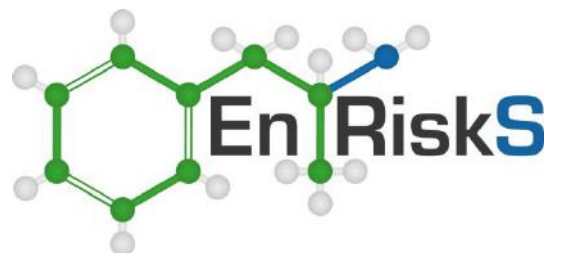
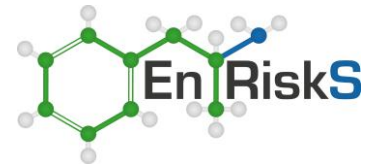


# 2019 Human Health and Ecological Risk Assessment for PFAS: Adelaide Airport

*Prepared for: Adelaide Airport Limited*

16 June 2020





## Document History and Status

<b>Report Reference</b>	AALAA/17/R001
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## Limitations

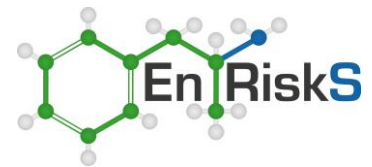
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It is prepared in accordance with the scope of work and for the purpose outlined in the Section 1 of this report.

The methodology adopted and sources of information used are outlined in this report. Environmental Risk Sciences Pty Ltd has made no independent verification of this information beyond the agreed scope of works and assumes no responsibility for any inaccuracies or omissions. No indications were found that information contained in the reports for use in this assessment was false.

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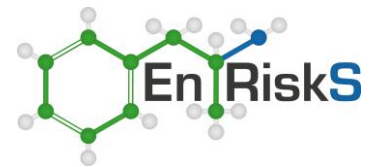
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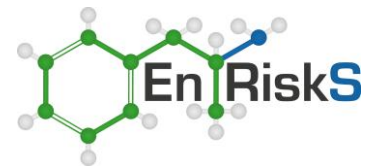
## Table of Contents

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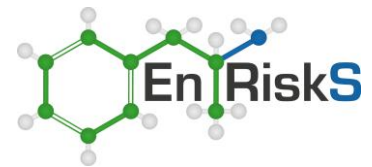
<b>Section 1. Background .....</b>	<b>1</b>
1.1 Introduction.....	1
1.2 Objectives.....	1
1.3 Methodology .....	2
1.4 Available Information .....	4
1.4.1 PFAS Assessment Reports and Information.....	4
1.4.2 Flora and Fauna Surveys.....	5
1.4.3 Adelaide Airport Guidance Documents .....	6
1.4.4 Advice from SA EPA .....	6
<b>Section 2. Site Setting and Conceptual Site Model.....</b>	<b>7</b>
2.1 Site Location.....	7
2.2 Geology, Hydrogeology, Hydrology and Groundwater Use.....	8
2.2.1 Hydrology .....	8
2.2.2 Geology.....	8
2.2.3 Hydrogeology .....	9
2.2.4 Interaction Between Groundwater and Surface Water.....	9
2.2.5 Use of Groundwater .....	12
2.2.6 Use of Surface Water .....	20
2.2.7 Other Sources of Water.....	21
2.3 Introduction to PFAS .....	21
2.4 Identified Potential PFAS Source Areas.....	23
<b>Section 3. HHRA, Issue Identification: On-Airport.....</b>	<b>24</b>
3.1 General.....	24
3.2 Potential for Exposure .....	24
3.3 Available Data .....	28
3.3.1 General.....	28
3.3.2 Current and Former FTG.....	28
3.3.3 Former Concrete Water Tank Area .....	29
3.3.4 Fire Station.....	29
3.3.5 Other Areas of the Site.....	30
3.3.6 Review of Adequacy and Completeness of Available Data .....	31
3.4 Nature and Extent of PFOS, PFOA and PFHxS.....	33
3.5 Review of Soil Data .....	34
3.5.1 General.....	34
3.5.2 Adopted Guidelines.....	34
3.5.3 Screening Assessment.....	34
3.6 Review of Water Data.....	35
3.6.1 General.....	35
3.6.2 Adopted Guidelines .....	35
3.6.3 Screening Assessment.....	36
3.7 Uncertainties.....	37



<b>Section 4. HHRA, Issue Identification – Off-Airport</b>	<b>39</b>
4.1 General	39
4.2 Potential for Exposure	39
4.2.1 Use of Off-Airport Groundwater	39
4.2.2 Use of Patawalonga Lake System	40
4.3 Nature and Extent of Impacts in Groundwater	46
4.3.1 Available Data	46
4.3.2 Adopted Guidelines	46
4.3.3 Screening Assessment	46
4.4 Nature and Extent of Impacts in Stormwater	47
4.4.1 Available Data	47
4.4.2 Adopted Guidelines	50
4.4.3 Screening Assessment	50
4.5 Nature and Extent of Impacts in Sediment	51
4.5.1 Available Data	51
4.5.2 Adopted Guidelines	52
4.5.3 Screening Assessment	52
4.6 Nature and Extent of Impacts in Fish	53
4.6.1 Available Data	53
4.6.2 Adopted Guidelines	53
4.6.3 Screening Assessment	53
4.7 Uncertainties	54
<b>Section 5. HHRA, Toxicity of PFAS to Humans</b>	<b>56</b>
5.1 Approach	56
5.2 PFAS Compounds	56
5.2.1 General	56
5.2.2 PFOS	57
5.2.3 Characterising toxicity for PFOS and PFHxS	58
5.3 Uncertainties	59
<b>Section 6. HHRA, Exposure Assessment: On-Airport</b>	<b>60</b>
6.1 General	60
6.2 Exposure Assumptions	60
6.3 Quantification of Exposures	61
6.3.1 Incidental Ingestion of Soil	61
6.3.2 Dermal Contact with Soil	62
6.3.3 Inhalation of Dust	62
6.3.4 Incidental Ingestion of Water	63
6.3.5 Dermal Contact with Water	63
6.4 Adopted Concentrations	64
6.5 Uncertainties	64
<b>Section 7. HHRA, Risk Characterisation: On-Airport</b>	<b>66</b>
7.1 Approach	66
7.2 Calculated Risks	66



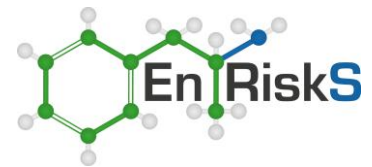
7.3	Uncertainties.....	68
<b>Section 8.</b>	<b>HHRA, Exposure Assessment: Off-Airport.....</b>	<b>69</b>
8.1	General.....	69
8.2	Exposure Assumptions.....	69
8.2.1	Home-Consumption of Chicken Eggs .....	69
8.2.2	Home-Consumption of Fruit and Vegetables .....	70
8.3	Quantification of Exposures.....	71
8.4	Adopted Concentrations .....	71
8.5	Uncertainties.....	71
<b>Section 9.</b>	<b>HHRA, Risk Characterisation: Off-Airport .....</b>	<b>72</b>
9.1	Approach .....	72
9.2	Calculated Risks.....	72
9.3	Uncertainties.....	72
9.3.1	General.....	72
9.3.2	Sensitivity Analysis 1, Well GW16_03.....	73
9.3.3	Sensitivity Analysis 2, Other PFAS .....	74
<b>Section 10.</b>	<b>Screening Level ERA – On-Airport .....</b>	<b>76</b>
10.1	General.....	76
10.2	Receptors and Exposure Pathways .....	76
10.3	Review of Potential Risks to Terrestrial Environments.....	77
10.4	Review of Potential Risks to Aquatic Environments .....	78
<b>Section 11.</b>	<b>Screening Level ERA – Off-Airport.....</b>	<b>79</b>
11.1	General.....	79
11.2	Review of Potential Risks to Aquatic Environments .....	79
<b>Section 12.</b>	<b>Conclusions.....</b>	<b>82</b>
<b>Section 13.</b>	<b>References .....</b>	<b>85</b>
 <b>Appendices:</b>		
Appendix A	Extracts of Assessment Data	
Appendix B	Derivation of Water RBC	
Appendix B	Toxicity Summary for PFOS and PFHxS	
Appendix C	Risk Calculations – On-Airport	
Appendix D	Risk Calculations – Off-Airport	



