



Airservices Australia

Gold Coast Airport Biota Sampling Report

March 2017

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1. Introduction

1.1 Background

A Preliminary Site Investigation (PSI) was undertaken at the Gold Coast airport (GCA) in mid-2016 (GHD, 2016) and the PSI report was provided to the New South Wales (NSW) Environment Protection Authority (EPA) and the Queensland (QLD) Interdepartmental Committee (IDC) in October 2016. In November 2016, NSW EPA raised concerns related to potential health risks to consumers of seafood arising from the migration of contaminants through surface water from the Airport into the Cobaki Broadwater and subsequently requested Airservices undertake a targeted aquatic biota investigation.

Airservices engaged GHD Pty Ltd (GHD) to design a sampling analysis and quality plan (SAQP) to investigate the potential impacts to beneficial users arising from consumption of seafood sourced from the water body(ies) adjacent to the GCA.

1.2 Scope

This report outlines the findings of field investigations to assess PFAS concentrations within the Cobaki Broadwater. Sampling included water and sediment quality analysis, as well as biota sampling and analysis. Bioaccumulation calculations have been undertaken to assess the risk to higher order consumers of seafood collected from the Cobaki Broadwater. The following report outlines the sampling methodology undertaken and the results of all testing completed at the Cobaki Broadwater.

1.3 Assumptions

This report has been prepared by GHD for Airservices Australia and may only be used and relied on by Airservices Australia for the purpose agreed between GHD and the Airservices Australia as set out in section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than Airservices Australia arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

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The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

2. Methods

2.1 Site selection

The assessment of surface waters, sediment and biota was conducted within the estuarine waters of the Cobaki Broadwater. Sample locations were chosen based both on their proximity to the GCA, where contamination is most likely to have occurred as a result of interactions between surface water and groundwater, and in locations upstream and downstream of the GCA, where contaminants may have migrated due to the tidal nature of the Cobaki Broadwater. The extent of sample locations provides an overall understanding of the potential spread of contamination due to tidal influences. The location of surface water and sediment quality sample locations are detailed below in Table 2-1 and are further presented in Figure 2-1.

Biota sampling took place within a similar range of sites, although the ecology of the target species was considered when undertaking all sampling and so sites were chosen appropriately. The locations of biota sampling are presented in Figure 2-2. Due to tidal influences within the study area, some sections (namely to the west of the airport and south of the main broadwater) could not be accessed due to the depth of water and tidal influence (further explained in sections 2.4.1 and 3.1).

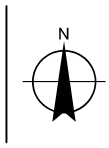
Table 2-1 Location of water and sediment sampling sites in the Cobaki Broadwater (Zone: 56J)


Site Code	Description of location	Easting	Northing
1	Downstream of GCA, close to mangroves	550167	6882614
2	Directly adjacent to GCA	550162	6883062
3	Upstream of GCA in passage to broadwater	549838	6883073
4	Within broadwater	549029	6883191
5	Within broadwater	548731	6883571



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 Metres
 Map Projection: Transverse Mercator
 Horizontal Datum: GDA 1994
 Grid: GDA 1994 MGA Zone 56



LEGEND
 Monitoring location

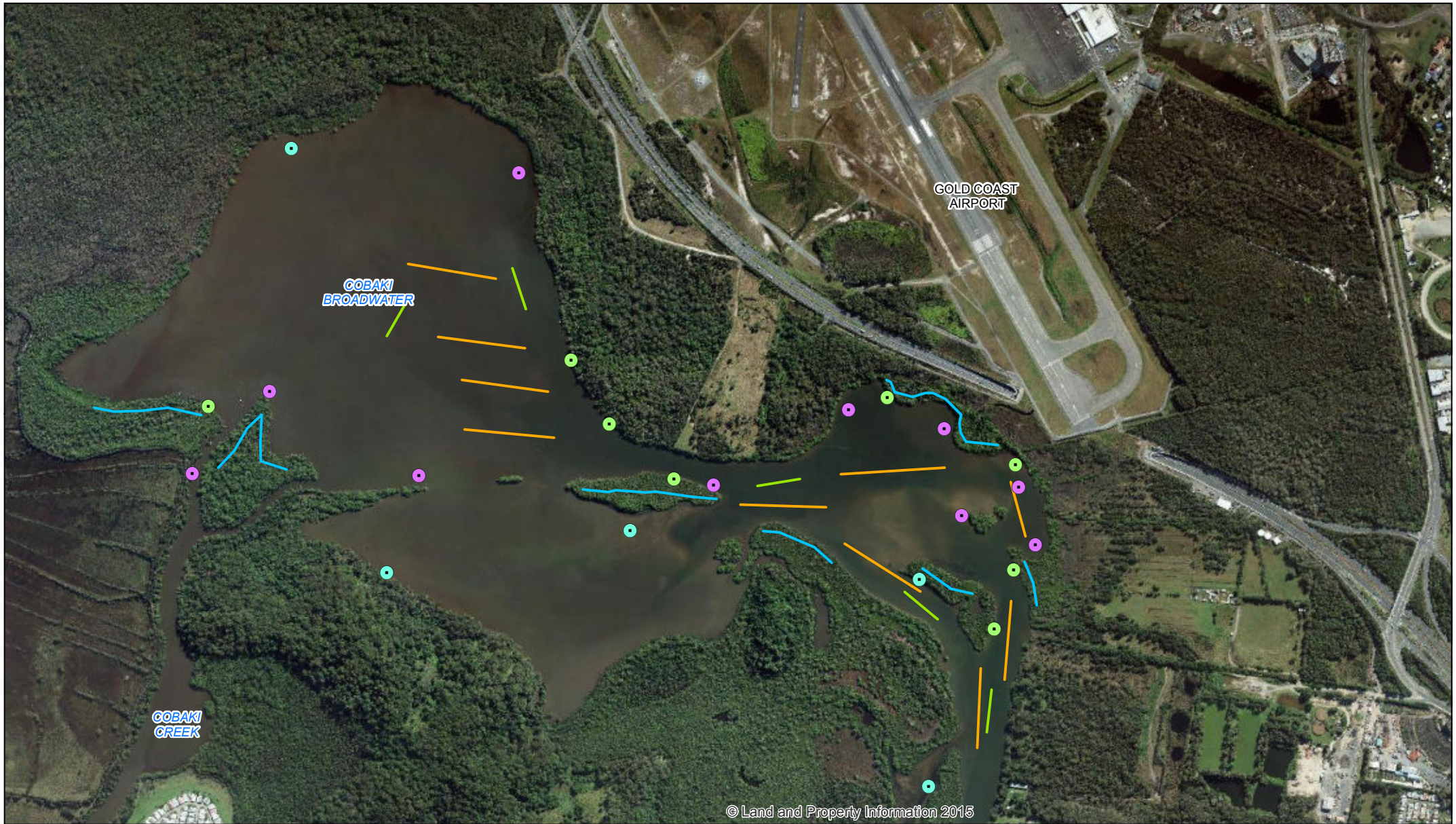


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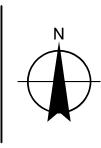
Water quality and sediment
 monitoring locations

Figure 2-1



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 Metres
 Map Projection: Transverse Mercator
 Horizontal Datum: GDA 1994
 Grid: GDA 1994 MGA Zone 56



LEGEND

- Crab pot
- Professional crab pot
- Oyster
- Fish collection
- Meander
- Sled



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Biota sampling locations

Figure 2-2

2.2 Surface water quality

2.2.1 *In-situ*

In-situ physico-chemical water quality parameters were recorded at each site (Figure 2-1), at 1 m depth using a hand held water quality meter (YSI 556 multimeter) calibrated to the manufacturers specifications, and a field Hach Turbidimeter 2100P. The following parameters were recorded:

- Dissolved oxygen (DO; mg/L and % saturation)
- Temperature (°C)
- Electrical Conductivity (EC; µS/cm)
- pH (pH unit)
- Turbidity (NTU)

2.2.2 Grab samples

Surface water samples were collected from five locations (Figure 2-1). Samples were collected by grab sampling with a dedicated sample bottle attached to an extendable arm from the side of a boat and below the water surface. Samples were placed in laboratory-supplied bottles appropriate for sampling of PFAS/PFOA and immediately stored in chilled insulated containers. All samples were transferred to Australian Laboratory Services (ALS) and accompanied by CoC documentation. Further detail on sample preservation, handling and transport is provided below in Section 2.5.

2.3 Sediment sampling

Estuarine sediment samples were collected at five locations corresponding with those where surface water samples were collected (Figure 2-1) using a weighted stainless steel Birge-Ekman grab sampler (dredge) which was lowered to the bottom by a rope. At each sampling location, three grab samples were collected and combined in a stainless steel bowl to create a composite sample. The Birge-Ekman grab sampler is the most suitable for use in soft sediments as well as inter-mixtures of sand, stones and other coarse debris. The specialised function of the sampler means it takes quantitative and qualitative samples, making the collection of similar amounts of material at each site possible, and therefore made sites comparable to each other. The grab sampler was cleaned between sites using a steel brush. Samples were placed into laboratory-supplied jars suitable for sampling of PFAS and filled to the top to eliminate headspace. Jars were stored in chilled, insulated containers before transportation to the nominated laboratory, accompanied by a chain of custody. Steel bowls and trowels were rinsed thoroughly prior to sampling as well as between each sampling location.

2.4 Biota sampling

A total of six aquatic species were selected for biological sampling (Table 2-2) as nominated by NSW DPI Fisheries (DPI 2016), five of which represented species likely to be commercially fished in the area. The sixth species: Mud Ark (*Anadara trapezia*), was included as it is thought to be consumed by local indigenous groups. A maximum of 40 individuals of each species were collected and all sampling was undertaken in accordance with the general guidelines in the NSW DPI-Fisheries Standard Operating Protocol for PFAS Sample Collection (Appendix A).

Table 2-2 Species and biological sample types in the Cobaki Broadwater

Scientific Name	Common Name	Sample required	Seafood type
<i>Mugil cephalus</i>	Sea Mullet	Fillet	Fish
<i>Liza argentea</i>	Fantail Mullet	Fillet	Fish
<i>Scylla serrata</i>	Mud Crab	Leg/Claw	Crustacean
<i>Saccostrea glomerata</i>	Sydney Rock Oyster	Whole animal	Shellfish
<i>Girella tricuspidata</i>	Luderick	Fillet	Fish
<i>Anadara trapezia</i>	Mud Ark	Whole animal	Shellfish

2.4.1 Fish

Fish sampling was undertaken with the aid of a local commercial fishing vessel. A maximum of forty individuals of each of the target species were collected and euthanised using the *iki jime* method. During standard commercial fishing practices using net hauls, all native fish besides the three target species were returned to the water. The location of each fish captured was recorded, and each fish numbered and placed inside a separate zip-lock bag before being placed on ice inside insulated containers. Samples were transported to the GHD biological laboratory in Brisbane to be processed. Each fish was checked for parasites, lesions and gill health. Any abnormalities observed were recorded.

