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PATTLE DELAMORE PARTNERS LTD

NZDF PFAS Investigation – Summary Report: RNZAF Base Ohakea, Stage C

New Zealand Defence Force

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Prepared for

New Zealand Defence Force

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Executive Summary

This report documents Stage C of a sampling investigation undertaken on private properties adjacent to the Royal New Zealand Air Force (RNZAF) Base Ohakea ('the site') for the New Zealand Defence Force (NZDF) to investigate the potential for contamination relating to the use of per- and poly-fluoroalkyl substances (PFAS) at the site.

Based on the sample results from Stage B, the investigation area for surface water was expanded. Additional groundwater bores were sampled; however there was no further expansion of the Stage B groundwater investigation area. This resulted in an increase of the number of surface water samples analysed (25 in Stage B versus 39 in Stage C). Some bores were unable to be resampled, therefore the overall number of bore samples was slightly less than Stage B (74 in Stage B versus 70 in Stage C).

In addition to groundwater and surface water sampling, the Stage C investigation scope included sampling and analysis of soil, eggs, cattle and sheep tissue. Summaries of Stage A and Stage B are provided in previous reports (PDP, February 2018a; PDP April 2018).

Groundwater

Groundwater sampling was undertaken over two weeks, from 14 May to 25 May, 2018. Based on bore use information provided by the landowners, 22 of the sample locations are currently used for potable and/or drinking water supply.

Of the 70 groundwater samples collected:

- PFAS compounds reported in 32 samples.
- Eighteen samples exceeded the interim drinking water guideline for the sum of total PFOS + PFHxS[1] (MoH, 2017). Two of these samples are from a single bore which has been used to top-up rain water tanks used for drinking water supply. The rain water tanks of two households which top-up supply from this bore were sampled in May and returned results below the interim drinking water guideline. NZDF have recently been advised of a third household which may use the bore to top-up a rain water tank. A sample will be collected from the tank on that property forthwith.
- Three samples exceeded the non-potable / recreation guideline for the sum of total PFOS + PFHxS.

Following the Stage A sampling, the Ministry for Primary Industries (MPI) provided site specific advice to landowners where groundwater samples exceeded the screening values developed by EnRisks (2017) for stock watering.

[1] Perfluorooctane sulfonate (PFOS) and perflourohexane sulphonate (PFHxS).

Based on the results of the Stage B sampling, there was no change to the advice given by the MPI.

For the Stage C results:

- Seventeen samples exceeded the Stock Watering and Fodder Irrigation Screening Value (SV) for home-grown beef consumption. This screening value is also applicable to home-grown sheep meat consumption.
- Fifteen samples exceeded the Stock Watering Only SV for home-grown beef consumption. This screening value is also applicable to home-grown sheep consumption.
- Twenty-two samples exceeded the Stock Watering and Fodder Irrigation SV for home-grown milk consumption.
- Nineteen samples exceeded the Stock Watering Only SV for home-grown milk consumption.
- Twelve samples exceeded the Stock Watering Only SV for home-grown egg consumption.

Comparing Stage C groundwater results to those collected from the same location during Stage B:

- Samples from 23 locations show decreased total PFOS + PFHxS concentrations (Median drop = 29% | Median absolute drop = 0.04 µg/L);
- Samples from 7 locations show increased total PFOS + PFHxS concentrations (Median rise = 20% | Median absolute rise = 0.05 µg/L);
- Samples from 33 locations show no change (i.e. concentration has not changed or has remained less than the limit of reporting (LOR));
- Eight sites were not re-sampled.
- One bore in particular has shown a significant increase in the concentration of total PFOS + PFHxS. The reason for this is currently unknown. To confirm the reliability of this result, the replicate sample collected for this bore is currently undergoing analysis at the laboratory. Resampling of this bore is also scheduled for late June.

Surface Water

A total of 39 surface water samples were collected from stream and pond locations (compared to 25 samples collected during Stage B).

Of the 39 surface water samples collected:

- PFAS compounds were reported in 28 surface water samples.

- Two samples exceeded the non-potable / recreation guideline, however water from these locations is not used for non-potable / recreational purposes.
- Twenty-one surface water samples exceeded the Stock Watering and Fodder Irrigation SV variously for home-grown beef, milk and/or eggs. Of these samples, 6 sites indicated water use for stock.