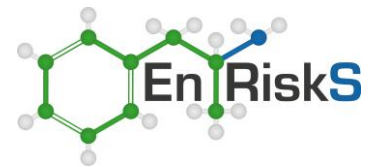
## Glossary of Terms

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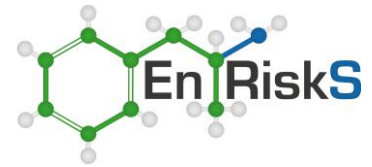
AAL	Adelaide Airport Limited
Additive Effect	An additive effect is where two or more substances act together to produce a total effect that is the same as the sum of the individual effects
Adsorption	The process of taking in. For a person or an animal, absorption is the process of a substance getting into the body through the eyes, skin, stomach, intestines, or lungs.
Adverse Health Effect	A change in body function or cell structure that might lead to disease or health problems
ANZECC	Australia and New Zealand Environment and Conservation Council
ASLP	Australian Standard Leaching Procedure
ASA	AirServices Australia
AT	Averaging Time
Background Level	An average or expected amount of a substance or material in a specific environment, or typical amounts of substances that occur naturally in an environment.
BW	Body weight
Carcinogen	A substance that causes cancer.
CF	Unit Conversion Factor
Chronic Exposure	Contact with a substance that occurs over a long time (more than 1 year) (compare with acute exposure and intermediate duration exposure)
Dermal Contact	Contact with (touching) the skin (see route of exposure).
Detection Limit	The lowest concentration of a chemical that can reliably be distinguished from a zero concentration.
Dose	The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An “exposure dose” is how much of a substance is encountered in the environment. An “absorbed dose” is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.
ED	Exposure Duration
EF	Exposure Frequency
EFSA	European Food Safety Authority
ET	Exposure time
Exposure	Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term (acute exposure), of intermediate duration, or long-term (chronic exposure).
Exposure Assessment	The process of finding out how people come into contact with a hazardous substance, how often and for how long they are in contact with the substance, and how much of the substance they are in contact with.
Exposure Pathway	The route a substance takes from its source (where it began) to its end point (where it ends), and how people can come into contact with (or get exposed to) it. An exposure pathway has five parts: a source of contamination (such as chemical leakage into the subsurface); an environmental media and transport mechanism (such as movement through groundwater); a point of exposure (such as a private well); a route of exposure (eating, drinking, breathing, or touching), and a receptor population (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a completed exposure pathway.
FSANZ	Food Standards Australia New Zealand
FTG	Fire Training Ground



Guideline Value	Guideline value is a concentration in soil, sediment, water, biota or air (established by relevant regulatory authorities such as the National Health and Medical Research Council (NHMRC), Australia and New Zealand Environment and Conservation Council (ANZECC) and World Health Organisation (WHO)), that is used to identify conditions below which no adverse effects, nuisance or indirect health effects are expected. The derivation of a guideline value utilises relevant studies on animals or humans and relevant factors to account for inter- and intra-species variations and uncertainty factors. Separate guidelines may be identified for protection of human health and the environment. Dependent on the source, guidelines will have different names, such as investigation level, trigger value, ambient guideline etc.
GWTP	Glenelg Waste Water Treatment Plant
HBGV	Health Based Guideline Value
HHERA	Human Health and Ecological Risk Assessment
HI	Hazard Index
HIL	Health Investigation Level
Ingestion	The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way (see route of exposure).
Inhalation	The act of breathing. A hazardous substance can enter the body this way (see route of exposure).
LOAEL	Lowest-observed-adverse-effect-level: The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals
LOR	Limit of Reporting
MDH	Minnesota Department of Health
No effect level	The tested dose of a substance that does not cause adverse effects in people or animals. See also NOAEL and LOAEL
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
NHMRC	National Health and Medical Research Council
NOAEL	No-observed-adverse-effect-level: The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals
PEF	Particulate Emission Factor: The potential concentration of a chemical in dust that might be in air as a result of wind erosion
PCCZ	Patawalonga Creek Conservation Zone
<b>PFAS</b>	<b>Per- or Poly-fluoroalkyl Substances</b>
<i>PFBA</i>	<i>Perfluorobutanoic Acid</i>
<i>PFPeA</i>	<i>Perfluoropentanoic Acid</i>
<i>PFHxA</i>	<i>Perfluorohexanoic Acid</i>
<i>PFHpA</i>	<i>Perfluoroheptanoic Acid</i>
<i>PFOA</i>	<i>Perfluorooctanoic Acid</i>
<i>PFNA</i>	<i>Perfluorononanoic Acid</i>
<i>PFDA</i>	<i>Perfluorodecanoic Acid</i>
<i>PFUdA</i>	<i>Perfluoroundecanoic Acid</i>
<i>PFDoA</i>	<i>Perfluorododecanoic Acid</i>
<i>PFBS</i>	<i>Perfluorobutanesulfonic Acid</i>
<i>PFHxS</i>	<i>Perfluorohexanesulfonic Acid</i>
<i>PFOS</i>	<i>Perfluorooctanesulfonic Acid</i>
<i>6:2 FtS</i>	<i>1H.1H.2H.2H-Perfluorooctansulfonic Acid</i>
<i>8:2 FtS</i>	<i>1H.1H.2H.2H-Perfluorodecanesulfonic Acid</i>
<i>PFOSA</i>	<i>Perfluorooctanesulfonamide</i>



Point of Exposure	The place where someone can come into contact with a substance present in the environment (see exposure pathway).
Population	A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age).
Receptor Population	People who could come into contact with hazardous substances (see exposure pathway).
Risk	The probability that something will cause injury or harm.
RME	Reasonable maximum exposure: The RME represents exposure scenario based on a set of exposure parameters that is representative of expected maximum exposure for that receptor and activity. The RME would not be expected to be exceeded except under highly specific and exceptional circumstances.
Route of Exposure	The way people come into contact with a hazardous substance. Three routes of exposure are breathing [inhalation], eating or drinking [ingestion], or contact with the skin (dermal contact)
SWL	Standing Water Level
T3	Serum Triiodothyronine
TF	Transfer Factor
TCZ	Tapleys Conservation Zone
TDS	Total Dissolved Solids
Toxicity	The degree of danger posed by a substance to human, animal or plant life.
Toxicity Data	Characterisation or quantitative value estimated (by recognised authorities) for each individual chemical for relevant exposure pathway (inhalation, oral or dermal), with special emphasis on dose-response characteristics. The data is based on available toxicity studies relevant to humans and/or animals and relevant safety factors.
Toxicological Profile	An assessment that examines, summarizes, and interprets information about a hazardous substance to determine harmful levels of exposure and associated health effects. A toxicological profile also identifies significant gaps in knowledge on the substance and describes areas where further research is needed.
Toxicology	The study of the harmful effects of substances on humans or animals.
TRV	Toxicity Reference Value, e.g. an RfD, ADI, TDI, or PTWI. A guideline toxicity value that incorporates uncertainty or safety factors to identify a safe dose assuming daily lifetime exposure to a substance that is unlikely to cause harm in humans.
Uncertainty Factor	Mathematical adjustments for reasons of safety when knowledge is incomplete. For example, factors used in the calculation of doses that are not harmful (adverse) to people. These factors are applied to the lowest-observed-adverse-effect-level (LOAEL) or the no-observed-adverse-effect-level (NOAEL) to derive a minimal risk level (MRL). Uncertainty factors are used to account for variations in people's sensitivity, for differences between animals and humans, and for differences between a LOAEL and a NOAEL. Scientists use uncertainty factors when they have some, but not all, the information from animal or human studies to decide whether an exposure will cause harm to people (also sometimes called a safety factor).
USEPA	United States Environmental Protection Agency
WHO	World Health Organisation



## Executive Summary

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### *Introduction*

Environmental Risk Sciences Pty Ltd (enRiskS) has been engaged by Adelaide Airport Limited (AAL) to review available data and undertake a human health and ecological risk assessment (HHERA) in relation to the presence of per- and polyfluoroalkyl substances (PFAS) at Adelaide Airport, South Australia (the “airport”; refer to plans in **Appendix A**).

Previous investigations conducted on-airport have detected concentrations of some PFAS in soil, sediment, groundwater and surface water. PFAS are a family of fluorine-containing compounds with unique properties to make materials stain- and stick-resistant. PFAS are often described as being “ubiquitous in the environment”. They have been widely used in man-made products such as paints, roof treatments, hardwood floor protectant, surface protection products (e.g. carpet and clothing treatments) and coatings for cardboard and packaging. Some PFAS are, or were also historically used in, fire-fighting foams (also known as aqueous film-forming foams; AFFF). PFAS are not found in the environment from natural sources, only from anthropogenic sources. The unique properties of PFAS make them persistent in the environment and highly mobile in soil and water (ATSDR 2018).

A number of activities that may lead to exposure to PFAS have been identified on- and off-airport, and this report presents an assessment of potential risks following these exposures. A qualitative assessment of risks to on- and off-airport environments has also been undertaken.

