section 5.7) is proposed to address the identified data gaps to assess the potential risks to human health and the environment, where appropriate.

The sampling program is detailed in the following sections. The proposed sample locations are shown in Figure 2.

7.2 Groundwater Assessment

The assessment of potential groundwater contamination will be constrained to resampling those wells adjacent to the spill area that were sampled and reported on as part of the previous investigation undertaken under the original Clean-Up Notice. Details of these wells are provided in Table 4.

As part of this investigation, existing wells will be gauged with an interface meter to measure depth to water and depth of the wells. Surveys of the sampled wells have been undertaken to allow the groundwater contour reconstruction.

Table 4: Groundwater monitoring wells and groundwater levels (16 June 2017).

Well ID	Easting (AMG)	Northing (AMG)	Elevation of the Top of Casing* (m AHD)	Elevation of the Natural Surface^ (m AHD)	SWL (m BTOC)	GW Elevation (m AHD)
MW01	500279.20	6991531.98	25.05	25.10	4.145	20.905
MW2A	500174.89	6991555.78	18.20	17.00	2.700	15.500
MW3A	500163.44	6991530.56	18.10	16.90	2.040	16.060
MW15	500152.19	6991628.91	13.94	12.33	2.470	11.470
MW16	500155.73	6991714.82	12.70	11.20	1.105	11.595

7.3 Surface Water and Sediment Assessment

To assess the potential for the migration of PFAS downstream within the receiving environment, samples of sediment and surface water will be collected from the nominated waterways.

Based on the results of the sampling conducted and reported under the original Clean-Up Notice, surface water and sediments sampling locations have been selected in the following locations:

- Previous investigation area:
  - Two locations in the unnamed creek up-gradient of the spill area (WUP1 and WUP2), one location in each stream in which the creek appears to be divided.
  - One location in Lagoon Creek, upstream of the confluence with unnamed creek (WUP3).
  - Fifteen locations down gradient of the spill affected area in the unnamed creek, Lagoon Creek and Saltwater Creek (W01 to W15).
- Expanded Investigation Area:
  - An additional 3 locations within Lagoon Creek upstream of the confluence of un-named creek and Lagoon Creek.
  - 11 locations in Hays Inlet and the associated tidal system, including:

i) 6 locations in Saltwater Creek/Kedron Brook downstream of Anzac Avenue.

ii) 1 location in the North Pine River to provide context to additional potential contaminant fluxes into Hays Inlet.

iii) 2 location in Freshwater Creek to provide context to additional potential contaminant fluxes into Hays Inlet.

iv) 2 locations adjacent to the Houghton Highway at the seaward margin of Hays Inlet.

In addition, one location is also nominated within the tidally influenced zone of Burpengary Creek. Whilst this sample is considered to be **outside** of the Investigation Area it is intended to provide context to samples within the Investigation Area.

Surface water samples will be collected prior to sediment samples. Surface water and sediment samples will be attempted to be co-located, however, this will be dependent upon the presence of surface water during the field program and the possibility of safe access to the sampling location.

All surface water samples will be assessed for water quality parameters prior sampling. These include redox potential, pH, temperature, dissolved oxygen and electrical conductivity.

7.4 Proposed Approach to Biota Assessment

A maximum of twenty sites will be sampled for biota as shown on Figure 2. The sites are comprised of the following:

- Five locations from the previous investigation area, namely: WUP3, W02, W05, W07, W10.
- Two additional locations within Lagoon Creek upstream of the confluence of un-named creek and Lagoon Creek
- 11 locations in Hays Inlet and the associated tidal system, including:
  - 6 locations in Saltwater Creek/Kedron Brook downstream of Anzac Avenue.
  - 1 location in the North Pine River to provide context to additional potential contaminant fluxes into Hays Inlet.
  - 2 location in Freshwater Creek to provide context to additional potential contaminant fluxes into Hays Inlet.
  - 2 locations adjacent to the Houghton Highway at the seaward margin of Hays Inlet.

In addition, one location is also nominated within the tidally influenced zone of Burpengary Creek. Whilst this sample is considered to be **outside** of the Investigation Area it is intended to provide context to samples within the Investigation Area.

Up to two samples per site will be analysed (contingent on the availability of targeted aquatic biota) up to a maximum of 40 discreet samples or sample-treatments[1].

Where possible and practical, biota samples will be co-located with surface water and sediment samples. The co-location of biota and surface water and sediment samples will be of particular importance when biota sampled are sedentary and therefore most suitable for the evaluation of field-based biota-sediment bioaccumulation factors. Such biota include burrowing bivalves and molluscs and other macrobenthos.

Biota will be sampled over ten days, using a range of sampling equipment. The sampling equipment will be selected according to the field conditions (hydrology, local topography, extent of submerged aquatic vegetation) and species targeted. A full discussion on the preferential sampling of groups of biota and appropriate sampling gear is included in Section 7.5.3.

[1] A sample-treatment relates to how the biota is prepared prior to analysis. A fin fish sample that is submitted both as a fileted (edible portion) and whole-of-body is considered to comprise two sample-treatments.

7.5 Sampling Methods

7.5.1 Groundwater

Groundwater Sampling

As part of this Monitoring Plan, only one round of sampling is proposed from the selected existing wells.

All standing water levels will be measured in a dedicated water level measuring event to allow interpretation of groundwater flow direction and gradient from site measurements made within a short timeframe. Water levels will be re-measured right before sampling.

Sampling will be undertaken using low flow techniques as the preference. Bailers may be used in the event that site specific groundwater conditions preclude low flow pumping.

The following materials, which have been confirmed by the supplier as being PFAS free, and will be used during groundwater sampling:

- Low flow polyethylene tubing.
- Bailers ESPCV153 – Clear view disposable bailer PVC clear 38 mm case.
- Rope EONFSR265- Rope polypropylene 1/8 inch braid yellow 305 m.
- Nitrile Gloves - PMD172090-E – Promed Nitrile powder free long cuff.

Field equipment calibration will be checked once per day and every time this is deemed as necessary, where instrument specifications support this. The calibration records from the supplier will be kept and field calibration with be recorded in the field logs.

The groundwater parameters will be tested after samples are collected using a calibrated water quality meter/probe, for the following field parameters: pH, electrical conductivity (EC), temperature, dissolved oxygen (DO) and redox potential. The type of water quality meter will be noted on the field data sheets.

A physical description of the sample will be recorded on the field data sheets including colour, turbidity, odour, films/sheens and NAPL.

Field QA/QC samples will include inter-laboratory and intra-laboratory duplicates for water samples (i.e. inclusive of surface water samples) as well as rinsate blanks of the dedicated equipment used in the field.

Sample Containers and Handling Procedures

The representative groundwater is to be transferred directly from tubing into the laboratory provided and pre-preserved bottles, appropriate for the PFAS analysis.

Sample containers will be placed in secure chilled coolers until shipping to the laboratory. Samples must be held and transported under Chain of Custody (CoC) protocols (Section 7.6.6).

7.5.2 Surface Water and Sediment

Surface Water and Sediment Sampling

Near surface water samples are planned to be collected prior to sediment samples. Dependent of weather conditions prior to and during the sampling program surface water locations may need to be modified to enable surface water samples to be obtained (if safe and practicable).

Surface water will be collected with a grab sampler from a depth of approximately 0.1 m below the water surface (unless the water is shallower, in which case the sample will be collected from the water present). Field parameters, pH, redox potential, dissolved oxygen, temperature and conductivity will be measured using a calibrated multi-parameter water quality meter. Descriptions of the water including, clarity, turbidity, and unusual colours will be recorded during sampling. Water will be poured directly into the laboratory-supplied bottles appropriate for PFAS analysis and samples will be placed immediately on ice.

Sediments will be collected after surface water sampling has been completed at the location. To the extent possible surface water and sediment samples will be co-located. However, if surface water is not present in a nominated sample location a sediment sample will still be collected. Upon collection the sediment sample will

be described (appearance and grain size, texture, inorganic and organic component and the presence of vegetation (algae, aquatic plants, etc) and recorded. The sample will be homogenised prior to being placed in laboratory supplied containers.

The location of the sampling point and the soil type and depths at which samples are taken will be noted in field records and classified in accordance with standard Golder methods.

Sample Containers and Handling Procedures

Samples are to be transferred immediately to laboratory prepared sample containers specific for PFAS analysis and placed in secure chilled coolers until transportation to the laboratory. Samples will be held and transported to laboratories under Chain of Custody (CoC) protocols (Section 7.6.4).

7.5.3 Biota

The biota sampling protocol will follow (where practicable and appropriate in terms of the scope for this investigation) the *Interim Guideline on the Assessment and Management of Perflouroalkyl and Polyfluoroalkyl Substances (PFAS)* (Western Australian Department of Environment Regulation, 2016).

There are a number of considerations that have been taken into account when determining the species that the monitoring programme will target. These relate to the twin objectives of the investigation of determining possible ecological or human health risk associated with the contamination event and include:

- Species that represent higher trophic level fauna (omnivores and secondary and tertiary order predators) within the tissues of which the persistent and bioaccumulative properties of PFAS are likely to be most apparent.
- Species that are targeted for human consumption in either recreational or commercial fisheries.
- Species that are sedentary or have relatively limited dispersal ranges during adult life stage which have the benefits of:
  - Likely being representative of potential PFAS uptake associated with the contamination event being evaluated.
  - Consistent with the evaluation of field-based biota-sediment bioaccumulation factors.

Based on the literature review and experience from the previous investigation sampling, aquatic fauna which have been identified as potentially present and which will be targeted by collection gear are summarised in Table 5.

Table 5: Proposed targeted biota.