Soil

Of the 110 soil samples collected:

- PFAS compounds were reported in 29 samples.
- Eight soil samples exceeded the residential 10% human health screening value for the sum of total PFOS + PFHxS; however there are no residential dwellings in the vicinity of these samples.
- Twenty-nine samples exceeded the home grown beef consumption and the home grown milk consumption screening values. Four samples exceed the home grown egg consumption screening values. It is understood these sites are used for grazing stock.

Animal Tissue

Three samples of meat were collected (one beef, two sheep). No PFAS compounds were detected in the beef sample. Both sheep meat samples reported concentrations of total PFOS + PFHxS above the LOR but below the Food Standards Australia New Zealand (FSANZ) trigger value. PFOA was not detected in any samples.

Seven chicken egg samples were collected. PFAS compounds were detected at concentrations above the LOR, yet below the FSANZ trigger value for six of the egg samples. One egg sample reported concentrations of total PFOS + PFHxS above the FSANZ trigger value. PFOA was not detected in the sample.

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1.0 Introduction

Pattle Delamore Partners Ltd (PDP), in conjunction with a number of other Environmental Consultancies, has been engaged by the New Zealand Defence Force (NZDF) to undertake an external sampling campaign to investigate the potential for surface water and groundwater contamination by the use of per- and poly-fluoroalkyl substances (PFAS) at properties adjacent to the Royal New Zealand Air Force (RNZAF) Base Ohakea.

Stage A and Stage B sample results, from sampling undertaken in December 2017 and February/March 2018 respectively, have been reported in previous Summary Reports (PDP, 2018a; PDP, 2018b).

Based on the Stage B sample results, an expanded investigation area was proposed for surface water sample locations only for this Stage C investigation. This resulted in an increase of the number of surface water samples analysed (25 in Stage B versus 39 in Stage C).

Some groundwater bores were unable to be resampled during Stage C for various reasons including the failure of the bore pump, access difficulties and a well running dry, therefore the number of bore samples is lightly lower compared to Stage B (74 in Stage B versus 70 in Stage C).

In addition to previous scopes, soil samples were collected during Stage C from a number of properties where overland flow and/or flooding of streams and drains has occurred.

In summary, Stage C sampling has involved:

- Repeat sampling of most locations sampled during Stage A and Stage B;
- Sampling at new surface water locations identified within the expanded investigation area;
- Shallow soil sampling at locations where overland flow/flooding from streams and drains has been identified; and
- Sampling of additional media including eggs, cattle tissue and sheep tissue.

The Stage C sample results for landowners of properties adjacent to RNZAF Base Ohakea have been reported in individual landowner reports, with recommendations regarding ongoing use of the water provided in those reports.

This summary report provides a summary of the Stage C sampling results in the context of the entire investigation area.

1.1 Project Objectives

The key project objectives for this sampling investigation were:

- To assess groundwater and surface water from sites adjacent to Base Ohakea and determine if PFAS compounds are present;
- To compare the concentrations of PFAS compounds present against interim drinking water guideline values and applicable screening values;
- To assess whether PFAS compounds are present in other sample media from sites adjacent to Base Ohakea where requested by the land owner; and
- Provide further data to update preliminary estimates of PFAS plume extent in groundwater made following Stage A and Stage B sampling.

1.2 Scope of Summary Report

The scope of this report involved:

- Collecting representative samples of groundwater, surface water, rainwater from tanks, soil, and animal material from adjacent sites and analyses of these samples for PFAS.
- Comparison of the laboratory results to guideline and screening value criteria (where available).
- Update of the estimated extent of the shallow groundwater plume with the new results.

2.0 Background

PFAS compounds, such as perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) are a group of manufactured chemicals used since the 1950s. PFAS have been and continue to be used in a wide range of industrial and commercial products including aqueous film forming foam (AFFF) used for fighting fuel fires. Recently PFAS have gained increasing scientific and regulatory interest due to their widespread use, their environmental persistence and because some PFAS (primarily PFOS and PFOA) display bioaccumulative and toxic properties to humans and wildlife (CONCAWE, 2016).

PFAS are emerging contaminants. NZDF is investigating the potential for contamination of ground and water associated with the use and storage of AFFF containing PFAS at its camps and bases. Investigations at Ohakea have identified PFAS in the soil and water on the base.

Ohakea is surrounded by pastoral land predominantly used for grazing cattle and dairy farming. Shallow (and deep) groundwater is used relatively extensively on

properties surrounding the base for water supply. A description of the geology and hydrogeology for the area is contained within Appendix A.

