Dioxin Assessment

Noosa River Catchment

Commercial fishing and sediment

July 2021

Queensland Government

Prepared by: Science and Technology Division, Department of Environment and Science

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July 2021

Executive Summary

Dioxins are ubiquitous persistent organic pollutants (POPs) that are formed by combustion processes such as bushfires, as by-products of manufacturing (including the manufacture of pesticides). They are found in kaolinitic clays where they are thought to be produced by natural processes. Concerns have been raised by members of the Noosa community that historical usage of the pesticides 2,4,5-T and 2,4-D in the forestry industry have contaminated the Noosa Catchment with 2,3,7,8- tetrachlorodibenzo para dioxin (TCDD). TCDD is has demonstrated to be the most toxic of the dioxin family (Van den Berg et al. 2006).

In response to these concerns, the Queensland Government undertook a sediment, water and biota survey for dioxins in the Noosa catchment in 2020 (DES 2020). Following a recommendation from Queensland Health in the DES (2020) report, a follow up survey was undertaken in 2021 to conduct sampling of fish caught commercially in the area. Fish were collected by commercial fishers in Lake Weyba. Sediment was also resampled from the four lakes in the Noosa Catchment—Lake Cootharaba, Lake Cooroibah, Doonella Lake and Lake Weyba.

Queensland Health concluded that the consumption of fish from the Noosa area sampled by DES was unlikely to result in an unacceptable risk to public health. The concentrations of TCDD and total dioxins were highest in the species of ponyfish and lowest in the whiting.

TCDD was reported in sediment at Lake Weyba, with other dioxins being measured in sediment at every site. This is consistent with national studies where dioxins were measured in every sediment sample collected, and is also consistent with previous sediment samples collected in this area (DES 2020).

Contents

1 Introduction

Dioxins are ubiquitous persistent organic pollutants (POPs). The term 'dioxins' is often used as a shorthand to refer to the family of related compounds polychlorinated dibenzo para dioxins (PCDDs or dioxins) and polychlorinated dibenzofurans (PCDFs or furans). Dioxins are formed by a combustion process (e.g. bushfires, sugar cane burns and motor vehicle emissions) (Gatehouse 2004), as by-products of manufacturing (such as the production of pesticides) (Hoogenboom et al. 2020), and have been found to be present in kaolinitic clays where they are thought to be produced through natural processes (Schmitz et al. 2011; Hoogenboom et al. 2020). Dioxins have low solubility in water and bind strongly to particulate organic matter (Gatehouse 2004), are highly persistent in the environment and bioaccumulate in the lipids of animals. As part of the 2004 National Dioxin Program, dioxins were measured in every sediment and fish sample collected (Müller et al. 2004).

Concerns have been raised by members of the Noosa community that historical usage of pesticides that contain 2,4,5-T and/or 2,4-D in the forestry industry have contaminated the Noosa Catchment with 2,3,7,8-tetrachlorodibenzo para dioxin (TCDD). TCDD is a contaminant in the production of 2,4,5-T (Office of Chemical Safety 2005 and references therein), and is considered to be the most toxic of the dioxin family (Müller et al. 2004). Products containing 2,4,5-T were deregistered in Australia in the late 1980s. In response to the community concern, the Department of Environment and Science undertook a sediment, water and biota survey in the Noosa River area in 2020 in order to assess the dioxin levels in the Noosa Catchment (DES 2020). In 2021, a follow up survey was undertaken to assess levels of dioxins present in fish caught in the lakes by commercial fishers and reassess sediment dioxin levels. This report presents the findings of the fish and sediment sampling conducted in 2021.

2 Site Selection

Five sites downstream of forestry, or downstream of lakes where historic forestry is known to have occurred in the Noosa Catchment, were chosen for sediment sampling in 2021 (Figure 1). These sites are the same as those sampled in 2020. The two sites in the Cooloola National Park selected as control sites in the 2020 study were not re-sampled in 2021.

Figure 1: Sites in the Noosa River Catchment downstream of historical forestry.

3 Sampling Methodology

3.1 Fish

Fish were collected in March 2021. Mullet, sand whiting, mud herring and ponyfish were collected at Lake Weyba (Table 1). Queensland Health and the Department of Agriculture and Fisheries advised that fish move within the Noosa Catchment and so Lake Weyba is considered to be representative of the other lakes in the area. As dioxins are stable and accumulate in the food chain, edible portions of fish were prepared for analysis (1 fillet per fish with scales removed but skin retained) to assess human dietary risk. The aim was to collect approximately 100g per fillet where possible (Table 1). The samples were then composited for each species prior to sending to NMI for analysis.

Table 1: Fish species, location and composite numbers collected during the March 2021 survey

Species	Location	Composite numbers	Average fillet weight g (standard deviation)
Sea Mullet	Lake Weyba	Thirteen fillets	95.6 (4.8)
Sand whiting	Lake Weyba	Ten fillets	84.3 (10.2)
Mud herring	Lake Weyba	Five fillets	45.8 (10.7)
Ponyfish	Lake Weyba	Thirteen fillets	50.8 (13)

3.2 Sediment

Sediment sampling occurred in April 2021. Ten samples were collected at each site using a standardised coring device comprised of an aluminium tube (15cm length, 2.8cm diameter) attached to the corer. The ten samples were collected in a triangular formation and were approximately 25m apart. After collection the samples were combined to form a composite sample. At two sites the composite samples were split into three, with blind duplicates sent to the main analytical laboratory, Australian Laboratory Services (ALS), and a triplicate sample sent to a secondary laboratory, National Measurement Institute (NMI), as part of quality control measures (see Appendix A for a summary of quality control results). Both these laboratories are National Association of Testing Authorities (NATA) accredited for dioxin analysis in sediment. As well as dioxins, particle size distribution and total organic carbon analyses were undertaken on each sample through the Chemistry Centre, Department of Environment and Science.

4 Results

4.1 Fish

The concentrations of TCDD and total dioxins were normalised to lipid concentration (Table 2). The concentrations of TCDD and total dioxins were highest in the Ponyfish and lowest in the Whiting (Table 2). The full set of analysis results from fish sampling are presented in Appendix B.

Table 2: Concentration of TCDD and Total Dioxins in fish from Lake Weyba normalised to lipid concentration.

Species	Lipid (g/100g)	TCDD (pg/g lipid)	Total dioxins (pg/g lipid)
Sea Mullet	10	160	298
Sand whiting	0.5	15	118
Mud herring	1.7	41	315
Ponyfish	6.2	339	1211

Queensland Health assessed the risk of consumption of fish collected from Lake Weyba. The detailed assessment is presented in Appendix E. In summary they found that:

Consumption of fish from the Noosa area sampled by DES is unlikely to result in an unacceptable risk to public health. Some members of the community may consume relatively larger quantities of one species (ponyfish) over extended seasons and may approach the recommended TMI. Seasonal consumption patterns, lifetime patterns of activity, and locality changes mitigate against the possibility of exceeding the dioxin tolerable intake guideline value over a lifetime.

As the sample size is very small, and collected over a short time frame, the result may not be representative of all biota in the area that may be consumed. The extent of commercial fishing, and the distribution of catch in the market (local, national, export) is not known. This assessment is conservative to allow for the worst-case scenario – that the fish is distributed through a local market to a population consuming a specialized cuisine in which ponyfish is popular.

4.2 Sediment

TCDD was reported at one site - Lake Weyba (duplicate sample results were 4.3 and 3 pg/g dw) (Table 3). The results are very similar with the previous sampling round in February 2020, however TCDD was not reported at the Lake Cootharaba North site during the 2021 sampling round. Dioxins were reported in sediments in all lakes sampled in the Noosa Catchment. This is consistent with results from the National Dioxins Program, where dioxins were measured in every sediment sample collected (Müller et al. 2004). The full set of sediment analysis results from ALS and NMI are presented in Appendix C and Appendix D, respectively.