Group	Species	Higher trophic organism	Human consumption	Sedentary/ limited dispersal range	Collection method
Freshwater system					
Fin fish	Mosquito fish, Swordtails and Platy			√	Seine, fyke and dip nets
	Eels	√			
	Perch	√	√		
Crustaceans	Glass shrimp			√	Seine and dip nets
Estuarine and marine system					
Crustaceans	Swimmer crabs		√		Seine and cast nets, crab pot/dilly
	Mud crabs		√	√	Crab pots

Group	Species	Higher trophic organism	Human consumption	Sedentary/ limited dispersal range	Collection method
	Prawns (various marine species)		√		Seine and cast nets
	Yabbies		√	√	Yabbie pump
Fin fish	Flathead	√	√	√	Seine, cast and gill nets, hand line
	Mullet		√		
	Bream	√	√		
	Gobies			√	Seine and cast nets, box traps
Bivalves and molluscs	Mixed- including cockles and pipis		√	√	Sediment collection and sieving

Sample handling and preparation

In the case of species suitable for the assessment of human health risk, the edible portions of organisms will be dissected and analysed independently of the remaining whole-of-body sample.

For this investigation, edible portions will be considered to include:

- Fillets of fin fish that will be processed skin-on.
- Adductor muscle of bivalves.
- Soft tissue (after removing the hard exoskeleton) of mud crabs and yabbies.
- Whole-of-body homogenised samples in the case of prawns.

Species suitable for the assessment of human health risk include those that either are targeted as part of a fishery or represent a trophic level and occupy an ecological niche similar to that of a species targeted in a fishery.

In the case of species not considered likely to be targeted for human consumption and therefore aligned to the assessment of ecological risk, whole-of-body samples will be analysed.

For PFAS analysis, the laboratory requires a minimum sample mass of 5 g wet weight. If samples of single organisms are less than 5 g wet weight, additional composited individuals of the same species from the same location will be homogenised to form a whole-of-body sample.

All samples will be kept until the end of the sampling period, at which point they will be assessed and prioritised for analytical testing. Where the same species is collected at all (or most) sites, these samples will be analysed as a priority as this will enable comparison between sites of PFAS concentrations for the same species. While the aim is to achieve consistency between the sites (where possible), disparities in the species collected may occur.

Each sample will be sorted by replicates and species. Samples will be washed on site with deionised water before being stored in laboratory supplied bags. Sample bags will be double bagged inside a master bag labelled with permanent marker to avoid potential contact between the sample and potential external source of PFAS. Sample labelling will follow Golder's procedures and standards (see section 7.6.2). Samples will be placed on ice after capture and then frozen until they are transferred to the laboratory for analysis. Samples will be transported by Golder staff. A total of two inter laboratory split samples will be sent for analysis to a second laboratory for QA/QC purposes.

Ethics approvals and collection permits – Sampling considerations

Collection of aquatic fauna will be performed by a qualified ecological subcontractor (FRC Environmental services) under the supervision of a Golder senior aquatic ecologist. FRC Environmental possesses local knowledge and appropriate sampling equipment.

Sampling will be performed under approved and current animal ethics and collection permits. Sampling methods will be consistent with Queensland Biosecurity requirements, and follow strict procedures for cleaning fishing gear prior to, and after deployment in order to avoid the potential for introduction and spread of pests or disease between sites.

Sampling within Hays Inlet as part of the wider Moreton Bay Maine Park will require specific permits. Application for these permits will be sought by DEHP from the relevant permit issuing agency when this monitoring plan is approved.

The information recorded during collection will include sampling equipment used, GPS location, net setting, checking and retrieval time and the species and number of individuals caught, retained, released and discarded. Noxious species collected during sampling such as mosquitofish *Gambusia* spp. or carp *Cyprinus carpio* will be humanely euthanised using ice slurry/iki-jime (as per Biosecurity Act 2014) and disposed of as per Section 7.6.8 where not subject to PFAS testing.

Individuals not retained for PFAS analysis will be quickly removed from the fishing device and released alive where possible. If by-catch individuals show signs of damage or injury that could impede their recovery and survival, they will be euthanised (ice slurry/iki-jime) and disposed of as per Section 7.6.8. If threatened species are caught these will be released without delay.

Based on the literature review, there is the potential that platypus (*Ornithorhynchus anatinus*) might be present in the area. Although their presence is considered unlikely, special care will be taken when setting traps and nets to avoid potential capture or drowning for by-catch aquatic fauna such as platypus, marine or freshwater turtles, cetaceans or dugong. Traps and fixed nets will, wherever possible, be set in a fashion to provide access to the surface to breath if trapped (e.g. trap set semi-submerged and caught end of fyke nets partially set above the surface).

7.6 General Field Procedures

7.6.1 PFAS Specific Considerations

PFAS are found in numerous common use items; the following specific precautions will be taken during all sampling activities:

- No use of Teflon™ containing materials (i.e. Teflon™ tubing, bailers, tape, plumbing paste).
- No glass sample jars.
- No Tyvek™ clothing will be worn.
- No clothing with stain or water resistant treatments (such as GoreTex™) will be worn.
- No Post-It™ Notes are to be handled or brought on site.
- Waterproof paper, notebooks, and labels (use standard paper and paper labels)
- No fast food wrappers, aluminium foil, disposable cups or microwave popcorn are to be handled or brought on site.
- Hands are to be washed prior to any sampling activities after handling such items listed above, and Nitrile gloves are to be worn during all sampling and sample handling activities.
- Chemical (blue) ice packs are not to be used.

PFAS can bind to glass, therefore all samples will be collected into laboratory supplied high density polyethylene (HDPE) or polypropylene containers.

7.6.2 Sample Labelling

The sample labels will include the sample identification number, date of collection, sampler initials and project number.

Each sample will be labelled with a unique sample identification number that will facilitate tracking and cross referencing of sample information. Quality Control (QC) samples also will be numbered with a unique sample number, consistent with the numbering system required for the project.

The following classification is consistent with industry protocols and suitable for importing data into a database (ESDAT).

Sample Location and Sample Identification:

XX00_ZZZ (e.g. SW01_1.2)

Legend

XX – Type of sample recovery (i.e. BH, TP, SS, MW, SV, SW or SD)

GW – Groundwater (Groundwater)

SW – Surface Water (Water)

SD – Sediment (Sediment)

000 – location specific identification

ZZZ – is to indicate the depth that the sample has been collected. For soil (and sediment) samples the interval is recorded, e.g. sample collected at 1.2 m to 1.4 m depth would have 1.2-1.4 as the ZZZ value. For groundwater samples, an indication of the water bearing unit or portion of the water bearing unit is nominated (note that the screen interval should be recorded on the borehole logs sheet/well construction records and in the well master.) S for shallow, I for intermediate and D for deep.

DDMMYYYY – Date information is provided on samples labels for all samples (YY –Year; MM – Month; DD – Day).

Naming convention for QA/QC samples:

For QC samples the naming convention will be:

- Rinsate: PPPP_QC1XX_DDMM
- Duplicate: PPPP_QC2XX_DDMM
- Triplicate: PPPP_QC2XX_DDMM
- Field Blank: PPPP_QC4XX_ DDMM
- Trip Blank: PPPP_QC5XX_ DDMM

7.6.3 Field Logs

A summary of activities performed will be recorded in a field logbook. Entries for each day will commence on a new page, which will be dated. Corrections will be made by marking through the error with a single line, to remain legible, and initialling this action followed by writing the correction.

Daily field record will include as a minimum:

- Date and time of activities
- Weather conditions
- List of subcontractors and personnel
- Summary of field works
- Health and safety observations / tool box talks

- Equipment calibration records, where appropriate.

At each investigation location the following general information will be recorded and retained by the field staff for reporting purposes:

- Unique sample identification number
- Date and time of collection
- Handheld GPS coordinates
- Initials of the sampling personnel
- Designation as to the type of sample (groundwater, surface water or sediment)
- Sample containers
- Collection method
- Photographs recorded
- Field parameters, where appropriate
- Analyses to be performed on sample
- Any other relevant comments on sampling appearance (odour, colour, sheen, filtering, preservation, etc.).

Referring to groundwater wells, the following specific information will also be recorded:

- Standpipe diameter and stick-up
- Total depth of the well and thickness of sediment at the base of the well, if any
- Depth to water and depth to NAPL, if present
- Calculated height of water in the standpipe and well volume, calculated thickness of NAPL, if present;
- Sampling time
- Type of water quality meter, and calibration update
- Field physio-chemical parameters readings (temperature, pH, turbidity, ORP, EC and DO).

7.6.4 Equipment Decontamination

Note: the equipment decontamination procedure has been developed based on current guidance (WA Department of Environment Regulation, 2017) for decontamination of sampling equipment for PFAS investigations. The decontamination procedure may not be appropriate for the collection of other contaminants (note analysis other than PFAS is not planned as part of this investigation).

All field equipment used to collect samples is to be either dedicated single use only, such as tubing and pump bladders, or is to be decontaminated between sampling locations.

All sampling and measurement equipment is to be decontaminated prior to field work, then before and after each use.

The decontamination procedures to be used for hand equipment will comprised the following stages:

- Remove encrusted materials by scraping.
- Scrub with brushes and phosphate free cleaning solution.
- Potable water rinse.
- Groundwater water sampling equipment to be rinsed with deionised or distilled water following decontamination (where appropriate).

Dedicated or single use disposable equipment such as bailers, tubing or nitrile gloves will not be decontaminated and will be disposed of appropriately following use.

7.6.5 Sample Storage and Transportation

Samples are to be kept secure and cool in coolers during the field program. Coolers are to contain ice (Not cooler bricks) during the field program and subsequent transportation to the laboratory. Ice should be double bagged to prevent melted water from impacting sample containers.