3.0 Methodology

Groundwater and surface water sampling was undertaken in groundwater supply wells and in surface water at selected locations adjacent to the base following the methodology outlined in the *Sampling Protocols for Monitoring Per and Poly-fluorinated Compounds in Groundwater and Surface Water for New Zealand Defence Force* (PDP, February 2018c) and the guidance documents referenced therein.

Soil sampling was undertaken following the procedures outlined in *Sampling and Analysis Plan for Protocols for Polyfluorinated Compounds at RNZAF Ohakea* (PDP, 2018d).

Sampling of animal tissue was undertaken following procedures developed by PDP.

Stage C Sampling was completed over two weeks, from 14 May to 25 May, 2018. All samples were sent to AsureQuality laboratories, Wellington under standard chain of custody procedures and were analysed for their PFAS suite.

4.0 Guidelines and Screening Values

The interim guidelines for drinking water and non-potable water / recreation currently used in New Zealand to compare with the water sample data collected during this project are presented in Table 1 along with additional screening criteria that have been prepared by NZDF consultants EnRisks. The screening criteria have been developed for water and soil and apply to animals/products grown and consumed at home (home-grown produce). The soil guidelines used during this project are presented in Table 2.

Animal tissue samples are compared to the Food Standards Australia New Zealand's (FSANZ) trigger points (for further investigation); these are provided in Table 3.

Guidelines are provided for three PFAS compounds only. These compounds are known to be associated with certain types of AFFF. Henceforth results are discussed for these three compounds only. Results for the full analytical suite of 28 PFAS are available in the laboratory reports. These are provided in a separate electronic file.

Table 1: Environmental and Human Health Guidelines – Water

Media	Sum of Total PFOS + PFHxS	PFOA	Total PFHxS	Total PFOS	Source
Drinking Water	0.07 µg/L	0.56 µg/L	-	-	MoH [1], AGDoH [2]
Non-potable Water / Recreation	0.7 µg/L	5.6 µg/L	-	-	AGDoH [2]
Stock Watering Only (home grown consumption)	-	Beef 150 µg/L	Beef 0.1 µg/L	Beef 0.1 µg/L	EnRisks [3]
	-	Milk 30 µg/L	Milk 0.02 µg/L	Milk 0.02 µg/L	
	-	Eggs 4 µg/L	Eggs 0.2 µg/L	Eggs 0.09 µg/L	
Stock Watering and Fodder Irrigation (home grown consumption)	-	Beef 60 µg/L	Beef 0.06 µg/L	Beef 0.05 µg/L	EnRisks [3]
	-	Milk 14 µg/L	Milk 0.008 µg/L	Milk 0.008 µg/L	

Notes:

1. *Ministry of Health (MoH, 2017) Interim Guidance Level for Drinking Water, PFOA, PFOS and PFHxS.*
2. *Australian Government Department of Health (AGDoH, 2017) Health Based Guidance Values for PFAS for Use in Site Investigations in Australia.*
3. *Site specific screening values from Livestock Uptake Modelling and Screening Criteria Development for PFAS. EnRisks, November 2017. Screening values calculated using a scenario of 10% of the tolerable daily intake. This is the most conservative scenario developed.*

Table 2: Environmental and Human Health Trigger Values – Soil

Media	Sum of Total PFOS + PFHxS	PFOA	Total PFHxS	Total PFOS	Source
Soil (residential 10% with garden / accessible soil)	9 µg/kg	100 µg/kg	-	-	HEPA [1, 2]
Soil (public open space)	1,000 µg/kg	10,000 µg/kg	-	-	HEPA [1, 3]
Soil (home grown beef consumption)	-	550 µg/kg	1 µg/kg	1 µg/kg	EnRisks [4]
Soil (home grown milk consumption)	-	160 µg/kg	0.2 µg/kg	0.2 µg/kg	EnRisks [4]
Soil (home grown egg consumption)	-	1,200 µg/kg	50 µg/kg	25 µg/kg	EnRisks [4]

Notes:

1. *PFAS National Environmental Management Plan. Heads of EPAs Australia and New Zealand (HEPA), January 2018.*
2. *Assumes home-grown produce providing up to 10% of fruit and vegetable intake (no poultry). Does not include home-grown poultry/egg.*
3. *Assumes public open space such as parks, playgrounds, playing fields, secondary schools and footpaths.*
4. *Site specific screening values from Livestock Uptake Modelling and Screening Criteria Development for PFAS. EnRisks, November 2017. Screening values calculated using a scenario of 10% of the tolerable daily intake. This is the most conservative scenario developed.*