In the GHD biological laboratory, fish were processed into composite samples in accordance with the NSW DPI-Fisheries Standard Operating Protocol for PFAS Sample Collection. Each fish was picked at random from the available individuals for each composite sample. The second fillet was removed and frozen in a laboratory-supplied container for further testing if required. The remains were disposed off-site. Composite samples were placed in laboratory-provided sample containers and labelled using the convention set out in the NSW DPI-Fisheries Standard Operating Protocol for PFAS Sample Collection before being frozen. Samples were then sent to ALS with the appropriate CoC documentation for testing.

2.4.2 Crustaceans

Ten commercial round crab pots were deployed in the survey area close to mangroves and in backwater areas. Pots were not deployed in open, deep water habitats adjacent to the project area as they were likely to be lost in strong currents and would have poor fishing ability in deeper waters, providing little value. GPS locations for each pot were recorded (Figure 2-2).

To increase the efficiency of sampling, a commercial crab fisherman operating within the Cobaki Broadwater was also utilised to gather mud crabs. GPS locations of all commercial crab pots from which individuals were collected are also presented in Figure 2-2. Where mud crabs were encountered as bycatch of fish collection methods, these individuals were also retained and claws removed as samples.

Individuals were euthanised in a bath of ice slurry. Claws were then removed and retained on ice before being transported to the GHD Biological Laboratory in Brisbane. The remains of sampled animals were disposed off-site.

In the GHD biological laboratory, mud crabs were processed into composite samples as per the NSW DPI-Fisheries Standard Operating Protocol for PFAS Sample Collection. One claw from each individual was picked at random from the available individuals for each composite sample and peeled. The flesh from nine individuals were used for composite sampling. The second claw was frozen in a laboratory-supplied container for further testing if required. Composite samples were placed in laboratory-provided sample containers and labelled using the convention set out in the NSW DPI-Fisheries Standard Operating Protocol for PFAS Sample Collection before

being frozen. Samples were then sent to ALS with the appropriate CoC documentation for testing.

2.4.3 Shellfish

The two species of shellfish nominated for sampling as part of this study differ in their habitat and therefore the techniques used for collection differ:

- Sydney rock oyster – scrape sampling
- Mud ark – dredge sampling, meander searches and snorkelling

Sydney rock oysters were removed from hard substrates where they were found by scraping and levering. Care was taken to target only oyster material and avoid other biofouling. Where individuals were removed from mangroves, care was taken not to damage stems and roots. Oysters were placed in an ice slurry bath before being individually placed in labelled zip-lock bags and put on ice inside insulated containers. Samples were then transported to GHD's Biological Laboratory in Brisbane.

Snorkelling surveys are a common technique used in the collection of mud arks, but within the Cobaki Broadwater, visibility was low and so this method could not be used. A modified Ockelmann sled-dredge was used to sample soft substrates. The steel sled-dredge has mouth dimensions of 50 cm x 14 cm and a 6 mm steel mesh net. The dredge was towed along the bottom with the mouth partially digging into the sediment to sample both mobile infauna and benthic epifauna; sediment washes through the mesh during the tow. Tows were approximately 100 m in length (depending on sediment type) at depth range of 1 m to 6 m at locations across different areas of the Cobaki Broadwater. The resultant trapped material was then lifted back onto the vessel and processed, which involves sorting of the sample through a 10 mm sieve. Non-target species were carefully collected and returned to the water as quickly as possible.

Meander surveys were undertaken within mangroves at low tide. This involved walking through sections of mangroves that were exposed at low tide and visually scanning the surface for mud arks in the substrate.

The GPS location of all scrape samples, sled tows and meander surveys were recorded. There were no mud ark individuals found during surveys, and so the location of these could not be recorded.

In the GHD biological laboratory, oysters were processed into composite samples following the NSW DPI-Fisheries Standard Operating Protocol for PFAS Sample Collection. An oyster was picked at random from the available individuals for each composite sample and shucked. 1 g of flesh was used for composite sampling along with the same process for nine other individuals. Composite samples were placed in laboratory-provided sample containers and labelled using the convention set out in the NSW DPI-Fisheries Standard Operating Protocol for PFAS Sample Collection before being frozen. Samples were then sent to ALS with the appropriate CoC documentation for testing. Residual oyster material (excluding shells) was placed into a laboratory-supplied container and frozen for later analysis if required.

2.4.4 Ethics and sample handling

All fauna handling and sample collection was conducted in compliance with the GHD Animal Ethics Committee's (AEC) requirements for the sampling methods employed and species being targeted. All methods were videoed to support reporting of ethical activities to the AEC. The wellbeing of animals was the priority for all tasks. A copy of the animal ethics post-survey report can be found in Appendix B.

2.5 Quality Assurance/Quality Control

Samples collected were preserved, handled and transported to maintain sample integrity in accordance with the procedures outlined below. Certificates of analysis for all analyses are provided in Appendix C and Appendix D

2.5.1 Water and sediment sampling

Sample containers were supplied pre-prepared by the laboratory and were labelled with the container preservative and the analytes it is suitable for. All sampling was completed by staff wearing powder-free nitrile gloves. All staff took extra care to wear only natural sunscreens and wore cotton clothing. Samples were labelled on site using a ball-point pen with the following information:

- Project identification number
- Sample identification number
- Date and time of sampling
- Initials of sample collector

QA/QC samples were labelled differently so that samples were delivered 'blind' to the laboratory. The same information as for a normal sample was recorded. The sample identification system used indicates only the type of verification sample along with a unique number. The number corresponded to a predetermined location.

Chain of custody forms

Chain of Custody (CoC) procedures were used to track samples, discourage tampering and provide a sampling summary. The CoC form was filled out on completion of field sampling. An individual CoC was completed for each discrete batch of samples.

The following information was included on the CoC form:

- Project identification number
- Sample number
- Date and time of collection
- Type of sample
- Number and type of container (if required)
- Analysis required
- Signature of sampler
- Signature of receiver (laboratory)

Each batch of samples sent to ALS included a CoC form. When the batch was relinquished (by GHD) and received (by the laboratory or courier), the party involved signed the form and indicated the time and date. The original copy accompanied the samples to the laboratory in the sample container. The original was signed by the laboratory, scanned and sent to GHD for filing. The laboratory and GHD have retained a copy as a record of samples sent and analyses requested.

Sample handling and packing

During fieldwork, samples were stored in a chilled container (esky with ice). At the end of work for each day, the CoC form was placed in a separate bag and sealed. The samples were then placed in a cooler containing ice. Samples were kept as close as possible to or below 4 °C. The

CoC form was placed in the cooler with the samples and fresh ice, before being sealed with tape / security seals and couriered to ALS.

Sample storage and disposal

Storage and disposal protocols are in accordance with National Association of Testing Authorities (NATA). The laboratory is responsible for ensuring samples are correctly stored and disposed of once submitted for analyses. The laboratory also ensured the correct sample containers (cleaned / washed / rinsed as required) were supplied for the analyses required as requested by GHD.

The correct sample containers were used and sample preparation methods specified by the laboratory, DPI Fisheries and the EPA were followed.

Sample receipt notification

A sample receipt notification (SRN) was issued by the laboratory on the same day samples were received. The SRN was forwarded in digital (pdf) format, and highlighted any discrepancies between the chain of custody forms and the samples received, in addition to any breakages or inadequacies in sample preservation, preparation or containers. These are available upon request.

2.5.2 Biota sampling

Biological sampling was conducted following the sampling procedure outlined by Department of Primary Industries – PFAS Sample Collection and Processing Protocol (2016).

Sample labelling

Sample containers were supplied and pre-prepared by the laboratory. All containers were labelled with a ball-point pen with a modified version of the sample labelling system used by DPI Fisheries: EstuaryCode.Rep#.SpCode (e.g. HUR.1.ACAAUS). The sample labelling is explained below:

Table 2-3 Species codes as set out by DPI Fisheries (DPI 2016).

Common Name	Species Name	Code
Sea Mullet	<i>Mugil cephalus</i>	MUGCEP
Fantail Mullet	<i>Liza argentea</i>	LIZARG
Luderick	<i>Girella tricuspidata</i>	GIRTRI
Mud Crab	<i>Scylla serrata</i>	SCYSER
Sydney Rock Oyster	<i>Saccostrea glomerata</i>	SACGLO
Mud Ark	<i>Anadara trapezia</i>	ANATRA

Sample handling and packing

Upon collection of animals, target species were isolated and placed in separate new, clean containers. Once a target organism was successfully captured, it was removed from the gear, euthanised and packaged. A sample label was placed on the outside of the container. Once the bags were sealed, organisms were placed immediately on ice and frozen/stored in a secure freezer until transported to the laboratory. Samples were then composited in accordance with DPI Fisheries protocols (detailed above in Section 2.4).

Sample storage and disposal

A refrigerated courier service was used to transport samples directly from the GHD laboratory to ALS. Samples were not transported until all animals (four composite samples) of a particular

species had been collected and processed. Storage and disposal protocols are in accordance with National Association of Testing Authorities (NATA).

ALS was responsible for ensuring samples are correctly stored and disposed of once submitted for analyses. Residual samples stored in a dedicated freezer at the GHD laboratory will be kept until such time as the EPA is satisfied with the current study and its outcomes.

2.6 Data analysis

2.6.1 Water and sediment quality

Concentrations of PFAS detected in waters, sediments and biota are presented as concentrations for every site of the study. In addition, a summary table of general statistics for the entire area is provided.

3. Results and Discussion

All the analytical results, together with the physico-chemical characterisation of the Cobaki Broadwater, are presented in this section. A general statistical summary of the PFAS concentration in waters and sediments is presented in Appendix F.

3.1 Environmental conditions

All biota sampling was completed within the Cobaki Broadwater between 24 and 26 January 2017. The tidal influence within the study site was obvious, with water visibly moving between the tidal peaks. The study site was accessed easily at high tide, although some sections of the Cobaki Broadwater were not navigable at low tide, namely the area to the west of the Airport (Figure 3-2). Given these restrictions, work was completed in the shallow sections of the Cobaki Broadwater during high tide, with deeper sections and exposed mangrove flats accessed and worked in during low tide. Data on the fluctuation of the tide at Tweed Heads is presented in Figure 3-1.

Weather during sampling was sunny, with wind bearing from the north-east, becoming strong in the afternoons. The water was relatively clear, although soft sediments on the substrate made visibility difficult, and so snorkelling was not a valid survey option for mud arks.