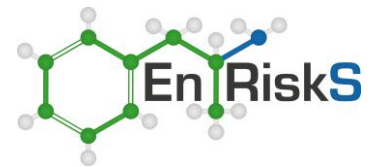
The HHERA is required to inform the Adelaide Airport Master Plan.

### *Objectives*

The objectives of the HHERA presented in this report are:

- To undertake an evaluation of the potential risks to human health associated with direct contact exposures from PFAS compounds in soil, groundwater and surface water on-airport, in the context of the ongoing use of the area as an airport;
- To undertake a qualitative evaluation of the potential risks to the on-airport terrestrial environment;
- To undertake an evaluation of the potential risks to human health associated with direct contact exposures from PFAS compounds in groundwater and surface water in off-airport areas, in the context of the existing land uses;
- To undertake a qualitative evaluation of the potential risks to the off-airport aquatic environments of Patawalonga Lake and Gulf St Vincent; and
- Based on the HHERA, identify any additional data that may be required to assist in refining the assessment of risk or in considering additional risk management measures that may be needed.

This assessment has been undertaken to evaluate potential risks to human health and the environment based on the information available up to 15 November 2019 and as described in **Section 1.4**. The HHERA has addressed human health and environmental risk issues relevant to PFAS in soil, groundwater and/or surface water at Adelaide Airport and off-airport. The assessment



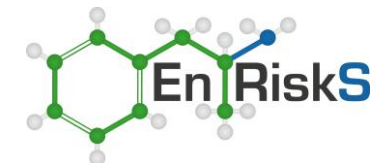
has not addressed human health or environmental risk issues associated with other chemicals or any other environmental media.

### **Conclusions**

**Table ES.1** provides an overview of the ways in which on- and off-airport receptors (including members of the community and the terrestrial and aquatic environments) may be exposed to PFAS, derived from the airport, and the conclusions and recommendations relevant to these areas. The conclusions and recommendations are made based on the available data, and with consideration of the available information on the existing land use patterns on-airport and off-airport, and the uncertainties identified in this assessment.

**Table ES.1: Conclusions and Recommendation, Risks to Human Health and the Environment from PFAS**

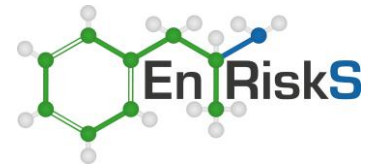
How the Community May be Exposed	Potential Risks to Human Health and the Environment <sup>1</sup>	Areas where Potential Risk Issues Identified <sup>1</sup>	Recommendations <sup>1</sup>
<b>Human Health – On-Airport, Current Exposures</b>			
Direct contact with PFAS in soil by Airport Workers	Low and acceptable except for 1 area.	Former and Current Fire Training Ground	Management measures outlined in the AAL Guideline for PFAS Work Health and Safety are supported and should be applied to all potential PFAS source areas at the airport. If works may intercept groundwater or surface water, the list of required personal protective equipment should be expanded to include long sleeves and long trousers, and waterproof boots if workers may get their feet wet in the course of activities.
Direct contact with PFAS in groundwater by Airport Workers.	Low and acceptable except for 2 areas.	Former and Current Fire Training Ground Fire Station	
Direct contact with PFAS in surface water by Airport Workers.	Low and acceptable.	NA	
Direct contact with recycled water by Airport workers and tenants.	Low and acceptable.	NA	
<b>Human Health – Off-Airport, Current Exposures</b>			
Non-potable use of groundwater with PFAS where exposures occur via direct contact	Low and acceptable.	NA	NA
Recreational use of Patawalonga Lake	Low and acceptable.	NA	NA
Consumption of fish caught from Patawalonga Lake	Low and acceptable.	NA	NA
<b>Human Health – Off-Airport, Potential Future Exposures</b>			
Use of groundwater with PFAS for filling swimming pools where exposures occur via direct contact	Low and acceptable.	NA	NA
Consumption of eggs from chickens on properties where PFAS is present in groundwater used for stock watering	Low and acceptable.	NA	NA
Ingestion of homegrown fruit and vegetables on properties where water containing PFAS is used for irrigation	Low and acceptable.	NA	NA
<b>Environment – On-Airport</b>			
<b>Terrestrial Environment</b>			
Direct toxicity and effects on higher order consumers due to bioaccumulation	Potential for adverse effects to the environment cannot be excluded in the investigated PFAS source areas	Former and Current Fire Training Ground Fire Station	These areas may require management when they are no longer required for operational purposes.



How the Community May be Exposed	Potential Risks to Human Health and the Environment <sup>1</sup>	Areas where Potential Risk Issues Identified <sup>1</sup>	Recommendations <sup>1</sup>
		Former Concrete Water Tank Area	Further sampling and analysis for PFAS in soil is recommended within the PCCZ, TCZ or areas of remnant indigenous vegetation, if there is evidence to suggest that soil within these areas may be impacted with PFAS.
<b>Environment – Off-Airport</b>			
<b>Aquatic Environment</b>			
Direct toxicity and effects on higher order consumers due to bioaccumulation	Low and acceptable.	NA	NA

**Notes:**

1 = The conclusions of the HHERA are based on the available sampling and analysis results.



## Section 1. Background

---

### 1.1 Introduction

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A number of activities that may lead to exposure to PFAS have been identified on- and off-airport, and this report presents an assessment of potential risks following these exposures. A qualitative assessment of risks to on- and off-airport environments has also been undertaken.

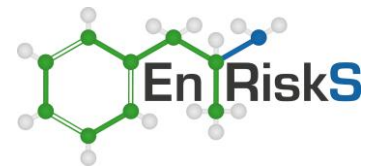
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has not addressed human health or environmental risk issues associated with other chemicals or any other environmental media.

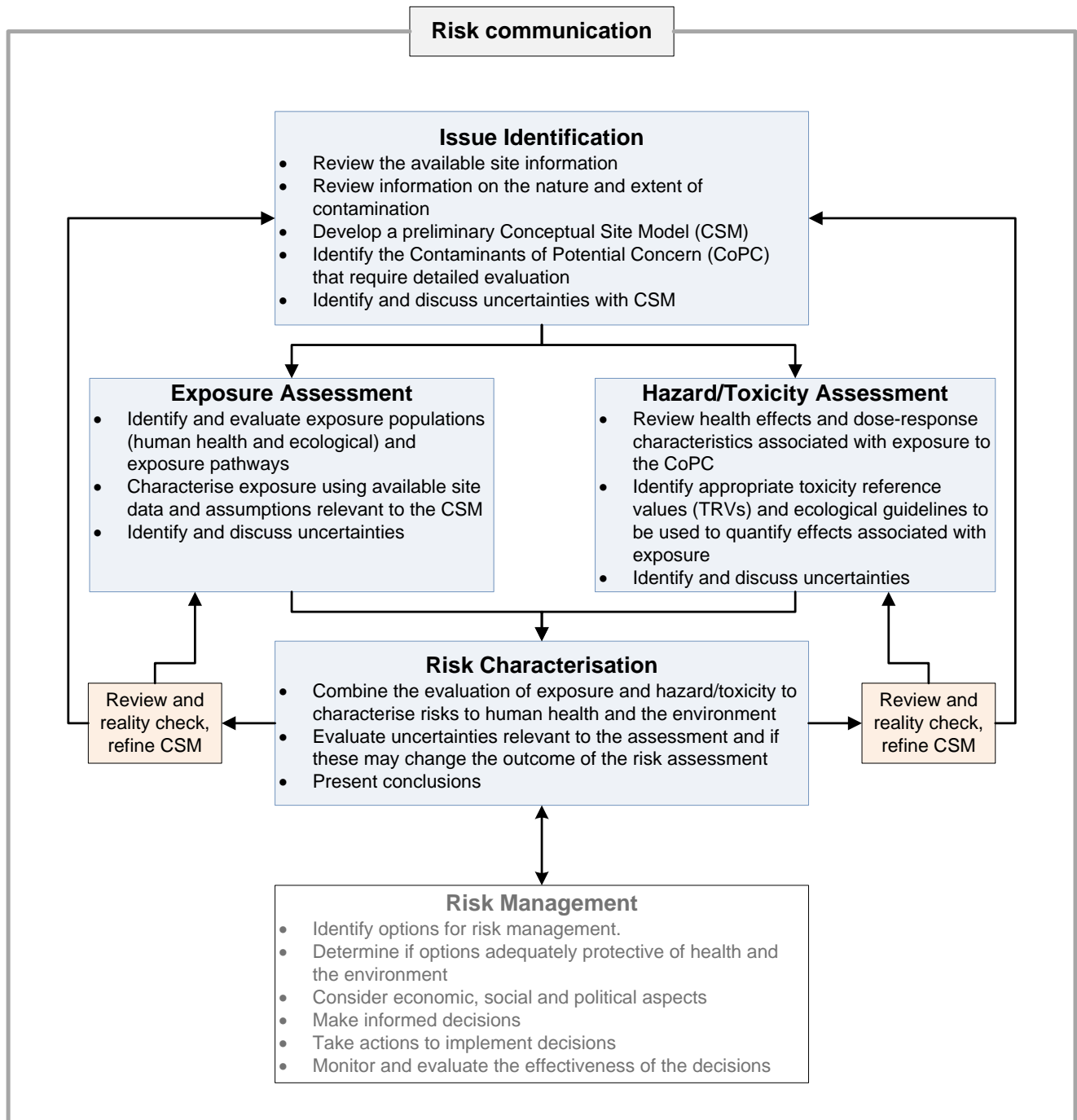
### 1.3 Methodology

In general, the approach taken for the assessment of human health and environmental risks is in accordance with guidelines/protocols endorsed by Australian regulators, including:

- enHealth Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards (enHealth 2012a);
- enHealth Australian Exposure Factor Guide (enHealth 2012b);
- Food Standards Australia New Zealand (FSANZ) guideline Perfluorinated Chemicals in food (FSANZ 2017a), and associated supporting documents:
  - Supporting Document 1 Hazard assessment report – Perfluorooctane sulfonate (PFOS), Perfluorooctanoic acid (PFOA), Perfluorohexane sulfonate (PFHxS) (FSANZ 2017b)
    - Critical review of pharmacokinetic modelling of PFOS and PFOA to assist in establishing HBGVs for these chemicals (FSANZ 2017c)
    - Immunomodulation by PFASs: a brief literature review (ToxConsult 2017)
  - Supporting Document 2 Assessment of potential dietary exposure to PFOS, PFOA and PFHxS occurring in foods sampled from contaminated sites (FSANZ 2017d)
    - Occurrence of and dietary exposure to PFOS, PFOA and PFHxS reported in the literature (FSANZ 2017e)
    - Occurrence of PFOS, PFOA and PFHxS in foods and water sampled from contaminated sites (FSANZ 2017f)
  - Supporting Document 3 Summary of other controls for perfluorinated chemicals (FSANZ 2017h)
  - Supporting Document 4 Criteria for the establishment of maximum levels in food (FSANZ 2017g)
- National Environmental Protection Measure – Assessment of Site Contamination (ASC NEPM) including:
  - Schedule B1 Investigation Levels for Soil and Groundwater (NEPC 1999 amended 2013a)
  - Schedule B4 Guideline on Health Risk Assessment Methodology (NEPC 1999 amended 2013c)
  - Schedule B5 Guideline on Ecological Risk Assessment (NEPC 1999 amended 2013d)
  - Schedule B6 Guideline on Risk Based Assessment of Groundwater Contamination (NEPC 1999 amended 2013c)
  - Schedule B7 Guideline on Health-Based Investigation Levels (NEPC 1999 amended 2013d)
- Australian Government National Health and Medical research Council (NHMRC) Guidance on Per and Polyfluoroalkyl substances (PFAS) in Recreational Water, 2019 (NHMRC 2019); and
- PFAS National Environmental Management Plan (the “PFAS NEMP”), January 2018 (HEPA 2018).

In addition, protocols and guidelines developed by international agencies have been used (and referenced) to provide supplementary guidance where required. International guidance has not been adopted where it is inconsistent with the Australian regulatory or policy setting.

The overall approach for the HHERA is outlined in the following (modified from enHealth 2012):



CRC CARE Technical Report 38, specifically Parts 1 to 4 (CRC CARE 2017b, 2017c, 2017d, 2017a), has not been considered in the HHERA. The FSANZ set of documents was released on 3 April 2017 while the CRC CARE documents were released in late March 2017. As a result, the findings and recommendations in the FSANZ documents were not available to CRC CARE. This means any guidance about health screening levels in the CRC CARE documents will need to be updated to reflect the recommendations by FSANZ. In addition, environment protection regulators have not yet adopted the CRC CARE documents as acceptable for use for either health or ecological risk assessment screening.

CRC CARE Technical Report 38 - Assessment, management and remediation for PFOS and PFOA Part 5: management and remediation of PFOS and PFOA (CRC CARE 2017e) provides some additional information on the management and remediation of PFAS contamination that may be considered by AAL alongside this HHRA where relevant.

The overall approach adopted in this assessment is as follows:

- Summary of relevant information and available data relevant to the development of a Conceptual Site Model (CSM) for PFAS in environmental media on- and off-airport as relevant to the assessment of health and environmental risks (**Section 2**);
- Issue identification for human health risk assessment, including comparison of concentrations of PFAS in environmental media with screening level guidelines for on-airport (**Section 3**) and off-airport (**Section 4**);
- Identification of an appropriate dose-response relationship and quantitative values (toxicity reference values; TRV) for the assessment of potential human health effects associated with exposures to PFAS (**Section 5**);
- Quantification of likely exposures by human receptors to PFAS for on-airport (**Section 6**) and off-airport (**Section 8**);
- Characterisation of human health and environmental risks on the basis of the above for on-airport (**Section 7**) and off-airport (**Section 9**). The characterisation of risk will present conclusions in relation to risk with consideration of the uncertainties identified in the assessment and any requirements to undertake risk management measures;
- Screening level ecological risk assessment for on-airport (**Section 10**) and off-airport (**Section 11**); and
- Conclusions (**Section 12**).

## 1.4 Available Information

This assessment has been conducted based on information and data presented in the reports listed below, that have been provided by AAL for use in the HHERA.

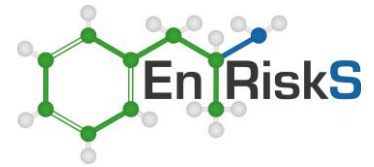
### 1.4.1 PFAS Assessment Reports and Information

1. GHD (2008), Report on ARFF National Testing Project, Preliminary Site Contamination Assessment – Former Adelaide ARFF Drill Ground, Adelaide Airport, August 2008;
2. Soil & Groundwater (S&G) (2009), Soil & Groundwater Investigation, Fire Training Facility, Adelaide Airport, South Australia, December 2009;
3. S&G (2011), Soil & Groundwater Investigation, Fire Training Facility, Adelaide Airport, South Australia, March 2011;

4. S&G (2012), Soil & Groundwater Investigation, Fire Training Facility, Adelaide Airport, South Australia, August 2012;
5. S&G (2013), Draft Soil & Groundwater Investigation - 2013, Fire Training Facility, Adelaide Airport, South Australia, June 2013;
6. LBW Environmental Projects (2016), Adelaide and Parafield Airports PFAS Investigation, August 2016;
7. Golder Associates (2016), Site History and Qualitative Risk Assessment of Perfluorinated Chemical Sources – Adelaide Airport, May 2016;
8. Golder Associates (2017), Annual Groundwater Monitoring Report 2016, February 2017;
9. GHD (2018a), Adelaide Airport Preliminary Site Investigation, January 2018;
10. GHD (2018b), Adelaide Airport Preliminary Sampling Report, February 2018;
11. Borelogs for wells GWP1-PFC to GWP4-PFC and GW1-PFC to GW3-PFC, installed by AAL;
12. Tabulated data for surface water samples collected from the stormwater drains by AAL at the Airports;
13. Tabulated laboratory analysis results for fish samples, understood to have been collected by SA EPA (file: PFAS Patawalonga samples (002).xlsx);
14. NMI Analysis Report No. RN1107973 (March 2016; groundwater);
15. NMI Analysis Report No. RN1117149 and RN1117188 (June 2016; soil and groundwater);
16. NMI Analysis Report No. RN1117695 (June 2016; groundwater);
17. NMI Analysis Report No. RN1120046 (June 2016; groundwater);
18. NMI Analysis Report No. RN1120762 (July 2016; groundwater);
19. Site plans showing Potential PFAS contamination sources and sampling locations up to February 2017 as compiled by AAL;
20. GHD (2017), Groundwater and Surface Water at Adelaide Airport Monitoring Event Report, December 2017;
21. Golder (2018a), Annual Groundwater Monitoring Report 2017, March 2018;
22. Golder (2018b), Background Groundwater Well Installation and PFAS Sampling, West Richmond, South Australia, December 2018;
23. Environmental Projects (2018), Adelaide and Parafield Airports Desktop Review of Current Off-airport Groundwater Use, March 2018; and
24. GHD (2019), Adelaide Airport Environmental Site Assessment Offsite Investigation, April 2019.