During sampling events, partially filled and unfilled coolers are to be kept under the custody of the sample custodian. The sample custodian is to be a designated member of the sampling team.

If samples are not sent to the laboratory on the day of collection, the method of storage such as in refrigerator or in cooler on ice, with ice regularly changed to maintain cool temperature, must be noted in the field log books and on the chain of custody form.

Samples are to be transported to the laboratories in cooled coolers, under chain of custody documentation. Prior to transportation, the coolers are to be security-sealed. Bottles should be packed to minimise the potential for breakage (i.e. bubble wrap or other padded material).

7.6.6 Chain of Custody Documentation

A chain of custody record must be utilised by field personnel to document possession of all samples collected for off-site laboratory analysis. The chain of custody record is to include, but is not limited to, the following information:

- Project name and number.
- Name(s) of sampler(s).
- Sample type, identification number and location.
- Date of collection.
- Number, type and size of containers.
- Required analyses.
- Preservatives.
- Signatures documenting change of sample custody.
- Turnaround time required for analytical results.

The coolers containing the samples will be sealed with tape and secured with a signed custody seal. The custody seal will provide an indication of whether the cooler was opened by unauthorised personnel.

The original CoC record must accompany the samples to the laboratory and be returned to the field engineer/scientist within 24 hours of sample receipt. A copy of the CoC record is to be placed in the appropriate project file.

7.6.7 Equipment Calibration

Equipment used to perform testing or data recording, including the water quality meter, will be calibrated to manufacturer's specifications by the supplier prior to use. The calibration records will be retained by the field engineer/scientist.

Calibration checks and adjustments will be performed as required during field operations. The identification of the specific device or equipment calibrated, date, reference standard, results or adjustments made and the signature of the person performing the calibration will be documented on field data sheets or in the field log book.

7.6.8 Waste Management and Disposal

Waste derived from the investigation activities will be managed according to the QLD Environmental Protection Regulation 2008.

At this stage it is expected that the only regulated waste produced during the investigation is groundwater extracted from the monitoring wells during purging. This waste will be disposed at the Toxfree facility which is authorised to receive this type of waste.

8.0 ANALYTICAL PLAN

This analytical plan discusses the laboratory testing details of the PFAS in groundwater, biota, surface water and sediment from the spill of waste AFFF.

The National Environment Protection (Assessment of Site Contamination) Measure (ASC NEPM) (Schedules B2& B3) requires that Australian laboratories undertaking analyses supporting the assessment of site contamination are to be accredited by National Association of Testing Laboratories (NATA) (where accreditation exists). Accreditation is granted after assessment of the technical competence of the laboratory and its staff against technical and management system criteria set out in ISO/IEC 17025:2005 (General requirements for the competence of testing and calibration laboratories).

Golder will be using Eurofins and ALS as the primary and check laboratories respectively selected for the chemical analysis.

Laboratory limits of reporting (LOR) for each parameter to be analysed are listed in the following sections, these have been selected considering the available assessment criteria (Section 9.0) and current technical capabilities of laboratories in Australia. Selected LOR are considered adequate to assess risk to human health and the environment.

Samples of all matrices will be analysed both for individual compounds and prepared using the TOP assay to assess PFAS precursors. Standard laboratory employed quality assurance checks will be used to confirm oxidant exhaustion has not occurred during oxidation of TOP assay samples.

8.1 Sediment Samples

Eurofins and ALS are NATA Accredited Australian laboratories capable of analysing PFAS compounds. These nominated laboratories use In-house QWI-ORG/EP231 methods based on ISO25101, ASTM D7968 & USEPA calls LCMS-MS.

Recommended technical holding times (THT) for PFOS, PFOA, 6:2 FTS and extended PFAS suite are 6 months.

Analysis will be for the following standard level PFAS Suite of 28 compounds and other chemicals and physical tests, Table 6. Additional PFAS compounds may be analysed dependent on laboratory capabilities.

Table 6: Analytical Suite for Soil / Sediment and LORs (µg/kg)

PFAS Substances	ALS LOR (µg/kg)	Eurofins LOR (µg/kg)
Perfluoroalkyl Sulfonic Acids		
Perfluorobutane sulfonic acid (PFBS)	0.2	0.1
Perfluoropentane sulfonic acid (PFPeS)	0.2	0.1
Perfluoro-n-hexane sulfonic acid (PFHxS)	0.2	0.1
Perfluoro-n-heptane sulfonic acid (PFHpS)	0.2	0.1
Perfluoro-n-octane sulfonic acid (PFOS)	0.2	0.1
Perfluorodecane sulfonic acid (PFDS)	0.2	0.1
Perfluoroalkyl Carboxylic Acids		
Perfluorobutanoic acid (PFBA)	1	0.5
Perfluoro pentanoic acid (PFPA or PFPeA)	0.2	0.1
Perfluoro-n-hexanoic acid (PFHxA)	0.2	0.1
Perfluoro-n-heptanoic acid (PFHpA)	0.2	0.1
Perfluoro-n-octanoic acid (PFOA)	0.2	0.1
Perfluoro-n-nonanoic acid (PFNA)	0.2	0.1
Perfluoro-n-decanoic acid (PFDA)	0.2	0.1
Perfluoro-n-undecanoic acid (PFUnDA)	0.2	0.1
Perfluoro-n-dodecanoic acid (PFDoDA)	0.2	0.1
Perfluoro-n-tridecanoic acid (PFTriDA)	0.2	0.1

PFAS Substances	ALS LOR (µg/kg)	Eurofins LOR (µg/kg)
Perfluoro-n-tetradecanoic acid (PFTeDA)	0.5	0.1
Perfluoroalkyl Sulfonamides		
Perfluorooctane sulfonamide (PFOSA)	0.2	0.1
N-Methylperfluoro-1-octane sulphonamide (N-MeFOSA)	0.5	0.5
N-Ethylperfluoro-1-octane sulphonamide (N-EtFOSA)	0.5	0.5
2-(N-Methylperfluoro-1-octane sulphonamide)-ethanol (N-MeFOSE)	0.5	0.5
2-(N-Ethylperfluoro-1-octane sulphonamide)-ethanol (N-EtFOSE)	0.5	0.5
N-Methylperfluoro-1-octane sulphonamidoacetic acid (N-MeFOSAA)	0.2	0.5
N-Ethylperfluoro-1-octane sulphonamidoacetic acid (N-EtFOSA)	0.2	0.5
Fluorotelomer Sulfonic Acids		
1H,1H,2H,2H-Perfluorooctanesulfonic Acid (4:2 FTS)	0.5	0.5
1H,1H,2H,2H-Perfluorooctanesulfonic Acid (6:2 FTS)	0.5	0.5
1H,1H,2H,2H-Perfluorodecanesulfonic Acid (8:2 FTS)	0.5	0.5
1H,1H,2H,2H-Perfluorooctanesulfonic Acid (10:2 FTS)	0.5	0.5
Sums		
Sum of PFAS	0.2	0.5
Sum of PFHxS and PFOS	0.2	0.5
Sum of PFAS (WA DER List)	0.2	0.5
Other Testing (sediments only)		
Total Organic Carbon (In house / APHA 5310)	0.2%	0.1%
Particle size distribution (AS1289.3.6.1)	75 microns	63 microns
ASLP (AS4439.2)	per chemical	

8.2 Groundwater and Surface Water Samples

Analysis will be for the following trace level PFAS Suite of 28 compounds, Table 7. Additional PFAS compounds may be analysed dependent on laboratory capabilities.

Table 7: Analytical Suite for Groundwater / Surface Water and LORs (µg/L)

PFAS Substances	ALS LOR (µg/L)	Eurofins LOR (µg/L)
Perfluoroalkyl Sulfonic Acids		
Perfluorobutane sulfonic acid (PFBS)	0.0005	0.001
Perfluoropentane sulfonic acid (PFPeS)	0.0005	0.001
Perfluoro-n-hexane sulfonic acid (PFHxS)	0.0005	0.001
Perfluoro-n-heptane sulfonic acid (PFHpS)	0.0005	0.001
Perfluoro-n-octane sulfonic acid (PFOS)	0.0003	0.0001
Perfluorodecane sulfonic acid (PFDS)	0.0005	0.001
Perfluoroalkyl Carboxylic Acids		
Perfluorobutanoic acid (PFBA)	0.002	0.005
Perfluoro pentanoic acid (PFPA or PFPeA)	0.0005	0.001
Perfluoro-n-hexanoic acid (PFHxA)	0.0005	0.001
Perfluoro-n-heptanoic acid (PFHpA)	0.0005	0.001
Perfluoro-n-octanoic acid (PFOA)	0.0005	0.001
Perfluoro-n-nonanoic acid (PFNA)	0.0005	0.001