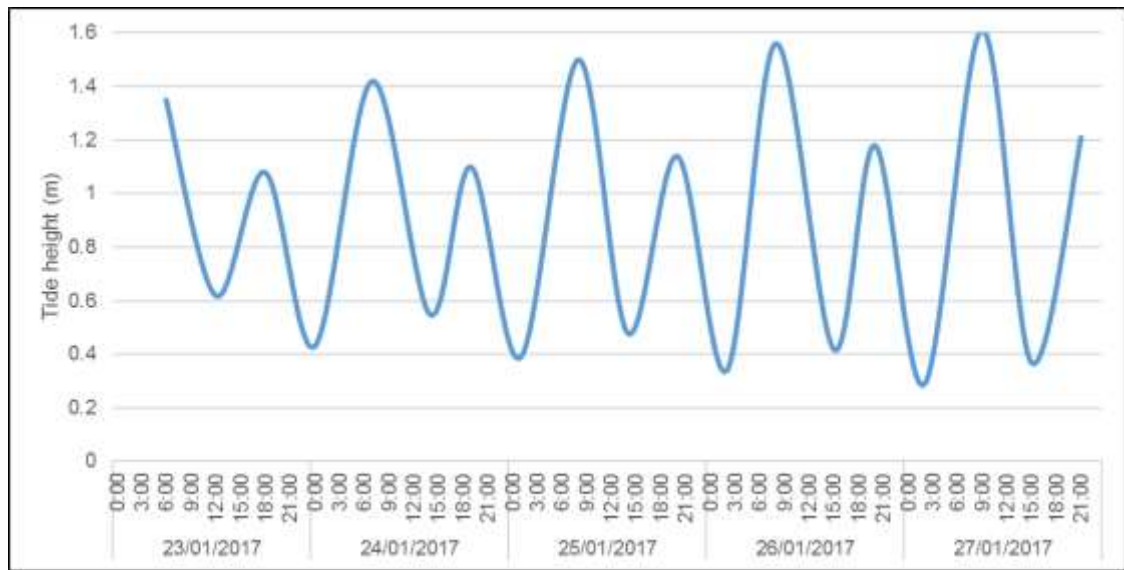
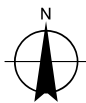


Figure 3-1 Tides recorded at Tweed Heads during sampling (BOM 2017).




Paper Size A4
 0 40 80 160 240 320
 Metres

Map Projection: Transverse Mercator
 Horizontal Datum: GDA 1994
 Grid: GDA 1994 MGA Zone 56



LEGEND

 Inaccessible at low tide



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Tidal areas of Cobaki Broadwater **Figure 3-2**

3.2 Water quality

3.2.1 Quality Assurance/Quality Control

Analyses conducted by ALS met the QA/QC thresholds and no outliers have been reported by the laboratory (see Appendix C and Appendix D). In addition to the laboratory quality control assessments, one duplicate was added for the water samples. The Relative Percent Deviation (RPD) specified by the laboratory was not exceeded by any of the PFASs.

A trip blank sample was included in the water analyses to monitor any cross-contamination in the analysis process. One container, exactly the same type as the containers used to collect all the water samples, was provided to the laboratory filled with Milli-Q filtered water (Reference A+, 0.22µm). Blank results showed a concentration of PFOS slightly above the LOR (0.003 µg/L). However, this positive was attributed to a potential analytical cross-contamination by the laboratory. The analyses was repeated and all concentration were below LOR (Certificates of Analysis of the new blank is provided in Appendix C).

3.2.2 Surface water

A physico-chemical characterization of the surface waters was conducted with the results presented in Table 3-1. Temperature increased from the Site 1 (in the lower region of the broadwater) to Site 5 (in the upper region). In contrast, EC, DO and pH values followed an inverse gradient, with increasing values from Site 5 to Site 1. Turbidity values ranged from 4.7 to 7.1 NTU, with no clear distribution pattern. These results present a typical distribution of physico-chemical parameters with the lower region of The Broadwater which shows a greater seawater influence.

Table 3-1 *In-situ* parameters collected during water sampling in the Cobaki Broadwater

Site	Temperature (°C)	EC (µS/cm)	DO (%)	DO (mg/L)	pH	Turbidity (NTU)
1	27	51,460	90	6.0	8.0	7.0
2	28	50,750	95	6.3	8.0	6.5
3	28	50,430	93	6.2	8.0	4.7
4	28	50,530	90	5.9	8.0	7.9
5	28	50,700	81	5.3	8.0	5.3

PFAS concentrations in the water samples collected from Sites 1 to 5 are presented in Table 3-2. Only PFOS and PFHxS were detected in concentrations above LOR. PFOS was present in water samples at all the Sites with values ranging from 0.003 µ/L to 0.009 µ/L, indicating that low concentrations of PFOS are well dispersed along the surface water in Cobaki Broadwater. The other PFAS species (PFHxS) above detection limits was detected in Sites 3 and 4, both at the LOR.

During the preparation of the SAQP (GHD 2017), the EPA recommended that the draft investigation level for 95% species protection is appropriate for use against results of analysed water quality samples collected in the Cobaki Broadwater (DEE 2016). However, salinity does influence the toxicity, fate and transport of PFOS and PFOA in the environment (Jeon et al, 2010) and, therefore, a more appropriate method of taking into account the potential for toxicity in the Broadwater is by applying the 99% Marine Species Protection value for protection of ecosystem health (CRC-CARE 2017). Further, PFAS toxicity in marine organisms will not necessarily be comparable to that observed in freshwater organisms and the differences can

have important ramifications in establishing tolerance thresholds. Nevertheless, to address the EPA’s recommendations, the results of this study have been compared against both sets of guidelines. As shown in Table 3-2, all surface water concentrations recorded for samples from the Cobaki Broadwater were orders of magnitude below the selected guidelines.

Table 3-2 PFAS concentrations in surface waters and comparison with available Guidelines



Sites	PFOS (µg/L)	PFHxS (µg/L)	Marine Guidelines PFOS (µg/L)	Freshwater Guidelines PFOS (µg/L)
Blank	0.003	-	99% Species protection	95% Species protection
1	0.008	<0.002	0.3	0.13
2	0.006	<0.002		
3	0.006	0.002		
4	0.009	0.002		
5	0.008	<0.002		




3.3 Sediment quality

3.3.1 Sediment

Sediment sampling was completed successfully using the Birge-Eckman grab sampler at all five sites within the Cobaki Broadwater. The spread of locations across the study area allowed for the capture of data in relation to different sediment types and therefore enabled a broader interpretation of how contaminants may be binding to the substrate. The characteristics of sediments collected at each site are presented below in Table 3-3.

Table 3-3 Characteristics of sediment samples collected

Site	Description	Photo
1	Mixture of sand and fine clay. Small layer of organic material. Very small amount of shell grit. Slight oily sheen to fine sediment	
2	Mainly sand and fine shell grit with a very small amount of organic matter and fine sediments.	

Site	Description	Photo
3	Small amount of sand, mostly made up of fine sediment and organic matter. No shell grit.	
4	Very dense clay with a layer of fine sand and silt. Dense substrate made of clay and organic matter. Very small and fine amount of shell grit.	
5	Sand and fine silt with an overlying layer of organic matter and shell grit layer underneath more dense and similar to sample 4, but layer not as thick. Sandy layer below.	

Sediment results are presented in Table 3-4. PFOS was detected in the sediments of the Cobaki Broadwater in the area adjacent to the Airport, (Site 3) where the sample reported a concentration of 0.0008 mg/kg and PFPeA was reported at the limit of detection at this site. PFOS was also detected at Site 5 at the level of detection. All the remaining PFAS species, including PFOA, were undetected. There are no Australian guidelines for PFOS toxicity in sediments. However, the PFOS concentration at Site 3 (0.0008 mg/kg) is slightly above the Norwegian sediment background concentration of 0.00017 mg/kg and is several orders of magnitude below the concentration designated as the Norwegian predicted no effect concentration (PNEC) for long term chronic toxic impacts, of 0.22 mg/kg (Bakke et al. 2010)¹.

¹ The Norwegian PNEC was adopted in the absence of other international published criteria

Table 3-4 PFAS concentrations detected in the sediments

Sites	PFOS (mg/Kg)	PFOA (mg/Kg)
1	<0.0002	<0.0002
2	<0.0002	<0.0002
3	0.0008	<0.0002
4	<0.0002	<0.0002
5	0.0002	<0.0002

3.4 Biota

3.4.1 Mud arks

A benthic sled was towed to capture mud arks during high tide in shallow areas and at low tide in deep areas, Mangrove flats and seagrass beds were searched on foot during low tide, but no mud arks were found at any site in the broadwater.

To support the absence of this species in the broadwater, was the scarcity of shell grit contained in any sediment samples or sled tows, and only a remnant single mud ark half shell was found. During the meander surveys (Figure 3-3), a large number of shells from cockles and oysters were recovered, but no shell grit or shell remnants of mud arks were found. Due to the large amount of survey effort undertaken in search of mud arks, it was determined that their distribution within the Cobaki Broadwater (if they are present) is sparse, and therefore the broadwater is unlikely to be an area targeted by local indigenous groups. Consequently, given their low densities, the likelihood of consumption of mud arks from the broadwater is low and the potential health problems for higher order consumers is negligible.



Figure 3-3 Mangrove flats at low tide in which meander surveys were completed

3.4.2 Species condition

The remaining five species recommended by the NSW DPI Fisheries were caught in sufficient numbers to compile four composite samples of ten individuals for analysis. Each fish and crab was measured and provided with a unique identification number. Lengths and sex of each individual are presented in Appendix E. The sex of fantail mullet collected during sampling were not able to be determined (juveniles). All fish species were found to be in good condition, without parasites or lesions. Gills on all fish were also observed to be in good health.

3.4.3 Analytical results and bioaccumulation

The analytical results revealed that all PFAS species in all biota samples were below the level of detection (Table 3-5). Consequently, bioaccumulation factors could not be calculated.

Table 3-5 PFAS concentrations for biota in Cobaki Broadwater.

PFAS	Species sampled in Cobaki Broadwater				
	Sea Mullet	Fantail Mullet	Mud Crab	Sydney Rock Oyster	Luderick
	µg/Kg				
PFOS	<0.5	<0.5	<0.5	<0.5	<0.5
PFHxS	<1.0	<1.0	<1.0	<1.0	<1.0
PFOA	<1.0	<1.0	<1.0	<1.0	<1.0

The PFAS concentrations in biota were below detection limits and therefore, there is no requirement to issue advice on the amount of fish that can safely be eaten.

4. Conclusions

The following observations and conclusions can be drawn from this work:

- All PFAS concentrations were below the LOR in all biota samples.
- The mud crabs are at greatest risk of exposure to PFAS as they burrow into the sediment in subtidal areas and feed on molluscs, crustaceans and worms. The mud crabs sampled within the Cobaki Broadwater do not show any indication of bioaccumulation of PFOS with tissue concentrations lower than the mean sediment concentrations.
- Generally, the concentrations of PFAS detected in the samples for water and sediments were below the LOR.
- All water PFOS concentrations were below the 99% species protection marine guideline of 0.3 µg/L.
- All water PFOS concentrations were below the 95% species protection freshwater guideline of 0.13 µg/L.
- All sediment PFOS concentrations were below the Norwegian PNEC of 0.22 mg/kg for long-term chronic impacts.
- As the PFAS concentrations in biota were below detection limits, therefore, there is no requirement to issue advice on the amount of fish that can safely be eaten.
- Although not a focus of the works undertaken, as the PFAS concentrations in water and sediment were below the criteria used, it can be concluded that adverse harm to public health arising from PFAS exposure during recreational use of the Cobaki Broadwater is unlikely.
- Based on the surface water, sediment and biota results presented in this report, it can be concluded that the concentrations of PFAS within Cobaki Broadwater are unlikely to cause adverse harm to the environment or to public health.

Based primarily on the low sediment PFAS concentrations detected, further investigations into the ecological and human health impacts from exposure to PFASs within the Cobaki Broadwater arising from the GCA are not considered to be necessary.

5. References

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Appendices

Appendix A – NSW DPI-Fisheries Standard Operating Protocol for PFAS Sample Collection.