Table 3: Dioxin concentrations (pg/g dw) in sediments collected in the Noosa Catchment in April 2021

Dioxins	Lake Cootharaba Nth	Lake Cootharaba Nth Duplicate	Lake Cootharaba Sth	Lake Cooroibah	Doonella Lake	Lake Weyba	Lake Weyba Duplicate
2378-TCDD	<0.5	<0.5	<0.5	<0.5	<0.5	**4.3**	**3**
12378-PeCDD	<2.5	<2.5	**5.5**	<2.5	<2.5	**52.1**	**34.3**
123478-HxCDD	<2.5	<2.5	**5.4**	**3.3**	<2.5	**36.6**	**38.8**
123678-HxCDD	**5.3**	<2.5	**11.9**	**7.6**	**3.7**	**58.5**	**26.6**
123789-HxCDD	**11.6**	**5.5**	**25**	**16.6**	**7.6**	**125**	**89.9**
1234678-HpCDD	**235**	**106**	**346**	**244**	**113**	**923**	**670**
OCDD	**8570**	**4580**	**5740**	**4640**	**2780**	**11300**	**8490**

2378-TCDF	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
12378-PeCDF	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
23478-PeCDF	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
123478-HxCDF	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
123678-HxCDF	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
234678-HxCDF	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
123789-HxCDF	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
1234678-HpCDF	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
1234789-HpCDF	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
OCDF	<5.0	<5.0	<5.0	<4.9	<4.9	<4.9	<4.9

5 Conclusions

An assessment of risks of the dioxins present in the fish to consumers undertaken by Queensland Health indicated a low risk and recommend the public refer to “How much fish should I eat” (FSANZ 2020), as these guidelines would also be protective of exposure to dioxins. TCDD was reported in sediment at one of the five sites sampled (Lake Weyba). Dioxins were measured in sediment at all sites. These results were consistent with what was found in 2020.

References

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Appendix A – Quality Control Results

The majority of compounds within the samples passed the quality control acceptance criteria of a relative percentage difference of 50% (DES 2018). The variability in results was found in both the blind duplicates sent to a single laboratory and between different laboratories. This is likely to be due to matrix interferences associated with extraction.

Table A1: Quality Control results (blind laboratory duplicates and inter-laboratory results). Red highlighted cells indicated exceedance of acceptance criteria.

				Dioxins																
				1234678-HpCDD	1,2,3,4,6,7,8-HpCDF	1,2,3,4,7,8,9-HpCDF	123478-HxCDD	1,2,3,4,7,8-HxCDF	123678-HxCDD	1,2,3,6,7,8-HxCDF	123789-HxCDD	1,2,3,7,8,9-HxCDF	2378-TCDD	12378-PeCDD	1,2,3,7,8-PeCDF	2,3,4,6,7,8-HxCDF	2,3,4,7,8-PeCDF	2378-TCDF	OCDD	OCDF
Lab Name	**Field ID**	**Date**	**Sample Type**	**pg/g**	**pg/g**	**pg/g**	**pg/g**	**pg/g**	**pg/g**	**pg/g**	**pg/g**	**pg/g**	**pg/g**	**pg/g**	**pg/g**	**pg/g**	**pg/g**	**pg/g**	**pg/g**	**pg/g**
ALSE-Brisbane	**NSA - 0421**	**28/04/2021**	**Normal**	235	<2.5	<2.5	<2.5	<2.5	5.3	<2.5	11.6	<2.5	<0.5	<2.5	<2.5	<2.5	<2.5	<0.5	8,570	<5.0
	AES - 0421	**28/04/2021**	**Field D**	106	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	5.5	<2.5	<0.5	<2.5	<2.5	<2.5	<2.5	<0.5	4,580	<5.0
			RPD	76	0	0	0	0	72	0	71	0	0	0	0	0	0	0	61	0
ALSE-Brisbane	**NSA - 0421**	**28/04/2021**	**Normal**	235	<2.5	<2.5	<2.5	<2.5	5.3	<2.5	11.6	<2.5	<0.5	<2.5	<2.5	<2.5	<2.5	<0.5	8,570	<5.0
NMI	**NSA-0421**	**28/04/2021**	**Interlab D**	150	0.26	<0.04	1.6	<0.03	3.3	<0.04	8	<0.07	<0.2	0.63	<0.1	<0.05	<0.03	<0.1	5,430	0.41
			RPD	44	0	0	0	0	47	0	37	0	0	0	0	0	0	0	45	0
ALSE-Brisbane	**WEY - 0421**	**29/04/2021**	**Normal**	923	<2.5	<2.5	36.6	<2.5	58.5	<2.5	125	<2.5	4.3	52.1	<2.5	<2.5	<2.5	<0.5	11,300	<4.9
	BEB - 0421	**29/04/2021**	**Field D**	670	<2.5	<2.5	38.8	<2.5	26.6	<2.5	89.9	<2.5	3.0	34.3	<2.5	<2.5	<2.5	<0.5	8,490	<4.9
			RPD	32	0	0	6	0	75	0	33	0	36	41	0	0	0	0	28	0
ALSE-Brisbane	**WEY - 0421**	**29/04/2021**	**Normal**	923	<2.5	<2.5	36.6	<2.5	58.5	<2.5	125	<2.5	4.3	52.1	<2.5	<2.5	<2.5	<0.5	11,300	<4.9
NMI	**WEY-0421**	**29/04/2021**	**Interlab D**	760	0.45	<0.06	26	<0.05	43	<0.1	100	<0.06	3.4	24	<0.1	<0.1	<0.08	<0.2	10,300	<0.2
			RPD	19	0	0	34	0	31	0	22	0	23	74	0	0	0	0	9	0

Appendix B - Fish results from NMI

Australian Government
National Measurement Institute

CERTIFICATE OF ANALYSIS # DAU21_161

Client	Department of Environment and Science Chemistry Centre Level 3 East, Block A, Ecosciences Precinct 41 Boggo Rd, Dutton Park QLD 4102	**Job No.**	DEPT82/210414
		Sampled by	Client
		Date Sampled	21-Mar-21
		Date Received	14-Apr-21
Contact	Susi Vardy		

The results relate only to the sample(s) as received and tested.

Method AUTL_MET_001 **Date Reported** 19-May-21

Details

The method is for determination of tetra- through octa-chlorinated dibenzo-p-dioxins (PCDDs) & dibenzofurans (PCDFs) in biota samples by high resolution gas chromatography/high resolution mass spectrometry (HRGC/HRMS).
This method provides data on all toxic 2,3,7,8-PCDD (seven) and PCDF (ten) isomers.
PCDD and PCDF totals for each homologue group (tetra to octa) are also reported.
The dioxin toxicity equivalent (WHO_{05}-TEQ_{DF}) in each sample is calculated using World Health Organization toxic equivalency factors (WHO_{05}-TEFs). All results are corrected for labelled surrogate recoveries and are reported on a fresh weight basis.

The sample is spiked with a range of isotopically labelled surrogate standards and exhaustively extracted. Clean up is effected by partitioning with sulphuric acid then distilled water. Further purification is performed using column chromatography on acid and base modified silica gels, basic alumina and carbon dispersed on celite.

Immediately prior to injection, internal standards are added to each extract, and an aliquot of the extract is injected into the GC. The analytes are separated by the GC and detected by a high-resolution (>10,000) mass spectrometer.

Authorisation

Nino Piro
Senior Chemist
Australian Ultra Trace Laboratory

Dr Alan Yates
Senior Analyst
Australian Ultra Trace Laboratory

Accreditation

NATA Accreditation Number : 198

Accredited for compliance with ISO/IEC 17025 - Testing.

Measurement uncertainty is available upon request.