Table 3: Human Health Trigger Points for Investigation – Plant and Animal Tissue					
Media	**Sum of Total PFOS + PFHxS**	**PFOA**	**Total PFHxS**	**Total PFOS**	**Source**
Meat Mammalian (all)	3.5 µg/kg	28 µg/kg	3.5 µg/kg	3.5 µg/kg	FSANZ [1]
Poultry eggs	11 µg/kg	85 µg/kg	11 µg/kg	11 µg/kg	

Notes:

1. *Assessment of potential dietary exposure to perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA) and perfluorohexane sulfonate (PFHxS) occurring in foods sampled from contaminated sites – Table 8, Supporting Document 2. Food Standards Australia New Zealand (FSANZ), April 2017.*

5.0 Quality Assurance/Quality Control

Due to the very low detection limits of PFAS required for this investigation, a robust quality assurance/quality control (QA/QC) programme was required.

5.1 Project Data Quality Objectives

The project data quality objectives (DQOs) were to:

1. Determine the presence or absence (less than 0.005 µg/L) of PFASs in groundwater from groundwater bores.
2. Determine the presence or absence (less than 0.005 µg/L) of PFASs in surface water.
3. Determine the presence or absence (less than 2 µg/kg) of PFASs in soil.
4. Determine the presence or absence (less than 0.4 µg/kg) of PFASs in animal tissue.

To determine if the DQOs were met, the internal QA/QC function ('QAChecker'), in the environmental database software ESdat, was used to calculate relative percent differences between sample duplicates and to check for detections of PFAS in blanks.

The results of the QA/QC check indicate that all samples meet the DQOs. This is with the exception of two rinsate blanks which had detections of 6:2 FTS. The concentration detected in one rinsate blank was very low (0.001 µg/L), and is close to the limit of reporting (LOR) for this compound, therefore applying the estimated measurement uncertainty to the results, the numerical value is not considered to be statistically significantly different from the LOR.

A much greater concentration of 6:2 FTS (0.14 µg/L) was detected in the second rinsate blank. The reason for this detection of 6:2 FTS only is currently unknown

and is being investigated. However, as 6:2 FTS was the only compound detected in the sample, it was not detected in high concentrations across other samples, and it is not one of the target compounds for this investigation, the detection is not considered to influence the reliability of the results.

A summary of the QA/QC check is provided in Appendix B. Additional information relating to the QA/QC results can be provided upon request.

5.2 PFAS Concentrations at the Limit of Reporting

Where low detections (sum of total PFHxS + PFOS < 0.005 µg/L) have been reported in groundwater and surface water samples, this may not represent a real presence of PFAS in the sampled water but may reflect uncertainty of measurement or sampling and/or analysis error. Where appropriate the presence of at PFAS near the limit of reporting has been, or will be, confirmed by re-sampling.

6.0 Results Summary and Comparison to Guidelines

The following were collected during the May sampling round:

- 70 groundwater samples;
- 39 surface water samples;
- 9 water samples from rain collection tanks;
- 110 soil samples;
- Three meat samples; and
- Seven egg samples.

6.1 Groundwater

A summary of the groundwater sample results is presented below along with a comparison of the results to the interim drinking water guidelines, the non-potable guidelines, and the screening values for stock watering and fodder irrigation developed by EnRisks (2017). Screening values defined for beef would also be conservative for the consumption of home-grown sheep meat (EnRisks, 2017). Currently there is no information of the applicability of these screening values to the consumption of home-grown goat meat or milk.

6.1.1 Drinking Water Guideline

Of the 70 groundwater samples collected:

- PFAS compounds were detected in 32 samples.
- Eighteen samples exceeded the interim drinking water guideline for the sum of total PFOS + PFHxS (MoH, 2017).

- Fourteen samples returned concentrations of the sum of total PFOS + PFHxS above the LOR but below the interim drinking water guideline (MoH, 2017).
- Thirty-eight samples were reported as less than the LOR for the sum of total PFOS + PFHxS.
- PFOA was reported in 23 samples, however no samples were found to exceed the interim drinking water guideline for PFOA.

6.1.2 Non-potable, Stock Watering and Fodder Irrigation Screening Values

- Three of the 70 groundwater samples exceeded the non-potable / recreation guideline for the sum of total PFOS + PFHxS.
- Seventeen groundwater samples exceeded the Stock Watering and Fodder Irrigation Screening Value (SV) for home-grown beef consumption.
- Fifteen groundwater samples exceeded the Stock Watering Only SV for home-grown beef consumption.
- Twenty-two groundwater samples exceeded the Stock Watering and Fodder Irrigation SV for home-grown milk consumption.
- Nineteen groundwater samples exceeded the Stock Watering Only SV for home-grown milk consumption.
- Twelve groundwater samples exceeded the Stock Watering Only SV for home-grown egg consumption.