PFAS Substances	ALS LOR (µg/L)	Eurofins LOR (µg/L)
Perfluoro-n-decanoic acid (PFDA)	0.0005	0.001
Perfluoro-n-undecanoic acid (PFUnDA)	0.0005	0.001
Perfluoro-n-dodecanoic acid (PFDoDA)	0.0005	0.001
Perfluoro-n-tridecanoic acid (PFTriDA)	0.0005	0.001
Perfluoro-n-tetradecanoic acid (PFTeDA)	0.0005	0.001
Perfluoroalkyl Sulfonamides		
Perfluorooctane sulfonamide (PFOSA)	0.0005	0.005
N-Methylperfluoro-1-octane sulphonamide (N-MeFOSA)	0.001	0.005
N-Ethylperfluoro-1-octane sulphonamide (N-EtFOSA)	0.001	0.005
2-(N-Methylperfluoro-1-octane sulphonamide)-ethanol (N-MeFOSE)	0.001	0.005
2-(N-Ethylperfluoro-1-octane sulphonamide)-ethanol (N-EtFOSE)	0.001	0.005
N-Methylperfluoro-1-octane sulphonamidoacetic acid (N-MeFOSAA)	0.0005	0.005
N-Ethylperfluoro-1-octane sulphonamidoacetic acid (N-EtFOSA)	0.0005	0.005
Fluorotelomer Sulfonic Acids		
1H,1H,2H,2H-Perfluorooctanesulfonic Acid (4:2 FTS)	0.001	0.001
1H,1H,2H,2H-Perfluorooctanesulfonic Acid (6:2 FTS)	0.001	0.005
1H,1H,2H,2H-Perfluorodecanesulfonic Acid (8:2 FTS)	0.001	0.001
1H,1H,2H,2H-Perfluorooctanesulfonic Acid (10:2 FTS)	0.001	0.001
Sums		
Sum of PFAS	0.0003	-
Sum of PFHxS and PFOS	0.0003	-
Sum of PFAS (WA DER List)	0.0003	-
Other Testing		
pH (APHA 4500 /)	0.01 pH units	0.01 pH unit
Total dissolved solids (APHA 2540 C /)	10 mg/L	10 mg/L

8.3 Biota Samples

Analysis will be for the following standard level PFAS Suite of 28 compounds, Table 8. Additional PFAS compounds may be analysed dependent on laboratory capabilities.

Table 8: Analytical Suite for Biota and LORs (µg/kg)

PFAS Substances	ALS LOR (µg/kg)	Eurofins LOR (µg/kg)
Perfluoroalkyl Sulfonic Acids		
Perfluorobutane sulfonic acid (PFBS)	1	0.5
Perfluoropentane sulfonic acid (PFPeS)	1	0.5
Perfluoro-n-hexane sulfonic acid (PFHxS)	1	0.5
Perfluoro-n-heptane sulfonic acid (PFHpS)	1	0.5
Perfluoro-n-octane sulfonic acid (PFOS)	1	0.5
Perfluorodecane sulfonic acid (PFDS)	1	0.5
Perfluoroalkyl Carboxylic Acids		
Perfluorobutanoic acid (PFBA)	5	0.5
Perfluoro pentanoic acid (PFPeA)	1	0.5
Perfluoro-n-hexanoic acid (PFHxA)	1	0.5
Perfluoro-n-heptanoic acid (PFHpA)	1	0.5
Perfluoro-n-octanoic acid (PFOA)	1	0.5
Perfluoro-n-nonanoic acid (PFNA)	1	0.5
Perfluoro-n-decanoic acid (PFDA)	1	0.5
Perfluoro-n-undecanoic acid (PFUnDA)	1	0.5
Perfluoro-n-dodecanoic acid (PFDoDA)	1	0.5
Perfluoro-n-tridecanoic acid (PFTriDA)	1	0.5
Perfluoro-n-tetradecanoic acid (PFTeDA)	2	0.5
Perfluoroalkyl Sulfonamides		
N-methyl perfluorooctane sulfonamide (MeFOSA)	2	0.5
N-methyl perfluorooctane sulfonamidoethanol (MeFOSE)	2	0.5
N-methyl perfluorooctane sulfonamidoacetic acid (MeFOAA)	1	0.5
Perfluorooctane sulfonamide (FOSA)	1	0.5
N-ethyl perfluorooctane sulfonamide (EtFOSA)	2	0.5
N-ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	2	0.5
N-ethyl perfluorooctane sulfonamidoacetic acid (EtFOSSA)	1	0.5
Fluorotelomer Sulfonic Acids		
1H,1H,2H,2H-Perfluorooctanesulfonic Acid (4:2 FTS)	2	0.5
1H,1H,2H,2H-Perfluorooctanesulfonic Acid (6:2 FTS)	2	0.5
1H,1H,2H,2H-Perfluorodecanesulfonic Acid (8:2 FTS)	2	0.5
1H,1H,2H,2H-Perfluorooctanesulfonic Acid (10:2 FTS)	2	0.5
Sum		
Sum of PFAS (sum of 28 analytes above)	1	0.5

9.0 ASSESSMENT CRITERIA

The analytical results will be screened against an adopted set of guideline values as part of a NEPM-based Tier 2 screening level assessment.

The NEPM 2013 states that a Tier 2 assessment is typically required when one or more contaminants are present at the site at levels that exceed Tier 1 guidance criteria, if there are no appropriate Tier 1 criteria, or if there are unresolved and significant uncertainties. A Tier 2 assessment includes a site-specific risk assessment and the development of site-specific risk-based criteria. Factors that may influence this are the public accessibility to the area, or the restricted fishing rights by humans, limited migratory areas by individual species, etc. Site-specific risk-based criteria are derived to be adequately protective of human health and ecological receptors, but also to take into account site-specific conditions such as relevant exposure pathway linkages to avoid being unnecessarily conservative. An assessment of the significance of exceedances may be necessary where they are marginal, or present over a limited area or limited time period.

The proposed screening values will assist in undertaking a preliminary review of the data, a review of the results will also be undertaken in the context of the Conceptual Site Model and potential for harm, regardless of compliance or otherwise with the nominated screening values.

Currently guidelines for PFOS and PFOA in Australia are in draft form.

We note that no reliable international screening guidelines are available for PFOS and PFOA in sediments. We propose to use the soil criteria for an initial screening and then consider the results in the context of the conceptual site model and pathway-receptor linkages (in particular the results from biota tissue testing). The criteria to screen the soil PFOS and PFOA concentrations, these are presented in Table 9.

Table 9: Adopted Soil Assessment Criteria

	PFOS (mg/kg)	PFOA (mg/kg)
Human Health Screening Levels, NSW Office of Environment and Heritage (OEH) (May 2017)[1]		
Human Health (Residential, low density)	0.009	0.1
Human Health (Residential, high density)	2	20
Human Health Commercial / Industrial	20	100
Ecological Screening Criteria protecting aquatic ecosystems, OEH (May 2017)[2]		
Residential and Parkland	0.01	-
Commercial / Industrial[3]	0.14	-
Ecological (Terrestrial) Screening Levels (ESLs), CRC Care Moderate Reliability Ecological Screening Levels (ESLs) – (CRC CARE 2017)		
Urban Residential and Public Open Space[4]	32	17
Commercial / Industrial[4]	60	48

[1]Calculated from the TDIs by OEH. These screening values do not consider the leaching pathway.

[2]Based on the Canadian Soil Guidelines Protective of Freshwater Life (EC 2017).

[3]Concentrations in the soil expected to protect against impacts on freshwater life from PFOS originating in soil that may enter the groundwater and subsequently discharge to a service water body. Based on Canadian Federal Soil Environmental Quality Guidelines (SEQGs) for Freshwater Life. These values account for bioaccumulation and/or off-site transport. These values should not be used for sediments.

[4]Moderate reliability screening levels based on experimental data for seven chronic endpoints for PFOS and six chronic and converted acute endpoints for PFOA. Experimental organisms included soil bacteria, earthworms, lettuce, turnips and cucumber. These values may be used to screen for direct toxicity on site only and should only be used if off-site transport and/or bioaccumulation are accounted for in other ways.

The proposed criteria used to screen the groundwater PFOS and PFOA concentrations are presented in Table 10.

Table 10: Adopted Groundwater Assessment Criteria

	PFOS/PFHxS (µg/L)	PFOA (µg/L)
Australian Government – Department of Health Guidance (Health 2017)		
Drinking Water quality value	0.07	0.56
Recreational Water Quality Value	0.7	5.6

The proposed criteria used to screen the surface water PFOS and PFOA concentrations are presented in Table 11.

Table 11: Adopted Surface Water Screening Values

	PFOS (µg/L)	PFOA (µg/L)
CRC-CARE Environmental Screening Levels (ESLs) derived from Draft Commonwealth Environmental Management Guidance (DOEE, 2016)		
Freshwater ESLs for 99% species protection-high conservation value systems	0.00023*	19
Freshwater ESLs for 95% species protection-slightly to moderately disturbed systems	0.13	220
Marine ESLs for 99% species protection-high conservation value systems	0.29	3,000
Marine ESLs for 95% species protection-slightly to moderately disturbed systems	7.8	8,500

*Laboratories' LORs are higher than this screening value and therefore LOR will be taken as the criterion.

The proposed criteria used to screen the biota PFOS and PFOA concentrations are presented in Table 12.

Table 12: Adopted Biota Assessment Criteria

	PFOS+PFHxS	PFOA
Food and Standards Australia New Zealand (FSANZ 2017)		
Tolerable Daily Intake	0.02 µg/kg$_{bw}$/day	0.16 µg/kg$_{bw}$/day
Finfish, Crustacea, Molluscs	5.2 µg/kg biota ww	41 µg/kg biota ww
Canadian Guidelines for Screening of Biota - Environment Canada (EC 2017)		
Fish Tissue for protection of aquatic life	8.3 mg/kg biota ww	-
Wildlife Diet for protection of mammalian consumers of aquatic biota	4.6 µg/kg biota ww	-
Wildlife Diet for protection of avian consumers of aquatic biota –	8.2 µg/kg biota ww	-

Notes:

µg/L – microgram per litre

mg/kg- milligram per kilogram

PFAS - Per- and Poly- Fluoroalkyl Substances

PFOS- Perflurooctanesulfonic acid

PFOA - Perflurooctanoic acid

PFHxS - Perflurohexane sulfonic acid

10.0 REFERENCES

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11.0 IMPORTANT INFORMATION

Your attention is drawn to the document Important Information Relating to this Report, which is included in Appendix B of this report. The statements presented in this document are intended to advise you of what your realistic expectations of this report should be, and to present you with recommendations on how to minimise the risks associated with the services provided for this project. The document is not intended to reduce the level of responsibility accepted by Golder Associates, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in so doing.