#### **1.4.2 Flora and Fauna Surveys**

25. BUSH-ANEW (November 1999), Survey of Remnant Indigenous Vegetation Proposed Golf Course Site, Adelaide Airport;
26. BUSH-ANEW (August 2002), Remnant Indigenous Vegetation Survey, Area A: Proposed North West Commercial Development Site, Adelaide Airport;
27. Delta Environmental Consulting (November 2010), Airport East: Rapid Bioassessment;
28. Delta Environmental Consulting (June 2016), Patawalonga Creek: 2016 Melaleuca Extents; and
29. Delta Environmental Consulting (January 2017), Patawalonga Creek Transects 2016.



### 1.4.3 Adelaide Airport Guidance Documents

30. Adelaide Airport Guideline: PFAS – Work Health and Safety (Per- and Poly-fluorinated Alkyl Substances), June 2016;
31. Adelaide Airport Guideline: Construction Dewatering, January 2016; and
32. Adelaide Airport Management Plan: Patawalonga Creek Conservation Zone, February 2017.

Adelaide Airport Master Plan:

33. Adelaide Airport Master Plan 2014<sup>1</sup>.

### 1.4.4 Advice from SA EPA

34. E-mail from Peter Goonan to Robert Kaftan, 23 February 2016.

Extracts of the relevant assessment data are provided in **Appendix A**. Note that Golder (2018a) was locked and extracts were therefore unable to be included.

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<sup>1</sup> [http://www.adelaideairport.com.au/corporate/wp-content/uploads/2015/04/NJ00176Masterplan\\_FA\\_WEB.pdf](http://www.adelaideairport.com.au/corporate/wp-content/uploads/2015/04/NJ00176Masterplan_FA_WEB.pdf)

## Section 2. Airport Setting and Conceptual Site Model

### 2.1 Airport Location

The Adelaide Airport Master Plan (AAL 2014) indicates that Adelaide Airport (the “airport”) is located approximately 6 km west of the Adelaide CBD. The airport occupies approximately 785 hectares and lies principally within the local government area of the City of West Torrens, with a small portion in the City of Sturt.

The airport is owned by the Commonwealth Government and currently used as an “Airport and associated commercial enterprises”. The current operating lease holder is AAL with small portions of the airport sub-leased to several other entities including Airservices Australia (ASA), Yandal Pty Ltd, Export Park Pty Ltd, Tyco Australia Pty Ltd, Australian Helicopters Pty Ltd, Celtic Industries Pty Ltd and Hot Melt Packaging Systems Pty Ltd (GHD 2016a). Except for the child care centre in the north-eastern portion, there are no sensitive land use tenancies at the airport. The child care centre is located upgradient of any potential or known PFAS impacted areas and has not been considered further in this HHERA.

The airport provides passenger, freight, general aviation, charter and helicopter services across the international, domestic and regional areas. Principal aviation facilities include a two-runway system with associated terminal, car parking, air freight, navigation, fuel and rescue and fire-fighting facilities (AAL 2014). Commercial areas are located in the northern, western and north-eastern parts of the airport and include hangars and maintenance areas for aviation operations, a service station, a number of food and beverage outlets, retail shopping areas including an IKEA and the Burbridge Commercial District, which contains large warehousing facilities for commercial operators.

The western boundary of the airport is located approximately 1 km from Gulf St Vincent. The land located immediately to the west of the airport is owned by the State Government under trust to Adelaide Shores who operate a recreational complex comprising golf courses, playing fields and other recreational facilities. The area of the golf course to the west of well GW16\_02 (refer to plans in **Appendix A**) is underlain by a former landfill. Several major commercial precincts are located on land surrounding the aviation operations (AAL 2014; AAL *pers. comm.*).

More specifically, land uses surrounding the airport comprise the following (GHD 2016a):

- North: Kooyonga Golf Course over Sir Donald Bradman Drive, with residential beyond;
- South: Brownhill Creek and the Glenelg Golf Club, with residential and commercial/industrial areas;
- East: Residential and commercial/industrial areas over Keswick Creek; and
- West: the Adelaide Shores Golf Club over Tapleys Hill Road, the Airport Drain, the Patawalonga Creek Conservation Zone (PCCZ), Tapleys Conservation Zone (TCZ) with Patawalonga Creek, commercial and recreational areas, a sewage treatment plant and West Beach/Gulf St Vincent beyond.

## 2.2 Geology, Hydrogeology, Hydrology and Groundwater Use

The following summary has been prepared from a review of the information presented in GHD (2018a) and information provided by AAL unless otherwise noted.

### 2.2.1 Hydrology

The airport is relatively flat, with a regional slope towards Patawalonga Creek and Gulf St Vincent, located to the west/south-west.

The nearest surface water bodies to the airport are:

- Cowandilla-Mile End Drain on the northern boundary of the airport;
- Airport Drain on the western airport boundary;
- Brownhill-Keswick Creeks: these creeks meet on the eastern boundary of the airport and from Brownhill Creek;
- Patawalonga Creek: located immediately to the west of the airport;
- Sturt River: located approximately 0.4 km to the south-west of the airport;
- Gulf St Vincent located approximately 1 km to the west of the airport; and
- Torrens River located approximately 1.6 km to the north-west of the airport.

Stormwater/surface water at the airport is collected into a network of drainage channels that include:

- Airport Drain, where the majority of stormwater from the airport is directed. Water from this drain then enters the Collection Pond; and
- Brownhill-Keswick Creeks (which also captures stormwater from a larger urban catchment) runs along the southern boundary of the airport. These creeks flow into the Diversion Pond.

Cowandilla-Mile End Drain (which also captures stormwater from a larger urban catchment) runs along the northern and north-eastern airport boundary and flows into Patawalonga Creek, and then into the Collection Pond. Stormwater runoff from the airport does not enter this system but is captured by Airport Drain.

Water within the Collection Pond and the Diversion Pond is discharged via the Barcoo Outlet, which is a discharge pipeline extending 200 m offshore into the Gulf St Vincent. As a result, under most conditions, stormwater and surface water from the airport will not reach Patawalonga Lake (where recreational activities occur). Stormwater is only allowed to discharge into Patawalonga Lake under exceptionally high flow conditions (noting that these conditions would also result in significant levels of dilution).

Stormwater drains at the airport are between 1.5 and 2.5 metres below ground level (m bgl).

### 2.2.2 Geology

The airport is underlain by the St Kilda Formation which comprises beach ridge deposits with shelly silts and sands, overlain by modern intertidal and swamp deposits. Intrusive investigations at the airport have identified variable fill material (comprising gravels, gravelly silty sands and clayey sands) in the top 1 m of the soil profile at the airport. The fill is underlain by natural sandy and silty clays (GHD 2018a).

### 2.2.3 Hydrogeology

Groundwater beneath the airport is generally present at around 1 to 3 metres below ground level (m bgl) (AAL 2016a), however groundwater levels as shallow as 0.2 m bgl have been reported in low lying areas in the western part of the airport following periods of high rainfall.

The inferred groundwater flow direction is to the west/north-west.

### 2.2.4 Interaction Between Groundwater and Surface Water

Given the shallow depth to groundwater there is the potential for interactions between surface water/stormwater and groundwater to increase the complexity of PFAS fate and transport at the airport.

To determine if interactions between groundwater and surface water may be occurring, the following aspects of the available assessment data were reviewed for three adjacent surface water and groundwater sampling locations in the period July to September 2016:

- Detections of other PFAS; and
- % PFOS compared to PFHxS.

These comparisons are shown in **Table 2.1** and **Table 2.2**.