6.1.3 Groundwater Results Summary

A summary of the groundwater results compared to the relevant drinking water and non-potable guidelines, and the stock watering and fodder irrigation screening values is provided in Table 4. The number of previous exceedances from Stage B sampling is provided in brackets, 74 samples were collected during Stage B, vs 70 in the current Stage C round. Note that the current and previous exceedances shown in the Tables below are not necessarily for samples from the same locations; therefore a direct comparison between Stage B and Stage C results is not applicable.

Table 4: Guideline and Screening Value Exceedences – Groundwater Samples (n=70)			
Guideline	**Number Exceeding the Relevant Guideline**	**Percent Exceeding the Relevant Guideline**	**Source**
Interim Drinking Water	18 (previously 15)	25% (previously 20%)	MoH[1], AGDoH [2]
Non-potable Water / Recreation	3 (previously 4)	4% (previously 5%)	AGDoH [2]
Site Specific Screening Value – Beef Consumption (home grown)			
Stock Watering and Fodder Irrigation	17 (previously 15)	24% (previously 20%)	EnRisks [3]
Stock Watering Only	15 (previously 11)	21% (previously 15%)	EnRisks [3]
Site Specific Screening Value – Milk Consumption (home grown)			
Stock Watering and Fodder Irrigation	22 (previously 21)	31% (previously 28%)	EnRisks [3]
Stock Watering Only	19 (previously 19)	27% (previously 26%)	EnRisks [3]
Site Specific Screening Value – Egg Consumption (home grown)			
Stock Watering Only	12 (previously 10)	17% (previously 13.5%)	EnRisks [3]

Notes:

1. *Ministry of Health (MoH, 2017) Interim Guidance Level for Drinking Water, PFOA, PFOS and PFHxS.*
2. *Australian Government Department of Health (AGDoH, 2017) Health Based Guidance Values for PFAS for Use in Site Investigations in Australia.*
3. *Site specific screening values from Livestock Uptake Modelling and Screening Criteria Development for PFAS. EnRisks, November 2017.*

6.2 Surface Water

A summary of the surface water sample results is presented below. Based on information of water use collected during sampling rounds, surface water sampled within the investigation area is not understood to be used for drinking water. Therefore results have been compared to the non-potable / recreation guideline and the stock watering and fodder irrigation screening values. This is

with the exception of rainwater collection tanks which are discussed in Section 6.3.

6.2.1 Non-potable, Stock Watering and Fodder Irrigation Screening Values

Of the 39 surface water samples collected:

- Two surface water samples exceeded the non-potable / recreation guidelines for the sum of total PFOS + PFHxS.
- Twelve surface water samples exceeded the Stock Watering and Fodder Irrigation SV for home-grown beef consumption.
- Six surface water samples exceeded the Stock Watering Only SV for home-grown beef consumption.
- Twenty-one surface water samples exceeded the Stock Watering and Fodder Irrigation SV for home-grown milk consumption.
- Twenty surface water samples exceeded the Stock Watering Only SV for home-grown milk consumption.
- Five surface water samples exceeded the Stock Watering Only SV for home-grown egg consumption.

6.2.2 Surface Water Results Summary

A summary of the surface water results compared to the relevant non-potable guidelines, stock watering and fodder irrigation screening values, is provided in Table 5. It is noted that changes in the numbers, and percentages of samples found to exceed guideline or screening values must be considered in the context of the greater number of surface water samples that were obtained during the Stage C sampling event, compared to the Stage B sampling event (25 in Stage B vs 39 in Stage A). The number of previous exceedances from Stage B sampling is provided in brackets.