Sample Details : Job No. DEPT82/210414

Laboratory Reg. No.	Client Sample Ref.	Matrix	Description
N21/009458X	WEY_SILCIL	Biota	Composite of 10 fish
N21/009459X	WEY_LEIEQU	Biota	Composite of 13 fish
N21/009460X	WEY_THRHAM	Biota	Composite of 5 fish
N21/009461X	WEY_MUGCEP	Biota	Composite of 13 fish

Project Details

Project Name	*Not specified*
Project Number	*Not specified*

Key

Analytes

TCDD	Tetrachlorodibenzo-p-dioxin	TCDF	Tetrachlorodibenzofuran
PeCDD	Pentachlorodibenzo-p-dioxin	PeCDF	Pentachlorodibenzofuran
HxCDD	Hexachlorodibenzo-p-dioxin	HxCDF	Hexachlorodibenzofuran
HpCDD	Heptachlorodibenzo-p-dioxin	HpCDF	Heptachlorodibenzofuran
OCDD	Octachlorodibenzo-p-dioxin	OCDF	Octachlorodibenzofuran

Units & Abbreviations

pg/g	picograms per gram
<	level less than limit of detection (LOD)
WHO_{05}-TEF†	World Health Organization toxic equivalency factor
WHO_{05}-TEQ_{DF}†	World Health Organization toxic equivalents (Dioxins & Furans)

† as defined by Van den Berg et al., *Toxicol. Sci.* ***93*** *(2), pp. 223–241* (2006)

TEQs are calculated by multiplying the quantified level for each individual dioxin and furan congener reported by the corresponding TEF value and summing the result:

$$WHO_{05}\text{-}TEQ_{DF} = \sum_{i=1}^{7}\left[PCDD_i \times TEF_i\right] + \sum_{j=1}^{10}\left[PCDF_j \times TEF_j\right]$$

i = PCDD congener index (1 - 7)
j = PCDF congener index (1 - 10)

Lower Bound TEQ	defines all congener values reported below the LOD as equal to zero.
Middle Bound TEQ	defines all congener values reported below the LOD as equal to half the LOD.
Upper Bound TEQ	defines all congener values reported below the LOD as equal to the LOD.

Surrogate Recovery	percentage recovery for $^{13}C_{12}$ labelled surrogate standard
⚐	Laboratory surrogate recovery outside normal acceptance criteria: Solid and liquid matrices **25 - 125%**

Results : Job No. DEPT82/210414

Laboratory Reg. No. N21/009458X **Date Extracted** 3-May-21

Client Sample Ref. WEY_SILCIL **DB5 Analysis** 11-May-21
Matrix Biota
Description Composite of 10 fish

PCDD/F Congeners	Level pg/g	WHO_{05}-TEF	WHO_{05}-TEQ contribution	Labelled Surrogate recovery	
2,3,7,8-TCDF	<0.008	0.1	0.0004	64	
2,3,7,8-TCDD	0.023	1	0.023	65	
1,2,3,7,8-PeCDF	<0.004	0.03	0.00006	72	
2,3,4,7,8-PeCDF	<0.003	0.3	0.00045	74	
1,2,3,7,8-PeCDD	0.063	1	0.063	83	
1,2,3,4,7,8-HxCDF	<0.01	0.1	0.0005	67	
1,2,3,6,7,8-HxCDF	<0.01	0.1	0.0005	62	
2,3,4,6,7,8-HxCDF	<0.01	0.1	0.0005	60	
1,2,3,7,8,9-HxCDF	<0.01	0.1	0.0005	51	
1,2,3,4,7,8-HxCDD	0.013	0.1	0.0013	58	
1,2,3,6,7,8-HxCDD	0.031	0.1	0.0031	54	
1,2,3,7,8,9-HxCDD	<0.008	0.1	0.0004		
1,2,3,4,6,7,8-HpCDF	<0.003	0.01	0.000015	59	
1,2,3,4,7,8,9-HpCDF	<0.003	0.01	0.000015	64	
1,2,3,4,6,7,8-HpCDD	0.071	0.01	0.00071	62	
OCDF	<0.005	0.0003	0.00000075		
OCDD	0.17	0.0003	0.000051	54	

PCDD/F Homologue Groups	Level pg/g
Total TCDF isomers	<0.06
Total TCDD isomers	0.073
Total PeCDF isomers	<0.02
Total PeCDD isomers	0.14
Total HxCDF isomers	<0.06
Total HxCDD isomers	0.098
Total HpCDF isomers	<0.006
Total HpCDD isomers	0.11

Summary Results		
Sum of PCDD and PCDF congeners		
Excluding LOD values	0.59	pg/g
WHO_{05} -TEQ_{DF}		
Lower Bound [excluding LOD values]	**0.091**	pg/g
Middle Bound [including half LOD values]	**0.095**	pg/g
Upper Bound [including LOD values]	**0.098**	pg/g

Results : Job No. DEPT82/210414

Laboratory Reg. No. N21/009459X **Date Extracted** 3-May-21

Client Sample Ref. WEY_LEIEQU **DB5 Analysis** 11-May-21
Matrix Biota **DB-Dioxin Analysis** 12-May-21
Description Composite of 13 fish

PCDD/F Congeners	Level pg/g	WHO_{05}-TEF	WHO_{05}-TEQ contribution	Labelled Surrogate recovery	
2,3,7,8-TCDF	0.12	0.1	0.012	71	
2,3,7,8-TCDD	0.97	1	0.97	70	
1,2,3,7,8-PeCDF	0.035	0.03	0.0010	82	
2,3,4,7,8-PeCDF	0.049	0.3	0.015	91	
1,2,3,7,8-PeCDD	6.5	1	6.5	97	
1,2,3,4,7,8-HxCDF	<0.008	0.1	0.0004	79	
1,2,3,6,7,8-HxCDF	<0.02	0.1	0.001	75	
2,3,4,6,7,8-HxCDF	<0.01	0.1	0.0005	72	
1,2,3,7,8,9-HxCDF	<0.01	0.1	0.0005	57	
1,2,3,4,7,8-HxCDD	2.5	0.1	0.25	71	
1,2,3,6,7,8-HxCDD	4.9	0.1	0.49	66	
1,2,3,7,8,9-HxCDD	2.0	0.1	0.20		
1,2,3,4,6,7,8-HpCDF	<0.007	0.01	0.000035	68	
1,2,3,4,7,8,9-HpCDF	<0.008	0.01	0.00004	76	
1,2,3,4,6,7,8-HpCDD	5.8	0.01	0.058	77	
OCDF	<0.009	0.0003	0.0000014		
OCDD	6.2	0.0003	0.0019	63	

PCDD/F Homologue Groups	Level pg/g
Total TCDF isomers	0.44
Total TCDD isomers	21
Total PeCDF isomers	0.41
Total PeCDD isomers	15
Total HxCDF isomers	<0.8
Total HxCDD isomers	25
Total HpCDF isomers	<0.02
Total HpCDD isomers	7.9

Summary Results		
Sum of PCDD and PCDF congeners		
Excluding LOD values	76	pg/g
WHO_{05} -TEQ_{DF}		
Lower Bound [excluding LOD values]	**8.5**	pg/g
Middle Bound [including half LOD values]	**8.5**	pg/g
Upper Bound [including LOD values]	**8.5**	pg/g

Results : Job No. DEPT82/210414

Laboratory Reg. No. N21/009460X **Date Extracted** 3-May-21

Client Sample Ref. WEY_THRHAM **DB5 Analysis** 11-May-21
Matrix Biota
Description Composite of 5 fish

PCDD/F Congeners	Level pg/g	WHO_{05}-TEF	WHO_{05}-TEQ contribution	Labelled Surrogate recovery	
2,3,7,8-TCDF	0.026	0.1	0.0026	57	
2,3,7,8-TCDD	0.19	1	0.19	60	
1,2,3,7,8-PeCDF	<0.02	0.03	0.0003	69	
2,3,4,7,8-PeCDF	<0.006	0.3	0.0009	78	
1,2,3,7,8-PeCDD	0.66	1	0.66	81	
1,2,3,4,7,8-HxCDF	<0.03	0.1	0.0015	72	
1,2,3,6,7,8-HxCDF	<0.02	0.1	0.001	65	
2,3,4,6,7,8-HxCDF	<0.02	0.1	0.001	61	
1,2,3,7,8,9-HxCDF	<0.03	0.1	0.0015	45	
1,2,3,4,7,8-HxCDD	0.14	0.1	0.014	60	
1,2,3,6,7,8-HxCDD	1.3	0.1	0.13	51	
1,2,3,7,8,9-HxCDD	0.62	0.1	0.062		
1,2,3,4,6,7,8-HpCDF	<0.005	0.01	0.000025	58	
1,2,3,4,7,8,9-HpCDF	<0.005	0.01	0.000025	78	
1,2,3,4,6,7,8-HpCDD	0.83	0.01	0.0083	76	
OCDF	<0.009	0.0003	0.0000014		
OCDD	0.80	0.0003	0.00024	63	