Report Signature Page

GOLDER ASSOCIATES PTY LTD

James Comley
Senior Environmental Scientist

Andrew Howes
Principal Environmental Scientist

MST-SS/AH/mst

A.B.N. 64 006 107 857

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FIGURES

LOCATION MAP

LEGEND

Proposed Sample Locations

- Original Sample Locations
- Proposed Additional Sample Locations
- Groundwater Well Locations
- State Controlled Roads
- Drainage (1:25k)

Investigation Area

- Previous Investigation Area*
- Expanded Investigation Area

***NOTE:** Previous Investigation Area as Specified in Clean Up Notice dated 12th May 2017
Reported in document 1780014-007-R-Rev0

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DRAFT

NOTES

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State Controlled Roads: © State of Queensland (Department of Transport and Main Roads) 2017.
Drainage: © State of Queensland (Department of Environment and Resource Management) 2010.

0 500 1,000 2,000 Metres

REFERENCE SCALE: 1:50,000 (at A3)

PROJECTION: GDA 1994 MGA Zone 56

CLIENT
TOX FREE AUSTRALIA PTY LTD.

PROJECT
NARANGBA INCIDENT - INVESTIGATION REPORT

TITLE
INVESTIGATION AREA

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-10-12
PREPARED	DP
DESIGN	DP
REVIEW	JC
APPROVED	JC

PROJECT No.	CONTROL	Rev.	FIGURE
1780114	001	A	1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 20mm

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LOCATION MAP

LEGEND

Proposed Sample Locations

- Original Sample Locations
- Proposed Additional Sample Locations
- Groundwater Well Locations
- State Controlled Roads
- Drainage (1:25k)

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NOTES

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Drainage: © State of Queensland (Department of Environment and Resource Management) 2010.

0 500 1,000 2,000 Metres

REFERENCE SCALE: 1:50,000 (at A3)

PROJECTION: GDA 1994 MGA Zone 56

CLIENT
TOX FREE AUSTRALIA PTY LTD.

PROJECT
NARANGBA INCIDENT - INVESTIGATION REPORT

TITLE
FIELD SAMPLE LOCATIONS WITH SURFACE WATER, SEDIMENT & BIOTA LOCATIONS

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-10-12
PREPARED	DP
DESIGN	DP
REVIEW	JC
APPROVED	JC

PROJECT No.	CONTROL	Rev.	FIGURE
1780114	001	A	2

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APPENDIX A

DEHP Environmental Evaluation Notice

Notice

Environmental Protection Act 1994

Environmental Evaluation

Notice to conduct or commission an environmental evaluation

This notice to conduct or commission an environmental evaluation is issued by the administering authority pursuant to 326B of the Environmental Protection Act 1994.

Tox Free Australia Pty Ltd
Level 1, 31 Cliff Street
FREMANTLE WA 6160

Tox Free Australia Pty Ltd
PO Box 119
NARANGBA QLD 4504

Your reference: 1780114-007

Our reference: CR78592 / STAT1204

27 September 2017 (as amended on 5 October 2017)

Take notice: that under the *Environmental Protection Act 1994* (the Act) a notice to conduct or commission an environmental investigation is issued to Tox Free Australia Pty Ltd ACN 127 853 561 (you) by the administering authority. The administering authority is the Chief Executive of the Department of Environment and Heritage Protection (the department).

The notice to conduct or commission an environmental investigation is issued in respect of your activities on land described as:

- 8-12 Krypton Street, Narangba QLD 4505 on land described as Lot 111 on CP909626 (the premises);
- The neighbouring property occupied by Queensland Organics at 65 Potassium Street, Narangba QLD 4505, on land described as Lot 112 on Plan CP867909 (Qld Organics site); and
- The receiving waterway at the rear of the premises on land described as Lot 535 on SP255151 (which is a tributary of Lagoon Creek), and downstream waterways including Lagoon Creek, Saltwater Creek, and Hays Inlet (the receiving waterways).

The notice was originally issued on 27 September 2017 with this amended notice issued on 5 October 2017. All amendments are identified in the amended notice, new text is shown as underlined and deleted text is shown as strikethrough.

A. Grounds

The notice to conduct or commission an environmental investigation is issued on the following grounds:

- The administering authority is satisfied that the discharge of a reported 800 litres of aqueous film-forming foam (AFFF) at the premises is an event that has caused environmental harm while an activity was being carried out.

The facts and circumstances forming the basis for these grounds are:

1. You carry out environmentally relevant activity (ERA) 56 - regulated waste storage and ERA 58 - regulated waste treatment at 8-12 Krypton Street, Narangba QLD 4505, on land described as Lot 111 on CP909626 (the premises), under the Environmental Authority EPPR004671413 (the EA).
2. The EA authorises treatment of regulated wastes at the premises, including organohalogens, providing treated waste can be sent to a facility lawfully able to receive that waste.
3. At 12.00pm on 28 April 2017, you notified the department that an intermediate bulk container (IBC), containing hazardous waste fell through the northern site fence into the Qld Organics site and approximately 800 litres has spilt on the Qld Organics site.
4. On 29 April 2017 authorised officers observed a foamy substance floating on top of the receiving waterway in the culvert beneath Potassium Street.
5. On 9 and 11 May 2017 you provided sample results for the recovered spilled contents and receiving waterway in the immediate vicinity of the spill.
6. Based on the information provided above (points 1 to 5), the department considers an event has occurred involving the release of per-fluoroalkyl and poly-fluoroalkyl substances; collectively termed "PFAS" from the premises to the Qld Organics site and the receiving waterways.
7. Environmental harm is defined in section 14 of the Act as follows:

   (1) Environmental harm is any adverse effect, or potential adverse effect (whether temporary or permanent and of whatever magnitude, duration or frequency) on an environmental value, and includes environmental nuisance.

   (2) Environmental harm may be caused by an activity—

   (a) whether the harm is a direct or indirect result of the activity; or

   (b) whether the harm results from the activity alone or from the combined effects of the activity and other activities or factors.
8. An environmental value is defined in section 9 of the Act as follows:

   (a) A quality or physical characteristic of the environment that is conducive to ecological health or public amenity or safety; or

   (b) Another quality of the environment identified and declared to be an environmental value under an environmental protection policy or regulation.
9. Under the *Environmental Protection (Water) Policy 2009* (Water EPP), all Queensland waters have prescribed environmental values and water quality objectives. Environmental values and water quality objectives for the receiving waterway are listed in Schedule 1 of the Water EPP see:

   https://www.ehp.qld.gov.au/water/policy/pdf/documents/pine-rivers-ev-2010.pdf.
10. Public amenity and safety are environmental values prescribed under the Act that may be adversely affected by PFAS contaminated surface water (including sediments), PFAS contaminated biota and secondary transfer of PFAS contaminants into products e.g. where hazardous contaminants are released to soil and reused to make products such as soil conditioners.

11. Ecological health is an environmental value under the Act that may be adversely affected by release of PFAS into the environment, for example, bioaccumulation through food chains to aquatic and terrestrial organisms.
12. The receiving waterway flows to Saltwater Creek, which flows south east into Moreton Bay (RAMSAR listed high ecological significance wetlands), via Hays Inlet. The Moreton Bay wetland is described as:
    - RE 12.3.5 and is defined as a wetland RE;
    - A palustrine wetland – vegetated swamp;
    - A coastal freshwater wetland likely to support migratory species;
    - Habitat for acid frogs;
    - Upstream of the High Ecological Significance (HES) Wetland associated with Saltwater Creek; and
    - Upstream of Hays Inlet is a highly protected zone of the Moreton Bay Marine Park, Fish Habitat Area and described as endangered RE 12.1.1.
13. PFAS are a group of man-made chemicals, which are of emerging international concern due to their toxicity, persistence and potential to bio-accumulate in the environment and people. Once released in the environment, many PFAS forms are quite mobile and can adversely affect a wide range of environmental values, including beneficial uses undertaken by people.
14. Poly-fluoroalkyl substances in AFFF such as fluorotelomers can be transformed in the environment to persistent end products. For such PFAS, the eventual transformation end-point compounds are highly persistent per-fluorinated compounds such as the perfluorocarboxylic acids (PFCAs) such as PFOA, including a range of its higher and lower homologous PFCAs. These may include C6 perfluorohexanoate (PFHxA), C9 perfluorononanoate (PFNA) and C10 perfluorodecanoate (PFDA).
15. Quality characteristics of the environment that are conducive to public amenity and safety include concentrations of PFAS in sediment, water and biota that are protective of human uses and safety.
16. PFAS can harm these environmental values by a variety of mechanisms including via concentration and accumulation in food stuff, contact and ingestion.
17. Quality characteristics conducive to ecological health are water, sediment and biota where concentrations of PFAS do not cause acute or chronic toxicity, or secondary poisoning through bio-concentration or bio-accumulation to the aquatic (including air breathing and non air breathing fauna) and terrestrial environment (e.g. avian fauna).
18. The department issued you a clean-up notice under section 363H of the Act on 12 May 2017 which was amended on 18 July 2017 (the clean-up notice). The clean-up notice required the clean-up and validation of the Qld Organics site and the receiving waterways and an investigation into the nature of extent of environmental harm (including potential harm) caused as a result of the PFAS spill incident.
19. On 9 August 2017, you notified the department of potential health risks associated based on whole organism biota results.
20. Concentrations to protect human consumption of seafood are very low as trigger points developed by Food Standards Australia New Zealand (FSANZ) for PFOS + PFHxS concentration in fish (ie. 5.2 micrograms/kg) and fish have been found to bio-accumulate PFOS by three to four orders of magnitude from the water column. Field-measured bioaccumulation factors range up to 9778 for

marine waters and 95,000 for fresh water environments (See Appendix - Table A1.2 Aquatic field bioaccumulation data for PFOS via http://www.rivm.nl/bibliotheek/rapporten/601714013.pdf (accessed 7/9/2017).