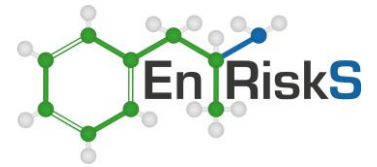
**Table 2.1: Summary of Co-Located Groundwater and Stormwater Data – Other PFAS Detected**

Sampling Locations	PFAS Detected in July – September 2016	Groundwater	Stormwater
SW16_03 & GW16_07 (Fire Station)	6:2 FtS	✓	✓
	8:2 FtS	✓	✓
	PFBS	✓	✓
	PFPeA	✓	✓
	PFPeS	✓	✓
	PFHxA	✓	✓
	PFHpA	✓	✓
	PFHpS	✓	✓
	PFOA	✓	✓
	PFNA	--	✓
	PFOSA	✓	✓
SW16_07 / SW5 & GW16_03 (Western Airport Boundary)	PFBS	--	✓
	PFPeA	--	✓
	PFHxA	--	✓
	PFHpA	--	✓
SW16_06 / SW10 & GW16_02 (Western Airport Boundary)	6:2 FtS	--	✓
	PFBA	--	✓
	PFBS	✓	✓
	PFHpA	✓	✓
	PFHpS	✓	✓
	PFHxA	✓	✓
	PFPeA	✓	✓
	PFPeS	✓	✓
	PFOA	✓	✓
	PFNA	--	✓

**Notes:**

Shading for ease of reading only

“✓” = PFAS detected, “--” = PFAS not detected



**Table 2.1** indicates that the PFAS profile (i.e. the occurrence of different PFAS chemicals) in groundwater and surface water/stormwater is most similar at the Fire Station (locations SW16\_03/GW16\_07) and somewhat similar on the western boundary of the airport (location SW16\_06, SW10 and GW16\_02). The PFAS profile at locations SW16\_07, SW5 and GW16\_03 (also on the western airport boundary) is not similar.

**Table 2.2: Summary of Co-Located Groundwater and Stormwater Data – PFOS and PFHxS**

Sampling Locations	Sampling Date	Groundwater				Stormwater		
		PFOS Conc. (µg/L)	PFHxS Conc. (µg/L)	% PFOS	SWL (m bgl)	PFOS Conc. (µg/L)	PFHxS Conc. (µg/L)	% PFOS
SW16_03 & GW16_07 (Fire Station)	August 2016 (GHD)	4,130	861	83%	0.155	125	114	52%
SW16_07 / SW5 & GW16_03 (Western Airport Boundary)	July 2016 (AAL)	--	--	--	--	0.042	0.043	49%
	August 2016 (GHD)	0.02	<0.02	100%	0.692	0.29	0.07	81%
	September 2016 (AAL)	--	--	--	--	0.09	0.18	33%
SW16_06 / SW10 & GW16_02 (Western Airport Boundary)	July 2016 (AAL)	--	--	--	--	16	9	64%
	August 2016 (GHD)	7.59	52	13%	0.692	14	9.05	61%
	September 2016 (AAL)	--	--	--	--	12	3.5	77%

**Notes:**

Shading for ease of reading only

-- = No data available

SWL = Groundwater Standing Water Level

m bgl = metres below ground level

**Table 2.2** indicates that the relative proportions of PFOS and PFHxS in groundwater and surface water/stormwater are most similar at locations SW16\_07, SW5 and GW16\_03 (western airport boundary) and the Fire Station (SW16\_03 / GW16\_07) in August 2016. Their relative proportions are not similar at location SW16\_06, SW10 and GW16\_02 (also on the western airport boundary). For the western boundary locations, this is the opposite to that observed for the PFAS profile (**Table 2.1**).

It is noted that groundwater standing water levels were in the range 0.2 to 0.7 m bgl in August 2016. The total rainfall recorded at the airport around this time (and in the preceding year) is shown in **Table 2.3**.

**Table 2.3: Total Monthly Rainfall at Adelaide Airport – 2015 to 2017 (mm)**

Month	2015	2016	2017
January	30	36.2	39.4
February	0.0	14.8	32.4
March	2.6	41.6	6.4
April	50	8.0	--
May	52.6	62.4	--
June	18.6	72.0	--
July	42.2	95.4	--
August	36.4	49.0	--
September	15.6	102.2	--
October	5.6	59.6	--
November	14.6	30.2	--
December	7.8	75.8	--

**Notes:**

Shading shows rainfall around the time of sampling by GHD (2016b).

1 = Ref. <http://www.bom.gov.au/climate/data/>

**Table 2.3** shows that there was a higher amount of rainfall in June to September 2016 as compared to 2015, hence it is likely that groundwater levels were also higher during this time.

In summary stormwater drains are present approximately 1.5 to 2.5 m bgl on the airport. Given this, the reported shallow depth to groundwater and the analysis presented in **Table 2.1** and **Table 2.2**, the available information suggests that there is some interaction between groundwater and surface water. Any such interactions would be expected to be greater during periods of higher rainfall (e.g. in winter in 2016). However, the available data relating to co-located groundwater and surface water conditions is limited, which makes the degree of potential interaction difficult to determine. The collection of additional co-located groundwater and surface water data, alongside review of groundwater standing water levels, may assist in better understanding the degree of interaction.

### 2.2.5 Use of Groundwater

Several reviews have been undertaken between 2016 and 2019 to determine the potential uses of groundwater at, and to the west of the airport. The reviews undertaken are discussed below.

In general terms, AAL has indicated that potable water at the airport, and in all areas surrounding the airport, is sourced from the reticulated water supply. No licenses are issued for the extraction of groundwater from the shallow aquifer for potable use off-airport. In Section 2.8.2 of the SA EPA Guidelines for the Assessment and Remediation of Groundwater Contamination (SA EPA 2009) it is

noted that groundwater in metropolitan Adelaide is not to be considered for potable use because of the salinity of the water and the presence of a town water supply.

Groundwater is not used by the neighbouring Golf Courses for irrigation or other purposes; golf course operations are understood to utilise recycled water from the Glenelg Waste Water Treatment Plant (GWTP) (AAL, pers. comm.).

### **GHD, 2016**

A groundwater database search undertaken by GHD on 13 June 2016 identified 872 registered groundwater wells within a 2.5 km radius of the airport. 110 of these wells were identified to be operating with the recorded well depth ranging from 0.3 to 340 m bgl. The registered bores are summarised in **Table 2.4**.

**Table 2.4: Summary of Registered Bores (GHD 2018a)**

Registered Use	No. Bores	Bores identified on-airport? <sup>1</sup>	Bores identified off-airport (west or north-west)? <sup>1</sup>
Domestic	219	No	Yes, closest bore located approximately 200 m west and north-west and adjacent to the northern boundary
General, Monitoring, Investigation, Observation and Unknown	605	Yes, numerous bore identified on-airport	Yes, closest bores located adjacent to the western and northern boundary and approximately 200 m to the north-west
Drainage and Industrial	31	Yes, 1 bore in the south-west corner	Yes, closest bore located approximately 1.2 km west and 800 m north-west
Irrigation	10	Yes, 1 bore located at the northern boundary	No, irrigation bores located to the north with the closest bore approximately 300 m from the northern boundary
Geothermal and Recharge	7	No	No, recharge bores located to the north with the closest bore approximately 1 km from the northern boundary

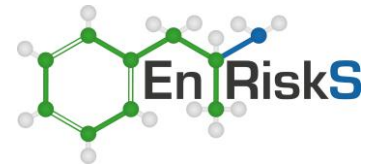
**Notes:**

1 = Based on a review of Figure 2 in Appendix D of GHD (2016a), where able to be determined based on the adopted colour scheme

**Table 2.4** indicates that one bore registered for irrigation purposes and one bore registered for drainage/industrial purposes was identified on-airport. However, it is understood that these bores are no longer in use. Further, the irrigation bore no longer exists as the location has recently been re-paved and it is likely the well was destroyed at this time (AAL, pers comm.).

**Table 2.4** also identifies that registered domestic, drainage/industrial and unknown bores are located downgradient of the airport. The total dissolved solids (TDS) concentrations in the registered wells was reported in the range 229 to 35,583 mg/L. The electrical conductivity of on-airport groundwater samples collected by GHD (2018a) was in the range 416 to 36,920  $\mu\text{S}/\text{cm}$  which equates to TDS concentrations of 266 to 23,629  $\text{mg}/\text{L}^2$ . In accordance with the Australian Drinking

<sup>2</sup> Based on a conversion factor of 0.64.