PCDD/F Homologue Groups	Level pg/g
Total TCDF isomers	0.074
Total TCDD isomers	0.69
Total PeCDF isomers	<0.09
Total PeCDD isomers	0.78
Total HxCDF isomers	<0.2
Total HxCDD isomers	2.2
Total HpCDF isomers	<0.02
Total HpCDD isomers	0.88

Summary Results			
Sum of PCDD and PCDF congeners			
	Excluding LOD values	5.4	pg/g
WHO_{05} -TEQ_{DF}			
	Lower Bound [excluding LOD values]	**1.1**	pg/g
	Middle Bound [including half LOD values]	**1.1**	pg/g
	Upper Bound [including LOD values]	**1.1**	pg/g

Results : Job No. DEPT82/210414

Laboratory Reg. No. N21/009461X **Date Extracted** 3-May-21

Client Sample Ref. WEY_MUGCEP **DB5 Analysis** 11-May-21
Matrix Biota **DB-Dioxin Analysis** 12-May-21
Description Composite of 13 fish

PCDD/F Congeners	Level pg/g	WHO_{05}-TEF	WHO_{05}-TEQ contribution	Labelled Surrogate recovery	
2,3,7,8-TCDF	0.29	0.1	0.029	72	
2,3,7,8-TCDD	0.57	1	0.57	72	
1,2,3,7,8-PeCDF	0.017	0.03	0.00050	84	
2,3,4,7,8-PeCDF	0.036	0.3	0.011	101	
1,2,3,7,8-PeCDD	2.1	1	2.1	102	
1,2,3,4,7,8-HxCDF	<0.009	0.1	0.00045	83	
1,2,3,6,7,8-HxCDF	<0.02	0.1	0.001	75	
2,3,4,6,7,8-HxCDF	<0.01	0.1	0.0005	71	
1,2,3,7,8,9-HxCDF	<0.02	0.1	0.001	55	
1,2,3,4,7,8-HxCDD	0.43	0.1	0.043	72	
1,2,3,6,7,8-HxCDD	0.77	0.1	0.077	64	
1,2,3,7,8,9-HxCDD	0.43	0.1	0.043		
1,2,3,4,6,7,8-HpCDF	<0.01	0.01	0.00005	65	
1,2,3,4,7,8,9-HpCDF	<0.01	0.01	0.00005	81	
1,2,3,4,6,7,8-HpCDD	0.96	0.01	0.0096	78	
OCDF	<0.008	0.0003	0.0000012		
OCDD	1.4	0.0003	0.00042	63	

PCDD/F Homologue Groups	Level pg/g
Total TCDF isomers	0.92
Total TCDD isomers	16
Total PeCDF isomers	0.19
Total PeCDD isomers	6.1
Total HxCDF isomers	<0.4
Total HxCDD isomers	4.8
Total HpCDF isomers	<0.04
Total HpCDD isomers	1.5

Summary Results		
Sum of PCDD and PCDF congeners		
Excluding LOD values	31	pg/g
WHO_{05} -TEQ_{DF}		
Lower Bound [excluding LOD values]	**2.9**	pg/g
Middle Bound [including half LOD values]	**2.9**	pg/g
Upper Bound [including LOD values]	**2.9**	pg/g

Appendix C – Sediment results from ALS

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB2112092**	Page	: 1 of 7
Client	: **QLD DEPT OF ENVIRONMENT & SCIENCE**	Laboratory	: Environmental Division Brisbane
Contact	: MS SUSI VARDY	Contact	: David Buckley
Address	: GPO BOX 2771 BRISBANE QLD, AUSTRALIA 4001	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3170 5604	Telephone	: +61 7 3552 8659
Project	: NSA_DIO	Date Samples Received	: 04-May-2021 15:25
Order number	: ----	Date Analysis Commenced	: 12-May-2021
C-O-C number	: ----	Issue Date	: 14-May-2021 11:06
Sampler	: BRENDA BADDILEY		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 7		
No. of samples analysed	: 7		

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, unless the sampling was conducted by ALS. 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.

Signatories	*Position*	*Accreditation Category*
Peter Blow	HRMS Chemist	GCMSMS, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the 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 sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

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.