21. On 15 August 2017, you provided a copy of the biota analysis which indicated all analysis of whole biota samples exceed the FSANZ criteria for PFOS + PFHxS (for edible portions). Although the Sample analysis results relate to whole fish and/or composited samples, and these results indicated very high PFOS + PFHxS analysis results for biota samples taken from the receiving waterways. Whole organism results ~~Edible portions~~ provided for two eel samples are shown below:

Environmental Value	PFAS	(FSANZ criteria) Guideline value µg/kg	Eel ~~edible~~ ~~portion~~ (Area 4) downstream in Lagoon Creek	Times exceeds guideline value	Eel ~~edible~~ upstream Area 3 µg/kg Lagoon Creek	Times exceeds guideline value
Public Safety – human consumption of seafood	PFOS + PFHxS	5.2 ug/kg	267.7 ug/kg	51.48	25 ug/kg	4.81
	PFOA	41 ug/kg	Nil		Nil	

22. As a result of this analysis the department is satisfied the discharge of AFFF (containing PFAS) into the receiving waterway, a tributary of Lagoon Creek, which flows via Saltwater Creek to Hays Inlet, may cause potential environmental harm to environmental values of these waters, including suitability for human consumption and public safety.

23. On 18 August 2017 you submitted an investigation in response to requirement 4 of the clean-up notice. This investigation included analysis for surface waters. Examples of these results for surface waters are:

Environmental Value	PFAS	Guideline value µg/L	Rear of Tox Free (site SW01) µg/L	Times exceeds guideline value	Receiving waterway Downstream concentration (Site SW15) µg/L	Times exceeds guideline value	Upstream SWUP3 ug/L	Times exceed guideline value
Recreational contact with waters (e.g. children playing in creek) 1	PFOS + PFHxS	0.7	3.8 TOPA5 7.75	5.42 11.07	0.223 TOPA5 0.27	Nil	Not detected <0.01 TOPA5 0.01	Nil
	PFOA	5.6	.07 TOPA5 0.27	Nil	0.01 TOPA5 <0.01	Nil	Not detected <0.01	Nil
Aquatic ecosystem protection 2	PFOS	0.00023	3.6 TOPA5 7.5	15,652 32,608	0.18 TOPA5 0.22	1,173 956	<0.01 TOPA5 0.01	43
	PFOA	19	.07 TOPA5 0.27	Nil	0.01 TOPA5 <0.01	Nil	Not detected <0.01	Nil
Protect high order avian fauna 3	PFOS	0.047	3.6 TOPA5 7.5	76.59 159.57	0.18 TOPA5 0.22	3.82 4.68	<0.01 TOPA 0.01	Nil
Protect high order mammalian predators 4	PFOS	0.0026	3.6 TOPA5 7.5	1,384.61 2,884.61	0.18 TOPA 5 0.22	69.23 84.61	< 0.01 TOPA5 0.01	4

Notes:

Note 1: The Commonwealth Department of Health has calculated recreational water quality values based on the latest FSANZ recommended tolerable daily intake levels for PFOS+PFHxS and PFOA for Australia

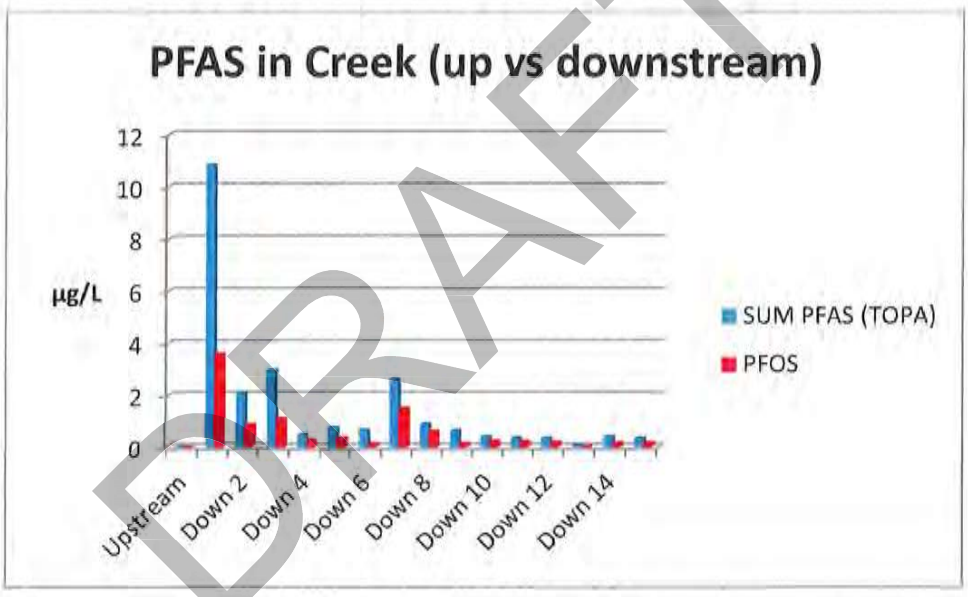
Note 2: Draft ANZECC water quality objectives for PFOS and PFOA, 99% species protection level to account for bioaccumulation

Note 3: Guideline value calculated by Giesy et al 2010 Giesy, J. P. et.al. (2010) Aquatic Toxicology of Perfluorinated Chemicals in D.M. Whitacre (ed.), Reviews of Environmental Contamination and Toxicology, Reviews of Environmental Contamination and Toxicology 202, 1- 52. http://www.usask.ca/toxicology/jgiesy/pdf/publications/JA-539.pdf

Note 4: Guideline value for PFOS to protect against secondary poisoning Dutch RIVM 2010 Environmental risk limits for PFOS. A proposal for water quality standards in accordance with the Water Framework Directive. RIVM Report 601714013/2010.

Note 5: TOPA converts precursers to PFAS compounds not detected by the LMC/MS analytical method.

24. Concentrations of PFAS compounds at the upstream site (Lagoon Creek) is significantly below all downstream locations (up to 35 times to 1084 times higher than upstream concentrations)



25. The investigation concluded that PFAS contamination from the spill had travelled the entire length of the sampled waterway (down to Anzac Avenue), and the full extent of impacts to biota downstream of the spill are not considered to be fully delineated. PFAS was observed present upstream of the spill at SWUP1, SWUP2 and SWUP3, however all upstream locations were less than the PFOS + PFHxS at location SW15 at the downstream study extent (near Anzac Avenue).

26. Surface water results detected PFAS at concentrations above level of reporting (LOR) in all locations with concentrations generally decreasing with distance from the site. Whilst PFAS in all samples exceeded ecological guidelines, the PFAS signature in downstream locations was consistent with the signature of the spilt PFAS material.

27. The department considers that PFAS present in soil on Lot 111 on CP909626, Lot 535 on SP255151 and Lot 112 on CP867909, poses a risk of environmental harm from leaching of PFAS compounds. The clean-up notice issued by the department required soil remedial works to achieve the limits stated in Table 1 of that notice. Following excavation of impacted soil undertaken as part of the clean-up activities, PFAS was still detected in soils at Tox Free and the Qld Organics premises, and within the waterway flood areas.

28. The department considers that the risks of leaching of PFAS compounds from soil and impacted concrete to waters, including groundwater has not been addressed and further remediation and validation works are required.
29. Further investigations are considered necessary to determine the extent of environmental harm to public safety, amenity and ecological health.

B. Requirements

The report on the environmental investigation must address the following relevant matters:

1. By 9 October 2017, you must engage suitably qualified person/s (SQP) to carry out the requirements of this notice.
2. By 31 October you must conduct interim monitoring comprising of a further round of sampling of surface waters and biota at each sampling locations selected for preparation of the Narangba incident – Investigation Report by Golder Associates dated 15 August 2017 and submit the results to the department.
3. By 16 October 2017, you must develop a monitoring plan to determine the nature and extent of environmental harm in downstream waters and provide a copy to the department. This plan must include the following:
   (i) Provide for the carrying out of an additional round of monitoring of surface waters, groundwater, sediment and biota at the same sample locations used for the Narangba incident – Investigation Report by Golder Associates dated 15 August 2017;
   (ii) Include additional sampling sites in a representative number of locations, (including but not limited to) upstream to the Bruce Highway and downstream extending at least downstream to Hays Inlet to the extent of the Houghton Highway Bridge (as shown on attached map); and
   (iii) Be consented to by a Contaminated Land Auditor.
4. By 28 February 2018 you must ensure the SQP investigates and submits a report to the department that includes the following:
   (a) The nature and extent of environmental harm (including potential harm) caused to receiving waters as a result of the contamination incident. This must include:
      (i) The extent of PFAS contamination likely to have been caused by the release to water quality, biota, and sediments utilising techniques available to detect trace concentrations of PFAS in the environment;
      (ii) The environmental harm and potential environmental harm caused to the freshwater and estuarine environmental values listed in Table 1;
      (iii) The monitoring locations used to determine the extent of environmental harm must include representative locations upstream of the contamination incident, and downstream waters including Saltwater Creek and Hays Inlet.
      (iv) Determination of PFAS concentrations in water, sediment and potentially affected biota at each of the sampling locations;
      (v) Testing and analysis for the suite of 20 to 28 standard fluorinated organic compounds by liquid chromatography-mass spectrometry (LC/MS/MS) and total oxidisable precursor