PFAS SAMPLE COLLECTION AND PROCESSING PROTOCOL

Version 22 November 2016

Project leaders

Name	Role	Phone	Email
Matt Taylor (NSW DPI)	Lead Investigator	0407 375 309	matt.taylor@dpi.nsw.gov.au
Emma Mitchell (NSW DPI)	Program Technical Coordinator	0427 722 707	emma.mitchell@dpi.nsw.gov.au

Other project details

Acc./Permit Number	Type	Notes
ACE14-11	Ethics approval	This ethics approval facilitates collection and handling of fish for this sampling program
P01/0059	Scientific research permit	This permit allows sampling for scientific research purposes by NSW DPI-F staff. Local Fisheries Officers must be notified at least 48 hrs before sampling commences. Marine Park Managers must also be informed prior to work in Port Stephens

Ensure all relevant SWMSs have been reviewed and signed.

DO NOT wear any Gortex products while undertaking sampling

Background

Collection of samples is required to establish the concentration of perfluoroalkyl substances (PFAS) in commercial, recreational and indigenous targeted species of fish and shellfish. The PFAS Interagency Advisory Group requires these samples to evaluate exposure to PFAS through seafood consumption and assess the associated risks to human health. Collection of these samples is a high priority, as several subsequent steps in the assessment process cannot occur without the data generated from the sampling program.

Sampling design and sample collection

The sampling design will be specified in a separate document specific to the particular estuary being targeted. The locations specified in this document are approximate areas only and some flexibility is afforded to accommodate gear or improve the likelihood of capturing target species. Effort on a particular day/night should be maximized, and multiple gear types used wherever possible. Unless there are other more efficient means, sampling should contract commercial fishers wherever possible. Table 1 lists common species targeted in the sampling program, and their associated sample codes.

Table 1. Common species targeted for sample collection within the PFAS program, and recommended sampling approach

Common Name	Species Name	Code	Gear
Sea Mullet	<i>Mugil cephalus</i>	MUGCEP	Mesh/haul
Fantail Mullet	<i>Liza argentea</i>	LIZARG	Mesh/haul
Yellowfin Bream	<i>Acanthopagrus australis</i>	ACAAUS	Mesh
Sand Whiting	<i>Sillago ciliata</i>	SILCIL	Mesh/haul
Dusky Flathead	<i>Platycephalus fuscus</i>	PLAFUS	Mesh/haul
Luderick	<i>Girella tricuspidata</i>	GIRTRI	Mesh
Silver Bidy	<i>Gerres subfasciatus</i>	GERSUB	Trawl/mesh
Mud Crab	<i>Scylla serrata</i>	SCYSER	Trap
Blue Crab	<i>Portunus pelagicus</i>	PORPEL	Trawl/Trap/Mesh
School Prawn	<i>Metapenaeus macleayi</i>	METMAC	Trawl/Haul
King Prawn	<i>Penaeus plebejus</i>	PENPLE	Trawl/Haul
Sydney Rock Oyster	<i>Saccostrea glomerata</i>	SACGLO	Hand
Mud Ark	<i>Anadara trapezia</i>	ANATRA	Hand

Four (4) composite samples are required from each location, with each composite comprised of tissue from ten (10) animals. This means that forty (40) individuals from each target species should be captured from each location. For prawns, each composite should contain **at least** 25 g of tissue (meaning that 4 x 20 = 100 g of prawn tissue from each prawn species is required from each location). All individuals should be of commercial size.

Post capture handling

Where gear has successfully captured a target organism, the fisher removes the organism from the gear and surrenders it directly to the NSW DPI staff member present on the vessel for euthanasia and packaging. A waypoint must be marked and recorded on the data sheets so that a GPS location can be traced back to each sample. Upon receiving animals, **target species are separated and placed in separate new, clean snaplock sample bags**. A waterproof sample label is stapled to the outside lip of the bag. Sampling labelling should follow the usual convention: *ReverseDateCode.EstuaryCode.Location.Rep#.SpCode Bag#* (e.g. 151021.HUR.2.1.ACAAUS Bag #2). The sample coding is explained as follows

ReverseDateCode: The date of sampling in the format *YYMMDD*. For example, the 12th October 2016 would be coded as 161012;

EstuaryCode: The code for the estuary being sampled as listed in Table 2;

Location: Corresponds to those in the estuary specific sampling plan (e.g. 1, 2, 3 etc)

Rep#: Increments for each **piece of gear** deployed at a location on a single day. For example, if target animals are captured in three traps and two mesh nets deployed at Location 4 in the Hunter River on a single day, this will mean that there should be replicates 1 through 5 for that fishing trip);

SpCode: The species code is noted as per Table 1 (e.g. ACAAUS);

Bag#: Where catches are large, multiple sample bags may be required for a single species captured in a single piece of gear, so a suffix must be added to the label and recorded on the data sheet. Note that **Bag # ONLY increments** when there are more animals of a **single species** captured in a **single gear deployment** (i.e. a single *Rep#*) than can fit into a **single bag**. For example; if 20 Luderick, 5 Sea Mullet and 2 Blue Crab are captured in the second mesh net (*Rep#* = 2) deployed at Location 3 in the Tweed River on the 12th

October 2016, you would end up with 4 bags: 1) the first 9 Luderick might fit in the first bag, so the tag would read 161012.TWR.3.2.**GIRTRI** Bag #1; 2) the next 11 Luderick might all fit in the second bag, so the tag would read 161012.TWR.3.2.**GIRTRI** Bag #2; 3) the 5 Sea Mullet will all fit in one bag, so the tag would read 161012.TWR.3.2.**MUGCEP** Bag #1; and 4) the 2 Blue Crab will all fit in one bag, so the tag would read 161012.TWR.3.2.**PORPEL** Bag #1. If all individuals for a single species captured in a single gear deployment can fit in 1 bag, the sample tag will read *Bag #1* (thus, most of you tags will read *Bag #1*).

This may seem complex, but it is necessary to be able to both track samples and to trace the compositions of the composites accurately back to a place and time where the animals were captured.

Once bags are sealed, organisms must be placed immediately on ice, and frozen/stored in a secure freezer until transport to the laboratory. Also, take a digital photograph of each bag so the contents and tag can be seen, and save into the project folder. Data is to be entered into the database **directly following** each trip, and datasheets scanned and archived.

Table 2. Estuary codes (including potential control or reference estuaries) used in sampling labelling regime

Estuary	Abbr.
Camden Haven River	CHR
Clarence River	CLR
Hawkesbury River	HKR
Hunter River	HUR
Lake Illawarra	LIL
Macleay River	MLR
Manning River	MNR
Myall Lakes	MYL
Port Stephens	PST
Richmond River	RMR
Shoalhaven River	SHR
Tweed River	TWR
Wallis Lake	WLL
Sydney Harbour	SHR
Hastings River	HTR
Georges River	GGR

Shipping, compositing and submission of samples

A refrigerated courier service will be used to ship samples direct from the storage facility to the laboratory. Samples are not to be shipped until all animals for a location/species combination (e.g. >40 fish) have been collected, as an entire sample set is required to be able to correctly composite the sample. On the day before sampling, samples are sorted into approved foam eskies with (generally) a single foam esky containing samples for one location/species combination (occasionally more than one esky must be used depending on the size of the organisms). Each box is sealed with tape, labelled with the shipping labels provided, and the shipment catalogued by the Program Technical Coordinator. These details are entered directly into the

database under Shipping Record, and then emailed directly to the Matt Taylor to pass on to the relevant laboratory manager.

At the laboratory, the relevant laboratory manager receives the sealed boxes and proceeds to composite samples, assigning a Laboratory Reference Number (LRN) to each composite as it is completed. Compositing involves sequentially assigning individuals from each **sample bag** within a **sample set** between the 4 composites from that location, recording the sample details, removing the scales from the fish, removing a single whole fillet from the fish (or removing the meat from a single whole claw from a crab, or peeling enough prawns to provide sufficient biomass for the composite), and placing the composited material into the labelled and barcoded sample receptacle (supplied by the lab). These details are entered onto the Chain-of-Custody form, and the LRN, composite code (*EstuaryCode.Location.SpeciesCode.CompositeNumber*; e.g. *TWR.4.MUGCEP.C3*), and sample details (i.e. the details of the individuals in each composite, including sample label, length and weight) entered into Lab_DATA section of the database. As part of this process fish are to have otoliths removed, and placed in a seed envelope labelled with the composite code and the individual number (e.g. *TWR.4.MUGCEP.C3 – 4* for the 4th individual in the composite sample). Animals should be sexed, gonads staged, and moult stage defined for crustaceans, and this entered into the database. The second fillet should be placed in a clean bag and re-frozen with a tag label stapled to the outside (e.g. *TWR.4.MUGCEP.C3 – 4* for the 4th individual in the composite sample), and stored for later analysis (if required).

The laboratory will then return the above data to the Program Technical Coordinator for inclusion in the central database. Fillet, otolith and homogenate samples are to be returned to the Program Technical Coordinator for storage at PSFI.

Appendix B – Animal ethics post-survey report

Post Survey Report for Medium and High Risk Fauna Surveys

Adverse Incident (Yes or No)	No
Project Details	GCA Biological Sampling
Project Number and Name	313424906 – GCA Biota
Date(s) of Survey	24/01/2017
Purpose of Survey	To collect 40 individuals of each target species for tissue sampling. Study is to determine risk to seafood consumers as a result of possible PFAS/PFOA contamination
Principle Researchers Name	Courtenay Mills
Associated Field Staff	N/A
Risk rating	Medium
Location of Survey (insert map with sample site locations)	
Cobaki Broadwater adjacent to Gold Coast Airport, NSW.	
Survey Method and Outcomes	
Standard Operating Procedures Employed (list them referring to section and name)	
3.3.7 Crab pots	
3.4.6 sled/dredge	
4.6.2 Euthanasia of Aquatic Animals	
40 individuals from each target species using Iki Jime method	
Number of Traps and/or Electrofishing Effort (make sure you advise as trapping efforts over the number of days or seconds for electrofishing effort)	
Electrofishing Effort: 10 crab pots, sled/dredge	
Frequency of Trap Check (e.g. once a day; every 2 hours specify what traps)	
twice per day	

Results

Weather Conditions over trapping period

Weather conditions at time of survey were generally fine. Wind from north-east

Species and number of species trapped

- Please provide individuals scientific and common names
- Include estimated average duration of species in traps

40 Fantail Mullet (*Liza argentea*)

40 Sea Mullet (*Mugil cephalus*)

40 Luderick / Black Bream (*Girella tricuspidata*)

40 Mud crabs (*Scylla serrata*)

Behavioural observations of level of stress of trapped fauna

(Important to explain the levels stress you observed and why they were)

Captured fish were euthanised immediately using Iki Jime method (video link in email)
Captured crabs were placed in an ice slurry as requested by DPI Fisheries and EPA. AQUI-S solution was not used as it is unknown if this poses a risk of false positive results in tests for PFOA/PFAS

Recommendations to improve Standard Operating Procedures (if applicable)

CERTIFICATE OF ANALYSIS

Work Order : **EB1701439**
Client : **GHD PTY LTD**
Contact : TARA STEELE
Address : PO BOX 5403
 NEWCASTLE WEST NSW, AUSTRALIA 2302
Telephone : +61 07 3316 3000
Project : 313424906
Order number : GCA
C-O-C number : ----
Sampler : TARA STEELE
Site : ----
Quote number : BN/455/16
No. of samples received : 13
No. of samples analysed : 13