- Analysis will be conducted by ALS Environmental, Brisbane, NATA accreditation no. 825, Site No. 818 (Micro site no. 18958).
- EP300: T = tetra, Pe = penta, Hx = hexa, Hp = hepta, O = octa, CDD dioxin = chlorinated dibenzo-p-dioxin, CDF furan = chlorinated dibenzofuran
- EP300L: The absolute recovery of 13C12 isotopically labelled compounds added by the Laboratory to both quantitate and measure extraction efficiency.
- EP300: LORs for Totals are calculated by multiplying the number of peaks by the individual LOR per compound.
- EP300: Refer to supplementary reports for individual analyte TEQs, sample-specific limits of reporting (LOR) and Quality Control results.
- EP300: I-TEQ = International toxic equivalence
  WHO-TEQ = World Health Organisation toxic equivalence
  I-TEQ1 (zero) and WHO-TEQ1 (zero) calculated treating <LOR as zero concentration
  I-TEQ2 (0.5 LOR) and WHO-TEQ2 (0.5 LOR) calculated treating <LOR as half LOR concentration
  I-TEQ3 (LOR) and WHO-TEQ3 (LOR) calculated treating <LOR as LOR concentration
- EP300: Samples dried prior to analysis. Results reported on a dry weight basis.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	WEY - 0421	BEB - 0421	NSA - 0421	AES - 0421	TWN - 0421
			Sampling date / time	29-Apr-2021 10:30	29-Apr-2021 11:15	28-Apr-2021 12:30	28-Apr-2021 13:00	28-Apr-2021 10:00
Compound	CAS Number	LOR	Unit	EB2112092-001	EB2112092-002	EB2112092-003	EB2112092-004	EB2112092-005
				Result	Result	Result	Result	Result
EP300A: Dioxins and Furans								
2378-TCDD	1746-01-6	-	pg/g	**4.3**	**3.0**	<0.5	<0.5	<0.5
12378-PeCDD	40321-76-4	-	pg/g	**52.1**	**34.3**	<2.5	<2.5	<2.5
123478-HxCDD	39227-28-6	-	pg/g	**36.6**	**38.8**	<2.5	<2.5	<2.5
123678-HxCDD	57653-85-7	-	pg/g	**58.5**	**26.6**	**5.3**	<2.5	**3.7**
123789-HxCDD	19408-74-3	-	pg/g	**125**	**89.9**	**11.6**	**5.5**	**7.6**
1234678-HpCDD	35822-46-9	-	pg/g	**923**	**670**	**235**	**106**	**113**
OCDD	3268-87-9	-	pg/g	**11300**	**8490**	**8570**	**4580**	**2780**
2378-TCDF	51207-31-9	-	pg/g	<0.5	<0.5	<0.5	<0.5	<0.5
12378-PeCDF	57117-41-6	-	pg/g	<2.5	<2.5	<2.5	<2.5	<2.5
23478-PeCDF	57117-31-4	-	pg/g	<2.5	<2.5	<2.5	<2.5	<2.5
123478-HxCDF	70648-26-9	-	pg/g	<2.5	<2.5	<2.5	<2.5	<2.5
123678-HxCDF	57117-44-9	-	pg/g	<2.5	<2.5	<2.5	<2.5	<2.5
234678-HxCDF	60851-34-5	-	pg/g	<2.5	<2.5	<2.5	<2.5	<2.5
123789-HxCDF	72918-21-9	-	pg/g	<2.5	<2.5	<2.5	<2.5	<2.5
1234678-HpCDF	67562-39-4	-	pg/g	<2.5	<2.5	<2.5	<2.5	<2.5
1234789-HpCDF	55673-89-7	-	pg/g	<2.5	<2.5	<2.5	<2.5	<2.5
OCDF	39001-02-0	-	pg/g	<4.9	<4.9	<5.0	<5.0	<4.9
EP300B: Dioxins and Furans - Group Totals								
Tetra-Dioxins	----	-	pg/g	**402**	**346**	**50.2**	**18.2**	**33.4**
Penta-Dioxins	----	-	pg/g	**857**	**650**	**96.9**	**36.2**	**56.4**
Hexa-Dioxins	----	-	pg/g	**3050**	**2240**	**580**	**243**	**320**
Hepta-Dioxins	----	-	pg/g	**3260**	**2460**	**913**	**423**	**439**
Octa-Dioxin	----	-	pg/g	**11300**	**8490**	**8570**	**4580**	**2780**
Tetra-Furans	----	-	pg/g	**9.6**	**7.4**	**4.1**	<5.5	<0.5
Penta-Furans	----	-	pg/g	<2.5	<2.5	<2.5	<2.5	<2.5
Hexa-Furans	----	-	pg/g	<22.2	<19.7	<2.5	<2.5	<2.5
Hepta-Furans	----	-	pg/g	<7.4	<7.4	<5.0	<7.5	<7.4
Octa-Furan	----	-	pg/g	<4.9	<4.9	<5.0	<5.0	<4.9
EP300C: Dioxins and Furans - Total Toxic Equivalency (TEQ)								
Total WHO-TEQ1 (zero)	----	-	pg/g	**91.03**	**62.08**	**6.61**	**2.98**	**3.09**
Total WHO-TEQ2 (0.5 LOR)	----	-	pg/g	**91.98**	**63.03**	**9.20**	**5.68**	**5.65**
Total WHO-TEQ3 (LOR)	----	-	pg/g	**92.93**	**63.98**	**11.79**	**8.38**	**8.21**
Total I-TEQ1 (zero)	----	-	pg/g	**72.89**	**50.87**	**12.61**	**6.19**	**5.04**
Total I-TEQ2 (0.5 LOR)	----	-	pg/g	**74.11**	**52.09**	**14.85**	**8.54**	**7.25**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	WEY - 0421	BEB - 0421	NSA - 0421	AES - 0421	TWN - 0421
			Sampling date / time	29-Apr-2021 10:30	29-Apr-2021 11:15	28-Apr-2021 12:30	28-Apr-2021 13:00	28-Apr-2021 10:00
Compound	CAS Number	LOR	Unit	EB2112092-001	EB2112092-002	EB2112092-003	EB2112092-004	EB2112092-005
				Result	Result	Result	Result	Result
EP300C: Dioxins and Furans - Total Toxic Equivalency (TEQ) - Continued								
Total I-TEQ3 (LOR)	----	-	pg/g	**75.34**	**53.32**	**17.09**	**10.89**	**9.47**
EP300L: Dioxins and Furans - Isotopically Labelled Standards								
2378-TCDD (13C12)	76523-40-5	0.25	%	**56.9**	**56.5**	**45.7**	**65.5**	**70.7**
12378-PeCDD (13C12)	109719-79-1	0.25	%	**99.9**	**86.4**	**53.9**	**98.3**	**107**
123478-HxCDD (13C12)	109719-80-4	0.25	%	**75.8**	**87.5**	**55.6**	**75.0**	**76.5**
123678-HxCDD (13C12)	109719-81-5	0.25	%	**75.1**	**73.2**	**58.6**	**76.2**	**79.6**
1234678-HpCDD (13C12)	109719-83-7	0.25	%	**94.9**	**87.3**	**60.3**	**87.6**	**93.7**
OCDD (13C12)	114423-97-1	0.25	%	**70.3**	**69.0**	**49.4**	**72.6**	**72.9**
2378-TCDF (13C12)	89059-46-1	0.25	%	**48.5**	**41.8**	**34.5**	**45.4**	**61.3**
12378-PeCDF (13C12)	109719-77-9	0.25	%	**99.1**	**78.4**	**51.3**	**91.3**	**105**
23478-PeCDF (13C12)	116843-02-8	0.25	%	**94.6**	**74.8**	**48.6**	**87.4**	**100**
123478-HxCDF (13C12)	114423-98-2	0.25	%	**72.4**	**75.9**	**53.1**	**70.0**	**75.0**
123678-HxCDF (13C12)	116843-03-9	0.25	%	**74.1**	**78.0**	**56.5**	**74.0**	**78.7**
234678-HxCDF (13C12)	116843-05-1	0.25	%	**77.9**	**81.4**	**56.8**	**79.3**	**81.9**
123789-HxCDF (13C12)	116843-04-0	0.25	%	**72.6**	**75.6**	**53.0**	**75.2**	**71.1**
1234678-HpCDF (13C12)	109719-84-8	0.25	%	**80.5**	**73.7**	**50.6**	**74.3**	**80.2**
1234789-HpCDF (13C12)	109719-94-0	0.25	%	**85.3**	**80.0**	**55.7**	**83.3**	**82.0**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	CRB - 0421	CTH - 0421	----	----	----
			Sampling date / time	28-Apr-2021 11:10	28-Apr-2021 14:15	----	----	----
Compound	CAS Number	LOR	Unit	EB2112092-006	EB2112092-007	--------	--------	--------
				Result	Result	----	----	----
EP300A: Dioxins and Furans								
2378-TCDD	1746-01-6	-	pg/g	<0.5	<0.5	----	----	----
12378-PeCDD	40321-76-4	-	pg/g	<2.5	5.5	----	----	----
123478-HxCDD	39227-28-6	-	pg/g	3.3	5.4	----	----	----
123678-HxCDD	57653-85-7	-	pg/g	7.6	11.9	----	----	----
123789-HxCDD	19408-74-3	-	pg/g	16.6	25.0	----	----	----
1234678-HpCDD	35822-46-9	-	pg/g	244	346	----	----	----
OCDD	3268-87-9	-	pg/g	4640	5740	----	----	----
2378-TCDF	51207-31-9	-	pg/g	<0.5	<0.5	----	----	----
12378-PeCDF	57117-41-6	-	pg/g	<2.5	<2.5	----	----	----
23478-PeCDF	57117-31-4	-	pg/g	<2.5	<2.5	----	----	----
123478-HxCDF	70648-26-9	-	pg/g	<2.5	<2.5	----	----	----
123678-HxCDF	57117-44-9	-	pg/g	<2.5	<2.5	----	----	----
234678-HxCDF	60851-34-5	-	pg/g	<2.5	<2.5	----	----	----
123789-HxCDF	72918-21-9	-	pg/g	<2.5	<2.5	----	----	----
1234678-HpCDF	67562-39-4	-	pg/g	<2.5	<2.5	----	----	----
1234789-HpCDF	55673-89-7	-	pg/g	<2.5	<2.5	----	----	----
OCDF	39001-02-0	-	pg/g	<4.9	<5.0	----	----	----
EP300B: Dioxins and Furans - Group Totals								
Tetra-Dioxins	----	-	pg/g	137	142	----	----	----
Penta-Dioxins	----	-	pg/g	169	242	----	----	----
Hexa-Dioxins	----	-	pg/g	816	1260	----	----	----
Hepta-Dioxins	----	-	pg/g	1050	1500	----	----	----
Octa-Dioxin	----	-	pg/g	4640	5740	----	----	----
Tetra-Furans	----	-	pg/g	<0.5	<8.9	----	----	----
Penta-Furans	----	-	pg/g	<2.5	<2.5	----	----	----
Hexa-Furans	----	-	pg/g	<2.5	<24.9	----	----	----
Hepta-Furans	----	-	pg/g	<7.4	<7.5	----	----	----
Octa-Furan	----	-	pg/g	<4.9	<5.0	----	----	----
EP300C: Dioxins and Furans - Total Toxic Equivalency (TEQ)								
Total WHO-TEQ1 (zero)	----	-	pg/g	6.58	14.91	----	----	----
Total WHO-TEQ2 (0.5 LOR)	----	-	pg/g	9.02	16.12	----	----	----
Total WHO-TEQ3 (LOR)	----	-	pg/g	11.45	17.32	----	----	----
Total I-TEQ1 (zero)	----	-	pg/g	9.83	16.18	----	----	----
Total I-TEQ2 (0.5 LOR)	----	-	pg/g	11.92	17.66	----	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	CRB - 0421	CTH - 0421	----	----	----
			Sampling date / time	28-Apr-2021 11:10	28-Apr-2021 14:15	----	----	----
Compound	CAS Number	LOR	Unit	EB2112092-006	EB2112092-007	--------	--------	--------
				Result	Result	----	----	----
EP300C: Dioxins and Furans - Total Toxic Equivalency (TEQ) - Continued								
Total I-TEQ3 (LOR)	----	-	pg/g	**14.01**	**19.14**	**----**	**----**	**----**
EP300L: Dioxins and Furans - Isotopically Labelled Standards								
2378-TCDD (13C12)	76523-40-5	0.25	%	**60.4**	**71.8**	**----**	**----**	**----**
12378-PeCDD (13C12)	109719-79-1	0.25	%	**95.6**	**93.2**	**----**	**----**	**----**
123478-HxCDD (13C12)	109719-80-4	0.25	%	**74.0**	**73.9**	**----**	**----**	**----**
123678-HxCDD (13C12)	109719-81-5	0.25	%	**79.7**	**73.3**	**----**	**----**	**----**
1234678-HpCDD (13C12)	109719-83-7	0.25	%	**80.7**	**80.5**	**----**	**----**	**----**
OCDD (13C12)	114423-97-1	0.25	%	**73.2**	**67.0**	**----**	**----**	**----**
2378-TCDF (13C12)	89059-46-1	0.25	%	**49.0**	**66.6**	**----**	**----**	**----**
12378-PeCDF (13C12)	109719-77-9	0.25	%	**95.3**	**82.9**	**----**	**----**	**----**
23478-PeCDF (13C12)	116843-02-8	0.25	%	**87.3**	**83.5**	**----**	**----**	**----**
123478-HxCDF (13C12)	114423-98-2	0.25	%	**71.7**	**68.0**	**----**	**----**	**----**
123678-HxCDF (13C12)	116843-03-9	0.25	%	**75.5**	**72.0**	**----**	**----**	**----**
234678-HxCDF (13C12)	116843-05-1	0.25	%	**78.8**	**75.2**	**----**	**----**	**----**
123789-HxCDF (13C12)	116843-04-0	0.25	%	**71.5**	**69.5**	**----**	**----**	**----**
1234678-HpCDF (13C12)	109719-84-8	0.25	%	**74.8**	**69.3**	**----**	**----**	**----**
1234789-HpCDF (13C12)	109719-94-0	0.25	%	**75.2**	**75.3**	**----**	**----**	**----**