(TOP) assay, reported as the analyses for the resulting perfluorinated carboxylates for C4 to C14 carbon chain length (TOP C4-C14);

(vi) Where comparisons are to be made of PFAS sediment concentrations between locations, incorporate determination on the < 63 micron size fraction and organic carbon content to allow standardisation;

(vii) Use of portion sizes and trigger points to estimate risks of exceeding the tolerable daily intakes, portion sizes and trigger points recommended by FSANZ shall be utilised;

(viii) Include an analysis of the data collected in accordance with this requirement. All monitoring results must be produced and submitted to the department detailing the measures necessary to manage environmental and human risks, based on the results obtained under the monitoring program;

(ix) Screening of potential health risks associated with sediment data shall consider the following approaches:

- screened for potential health risks of PFOS and PFHxS by using field-based biota-sediment bioaccumulation factors (Sediment BAF). These are obtained from studies that measure PFAS concentration in biota such as fish and the corresponding concentrations in the sediment. For example, if the concentration in fish is 100 units and that in the sediments 10 units, the sediment BAF is 10;

- biota sediment accumulation factors for fish published by CRC CARE for PFAS;

- use of paired (co-located) sediment and biota tissues from sessile organisms to calculate BAFs. Sessile organisms are preferred so that biota tissue concentrations of PFAS may be related to uptake from sediment concentrations. These BAFs can be used to make quantitative estimates of select PFAS levels in tissues of the same species from co-located sediment data. Potential health risks of consuming those organisms can be assessed based on estimated portion sizes of sessile organisms likely to be consumed by humans.

(x) Sampling and analysis of all environmental water must wherever practicable achieve the limits of reporting listed in Table 2.

(b) Evaluation of extent of and risks posed by residual contaminants on Lot 112 on CP867909 and Lot 535 on SP255151:

(i) ensuring compliance with quality control measures for contaminated site assessments prescribed in the National Environmental Protection (Assessment of Site Contamination) Measure 1999 (NEPM);

(ii) evaluation of ecological and health risks as a result of residual PFAS leaching from soil and potential impacts to environmental values of surface waters and groundwater and risks to human and ecological health;

(iii) includes groundwater height data from groundwater bore(s) installed in the vicinity of the incident, characterisation of extent of vertical depth of soil contamination and lithology at the site and monitoring of groundwater quality for the current suite of 28 PFAS identifiable by LC/MSMS analysis both with and without digestion using the total oxidisable precursor assay; and

(iv) risks associated with leaching of contaminants from soils impacted by PFAS compounds.

5. By 28 February 2018 you must submit to the department a critical review and assessment by a Contaminated Land Auditor.

6. In the event that environmental monitoring of receiving waters identifies a risk to public safety or human consumption of aquatic foodstuff, you must notify the department of the results and findings within 24 hours of becoming aware of the risk.

7. You must provide copies of laboratory analysis and tabulated data in electronic format to the department for surface water and biota within 5 days of receipt of those results.

8. Investigation and testing requirements

(a) All investigations are to be conducted in accordance with the Act, Water EPP, Queensland Water Quality Guidelines (2009) – see http://www.ehp.qld.gov.au/water/pdf/water-quality-guidelines.pdf, the Monitoring and Sampling Manual 2009 Environmental Protection (Water) Policy 2009 Version 2 September 2010 see - http://www.ehp.qld.gov.au/water/pdf/monitoring-man-2009-v2.pdf, the National Environmental Protection (Assessment of Site Contamination) Measure 1999 – see http://nepc.gov.au/nepms/assessment-site-contamination, the Guidelines for Contaminated Land Professionals – see http://www.ehp.qld.gov.au/licences-permits/contaminated-land/documents/guideline-contaminated-land-professionals.pdf and the Tolerable Daily Intakes for PFOS, PFOA, and PFHxS recommended by Food Standards Australia New Zealand (FSANZ); The Canadian Federal Wildlife Guideline published by Environmental & Climate Change Canada, for PFOS screening to protect higher order mammalian and avian predators.

(b) Where TOP Assay is conducted, quality assurance checks must include that oxidant exhaustion has not occurred (e.g. reanalysis to determine presence of fluorotelomer);

(c) Wherever practical, all samples must be analysed by a NATA accredited laboratory;

(d) Biota samples must be analysed for TOPA; and

(e) Biota samples must include edible fish, prawns and crabs all of which would be targeted in areas open to fishing further downstream.

Definitions

'Suitably qualified person' (SQP) means

(a) For assessment of land that is contaminated or is suspected of being contaminated, the person must be a SQP pursuant to Section 549 of the Act; and

(b) a person or persons who has demonstrated professional qualifications, training, skills or experience relevant to PFAS and can give authoritative assessment, advice and analysis to performance relative to the subject matter using the relevant protocols, standards, methods or literature.

'contaminated land auditor' means an auditor approved for a contaminated land investigation document under section 567 of the Act, who has relevant experience in PFAS that the report prepared by the SQP is in accordance with and meets the criteria listed in this notice.

'waters' includes river, stream, lake, lagoon, pond, swamp, wetland, unconfined surface water, unconfined water natural or artificial water course, ben and bank of any waters, dams, non tidal, or tidal waters (including the sea),

stormwater channel, stormwater drain, roadside gutter, stormwater runoff, and groundwater and any part thereof.

The environmental report must be submitted to the department on or before:

- **28 February 2018**

As the recipient of this notice, you are also required to provide a statutory declaration in the form attached, to accompany the environmental report submitted to the department. The auditor OR suitably qualified person who prepares the environmental report must also provide a statutory declaration in the form attached to accompany the environmental report submitted to the department.

You can view an electronic version of the statutory declaration for a recipient using the following search term (ESR/2016/1997).[1]

An electronic version of the statutory declaration for a suitably qualified person form is available using the search term (ESR/2016/2266).

Take notice:

1. the requirements of the notice to conduct or commission an environmental investigation take effect immediately upon service of this notice;
2. this notice remains in force until further notice from the department; and
3. you are responsible for meeting the costs of conducting or commissioning the environmental evaluation, preparing the environmental report and providing any further information as requested by the department.

C. Reviews and appeals

The provisions regarding reviews of decisions and appeals are found in sections 519 to 539 of the Act.

A person who is dissatisfied with certain decisions of the department, may be able to apply to have the department review that original decision.

Generally, a request to have a decision reviewed must be made:

- within 10 business days of the decision being notified to the person;
- be supported by enough information to enable the department to decide the application for review; and
- be made using the application for review of an original decision form (ESR/2015/1573).

Where an application has been made for a decision to be reviewed, the applicant may also apply to the relevant court for a stay of the decision to secure the effectiveness of the review.

Once the original decision has been reviewed, a person who is dissatisfied with the review decision may be able to appeal against that decision to the relevant court within 22 business days after receiving notice of the review decision.

A person whose interests are or would be adversely affected by a decision of the department may also be able to request a statement of reasons for a decision or a statutory order review under the *Judicial Review Act 1991*.

[1] This is the publication number. The publication number can be used as a search term to find the latest version of a publication at <www.ehp.qld.gov.au>.

For further information about reviews and appeals see the:

1. Information sheet - internal review and appeal to the Planning and Environment Court (ESR/2015/1572).

You may have other legal rights or obligations and should seek your own legal advice.

D. Penalty

Failure to comply with a notice to conduct or commission an environmental evaluation is an offence.

1. The maximum penalty for an individual is 300 penalty units, totalling $37,845 and the maximum penalty for a corporation is 1500 penalty units, totalling $189,225.

Should you have any queries in relation to this notice, please contact Leonie Clough of the department on telephone number 07 5316 8410.

Signature	Date
	5 October 2017 ~~27 September 2017~~

Kate Harbert
Compliance Manager
Delegate of the Chief Executive
Department of Environment and Heritage Protection
Environmental Protection Act 1994

Enquiries:
Environmental Services and Regulation
Department of Environment and Heritage Protection
33 King Street, Caboolture QLD 4510
Ph: (07) 5316 8402
Email: ESCompliance-BrisbaneMoreton@ehp.qld.go.au

Attachments

Table 1 - Environmental values

Map of study extent

Table 2 - Limit of reporting requirements for water samples taken from fresh and marine environmental waters

Table 1 –Environmental values

• Environmental value	• Effect types and criteria and/or approaches needed to protect environmental values
• Ecological health	• Potential adverse effects of chronic and acute toxicity to aquatic and terrestrial flora and fauna due to toxicity of PFAS compounds. The wetland to the north of Potassium Street is essential habitat for the wallum froglet (acid frog) and the koala. • Secondary poisoning of higher trophic level organisms e.g. higher level predators such as fish and dolphins due to due to high persistence and bioaccumulation characteristics of PFAS compounds. • Secondary poisoning of terrestrial fauna that consumes aquatic fauna e.g. high level avian predators, water rats.
• Public amenity	• Adverse effects on amenity of locality from pollution of areas enjoyed by the public
• Public safety	• Potential adverse effects on public health by increasing doses of PFAS compounds which contribute to persons accumulating persistent PFAS compounds in their bodies and where such compounds are not biologically required in the human body and the health effects of which are currently uncertain. • There is potential for exceedance in exposed persons of tolerable daily intakes values (TDI) for perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA) and perfluorohexane sulfonate (PFHxS) [or homologous PFAS substances] developed by the Food Standards Australia New Zealand (FSANZ) • Potential exposures include: • Contact with contaminated sediment, including incidental ingestion by children • Potential reuse of treated sewage effluent • Potential reuse of biosolids • Recreational and other uses of affected waters • Suitability for human consumption of aquatic food stuff
• Protection of an aquatic ecosystem	• Ecological health of an aquatic ecosystem – protect against chronic and acute toxic effects due to toxicity of PFAS compounds, including due to bioaccumulation • Ecological health of an aquatic ecosystem – protect against bio-accumulation in non-air breathing organisms e.g. higher level predators, sharks and rays • Ecological health of an aquatic ecosystem – protect against bio-accumulation in air breathing organisms e.g. water rats, birds, dolphins, turtles, dugong • Ecological health of benthic flora and fauna from effects of bioaccumulation of PFAS adsorbed to sediments and in pore water
• Suitability for recreation	• Use of water for recreation e.g. wading, swimming, boating
• Suitability for aquaculture	• Use to culture aquatic foods e.g. fish, crustaceans without breaching food standards due to bioaccumulation of PFAS