Page : 1 of 11
Laboratory : Environmental Division Brisbane
Contact : Vanessa Turnbull
Address : 2 Byth Street Stafford QLD Australia 4053

Telephone : 61-7-3552 8660
Date Samples Received : 24-Jan-2017 17:05
Date Analysis Commenced : 31-Jan-2017
Issue Date : 03-Feb-2017 17:07



Accreditation No. 825
 Accredited for compliance with
 ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Alex Rossi	Organic Chemist	Sydney Organics, Smithfield, NSW
Edwandy Fadjjar	Organic Coordinator	Sydney Inorganics, Smithfield, NSW



General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	SCOB1	SCOB2	SCOB3	SCOB4	SCOB5
Client sampling date / time				24-Jan-2017 08:45	24-Jan-2017 09:35	24-Jan-2017 09:45	24-Jan-2017 10:00	24-Jan-2017 10:10	
Compound	CAS Number	LOR	Unit	EB1701439-007	EB1701439-008	EB1701439-009	EB1701439-010	EB1701439-011	
				Result	Result	Result	Result	Result	
EA055: Moisture Content									
Moisture Content (dried @ 103°C)	----	1	%	35.6	31.4	65.7	44.6	43.2	
EP231A: Perfluoroalkyl Sulfonic Acids									
Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	
Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	
Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	
Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	
Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.0002	mg/kg	<0.0002	<0.0002	0.0008	<0.0002	0.0002	
Perfluorodecane sulfonic acid (PFDS)	335-77-3	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	
EP231B: Perfluoroalkyl Carboxylic Acids									
Perfluorobutanoic acid (PFBA)	375-22-4	0.001	mg/kg	<0.001	<0.001	<0.001	<0.001	<0.001	
Perfluoropentanoic acid (PFPeA)	2706-90-3	0.0002	mg/kg	<0.0002	<0.0002	0.0002	<0.0002	<0.0002	
Perfluorohexanoic acid (PFHxA)	307-24-4	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	
Perfluoroheptanoic acid (PFHpA)	375-85-9	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	
Perfluorooctanoic acid (PFOA)	335-67-1	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	
Perfluorononanoic acid (PFNA)	375-95-1	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	
Perfluorodecanoic acid (PFDA)	335-76-2	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	
Perfluoroundecanoic acid (PFUnDA)	2058-94-8	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	
Perfluorododecanoic acid (PFDoDA)	307-55-1	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	
Perfluorotridecanoic acid (PFTrDA)	72629-94-8	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	
Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	
EP231C: Perfluoroalkyl Sulfonamides									
Perfluorooctane sulfonamide (FOSA)	754-91-6	0.0002	mg/kg	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	
N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	0.0005	mg/kg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	SCOB1	SCOB2	SCOB3	SCOB4	SCOB5
Client sampling date / time					24-Jan-2017 08:45	24-Jan-2017 09:35	24-Jan-2017 09:45	24-Jan-2017 10:00	24-Jan-2017 10:10
Compound	CAS Number	LOR	Unit		EB1701439-007	EB1701439-008	EB1701439-009	EB1701439-010	EB1701439-011
					Result	Result	Result	Result	Result
EP231C: Perfluoroalkyl Sulfonamides - Continued									
N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	0.0005	mg/kg		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	2448-09-7	0.0005	mg/kg		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	0.0005	mg/kg		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	0.0002	mg/kg		<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	0.0002	mg/kg		<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
EP231D: (n:2) Fluorotelomer Sulfonic Acids									
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.0005	mg/kg		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.0005	mg/kg		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.0005	mg/kg		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.0005	mg/kg		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
EP231P: PFAS Sums									
Sum of PFAS	----	0.0002	mg/kg		<0.0002	<0.0002	0.0010	<0.0002	0.0002
Sum of PFHxS and PFOS	355-46-4/1763-23-1	0.0002	mg/kg		<0.0002	<0.0002	0.0008	<0.0002	0.0002
Sum of PFAS (WA DER List)	----	0.0002	mg/kg		<0.0002	<0.0002	0.0010	<0.0002	0.0002
EP231S: PFAS Surrogate									
13C4-PFOS	----	0.0002	%		110	128	117	114	130



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)		Client sample ID			SCOB6	----	----	----	----
Client sampling date / time		24-Jan-2017 10:00			----	----	----	----	----
Compound	CAS Number	LOR	Unit	EB1701439-012	-----	-----	-----	-----	-----
				Result	----	----	----	----	----
EA055: Moisture Content									
Moisture Content (dried @ 103°C)	----	1	%	47.6	----	----	----	----	----
EP231A: Perfluoroalkyl Sulfonic Acids									
Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.0002	mg/kg	<0.0002	----	----	----	----	----
Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	0.0002	mg/kg	<0.0002	----	----	----	----	----
Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.0002	mg/kg	<0.0002	----	----	----	----	----
Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	0.0002	mg/kg	<0.0002	----	----	----	----	----
Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.0002	mg/kg	<0.0002	----	----	----	----	----
Perfluorodecane sulfonic acid (PFDS)	335-77-3	0.0002	mg/kg	<0.0002	----	----	----	----	----
EP231B: Perfluoroalkyl Carboxylic Acids									
Perfluorobutanoic acid (PFBA)	375-22-4	0.001	mg/kg	<0.001	----	----	----	----	----
Perfluoropentanoic acid (PFPeA)	2706-90-3	0.0002	mg/kg	<0.0002	----	----	----	----	----
Perfluorohexanoic acid (PFHxA)	307-24-4	0.0002	mg/kg	<0.0002	----	----	----	----	----
Perfluoroheptanoic acid (PFHpA)	375-85-9	0.0002	mg/kg	<0.0002	----	----	----	----	----
Perfluorooctanoic acid (PFOA)	335-67-1	0.0002	mg/kg	<0.0002	----	----	----	----	----
Perfluorononanoic acid (PFNA)	375-95-1	0.0002	mg/kg	<0.0002	----	----	----	----	----
Perfluorodecanoic acid (PFDA)	335-76-2	0.0002	mg/kg	<0.0002	----	----	----	----	----
Perfluoroundecanoic acid (PFUnDA)	2058-94-8	0.0002	mg/kg	<0.0002	----	----	----	----	----
Perfluorododecanoic acid (PFDoDA)	307-55-1	0.0002	mg/kg	<0.0002	----	----	----	----	----
Perfluorotridecanoic acid (PFTrDA)	72629-94-8	0.0002	mg/kg	<0.0002	----	----	----	----	----
Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.0005	mg/kg	<0.0005	----	----	----	----	----
EP231C: Perfluoroalkyl Sulfonamides									
Perfluorooctane sulfonamide (FOSA)	754-91-6	0.0002	mg/kg	<0.0002	----	----	----	----	----
N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	0.0005	mg/kg	<0.0005	----	----	----	----	----



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	SCOB6	----	----	----	----
Client sampling date / time				24-Jan-2017 10:00	----	----	----	----	
Compound	CAS Number	LOR	Unit	EB1701439-012	-----	-----	-----	-----	
				Result	----	----	----	----	
EP231C: Perfluoroalkyl Sulfonamides - Continued									
N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	0.0005	mg/kg	<0.0005	----	----	----	----	
N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	2448-09-7	0.0005	mg/kg	<0.0005	----	----	----	----	
N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	0.0005	mg/kg	<0.0005	----	----	----	----	
N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	0.0002	mg/kg	<0.0002	----	----	----	----	
N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	0.0002	mg/kg	<0.0002	----	----	----	----	
EP231D: (n:2) Fluorotelomer Sulfonic Acids									
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.0005	mg/kg	<0.0005	----	----	----	----	
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.0005	mg/kg	<0.0005	----	----	----	----	
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.0005	mg/kg	<0.0005	----	----	----	----	
10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.0005	mg/kg	<0.0005	----	----	----	----	
EP231P: PFAS Sums									
Sum of PFAS	----	0.0002	mg/kg	<0.0002	----	----	----	----	
Sum of PFHxS and PFOS	355-46-4/1763-23-1	0.0002	mg/kg	<0.0002	----	----	----	----	
Sum of PFAS (WA DER List)	----	0.0002	mg/kg	<0.0002	----	----	----	----	
EP231S: PFAS Surrogate									
13C4-PFOS	----	0.0002	%	112	----	----	----	----	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WCOB1	WCOB2	WCOB3	WCOB4	WCOB5
Client sampling date / time				24-Jan-2017 08:45	24-Jan-2017 09:35	24-Jan-2017 09:45	24-Jan-2017 10:00	24-Jan-2017 10:00	
Compound	CAS Number	LOR	Unit	EB1701439-001	EB1701439-002	EB1701439-003	EB1701439-004	EB1701439-005	
				Result	Result	Result	Result	Result	
EP231A: Perfluoroalkyl Sulfonic Acids									
Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.002	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	
Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	0.002	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	
Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.002	µg/L	<0.002	<0.002	0.002	0.002	<0.002	
Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	0.002	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	
Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.002	µg/L	0.008	0.006	0.006	0.009	0.008	
Perfluorodecane sulfonic acid (PFDS)	335-77-3	0.002	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	
EP231B: Perfluoroalkyl Carboxylic Acids									
Perfluorobutanoic acid (PFBA)	375-22-4	0.01	µg/L	<0.01	<0.01	<0.01	<0.01	<0.01	
Perfluoropentanoic acid (PFPeA)	2706-90-3	0.002	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	
Perfluorohexanoic acid (PFHxA)	307-24-4	0.002	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	
Perfluoroheptanoic acid (PFHpA)	375-85-9	0.002	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	
Perfluorooctanoic acid (PFOA)	335-67-1	0.002	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	
Perfluorononanoic acid (PFNA)	375-95-1	0.002	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	
Perfluorodecanoic acid (PFDA)	335-76-2	0.002	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	
Perfluoroundecanoic acid (PFUnDA)	2058-94-8	0.002	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	
Perfluorododecanoic acid (PFDoDA)	307-55-1	0.002	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	
Perfluorotridecanoic acid (PFTrDA)	72629-94-8	0.002	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	
Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.005	µg/L	<0.005	<0.005	<0.005	<0.005	<0.005	
EP231C: Perfluoroalkyl Sulfonamides									
Perfluorooctane sulfonamide (FOSA)	754-91-6	0.002	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	
N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	0.005	µg/L	<0.005	<0.005	<0.005	<0.005	<0.005	
N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	0.005	µg/L	<0.005	<0.005	<0.005	<0.005	<0.005	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WCOB1	WCOB2	WCOB3	WCOB4	WCOB5
Client sampling date / time					24-Jan-2017 08:45	24-Jan-2017 09:35	24-Jan-2017 09:45	24-Jan-2017 10:00	24-Jan-2017 10:00
Compound	CAS Number	LOR	Unit	EB1701439-001	EB1701439-002	EB1701439-003	EB1701439-004	EB1701439-005	
				Result	Result	Result	Result	Result	
EP231C: Perfluoroalkyl Sulfonamides - Continued									
N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	2448-09-7	0.005	µg/L	<0.005	<0.005	<0.005	<0.005	<0.005	
N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	0.005	µg/L	<0.005	<0.005	<0.005	<0.005	<0.005	
N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	0.002	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	
N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	0.002	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	
EP231D: (n:2) Fluorotelomer Sulfonic Acids									
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.005	µg/L	<0.005	<0.005	<0.005	<0.005	<0.005	
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.005	µg/L	<0.005	<0.005	<0.005	<0.005	<0.005	
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.005	µg/L	<0.005	<0.005	<0.005	<0.005	<0.005	
10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.005	µg/L	<0.005	<0.005	<0.005	<0.005	<0.005	
EP231P: PFAS Sums									
Sum of PFAS	----	0.002	µg/L	0.008	0.006	0.008	0.011	0.008	
Sum of PFHxS and PFOS	355-46-4/1763-23-1	0.002	µg/L	0.008	0.006	0.008	0.011	0.008	
Sum of PFAS (WA DER List)	----	0.002	µg/L	<0.002	<0.002	0.002	0.002	<0.002	
EP231S: PFAS Surrogate									
13C4-PFOS	----	0.002	%	95.2	85.1	92.8	90.5	96.1	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WCOB6	SCOB7	----	----	----
Client sampling date / time				24-Jan-2017 10:10	[24-Jan-2017]	----	----	----	
Compound	CAS Number	LOR	Unit	EB1701439-006	EB1701439-013	-----	-----	-----	
				Result	Result	----	----	----	
EP231A: Perfluoroalkyl Sulfonic Acids									
Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.002	µg/L	<0.002	<0.002	----	----	----	
Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	0.002	µg/L	<0.002	<0.002	----	----	----	
Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.002	µg/L	0.003	<0.002	----	----	----	
Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	0.002	µg/L	<0.002	<0.002	----	----	----	
Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.002	µg/L	0.005	0.003	----	----	----	
Perfluorodecane sulfonic acid (PFDS)	335-77-3	0.002	µg/L	<0.002	<0.002	----	----	----	
EP231B: Perfluoroalkyl Carboxylic Acids									
Perfluorobutanoic acid (PFBA)	375-22-4	0.01	µg/L	<0.01	<0.01	----	----	----	
Perfluoropentanoic acid (PFPeA)	2706-90-3	0.002	µg/L	<0.002	<0.002	----	----	----	
Perfluorohexanoic acid (PFHxA)	307-24-4	0.002	µg/L	<0.002	<0.002	----	----	----	
Perfluoroheptanoic acid (PFHpA)	375-85-9	0.002	µg/L	<0.002	<0.002	----	----	----	
Perfluorooctanoic acid (PFOA)	335-67-1	0.002	µg/L	<0.002	<0.002	----	----	----	
Perfluorononanoic acid (PFNA)	375-95-1	0.002	µg/L	<0.002	<0.002	----	----	----	
Perfluorodecanoic acid (PFDA)	335-76-2	0.002	µg/L	<0.002	<0.002	----	----	----	
Perfluoroundecanoic acid (PFUnDA)	2058-94-8	0.002	µg/L	<0.002	<0.002	----	----	----	
Perfluorododecanoic acid (PFDoDA)	307-55-1	0.002	µg/L	<0.002	<0.002	----	----	----	
Perfluorotridecanoic acid (PFTrDA)	72629-94-8	0.002	µg/L	<0.002	<0.002	----	----	----	
Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.005	µg/L	<0.005	<0.005	----	----	----	
EP231C: Perfluoroalkyl Sulfonamides									
Perfluorooctane sulfonamide (FOSA)	754-91-6	0.002	µg/L	<0.002	<0.002	----	----	----	
N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	0.005	µg/L	<0.005	<0.005	----	----	----	
N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	0.005	µg/L	<0.005	<0.005	----	----	----	