Surrogate Control Limits

Sub-Matrix: **SOIL**

Compound	CAS Number	Recovery Limits (%) Low	High
EP300L: Dioxins and Furans - Isotopically Labelled Standards			
2378-TCDD (13C12)	76523-40-5	25	164
12378-PeCDD (13C12)	109719-79-1	25	181
123478-HxCDD (13C12)	109719-80-4	32	141
123678-HxCDD (13C12)	109719-81-5	28	130
1234678-HpCDD (13C12)	109719-83-7	23	140
OCDD (13C12)	114423-97-1	17	157
2378-TCDF (13C12)	89059-46-1	24	169
12378-PeCDF (13C12)	109719-77-9	24	185
23478-PeCDF (13C12)	116843-02-8	21	178
123478-HxCDF (13C12)	114423-98-2	26	152
123678-HxCDF (13C12)	116843-03-9	26	123
234678-HxCDF (13C12)	116843-05-1	28	136
123789-HxCDF (13C12)	116843-04-0	29	147
1234678-HpCDF (13C12)	109719-84-8	28	143
1234789-HpCDF (13C12)	109719-94-0	26	138

Appendix D – Sediment Results from NMI

Australian Government
National Measurement Institute

CERTIFICATE OF ANALYSIS # DAU21_170

Client	Department of Environment and Science Chemistry Centre Level 3 East, Block A, Ecosciences Precinct 41 Boggo Rd, Dutton Park QLD 4102	**Job No.**	DEPT82/210505
		Sampled by	Client
		Date Sampled	28/29-May-21
		Date Received	5-May-21
Contact	Susi Vardy		

The results relate only to the sample(s) as received and tested.

Method AUTL_MET_001 **Date Reported** 28-May-21

Details

The method is for determination of tetra- through octa-chlorinated dibenzo-p-dioxins (PCDDs) & dibenzofurans (PCDFs) in solid samples by high resolution gas chromatography/high resolution mass spectrometry (HRGC/HRMS).
This method provides data on all toxic 2,3,7,8-PCDD (seven) and PCDF (ten) isomers. PCDD and PCDF totals for each homologue group (tetra to octa) are also reported.
The dioxin toxicity equivalent (WHO_{05}-TEQ_{DF}) in each sample is calculated using World Health Organization toxic equivalency factors (WHO_{05}-TEFs). All results are corrected for labelled surrogate recoveries and are reported on a dry weight basis.

After sampling, the solid is spiked with a range of isotopically labelled surrogate standards and exhaustively extracted. Clean up is effected by partitioning with sulphuric acid then distilled water. Further purification is performed using column chromatography on acid and base modified silica gels, basic alumina and carbon dispersed on celite.

Immediately prior to injection, internal standards are added to each extract, and an aliquot of the extract is injected into the GC. The analytes are separated by the GC and detected by a high-resolution (>10,000) mass spectrometer.

Authorisation

Robert Crough
Chemist
Australian Ultra Trace Laboratory

Dr Alan Yates
Senior Analyst
Australian Ultra Trace Laboratory

Accreditation

NATA Accreditation Number : 198

Accredited for compliance with ISO/IEC 17025 - Testing.

This report shall not be reproduced, except in full.
Measurement uncertainty is available upon request.

Sample Details : Job No. DEPT82/210505

Laboratory Reg. No.	Client Sample Ref.	Matrix	Description
N21/011308X	WEY-0421	Solid	Sediment 29/04/21 1030
N21/011309X	NSA-0421	Solid	Sediment 28/04/21 1230

Project Details

Project Name	*Not specified*
Project Number	*Not specified*

Key

Analytes

TCDD	Tetrachlorodibenzo-p-dioxin	TCDF	Tetrachlorodibenzofuran
PeCDD	Pentachlorodibenzo-p-dioxin	PeCDF	Pentachlorodibenzofuran
HxCDD	Hexachlorodibenzo-p-dioxin	HxCDF	Hexachlorodibenzofuran
HpCDD	Heptachlorodibenzo-p-dioxin	HpCDF	Heptachlorodibenzofuran
OCDD	Octachlorodibenzo-p-dioxin	OCDF	Octachlorodibenzofuran

Units & Abbreviations

pg/g	picograms per gram
<	level less than limit of detection (LOD)
WHO_{05}-TEF†	World Health Organization toxic equivalency factor
WHO_{05}-TEQ_{DF}†	World Health Organization toxic equivalents (Dioxins & Furans)

† as defined by Van den Berg et al., *Toxicol. Sci.* ***93*** *(2), pp. 223–241* (2006)

TEQs are calculated by multiplying the quantified level for each individual dioxin and furan congener reported by the corresponding TEF value and summing the result:

$$WHO_{05}\text{-}TEQ_{DF} = \sum_{i=1}^{7}\left[PCDD_i \times TEF_i\right] + \sum_{j=1}^{10}\left[PCDF_j \times TEF_j\right]$$

i = PCDD congener index (1 - 7)
j = PCDF congener index (1 - 10)

Lower Bound TEQ	defines all congener values reported below the LOD as equal to zero.
Middle Bound TEQ	defines all congener values reported below the LOD as equal to half the LOD.
Upper Bound TEQ	defines all congener values reported below the LOD as equal to the LOD.