Table 5: Guideline and Screening Value Exceedences – Surface Water Samples (n=39)			
Guideline	**Number Exceeding the Relevant Guideline**	**Percent Exceeding the Relevant Guideline**	**Source**
Non-potable Water / Recreation	2 (previously 1)	5% (previously 4%)	AGDoH [2]
Site Specific Screening Value – Beef Consumption (home grown)			
Stock Watering and Fodder Irrigation	12 (previously 14)	31% (previously 56%)	EnRisks [3]
Stock Watering Only	6 (previously 10)	15% (previously 40%)	EnRisks [3]
Site Specific Screening Value – Milk Consumption (home grown)			
Stock Watering and Fodder Irrigation	21 (previously 17)	54% (previously 68%)	EnRisks [3]
Stock Watering Only	20 (previously 17)	51% (previously 68%)	EnRisks [3]
Site Specific Screening Value – Egg Consumption (home grown)			
Stock Watering Only	5 (previously 10)	13% (previously 40%)	EnRisks [3]

Notes:

1. *Ministry of Health (MoH, 2017) Interim Guidance Level for Drinking Water, PFOA, PFOS and PFHxS.*
2. *Australian Government Department of Health (AGDoH, 2017) Health Based Guidance Values for PFAS for Use in Site Investigations in Australia.*
3. *Site specific screening values from Livestock Uptake Modelling and Screening Criteria Development for PFAS. EnRisks, November 2017.*
4. *PFAS National Environmental Management Plan. Heads of EPAs Australia and New Zealand (HEPA), January 2018.*

6.3 Rainwater

Nine water samples were collected from rain collection tanks. These samples were collected to establish whether rain water tanks were contaminated with PFAS and would need to be replaced. All samples returned concentrations of PFAS compounds below the LOR.

6.4 Soil

A summary of the soil sample results is presented below. Soil samples are compared to human health screening values for residential and public open space land uses (guidelines for agricultural land use are not currently available) and the screening values developed by EnRisks for the consumption of home-grown beef, milk and eggs. A site specific risk assessment will be conducted on those properties where these guideline values and screening values are exceeded.

6.4.1 Human Health Screening Values

Of the 110 soil samples collected:

- Eight soil samples exceeded the residential 10% human health screening value for the sum of total PFOS + PFHxS.
- No soil samples exceed the residential 10% human health screening value for PFOA.
- No soil samples exceed the public open space human health screening value for the sum of total PFOS + PFHxS or for PFOA.

6.4.2 Beef, Egg and Milk Screening Values

Of the 110 soil samples collected:

- Twenty-nine soil samples exceeded the home grown beef consumption screening value.
- Twenty-nine soil samples exceeded the home grown milk consumption screening value.
- Four soil samples exceeded the home grown egg consumption screening value.

Table 6: Screening Value Exceedences – Soil Samples (n=110)		
Human Health Screening Value	**Number Exceeding the Relevant Criteria**	**Source**
Soil (residential 10% with garden / accessible soil)	8	HEPA [1]
Soil (public open space)	0	HEPA [1]
Site Specific Screening Values		
Soil (home grown beef consumption)	29	EnRisks [2]
Soil (home grown milk consumption)	29	EnRisks [2]
Soil (home grown egg consumption)	4	EnRisks [2]

Notes:

1. *PFAS National Environmental Management Plan. Heads of EPAs Australia and New Zealand (HEPA), January 2018.*
2. *Site specific screening values from Livestock Uptake Modelling and Screening Criteria Development for PFAS. EnRisks, November 2017.*

6.5 Animal Tissue

6.5.1 Cattle and Sheep Meat

One sample of beef meat and two samples of sheep meat were collected. No PFAS compounds were detected above the LOR in the beef meat sample.

PFAS compounds were detected at concentrations above the LOR in both the sheep meat samples; however the concentrations were below the FSANZ trigger point value.

6.5.2 Egg

Seven chicken egg samples were collected from a property. The eggs were provided by the landowner, from four chickens living on one property. PFAS compounds were detected at concentrations above the LOR in all samples. Total PFOS + PFHxS were detected in all egg samples; however concentrations were below the FSANZ trigger point value. This is with the exception of one egg sample which was found to contain concentrations of total PFOS + PFHxS exceeding the FSANZ trigger point value. The owner of the chickens had been advised previously by the Ministry for Primary Industries (MPI) to not eat home-grown eggs from chickens on this property.

7.0 Ohakea Groundwater Assessment

The Stage C sample results have been used to produce an interpreted plume extent of total PFOS + PFHxS concentration ≥0.05 µg/L within the shallow groundwater system at Ohakea (note that the approach taken for the RNZAF Base Woodbourne investigation was to assess the plume extent above the LOR). The interpreted plume was developed based on the returned groundwater and surface water sample results as well as qualitative use of the previously developed 3D numerical groundwater flow model (PDP, 2017b).