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	WCOB6	SCOB7	----	----	----
Client sampling date / time				24-Jan-2017 10:10	[24-Jan-2017]	----	----	----	
Compound	CAS Number	LOR	Unit	EB1701439-006	EB1701439-013	-----	-----	-----	
				Result	Result	----	----	----	
EP231C: Perfluoroalkyl Sulfonamides - Continued									
N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	2448-09-7	0.005	µg/L	<0.005	<0.005	----	----	----	
N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	0.005	µg/L	<0.005	<0.005	----	----	----	
N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	0.002	µg/L	<0.002	<0.002	----	----	----	
N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	0.002	µg/L	<0.002	<0.002	----	----	----	
EP231D: (n:2) Fluorotelomer Sulfonic Acids									
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.005	µg/L	<0.005	<0.005	----	----	----	
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.005	µg/L	<0.005	<0.005	----	----	----	
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.005	µg/L	<0.005	<0.005	----	----	----	
10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.005	µg/L	<0.005	<0.005	----	----	----	
EP231P: PFAS Sums									
Sum of PFAS	----	0.002	µg/L	0.008	0.003	----	----	----	
Sum of PFHxS and PFOS	355-46-4/1763-23-1	0.002	µg/L	0.008	0.003	----	----	----	
Sum of PFAS (WA DER List)	----	0.002	µg/L	0.003	<0.002	----	----	----	
EP231S: PFAS Surrogate									
13C4-PFOS	----	0.002	%	86.8	97.1	----	----	----	



Surrogate Control Limits

Sub-Matrix: SOIL		Recovery Limits (%)	
Compound	CAS Number	Low	High
EP231S: PFAS Surrogate			
13C4-PFOS	----	70	130

Sub-Matrix: WATER		Recovery Limits (%)	
Compound	CAS Number	Low	High
EP231S: PFAS Surrogate			
13C4-PFOS	----	70	120

Appendix C – Surface water and sediments quality certificate of analysis

CERTIFICATE OF ANALYSIS

Work Order : **EB1701809**
Client : **GHD PTY LTD**
Contact : TARA STEELE
Address : GPO BOX 668
 BRISBANE QLD, AUSTRALIA 4001
Telephone : +61 07 3316 3000
Project : 313424906
Order number : GCA
C-O-C number : ----
Sampler : TARA STEELE
Site : ----
Quote number : BN/455/16
No. of samples received : 5
No. of samples analysed : 5

Page : 1 of 6
Laboratory : Environmental Division Brisbane
Contact : Vanessa Turnbull
Address : 2 Byth Street Stafford QLD Australia 4053
Telephone : 61-7-3552 8660
Date Samples Received : 31-Jan-2017 11:50
Date Analysis Commenced : 01-Feb-2017
Issue Date : 07-Feb-2017 13:33



Accreditation No. 825
 Accredited for compliance with
 ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Lana Nguyen	Senior LCMS Chemist	Sydney Organics, Smithfield, NSW



General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- **SPLIT WORK ORDER:** It should be noted that ALS has split this work order over the following work orders EB1701809/EB1701814. For any further information regarding this processing of samples please contact ALS client services division on ALSEnviro.Brisbane@alsglobal.com



Analytical Results

Sub-Matrix: PORE WATER (Matrix: WATER)				Client sample ID	SCOB08	SCOB09	SCOB10	SCOB11	SCOB12
Client sampling date / time				26-Jan-2017 07:30	26-Jan-2017 07:35	26-Jan-2017 07:45	26-Jan-2017 07:50	26-Jan-2017 09:00	
Compound	CAS Number	LOR	Unit	EB1701809-001	EB1701809-002	EB1701809-003	EB1701809-004	EB1701809-005	
				Result	Result	Result	Result	Result	
EP231A: Perfluoroalkyl Sulfonic Acids									
Perfluorobutane sulfonic acid (PFBS)	375-73-5	0.002	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	
Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	0.002	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	
Perfluorohexane sulfonic acid (PFHxS)	355-46-4	0.002	µg/L	0.003	0.007	0.003	0.005	0.005	
Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	0.002	µg/L	<0.002	0.003	0.007	0.007	0.050	
Perfluorooctane sulfonic acid (PFOS)	1763-23-1	0.002	µg/L	<0.002	0.026	0.016	0.022	0.011	
Perfluorodecane sulfonic acid (PFDS)	335-77-3	0.002	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	
EP231B: Perfluoroalkyl Carboxylic Acids									
Perfluorobutanoic acid (PFBA)	375-22-4	0.01	µg/L	<0.01	<0.01	<0.01	<0.01	<0.01	
Perfluoropentanoic acid (PFPeA)	2706-90-3	0.002	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	
Perfluorohexanoic acid (PFHxA)	307-24-4	0.002	µg/L	<0.002	0.014	<0.002	0.002	<0.002	
Perfluoroheptanoic acid (PFHpA)	375-85-9	0.002	µg/L	<0.002	0.005	<0.002	<0.002	<0.002	
Perfluorooctanoic acid (PFOA)	335-67-1	0.002	µg/L	<0.002	0.015	0.003	0.003	0.003	
Perfluorononanoic acid (PFNA)	375-95-1	0.002	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	
Perfluorodecanoic acid (PFDA)	335-76-2	0.002	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	
Perfluoroundecanoic acid (PFUnDA)	2058-94-8	0.002	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	
Perfluorododecanoic acid (PFDoDA)	307-55-1	0.002	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	
Perfluorotridecanoic acid (PFTTrDA)	72629-94-8	0.002	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	
Perfluorotetradecanoic acid (PFTeDA)	376-06-7	0.005	µg/L	<0.005	<0.005	<0.005	<0.005	<0.005	
EP231C: Perfluoroalkyl Sulfonamides									
Perfluorooctane sulfonamide (FOSA)	754-91-6	0.002	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	
N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	0.005	µg/L	<0.005	<0.005	<0.005	<0.005	<0.005	
N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	0.005	µg/L	<0.005	<0.005	<0.005	<0.005	<0.005	



Analytical Results

Sub-Matrix: PORE WATER (Matrix: WATER)				Client sample ID	SCOB08	SCOB09	SCOB10	SCOB11	SCOB12
Client sampling date / time					26-Jan-2017 07:30	26-Jan-2017 07:35	26-Jan-2017 07:45	26-Jan-2017 07:50	26-Jan-2017 09:00
Compound	CAS Number	LOR	Unit	EB1701809-001	EB1701809-002	EB1701809-003	EB1701809-004	EB1701809-005	
				Result	Result	Result	Result	Result	
EP231C: Perfluoroalkyl Sulfonamides - Continued									
N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	2448-09-7	0.005	µg/L	<0.005	<0.005	<0.005	<0.005	<0.005	
N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	0.005	µg/L	<0.005	<0.005	<0.005	<0.005	<0.005	
N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	0.002	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	
N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	0.002	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	
EP231D: (n:2) Fluorotelomer Sulfonic Acids									
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	0.005	µg/L	<0.005	<0.005	<0.005	<0.005	<0.005	
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	0.005	µg/L	<0.005	<0.005	<0.005	<0.005	<0.005	
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	0.005	µg/L	<0.005	<0.005	<0.005	<0.005	<0.005	
10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	0.005	µg/L	<0.005	<0.005	<0.005	<0.005	<0.005	
EP231P: PFAS Sums									
Sum of PFAS	----	0.002	µg/L	0.003	0.070	0.029	0.039	0.069	
Sum of PFHxS and PFOS	355-46-4/1763-23-1	0.002	µg/L	0.003	0.033	0.019	0.027	0.016	
Sum of PFAS (WA DER List)	----	0.002	µg/L	0.003	0.041	0.006	0.010	0.008	
EP231S: PFAS Surrogate									
13C4-PFOS	----	0.002	%	90.0	85.0	88.0	85.0	82.0	