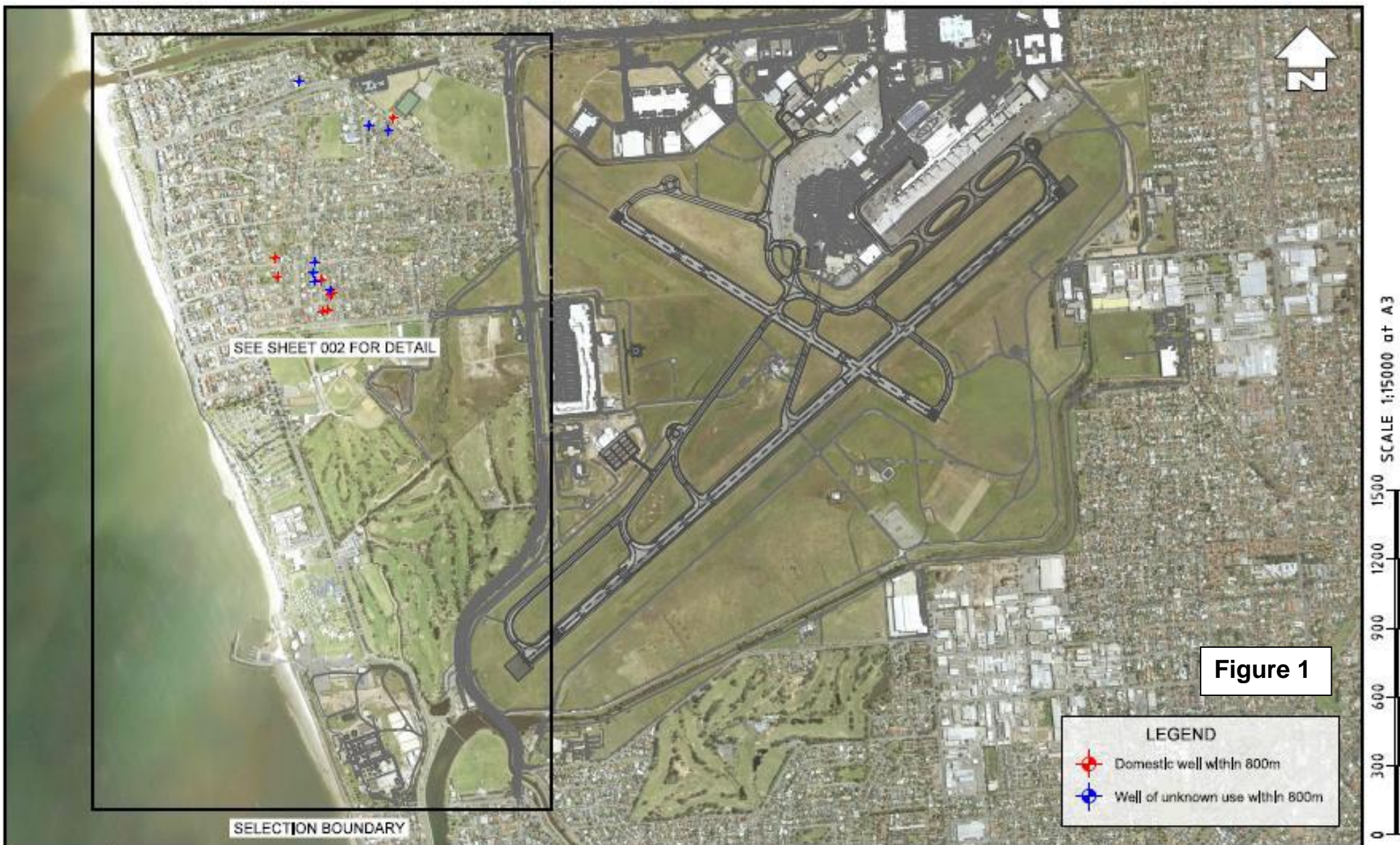


Water Guidelines (NHMRC 2011 Updated 2016), water with a TDS of less than 600 mg/L is regarded as good quality drinking water.

### ***Environmental Projects, 2017***

A further review of the potential for off-airport groundwater use was undertaken by Environmental Projects in 2017 (Environmental Projects 2017). Approximately 185 groundwater bores were identified to be located within a 1 km radius of the airport. Of these bores, 15 domestic bores or unknown bores were located within 800 m of the western airport boundary and considered to have the potential to be active and impacted by airport activities. It was identified that these bores had a high salinity ( $>2,500 \mu\text{S/cm}$  electrical conductivity) and were constructed prior to 1985. It was also likely that the domestic bores were targeting deeper aquifers than that investigated at the airport.

The locations of the identified bores are shown on **Figure 1** and **Figure 2**.



**Figure 1**

**LEGEND**

- ✕ Domestic well within 800m
- ✕ Well of unknown use within 800m

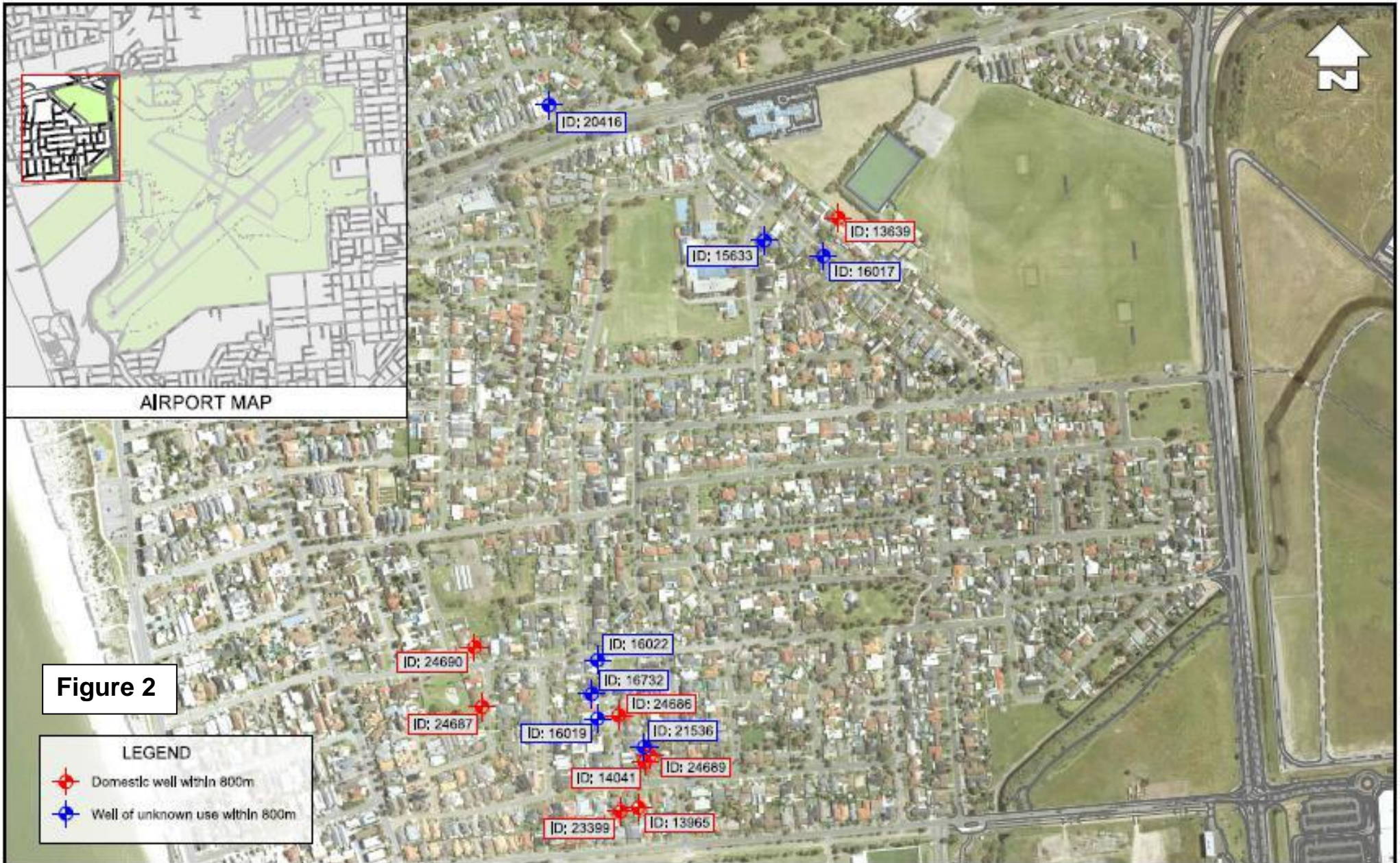
N.A	NEW DRAWING	RJK	24.04.18	0
DRAWN	COMMENTS	APPROVED	DATE	NO.

**ADELAIDE AIRPORT**  
**GROUNDWATER USE MAP**  
 PFAS INSPECTION  
 OFF-AIRPORT

1 James Bonney Drive  
 Adelaide Airport  
 South Australia 5000

Phone +61 8 8308 8211  
 Fax +61 8 8308 2011  
 ad@adelaideairport.com.au

DRAWING NO.	C2042
SHEET NO.	A3 001



N.A	NEW DRAWING	RJK	24.04.18	0
DRAWN	COMMENTS	APPROVED	DATE	NO.