Surrogate Recovery	percentage recovery for $^{13}C_{12}$ labelled surrogate standard
⚑	Laboratory surrogate recovery outside normal acceptance criteria: Solid and liquid matrices **25 - 125%**

Results : Job No. DEPT82/210505

Laboratory Reg. No. N21/011308X **Date Extracted** 20-May-21

Client Sample Ref. WEY-0421 **DB5 Analysis** 27-May-21
Matrix Solid
Description Sediment 29/04/21 1030

PCDD/F Congeners	Level pg/g	WHO_{05}-TEF	WHO_{05}-TEQ contribution	Labelled Surrogate recovery	
2,3,7,8-TCDF	<0.2	0.1	0.01	54	
2,3,7,8-TCDD	3.4	1	3.4	57	
1,2,3,7,8-PeCDF	<0.1	0.03	0.0015	56	
2,3,4,7,8-PeCDF	<0.08	0.3	0.012	60	
1,2,3,7,8-PeCDD	24	1	24	62	
1,2,3,4,7,8-HxCDF	<0.05	0.1	0.0025	59	
1,2,3,6,7,8-HxCDF	<0.1	0.1	0.005	52	
2,3,4,6,7,8-HxCDF	<0.1	0.1	0.005	52	
1,2,3,7,8,9-HxCDF	<0.06	0.1	0.003	49	
1,2,3,4,7,8-HxCDD	26	0.1	2.6	56	
1,2,3,6,7,8-HxCDD	43	0.1	4.3	51	
1,2,3,7,8,9-HxCDD	100	0.1	10		
1,2,3,4,6,7,8-HpCDF	0.45	0.01	0.0045	45	
1,2,3,4,7,8,9-HpCDF	<0.06	0.01	0.0003	55	
1,2,3,4,6,7,8-HpCDD	760	0.01	7.6	51	
OCDF	<0.2	0.0003	0.00003		
OCDD	10300	0.0003	3.1	46	

PCDD/F Homologue Groups	Level pg/g
Total TCDF isomers	4.7
Total TCDD isomers	360
Total PeCDF isomers	0.43
Total PeCDD isomers	930
Total HxCDF isomers	1.4
Total HxCDD isomers	2630
Total HpCDF isomers	2.0
Total HpCDD isomers	3250

Summary Results			
Sum of PCDD and PCDF congeners			
	Excluding LOD values	17500	pg/g
WHO_{05} -TEQ_{DF}			
	Lower Bound [excluding LOD values]	**55**	pg/g
	Middle Bound [including half LOD values]	**55**	pg/g
	Upper Bound [including LOD values]	**55**	pg/g

Results : Job No. DEPT82/210505

Laboratory Reg. No. N21/011309X **Date Extracted** 20-May-21

Client Sample Ref. NSA-0421 **DB5 Analysis** 27-May-21
Matrix Solid
Description Sediment 28/04/21 1230

PCDD/F Congeners	Level pg/g	WHO_{05}-TEF	WHO_{05}-TEQ contribution	Labelled Surrogate recovery	
2,3,7,8-TCDF	<0.1	0.1	0.005	66	
2,3,7,8-TCDD	<0.2	1	0.1	79	
1,2,3,7,8-PeCDF	<0.1	0.03	0.0015	73	
2,3,4,7,8-PeCDF	<0.03	0.3	0.0045	76	
1,2,3,7,8-PeCDD	0.63	1	0.63	82	
1,2,3,4,7,8-HxCDF	<0.03	0.1	0.0015	84	
1,2,3,6,7,8-HxCDF	<0.04	0.1	0.002	72	
2,3,4,6,7,8-HxCDF	<0.05	0.1	0.0025	70	
1,2,3,7,8,9-HxCDF	<0.07	0.1	0.0035	65	
1,2,3,4,7,8-HxCDD	1.6	0.1	0.16	75	
1,2,3,6,7,8-HxCDD	3.3	0.1	0.33	71	
1,2,3,7,8,9-HxCDD	8.0	0.1	0.80		
1,2,3,4,6,7,8-HpCDF	0.26	0.01	0.0026	70	
1,2,3,4,7,8,9-HpCDF	<0.04	0.01	0.0002	76	
1,2,3,4,6,7,8-HpCDD	150	0.01	1.5	73	
OCDF	0.41	0.0003	0.00012		
OCDD	5430	0.0003	1.6	79	

PCDD/F Homologue Groups	Level pg/g
Total TCDF isomers	2.0
Total TCDD isomers	33
Total PeCDF isomers	<0.5
Total PeCDD isomers	73
Total HxCDF isomers	0.38
Total HxCDD isomers	380
Total HpCDF isomers	0.71
Total HpCDD isomers	670

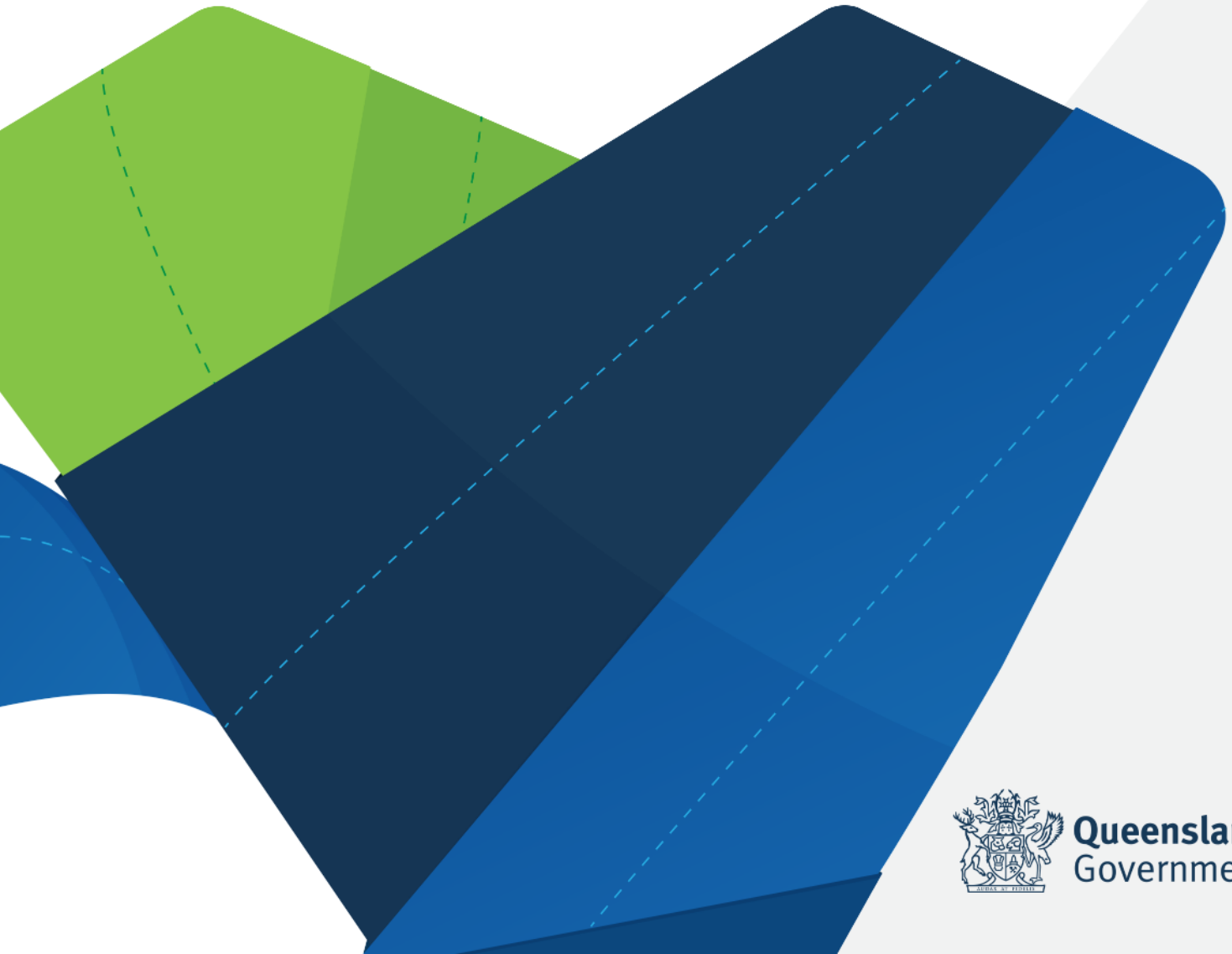
Summary Results			
Sum of PCDD and PCDF congeners			
	Excluding LOD values	6590	pg/g
WHO_{05} -TEQ_{DF}			
	Lower Bound [excluding LOD values]	**5.0**	pg/g
	Middle Bound [including half LOD values]	**5.1**	pg/g
	Upper Bound [including LOD values]	**5.3**	pg/g

Appendix E - Assessment of dioxins in biota for human consumption – Noosa Lakes

Queensland Health

Addendum to Assessment of dioxin in biota for human consumption – Noosa Lakes: Commercial Fishing

July 2021



Queensland Government

Background

Queensland Health has previously assessed the data provided by the Department of Environment and Science (DES) on biota samples for human consumption collected in the Noosa lakes. Biota sampling was undertaken in May 2020 following detection of dioxins and dioxin-like compounds in lake sediments. Only the consumption of fish and shellfish by recreational fishers catching fish for family consumption was considered, as this is expected to be the highest exposure risk. In this addendum, additional data is available, and the risks associated with commercially caught fish are considered.