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	SCOB08	SCOB09	SCOB10	SCOB11	SCOB12
Client sampling date / time				26-Jan-2017 07:30	26-Jan-2017 07:35	26-Jan-2017 07:45	26-Jan-2017 07:50	26-Jan-2017 09:00	
Compound	CAS Number	LOR	Unit	EB1701809-001	EB1701809-002	EB1701809-003	EB1701809-004	EB1701809-005	
				Result	Result	Result	Result	Result	
EN82: Porewater Extraction									
Volume	----	1	mL	18	30	40	25	29	



Surrogate Control Limits

Sub-Matrix: PORE WATER		Recovery Limits (%)	
Compound	CAS Number	Low	High
EP231S: PFAS Surrogate			
13C4-PFOS	----	70	120

Appendix D – Biota Certificate of Analysis

CERTIFICATE OF ANALYSIS

Work Order : **EB1701814**
Client : **GHD PTY LTD**
Contact : TARA STEELE
Address : GPO BOX 668
 BRISBANE QLD, AUSTRALIA 4001
Telephone : +61 07 3316 3000
Project : 313424906 GCA
Order number : GCA
C-O-C number : ----
Sampler : TARA STEELE
Site : ----
Quote number : BN/455/16
No. of samples received : 20
No. of samples analysed : 20

Page : 1 of 10
Laboratory : Environmental Division Brisbane
Contact : Vanessa Turnbull
Address : 2 Byth Street Stafford QLD Australia 4053
Telephone : 61-7-3552 8660
Date Samples Received : 31-Jan-2017 11:50
Date Analysis Commenced : 03-Feb-2017
Issue Date : 10-Feb-2017 09:26



Accreditation No. 825
 Accredited for compliance with
 ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Gaston Allende	R&D Chemist	Sydney Organics, Smithfield, NSW



General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- **SPLIT WORK ORDER: It should be noted that ALS has split this work order over the following work orders (EB1701809). For any further information regarding this processing of samples please contact ALS client services division on ALSEnviro.Brisbane@alsglobal.com.**
- EP231X: ALS is not NATA accredited for the analysis of PFAS in biota when performed under ALS Method EP231X.



Analytical Results

Sub-Matrix: BIOTA (Matrix: BIOTA)				Client sample ID	TWR.1.MUGCEP	TWR.2.MUGCEP	TWR.3.MUGCEP	TWR.4.MUGCEP	TWR.1.LAZARG
Client sampling date / time				27-Jan-2017 14:00	27-Jan-2017 14:00	27-Jan-2017 14:00	27-Jan-2017 14:00	27-Jan-2017 14:15	
Compound	CAS Number	LOR	Unit	EB1701814-001	EB1701814-002	EB1701814-003	EB1701814-004	EB1701814-005	
				Result	Result	Result	Result	Result	
Biota Sample Pre-Preparation									
∅ Sample Description	----	-	--	fish	fish	fish	fish	fish	
∅ Weight of Sample Prepared	----	0.1	g	5.0	5.0	5.0	5.0	5.0	
EP231A: Perfluoroalkyl Sulfonic Acids									
∅ Perfluorobutane sulfonic acid (PFBS)	375-73-5	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluorohexane sulfonic acid (PFHxS)	355-46-4	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluorooctane sulfonic acid (PFOS) - Linear	2795-39-3	0.5	µg/kg	<0.5	<0.5	<0.5	<0.5	<0.5	
∅ Perfluorooctane sulfonic acid (PFOS) - Branched	----	0.5	µg/kg	<0.5	<0.5	<0.5	<0.5	<0.5	
∅ Perfluorooctane sulfonic acid (PFOS)	1763-23-1	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluorodecane sulfonic acid (PFDS)	335-77-3	1	µg/kg	<1	<1	<1	<1	<1	
EP231B: Perfluoroalkyl Carboxylic Acids									
∅ Perfluorobutanoic acid (PFBA)	375-22-4	5	µg/kg	<5	<5	<5	<5	<5	
∅ Perfluoropentanoic acid (PFPeA)	2706-90-3	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluorohexanoic acid (PFHxA)	307-24-4	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluoroheptanoic acid (PFHpA)	375-85-9	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluorooctanoic acid (PFOA)	335-67-1	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluorononanoic acid (PFNA)	375-95-1	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluorodecanoic acid (PFDA)	335-76-2	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluoroundecanoic acid (PFUnDA)	2058-94-8	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluorododecanoic acid (PFDoDA)	307-55-1	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluorotridecanoic acid (PFTrDA)	72629-94-8	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluorotetradecanoic acid (PFTeDA)	376-06-7	2	µg/kg	<2	<2	<2	<2	<2	



Analytical Results

Sub-Matrix: BIOTA (Matrix: BIOTA)				Client sample ID	TWR.1.MUGCEP	TWR.2.MUGCEP	TWR.3.MUGCEP	TWR.4.MUGCEP	TWR.1.LAZARG
Client sampling date / time				27-Jan-2017 14:00	27-Jan-2017 14:00	27-Jan-2017 14:00	27-Jan-2017 14:00	27-Jan-2017 14:15	
Compound	CAS Number	LOR	Unit	EB1701814-001	EB1701814-002	EB1701814-003	EB1701814-004	EB1701814-005	
				Result	Result	Result	Result	Result	
EP231C: Perfluoroalkyl Sulfonamides									
∅ Perfluorooctane sulfonamide (FOSA)	754-91-6	1	µg/kg	<1	<1	<1	<1	<1	
∅ N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	2	µg/kg	<2	<2	<2	<2	<2	
∅ N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	2	µg/kg	<2	<2	<2	<2	<2	
∅ N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	2448-09-7	2	µg/kg	<2	<2	<2	<2	<2	
∅ N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	2	µg/kg	<2	<2	<2	<2	<2	
∅ N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	1	µg/kg	<1	<1	<1	<1	<1	
∅ N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	1	µg/kg	<1	<1	<1	<1	<1	
EP231D: (n:2) Fluorotelomer Sulfonic Acids									
∅ 4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	2	µg/kg	<2	<2	<2	<2	<2	
∅ 6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	2	µg/kg	<2	<2	<2	<2	<2	
∅ 8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	2	µg/kg	<2	<2	<2	<2	<2	
∅ 10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	2	µg/kg	<2	<2	<2	<2	<2	



Analytical Results

Sub-Matrix: BIOTA (Matrix: BIOTA)				Client sample ID	TWR.2.LAZARG	TWR.3.LAZARG	TWR.4.LAZARG	TWR.1.GIRTRI	TWR.2.GIRTRI
Client sampling date / time				27-Jan-2017 14:15	27-Jan-2017 14:15	27-Jan-2017 14:15	27-Jan-2017 14:30	27-Jan-2017 14:30	
Compound	CAS Number	LOR	Unit	EB1701814-006	EB1701814-007	EB1701814-008	EB1701814-009	EB1701814-010	
				Result	Result	Result	Result	Result	
Biota Sample Pre-Preparation									
∅ Sample Description	----	-	--	fish	fish	fish	fish	fish	
∅ Weight of Sample Prepared	----	0.1	g	5.0	5.0	5.0	5.0	5.0	
EP231A: Perfluoroalkyl Sulfonic Acids									
∅ Perfluorobutane sulfonic acid (PFBS)	375-73-5	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluorohexane sulfonic acid (PFHxS)	355-46-4	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluorooctane sulfonic acid (PFOS) - Linear	2795-39-3	0.5	µg/kg	<0.5	<0.5	<0.5	<0.5	<0.5	
∅ Perfluorooctane sulfonic acid (PFOS) - Branched	----	0.5	µg/kg	<0.5	<0.5	<0.5	<0.5	<0.5	
∅ Perfluorooctane sulfonic acid (PFOS)	1763-23-1	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluorodecane sulfonic acid (PFDS)	335-77-3	1	µg/kg	<1	<1	<1	<1	<1	
EP231B: Perfluoroalkyl Carboxylic Acids									
∅ Perfluorobutanoic acid (PFBA)	375-22-4	5	µg/kg	<5	<5	<5	<5	<5	
∅ Perfluoropentanoic acid (PFPeA)	2706-90-3	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluorohexanoic acid (PFHxA)	307-24-4	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluoroheptanoic acid (PFHpA)	375-85-9	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluorooctanoic acid (PFOA)	335-67-1	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluorononanoic acid (PFNA)	375-95-1	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluorodecanoic acid (PFDA)	335-76-2	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluoroundecanoic acid (PFUnDA)	2058-94-8	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluorododecanoic acid (PFDoDA)	307-55-1	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluorotridecanoic acid (PFTrDA)	72629-94-8	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluorotetradecanoic acid (PFTeDA)	376-06-7	2	µg/kg	<2	<2	<2	<2	<2	



Analytical Results

Sub-Matrix: BIOTA (Matrix: BIOTA)				Client sample ID	TWR.2.LAZARG	TWR.3.LAZARG	TWR.4.LAZARG	TWR.1.GIRTRI	TWR.2.GIRTRI
Client sampling date / time					27-Jan-2017 14:15	27-Jan-2017 14:15	27-Jan-2017 14:15	27-Jan-2017 14:30	27-Jan-2017 14:30
Compound	CAS Number	LOR	Unit	EB1701814-006	EB1701814-007	EB1701814-008	EB1701814-009	EB1701814-010	
				Result	Result	Result	Result	Result	
EP231C: Perfluoroalkyl Sulfonamides									
∅ Perfluorooctane sulfonamide (FOSA)	754-91-6	1	µg/kg	<1	<1	<1	<1	<1	
∅ N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	2	µg/kg	<2	<2	<2	<2	<2	
∅ N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	2	µg/kg	<2	<2	<2	<2	<2	
∅ N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	2448-09-7	2	µg/kg	<2	<2	<2	<2	<2	
∅ N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	2	µg/kg	<2	<2	<2	<2	<2	
∅ N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	1	µg/kg	<1	<1	<1	<1	<1	
∅ N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	1	µg/kg	<1	<1	<1	<1	<1	
EP231D: (n:2) Fluorotelomer Sulfonic Acids									
∅ 4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	2	µg/kg	<2	<2	<2	<2	<2	
∅ 6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	2	µg/kg	<2	<2	<2	<2	<2	
∅ 8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	2	µg/kg	<2	<2	<2	<2	<2	
∅ 10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	2	µg/kg	<2	<2	<2	<2	<2	