Of the 70 groundwater bore locations sampled in Stage C, 29 bores have information on bore depth, which has been used to assume a sample depth. Nineteen bores have a depth less than 20 m below ground level (bgl) and 10 bores have a recorded depth greater than 20 m bgl. For the remaining 45 bores without depth information, it has been assumed that these samples are from shallow bores <20 m bgl. It should be noted that the 'shallow' groundwater system at Ohakea as a whole, is considered to extend to ~50 m bgl. Sample depth is a very important aspect for interpreting the results. This is due to the hydrogeological understanding that shallow groundwater is likely to contain higher concentrations of PFAS than deeper groundwater. Surface water is also a very important aspect as there is a significant degree of groundwater – surface water interaction within the Ohakea system.

The results from Stage C have been used to further refine the estimated shallow groundwater plume extent for total PFOS + PFHxS that was developed following completion of Stage A (and refined following completion of Stage B).

Summary statistics for off-site sample locations of the Stage B (February 2018) and Stage C (May 2018) monitoring rounds are provided below:

For groundwater samples only:

- Samples from 23 locations show decreased total PFOS + PFHxS concentrations (Median drop = 29% | Median absolute drop = 0.04 µg/L);
- Samples from 7 locations show increased total PFOS + PFHxS concentrations (Median rise = 20% | Median absolute rise = 0.05 µg/L);
- Samples from 33 locations show no change (i.e. concentration has not changed or has remained less than the LOR);
- Eight sites were not re-sampled.

Some notable changes between the sampling events with respect to individual groundwater bores were:

- Two bores that were previously below the drinking water guideline for total PFOS + PFHxS, measured above the guideline in Stage C. One of these bores has shown a significant increase in the concentration of total PFOS + PFHxS. The reason for this is currently unknown. The replicate sample collected for this bore is currently undergoing analysis at the laboratory and resampling of the bore is scheduled for late June.
- One bore was above guideline for total PFOS + PFHxS (0.11 µg/L) in Stage B, but was below guideline (0.034 µg/L) in Stage C.

8.0 Discussion

This section discusses groundwater, surface water and soil results. Further assessment and discussion of the meat and egg results is outside the scope of this report.

8.1 Groundwater Users

8.1.1 Drinking Water

Based on information gathered during this investigation, 22 groundwater bores have been confirmed as being used or potentially used for drinking/potable water supply. A further five groundwater bores were previously used for drinking water or were used as back-up supplies (i.e. to top up rainwater tanks when running low).

One of the bores has been used to top-up rain water tanks used for drinking water supply. The rain water tanks of two households which top-up supply from the bore were sampled in May and returned results below the interim drinking water guideline. NZDF have recently been advised of a third household which may use the bore to top-up a rain water tank. A sample will be collected from the tank on that property forthwith.

Six bores used for potable supply reported concentrations of total PFOS + PFHxS above the LOR, but below the drinking water guideline.

Thirteen bores used for potable supply reported concentrations of total PFOS + PFHxS below the LOR. As with previous sampling rounds, a deeper bore (57 m deep) located approximately 800 m to the west of the Base did not contain PFAS at reportable concentrations, despite being approximately 400 m down gradient of a number of bores with concentrations of PFAS above the drinking water guideline.

8.1.2 Non-potable, Stock Watering and Fodder Irrigation

Sample results have been compared to the non-potable guidelines (AGDoH, 2017) and the site specific screening values (EnRisks, 2017) (refer Table 1). The EnRisk screening values are used to assess the risk of on-farm consumption of farm grown products (e.g. homekill) only (which are assumed to drink groundwater), which is a more conservative exposure pathway given the potential for consumption of larger quantities of beef, milk or eggs from a single animal. These screening values are not relevant for produce supplied to the general market. Screening values defined for beef would also be conservative for the consumption of sheep meat (EnRisks, 2017).

Three samples exceeded the non-potable guideline for the sum of PFOS + PFHxS. Two of which indicated water was used for non-potable / recreation purposes.

Twenty-two samples exceeded the screening value for home-grown milk consumption and seventeen samples exceeded the screening value for home-grown beef consumption. Of these samples, 16 sites indicated water use for stock and two indicated water use for stock and irrigation.

Twelve samples exceeded the screening value for home-grown eggs. One of these sites indicated water was previously used for chickens, however after advice following the Stage B sampling round, this water is no longer used for chickens.

8.1.3 Site Specific Advice from MPI

Following the results of the Stage A sampling, the MPI provided independent site specific advice to landowners of 16 bores located on twelve properties where concentrations of PFAS in groundwater were found to exceed some or all of the screening values developed by EnRisks. Based on the Stage B results, there was no change in the advice given to these landowners.