In this assessment, dioxin means dioxin and dioxin-like compounds as selected by DES in their analysis and report. All values are Toxic Equivalents (TEQ) for these compounds.

Results

In the initial assessment, dioxin analysis results of biota samples (Table 1) collected from Lake Weyba, Lake Cootharaba and Lake Cooroibah in the Noosa area were used in this assessment. As the results from the two composite fish samples in the original survey were similar, the 1.7 pg TEQ/g value was selected for the initial exposure calculation (as this was not expected to make a substantive difference to the calculation).

Subsequently, sampling was undertaken to replicate a commercial catch (Table 2). All samples were caught in Lake Weyba in March 2021. As the results from these composite samples varied, a mean TEQ/g value was used in the calculation.

The lakes are interconnected and fish are expected to move through the system, so results are expected to be applicable to the whole system. The results for each species were averaged for assessment purposes.

Table 1 Results reported by Dept of Environment and Science of dioxin analysis in finfish for human consumption in Noosa in June 2020

Sample ID	Matrix	Location	FAT (%)	TEQ_{DF} (pg/g)	Sample
WEY-MUL-28520	Mullet	Lake Weyba	4.1	1.7	Composite Sample (5 Fillets)
COO-MUL-29520	Mullet	Lake Cootharaba	8.6	1.3	Composite Sample (4 Fillets)

ND = not determined

Table 2 Results reported for samples collected in April 2021 in conditions replicating a commercial catch

Sample ID	Matrix	Location	FAT (%)	TEQ_{DF} (pg/g)	Sample
WEY_SILCIL	Sand whiting	Lake Weyba	0.5	0.095	Composite Sample (10 Fillets)
WEY_LEIEQU	Ponyfish	Lake Weyba	6.2	8.5	Composite Sample (13 Fillets)
WEY_THRHAM	Mud herring	Lake Weyba	1.7	1.1	Composite Sample (5 fillets)
WEY_MUGCEP	Sea mullet	Lake Weyba	10.0	2.9	Composite Sample (13 fillets)
Mean				3.2	

Guideline Value

The NHMRC established a Tolerable Monthly Intake (TMI) guideline value (GV) for dioxins of 70 pg TEQ/kg body weight per month (NHMRC, 2002). By taking into account background exposures and consumption data, Food Standards Australia New Zealand (FSANZ) estimated the limit for dioxin concentration in fish and seafood for human consumption was 6 pg TEQ/g fresh weight of fish (FSANZ, 2007). The FSANZ assessment is based on a single serve of fish from the contaminated area per week. Exceedance of the FSANZ limit should trigger a risk assessment but does not necessarily indicate that the fish is unsuitable for human consumption.

Exposure

Exposure values (Equation 1) and hazard quotients (Equation 2) for consumption of recreationally caught fish were calculated for 1, 2 and 3 serves of fish per week. If an adult were to consume up to 3 serves per week of fish from the Noosa area as sampled, the intake could reach around 60% of the TMI - approximately 44 pg TEQ/Kg bw per day (Table 3). Exposure values for children are not reported separately. If exposure as a child (6 years of a total 70 year lifetime) and exposure as an adult (balance of 70 year lifespan) is considered, the risk is not significantly different.

$$Intake\ (dioxin) = \frac{Conc \times (portion\ size * frequency)}{Body\ weight}$$ *Equation 1*

Where:
Intake is intake of dioxin in pg TEQ/kg
Conc is the concentration of dioxin in fish
Portion size is the weight in g of fish consumed in a meal
Frequency is the number of meals consumed per month
Body weight is the default body weight for an adult in kg.

$$HQ = \frac{Intake}{Guideline}$$ *Equation 2*

Where:
HQ is the hazard quotient
Intake is the intake of dioxin from Equation 1

For commercially caught fish, exposure values and hazard quotients were calculated for 1, 2 and 3 serves of fish per month, representing 25% of total intake of fish being sourced from the Noosa Lakes. Only at the highest consumption level does the contribution to dioxin TMI exceed the fish contribution to diet.

Table 3 Calculated exposure and hazard quotient for consumption of commercially caught fish sampled from Noosa lakes.

Parameter	Units	1 meal per month	2 meals per month	3 meals per month
Concentration	pg/g	3.2	3.2	3.2
Portion size (fish)	g/meal	150.00	150.00	150.00
Frequency	meals/month	1.00	2.00	3.00
Ingestion Rate (fish)	g/month	**150**	**300**	**450**
body weight	kg	70	70	70
Intake (dioxin)	pg/kg bw month	**6.86**	**13.7**	**20.6**
GV (NHMRC)	pg/g bw month	70	70	70
HQ		0.1	0.2	0.29

Reassessing the recreational exposure to take into account the new dioxin concentration data (mean fish dioxin concentration from all samples) does not significantly change the outcome of the initial risk assessment.

Ponyfish.

The composite sample of ponyfish exceeded the FSANZ limit of 6 pg TEQ/g (pg of dioxin toxicity equivalence per g fresh weight of fish). Ponyfish is caught by both recreational and commercial fishers and is available in fish markets in Australia. The Department of Agriculture and Fisheries advise that the commercial harvest of ponyfish in Queensland has varied from 2 to 22 tons per year over the last five years. The catch is expected to be spread over a wide area and is only a small part of total fish catch in the east coast net fisheries of between 5,000 and 7,000 tons.

Ponyfish is popular in some cuisines, for example Keralan and Filipino. It is possible that some communities in Australia will consume more of this species than the general population. The parameters in this assessment are likely conservative enough to cover the risk to these communities. The number of portions of ponyfish that can be consumed in one month without exceeding the TMI, calculated using Equation 3 is shown in Table 4

$$Portions\ per\ month = \frac{TMI \times Body\ weight}{Conc\ \times Portion\ size} \qquad \textit{Equation 3}$$

Where:
TMI is the tolerable monthly intake in pg TEQ/kg bw per month
Body weight is the default Conc is the concentration of dioxin in fish
body weight for an adult in kg.
Portion size is the weight in g of fish consumed in a meal

Table 4 Calculation of the mass and portions per month of ponyfish that can be consumed before exceeding the dioxin TMI.

Ponyfish		
TMI	pg/kg bw month	70
Body weight	kg	70
Max intake	pg/month	4900
conc in fish	pg/g	8.5
mass of fish	g/month	576
portion size	g/month	150
portions/month		3.8

Uncertainties

As the sample size is very small, and collected over a short time frame, the result may not be representative of all biota in the area that may be consumed. The extent of commercial fishing, and the distribution of catch in the market (local, national, export) is not known. This assessment is conservative to allow for the worst-case scenario – that the fish is distributed through a local market to a population consuming a specialized cuisine in which ponyfish is popular.

This risk assessment assumes that the fish is the major source of dioxin in the diet, and that dioxins in other source foods such as fatty meats, dairy and eggs are at trace concentrations.

Conclusion

Consumption of fish from the Noosa area sampled by DES is unlikely to result in an unacceptable risk to public health. Some members of the community may consume relatively larger quantities of one species (ponyfish) over extended seasons and may approach the recommended TMI. Seasonal consumption patterns, lifetime patterns of activity, and locality changes mitigate against the possibility of exceeding the dioxin tolerable intake guideline value over a lifetime.

Recommendation

No specific advice on the consumption of fish due to dioxins in the Noosa area is required. If public concerns are noted, media reminders of the recommendations on “How much fish should I eat” (FSANZ 2020), as these guidelines would also be protective of exposure to dioxins.

References

FSANZ. (2007). *Dioxins in Seafood from Sydney Harbour A Revised Assessment of the Public Health and Safety Risk. Technical Series Report No: 32.* Food Standards Australia and New Zealand. Canberra

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