Analytical Results

Sub-Matrix: BIOTA (Matrix: BIOTA)				Client sample ID	TWR.3.GIRTRI	TWR.4.GIRTRI	TWR.1.SCYSER	TWR.2.SCYSER	TWR.3.SCYSER
Client sampling date / time					27-Jan-2017 14:30	27-Jan-2017 14:30	30-Jan-2017 14:45	30-Jan-2017 14:45	30-Jan-2017 14:45
Compound	CAS Number	LOR	Unit	EB1701814-011	EB1701814-012	EB1701814-013	EB1701814-014	EB1701814-015	
				Result	Result	Result	Result	Result	
Biota Sample Pre-Preparation									
∅ Sample Description	----	-	--	fish	fish	fish	fish	fish	
∅ Weight of Sample Prepared	----	0.1	g	5.0	5.0	5.0	5.0	5.0	
EP231A: Perfluoroalkyl Sulfonic Acids									
∅ Perfluorobutane sulfonic acid (PFBS)	375-73-5	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluorohexane sulfonic acid (PFHxS)	355-46-4	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluorooctane sulfonic acid (PFOS) - Linear	2795-39-3	0.5	µg/kg	<0.5	<0.5	<0.5	<0.5	<0.5	
∅ Perfluorooctane sulfonic acid (PFOS) - Branched	----	0.5	µg/kg	<0.5	<0.5	<0.5	<0.5	<0.5	
∅ Perfluorooctane sulfonic acid (PFOS)	1763-23-1	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluorodecane sulfonic acid (PFDS)	335-77-3	1	µg/kg	<1	<1	<1	<1	<1	
EP231B: Perfluoroalkyl Carboxylic Acids									
∅ Perfluorobutanoic acid (PFBA)	375-22-4	5	µg/kg	<5	<5	<5	<5	<5	
∅ Perfluoropentanoic acid (PFPeA)	2706-90-3	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluorohexanoic acid (PFHxA)	307-24-4	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluoroheptanoic acid (PFHpA)	375-85-9	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluorooctanoic acid (PFOA)	335-67-1	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluorononanoic acid (PFNA)	375-95-1	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluorodecanoic acid (PFDA)	335-76-2	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluoroundecanoic acid (PFUnDA)	2058-94-8	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluorododecanoic acid (PFDoDA)	307-55-1	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluorotridecanoic acid (PFTrDA)	72629-94-8	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluorotetradecanoic acid (PFTeDA)	376-06-7	2	µg/kg	<2	<2	<2	<2	<2	



Analytical Results

Sub-Matrix: BIOTA (Matrix: BIOTA)				Client sample ID	TWR.3.GIRTRI	TWR.4.GIRTRI	TWR.1.SCYSER	TWR.2.SCYSER	TWR.3.SCYSER
Client sampling date / time					27-Jan-2017 14:30	27-Jan-2017 14:30	30-Jan-2017 14:45	30-Jan-2017 14:45	30-Jan-2017 14:45
Compound	CAS Number	LOR	Unit	EB1701814-011	EB1701814-012	EB1701814-013	EB1701814-014	EB1701814-015	
				Result	Result	Result	Result	Result	
EP231C: Perfluoroalkyl Sulfonamides									
∅ Perfluorooctane sulfonamide (FOSA)	754-91-6	1	µg/kg	<1	<1	<1	<1	<1	
∅ N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	2	µg/kg	<2	<2	<2	<2	<2	
∅ N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	2	µg/kg	<2	<2	<2	<2	<2	
∅ N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	2448-09-7	2	µg/kg	<2	<2	<2	<2	<2	
∅ N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	2	µg/kg	<2	<2	<2	<2	<2	
∅ N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	1	µg/kg	<1	<1	<1	<1	<1	
∅ N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	1	µg/kg	<1	<1	<1	<1	<1	
EP231D: (n:2) Fluorotelomer Sulfonic Acids									
∅ 4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	2	µg/kg	<2	<2	<2	<2	<2	
∅ 6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	2	µg/kg	<2	<2	<2	<2	<2	
∅ 8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	2	µg/kg	<2	<2	<2	<2	<2	
∅ 10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	2	µg/kg	<2	<2	<2	<2	<2	



Analytical Results

Sub-Matrix: BIOTA (Matrix: BIOTA)				Client sample ID	TWR.4.SCYSER	TWR.1.SACGLO	TWR.2.SACGLO	TWR.3.SACGLO	TWR.4.SACGLO
Client sampling date / time				30-Jan-2017 14:45	30-Jan-2017 15:00	30-Jan-2017 15:00	30-Jan-2017 15:00	30-Jan-2017 15:00	
Compound	CAS Number	LOR	Unit	EB1701814-016	EB1701814-017	EB1701814-018	EB1701814-019	EB1701814-020	
				Result	Result	Result	Result	Result	
Biota Sample Pre-Preparation									
∅ Sample Description	----	-	--	fish	fish	fish	fish	fish	
∅ Weight of Sample Prepared	----	0.1	g	5.0	5.0	5.0	5.0	5.0	
EP231A: Perfluoroalkyl Sulfonic Acids									
∅ Perfluorobutane sulfonic acid (PFBS)	375-73-5	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluoropentane sulfonic acid (PFPeS)	2706-91-4	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluorohexane sulfonic acid (PFHxS)	355-46-4	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluoroheptane sulfonic acid (PFHpS)	375-92-8	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluorooctane sulfonic acid (PFOS) - Linear	2795-39-3	0.5	µg/kg	<0.5	<0.5	<0.5	<0.5	<0.5	
∅ Perfluorooctane sulfonic acid (PFOS) - Branched	----	0.5	µg/kg	<0.5	<0.5	<0.5	<0.5	<0.5	
∅ Perfluorooctane sulfonic acid (PFOS)	1763-23-1	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluorodecane sulfonic acid (PFDS)	335-77-3	1	µg/kg	<1	<1	<1	<1	<1	
EP231B: Perfluoroalkyl Carboxylic Acids									
∅ Perfluorobutanoic acid (PFBA)	375-22-4	5	µg/kg	<5	<5	<5	<5	<5	
∅ Perfluoropentanoic acid (PFPeA)	2706-90-3	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluorohexanoic acid (PFHxA)	307-24-4	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluoroheptanoic acid (PFHpA)	375-85-9	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluorooctanoic acid (PFOA)	335-67-1	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluorononanoic acid (PFNA)	375-95-1	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluorodecanoic acid (PFDA)	335-76-2	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluoroundecanoic acid (PFUnDA)	2058-94-8	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluorododecanoic acid (PFDoDA)	307-55-1	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluorotridecanoic acid (PFTrDA)	72629-94-8	1	µg/kg	<1	<1	<1	<1	<1	
∅ Perfluorotetradecanoic acid (PFTeDA)	376-06-7	2	µg/kg	<2	<2	<2	<2	<2	



Analytical Results

Sub-Matrix: BIOTA (Matrix: BIOTA)				Client sample ID	TWR.4.SCYSER	TWR.1.SACGLO	TWR.2.SACGLO	TWR.3.SACGLO	TWR.4.SACGLO
Client sampling date / time				30-Jan-2017 14:45	30-Jan-2017 15:00	30-Jan-2017 15:00	30-Jan-2017 15:00	30-Jan-2017 15:00	
Compound	CAS Number	LOR	Unit	EB1701814-016	EB1701814-017	EB1701814-018	EB1701814-019	EB1701814-020	
				Result	Result	Result	Result	Result	
EP231C: Perfluoroalkyl Sulfonamides									
∅ Perfluorooctane sulfonamide (FOSA)	754-91-6	1	µg/kg	<1	<1	<1	<1	<1	
∅ N-Methyl perfluorooctane sulfonamide (MeFOSA)	31506-32-8	2	µg/kg	<2	<2	<2	<2	<2	
∅ N-Ethyl perfluorooctane sulfonamide (EtFOSA)	4151-50-2	2	µg/kg	<2	<2	<2	<2	<2	
∅ N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	2448-09-7	2	µg/kg	<2	<2	<2	<2	<2	
∅ N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	1691-99-2	2	µg/kg	<2	<2	<2	<2	<2	
∅ N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	2355-31-9	1	µg/kg	<1	<1	<1	<1	<1	
∅ N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	2991-50-6	1	µg/kg	<1	<1	<1	<1	<1	
EP231D: (n:2) Fluorotelomer Sulfonic Acids									
∅ 4:2 Fluorotelomer sulfonic acid (4:2 FTS)	757124-72-4	2	µg/kg	<2	<2	<2	<2	<2	
∅ 6:2 Fluorotelomer sulfonic acid (6:2 FTS)	27619-97-2	2	µg/kg	<2	<2	<2	<2	<2	
∅ 8:2 Fluorotelomer sulfonic acid (8:2 FTS)	39108-34-4	2	µg/kg	<2	<2	<2	<2	<2	
∅ 10:2 Fluorotelomer sulfonic acid (10:2 FTS)	120226-60-0	2	µg/kg	<2	<2	<2	<2	<2	

Appendix E – Fish and Crab lengths

Species	Attribute	Counts																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
MUGCEP		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	Length	32	41	35	30	30	21	38	32	28	25	25	21	40	35	32	33	28	38	36	28
	Sex	M	F	F	F	F	M	F	M	M	F	M	F	F	M	M	M	M	M	M	F
		21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
	Length	35	26	34	33	38	39	28	31	35	29	29	29	27	38	44	24	26	39	32	32
Sex	M	M	M	M	F	M	M	M	M	M	F	M	M	M	F	M	M	M	F	F	
LIZARG		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	Length	11	15	19	12	21	12	15	16	18	11	15	14	18	10	9	15	12	17	12	15
	Sex	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Length	14	13	18	10	10	15	12	18	19	17	16	13	12	11	10	18	17	15	12	18
	Sex	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GIRTRI		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	Length	30	35	40	28	21	35	36	35	34	38	32	37	39	36	31	38	35	40	39	35
	Sex	M	M	M	M	M	M	F	F	M	F	F	M	M	F	F	M	M	M	F	F
	Length	31	38	36	39	35	31	32	35	34	38	39	37	36	32	35	35	34	34	38	33
	Sex	F	M	M	M	F	M	M	M	M	M	M	M	M	M	F	M	F	M	F	F
SCYSER		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	Length	8.9	9.2	9.5	10	9.1	8.5	9	8.7	8.8	8.9	9	9.2	9	8.8	11.1	10.2	10	9.8	10.2	12
	Sex	M	M	M	M	F	M	M	F	F	F	M	M	M	M	F	M	F	F	M	F
	Length	8.8	8.9	9.1	9.2	8.5	8.6	8.9	9	98.9	9.2	9.8	8.5	8.7	9	8.9	9	8.5	8.5	8.7	9
	Sex	M	M	M	M	M	M	F	M	F	F	M	M	F	F	M	F	M	F	F	F

Appendix F – Summary Table with the general statistics for the concentrations of PFAS in Cobaki Broadwater

Statistic Parameters	PFHxS	PFOS	PFOA	Sum PFAS
Water summary	µg/L			
n	5	5	5	5
% Detects	40	100	0	100
Minimum	0.002	0.006	<0.002	0.006
Maximum	0.002	0.009	<0.002	0.011
Mean	0.002	0.007	<0.002	0.008
Std Dev	-	0.001	-	0.002
95% UCL	-	0.001		0.002
Sediment Summary	mg/kg			
n	5	5	5	5
% Detects	0	40	0	40
Minimum	<0.0002	<0.0002	<0.0002	<0.0002
Maximum	<0.0002	0.0008	<0.0002	0.001
Mean	<0.0002	0.0005	<0.0002	0.0006
Std Dev	-	0.0004	-	0.0004
95% UCL	-	0.0006	-	0.0005

GHD

180 Lonsdale Street
Melbourne VIC 3000
T: 03 8687 8000 F: 03 8687 8111 E: melmail@ghd.com

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