Fourteen of the bores MPI provided specific advice for in Stage A are included in the samples discussed above in Section 8.1.2.

8.2 Surface Water Users

PFAS compounds have been reported in 28 of the 39 surface water samples collected. Two of these samples exceeded the non-potable guideline for the sum of PFOS + PFHxS. However water from these sites was not indicated as being used for non-potable / recreation purposes. Twenty-one samples exceeded the screening value for home-grown milk consumption and twelve samples exceeded the screening value for home-grown beef consumption. Of these samples, 6 sites indicated water use for stock.

In general, the surface water samples are located on streams that have been identified as the main stormwater discharge points for Base Ohakea. An

exception to this are the four surface water samples collected from ponds in the southwest of the investigation area. Groundwater samples collected up gradient returned concentrations below the LOR suggesting the pond water is not sourced from groundwater. At the time of sampling the overland flow path feeding these ponds was dry. Most PFAS are not volatile; hence the elevated concentrations recorded here may be a result of concentrated PFAS in the remaining pond water following evaporation of pond water.

8.3 Soil

PFAS compounds were reported in 29 of the 110 soil samples collected. Eight of these samples exceeded the residential 10% human health screening value for the sum of total PFOS + PFHxS; however there are currently no residential dwellings in the vicinity of these samples.

Twenty-nine of the 30 soil samples mentioned above were found to exceed the home grown beef consumption and the home grown milk consumption screening values. Based on information collected during Stage B, these sites are used for grazing stock.

8.4 Results Interpretation Limitations

Due to their physiochemical properties, the fate and transport of PFAS is complicated and poorly understood. As such, extrapolation of these results, particularly to locations down-gradient, is uncertain and may not represent the actual conditions present. On this basis, any assessment of risk to receptors located outside the current investigation area is limited.

9.0 References

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EnRiskS, 2017. *Livestock Uptake Modelling and Screening Criteria Development for PFAS, draft.* Revision C. Environmental Risk Sciences Pty Ltd. 1 November 2017.

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PDP, 2018d. *Sampling and Analysis Plan for Protocols for Polyfluorinated Compounds at RNZAF Ohakea.* Pattle Delamore Partners Ltd. May 2018.

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Appendix A

Site Description

Appendix A: Site Description

Geology and Hydrogeology

The Geological Map of the Taranaki Area (Townsend et al., 2008) indicates that the area is underlain by Late Pleistocene river deposits; poorly to moderately sorted gravel with minor sand and silt underlying terraces and includes minor fan deposits and loess.

Regional groundwater flow direction is expected to be in a west to southwest direction towards the Rangitikei River and the west coast. Close to the Rangitikei River, local groundwater will be primarily influenced by the river and therefore flow direction is inferred to be towards the Rangitikei River.

Based on the geology, it is possible that variations in groundwater level may be due to discontinuous lenses of low permeability silt and clay layers acting as an aquitard beneath coarser sand and gravel layers.

Topography and Hydrology

The regional topography near the Rangitikei River is dominated by a succession of paleo river terraces that step down to the current level of the river. As such, the majority of the area is flat; except in the west of the investigation area where the land slopes steeply to the lower river terrace approximately 8 m below.

The Rangitikei River borders the north and west boundary of the investigation area. The Makowhai Stream runs along the eastern boundary of the investigation area, eventually discharging to the Rangitikei River. Numerous open drainage ditches run through the investigation area, particularly alongside the roads and eventually discharge in to the Rangitikei River (in the south east this is via the Makowhai Stream).

Reference

Townsend, D.; Vonk, A.; Kamp, P.J.J. (compilers), 2008: *Geology of the Taranaki area: scale 1:250,000*. Lower Hutt: GNS Science. Institute of Geological & Nuclear Sciences 1:250,000 geological map 7. 77 p.

Appendix B

Quality Assurance / Quality Control Summary

ESDAT QA Checker
Project:A02684802_Combined_Database
Filter: [Sampled_Date-Time] >= #01 Apr 2018# and [Sampled_Date-Time] <= #21 Jun 2018#

Overview Summary
- Count of Samples
- Count of Results

Holding Times

Blanks
- Detects in Blanks (2)

Duplicates
- All Field Duplicates (2304)
- All Field Inter-lab Duplicates (0)
- Field Duplicates with high RPDs (0)
- Field Inter-lab Duplicates with high RPDs (0)
- Lab Duplicates with high RPDs (0)

Lab Control Samples
- SDG's without a Laboratory Control Sample (0)
- Laboratory Control Samples, Error > 25% (0)