	• Use to culture aquatic foods e.g. fish, crustaceans without causing ill-health in culture organisms, including brood stock due to PFAS toxicity
• Suitability for human consumer	• Suitability to grow organisms in aquatic environments for wild harvest for human consumption, including benthic organisms exposed to sediments - Potential adverse effects on concentration of PFAS compounds in aquatic organisms used as for food (including commercial and recreational) • Environmental harm includes the that causes actual or potential loss or damage to property, namely actual or potential loss to commercial fisherman in the receiving environment
• Cultural and spiritual use	• Any potential impact on species of special cultural significance

Map of Study Extent

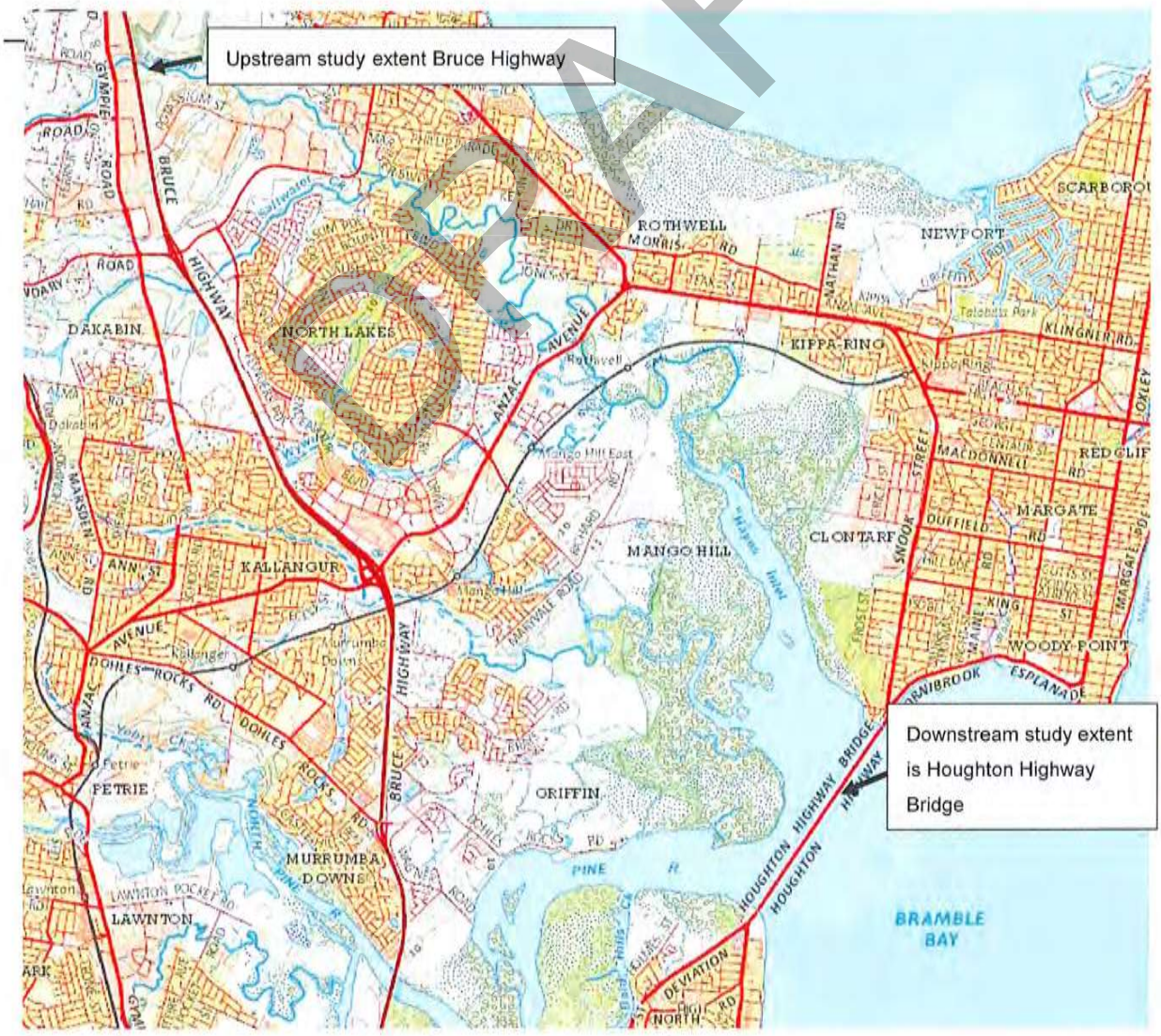


Table 2 – Limit of reporting requirements for water samples taken from fresh and marine environmental waters (see Notes)

Perfluoroalkyl and Polyfluoroalkyl Substances	Required Limit of Reporting µg/L
Perfluoroalkyl Sulfonic Acids	
Perfluorobutane sulfonic acid (PFBS)	0.0005
Perfluoropentane sulfonic acid (PFPeS)	0.0005
Perfluorohexane sulfonic acid (PFHxS)	0.0005
Perfluoroheptane sulfonic acid (PFHpS)	0.0005
Perfluorooctane sulfonic acid (PFOS)	0.0003
Perfluorodecane sulfonic acid (PFDS)	0.0005
Perfluoroalkyl Carboxylic Acids	
Perfluorobutanoic acid (PFBA)	0.002
Perfluoropentanoic acid (PFPeA)	0.0005
Perfluorohexanoic acid (PFHxA)	0.0005
Perfluoroheptanoic acid (PFHpA)	0.0005
Perfluorooctanoic acid (PFOA)	0.0005
Perfluorononanoic acid (PFNA)	0.0005
Perfluorodecanoic acid (PFDA)	0.0005
Perfluoroundecanoic acid (PFUnDA)	0.0005
Perfluorododecanoic acid (PFDoDA)	0.0005
Perfluorotridecanoic acid (PFTrDA)	0.0005
Perfluorotetradecanoic acid (PFTeDA)	0.0005
Perfluoroalkyl Sulfonamides	
Perfluorooctane sulfonamide (FOSA)	0.001
N-Methyl perfluorooctane sulfonamide (MeFOSA)	0.0005
N-Ethyl perfluorooctane sulfonamide (EtFOSA)	0.0005
N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	0.0005
N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	0.0005
N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	0.001
N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	0.001
Fluorotelomer Sulfonic Acids	
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	0.001
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	0.001
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	0.001
10:2 Fluorotelomer sulfonic acid (10:2 FTS)	0.001

Notes: Does not apply to waste water samples. LOR for TOPA analysis may need to be adjusted for some samples due to matrix effects and degree/nature of any precursor presence.

APPENDIX B

Important Information

IMPORTANT INFORMATION RELATING TO THIS REPORT

The document ("Report") to which this page is attached and which this page forms a part of, has been issued by Golder Associates Pty Ltd ("Golder") subject to the important limitations and other qualifications set out below.

This Report constitutes or is part of services ("Services") provided by Golder to its client ("Client") under and subject to a contract between Golder and its Client ("Contract"). The contents of this page are not intended to and do not alter Golder's obligations (including any limits on those obligations) to its Client under the Contract.

This Report is provided for use solely by Golder's Client and persons acting on the Client's behalf, such as its professional advisers. Golder is responsible only to its Client for this Report. Golder has no responsibility to any other person who relies or makes decisions based upon this Report or who makes any other use of this Report. Golder accepts no responsibility for any loss or damage suffered by any person other than its Client as a result of any reliance upon any part of this Report, decisions made based upon this Report or any other use of it.

This Report has been prepared in the context of the circumstances and purposes referred to in, or derived from, the Contract and Golder accepts no responsibility for use of the Report, in whole or in part, in any other context or circumstance or for any other purpose.

The scope of Golder's Services and the period of time they relate to are determined by the Contract and are subject to restrictions and limitations set out in the Contract. If a service or other work is not expressly referred to in this Report, do not assume that it has been provided or performed. If a matter is not addressed in this Report, do not assume that any determination has been made by Golder in regards to it.

At any location relevant to the Services conditions may exist which were not detected by Golder, in particular due to the specific scope of the investigation Golder has been engaged to undertake. Conditions can only be verified at the exact location of any tests undertaken. Variations in conditions may occur between tested locations and there may be conditions which have not been revealed by the investigation and which have not therefore been taken into account in this Report.

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Where permitted by the Contract, Golder may have retained subconsultants affiliated with Golder to provide some or all of the Services. However, it is Golder which remains solely responsible for the Services and there is no legal recourse against any of Golder's affiliated companies or the employees, officers or directors of any of them.

By date, or revision, the Report supersedes any prior report or other document issued by Golder dealing with any matter that is addressed in the Report.

Any uncertainty as to the extent to which this Report can be used or relied upon in any respect should be referred to Golder for clarification.

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