**ADELAIDE AIRPORT**  
**GROUNDWATER USE MAP**  
 PFAS INSPECTION  
 OFF-AIRPORT

**Adelaide Airport**  
 1 James Bonar Drive  
 Adelaide Airport  
 South Australia 5052  
 Phone +61 8 8206 8211  
 Fax +61 8 8206 8311  
 www.adelaideairport.com.au

DRAWING NO.	C2042
SHEET NO.	A3 002



### **GHD, 2019**

Between November 2018 and February 2019, GHD conducted a further investigation, including an up to date registered groundwater bore search and a water use survey of residential and recreational properties within a defined investigation area to the west of the airport (GHD 2019). A total of 24 registered groundwater bores were identified within the investigation area. Phase 1 of the water use survey covered 100 properties in the suburb of West Beach within 200 m of the airport's western boundary. The investigation area and water use survey was subsequently extended to cover an additional 113 properties within 500 m of the western airport boundary in Phase 2. The survey was conducted via doorknock and on-line survey. The Phase 1 and Phase 2 investigation area is shown on **Figure 3**.



Figure 3



Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1994  
Grid: GDA 1994 MGA Zone 54

Airservices Australia  
Airservices Bore Survey and  
Surface Water Sampling  
  
Groundwater Use Survey Areas  
and Well Locations

Project No. 33-18931  
Revision No. A  
Date 22 Feb 2019

FIGURE 1

Data source: Streets - SA DPTI 2015, Cadastre - SA DPTI 2014, Satellite Imagery - ESRI Imagery, Basemap (Extracted 19 Oct 2018), Created by: kvalesco

A total of 46 responses to the water use survey were received: 22 residents responded to the Phase 1 survey with an additional 24 residents responding to the Phase 2 survey. This represents a 22% response rate.

The water use survey results indicated the following:

- 44 respondents (96%) were residential property owners. The remaining 2 responses were from a commercial property and a recreational property;
- Mains water was connected to all buildings;
- Groundwater bores were identified at 2 properties;
- No properties had bore water connected to buildings;
- Rainwater was utilised at 8 properties;
- The source of water used for outdoor/non-potable use was mains water at 44 properties, tank water at 21 properties and bore water at 2 properties. The bore water was used for irrigating lawns. One of these properties also has a rainwater tank however it was indicated that the tank was never used to store bore water; and
- Bore water is not used for stock watering or swimming.

Five off-airport groundwater wells were also installed and sampled within the investigation area by GHD (wells GW16\_11, GW16\_12, GW16\_13, GW16\_14 and GW16\_15; refer to **Section 4** for further information). Western boundary well GW16\_03 was also sampled during the investigation. TDS concentrations reported in these wells are summarised in **Table 2.5**, alongside the information provided in relation to the suitability of water for irrigating fruit/vegetables or watering chickens (ANZECC 1992).

**Table 2.5: Summary of Groundwater TDS Concentrations (GHD 2019)**

Well ID	TDS Concentration (mg/L)		Comments (with Reference to ANZECC 1992) <sup>1</sup>
	November 2018	February 2019	
GW16_03 (boundary)	--	16,000	Class 5 for fruit and vegetables. Unsuitable for chickens
GW16_11 (off-airport)	23,500	20,900	Class 5 for fruit and vegetables. Unsuitable for chickens
GW16_12 (off-airport)	10,300	11,500	Class 5 for fruit and vegetables. Unsuitable for chickens
GW16_13 (off-airport)	15,700	2,700	<b>November 2018:</b> Class 5 for fruit and vegetables. Unsuitable for chickens <b>February 2019:</b> Class 4 for fruit and vegetables. Suitable for chickens
GW16_14 (off-airport)	--	1,300	Class 3 for fruit and vegetables. Suitable for chickens
GW16_15 (off-airport)	--	8,500	Class 5 for fruit and vegetables. Unsuitable for chickens

**Notes:**

1 = ANZECC (1992) has since been revised (in 2018) however the revised guidance does not include all the information available in ANZECC (1992) in relation to this issue. Hence, ANZECC (1992) has been referred to.

A summary of the ANZECC (1992) water classes for fruit and vegetables is provided in **Table 2.6**.

**Table 2.6: Summary of Water Class Based on TDS (ANZECC 1992)**

Class (Well ID)	TDS Concentration (mg/L)	Description	Fruit/Vegetable Suitable For:
Class 3 (GW16_14)	500-1,500	High salinity, requires adequate drainage and salinity control, and salt tolerant plants	<b>Fruit:</b> Mulberry, apple, pear, raspberry, quince <b>Vegetables:</b> Cauliflower, bell pepper, cabbage, broccoli, tomato, beans, sweet potato, artichoke
Class 4 (GW16_13)	1,500-3,500	Very high salinity, not suitable for use under ordinary conditions	<b>Fruit:</b> Olive, fig, pomegranate, cantaloupe <b>Vegetables:</b> Spinach, asparagus, kale, beets, gherkin
Class 5 (Remaining wells)	>3,500	Extremely high salinity and can be used only on permeable, well-drained soils under good management and for salt tolerant crops or occasional emergency use	<b>Fruit:</b> None. ANZECC guidance lists water as suitable for dates however the TDS concentrations are over double the threshold and unlikely to be suitable. <b>Vegetables:</b> None

Review of **Table 2.5** and **Table 2.6** indicates that the groundwater quality at well GW16\_13 and GW16\_14 may be suitable for growing some fruit and vegetables and watering chickens. Groundwater at other wells is not suitable for this purpose.

The future use of groundwater for filling swimming pools is also considered possible.

### Summary

In summary, the available information indicates that groundwater to the west of the airport is not currently used for potable water supply or for any non-potable uses except for irrigating lawns at 2 properties. This means that groundwater is not being used in a way that could result in the accumulation of PFAS into edible products that could be subsequently home consumed. This exposure pathway is currently incomplete, and where there is no exposure to PFAS in edible products, there are no health risks from PFAS in edible products. No swimming pools have been identified. Hence, the only exposure pathway of concern in relation to the current use of groundwater in the off-airport investigation area is incidental direct contact during the non-potable use.

Except for wells GW16\_13 and GW16\_14, groundwater is not suitable for growing fruit/vegetables or watering chickens due to its high TDS content. In the area of GW16\_13 and GW16\_14, the future use of groundwater for watering fruit, vegetables and chickens is considered possible, noting also that the identified registered domestic bores are in this area (GHD 2019). The future use of groundwater for filling swimming pools is also considered possible, as is the potential for incidental direct contact with groundwater during non-potable use.

The above exposure pathways have been considered further in this HHERA.

### 2.2.6 Use of Surface Water

The extraction and use of surface water has not been identified during any of the investigations undertaken at the airport. This HHERA has assumed that surface water on- and off-airport is not extracted for any use.

### 2.2.7 Other Sources of Water

AAL (2014) notes that where practicable, recreation areas and associated facilities should be irrigated with or serviced by the re-use of treated stormwater runoff and/or treated effluent from the GWTP.

Recycled water from the GWTP has been used to irrigate areas of the airport for more than 15 years. Wells labelled “IRR”, located in the north-eastern corner of the airport, are groundwater wells installed to monitor groundwater conditions following the use of water from the GWTP for irrigation (they are not wells installed to access groundwater as a source of irrigation water). AAL (2014) indicates that recycled water is also used for flushing toilets in the main terminal building and in the Australian Federal Police Building, the plant nurse (which is no longer operational; AAL *pers. comm.*) and the terminal plaza water feature.

Stormwater currently harvested from the short-term car park roof is collected and piped into Terminal 1 for use in the air conditioning system however stormwater is not used for any other purpose at the airport. The Adelaide Airport Stormwater Harvesting Scheme is a stormwater re-use program that is currently being evaluated for future use at the airport within a trial, however is not currently operational. It is proposed that this scheme will source water from the Brownhill/Keswick Creek system and will initially harvest around 400 ML/year (AAL, 2014). PFAS risk issues should be considered during the future planning, design commissioning and implementation of the Adelaide Airport Stormwater Harvesting Scheme.

## 2.3 Introduction to PFAS

This section is an introduction to PFAS chemicals that has been compiled based on enRiskS' experience in undertaking human health and ecological risks assessments for PFAS in Australia.

As indicated in **Section 1**, PFAS do not occur naturally in the environment. They are man-made chemicals with unique properties that make materials stain- and water-resistant because the compounds repel oil, grease and water. These unique properties also make them persistent in the environment and highly mobile in soil and water i.e. they readily leach into groundwater.

Most environmental investigations for contaminated sites involve chemicals that break down over time, and this is considered when assessing the fate of the chemical. Many of the chemicals in the PFAS family do not break down over time in the environment due to the strength of the carbon fluorine bond. As a result, investigations of sites which may be contaminated with PFAS chemicals are focused on where the chemicals are and how and where they may travel, over longer timeframes and usually with less (or no) attenuation.

Not only are PFAS chemicals extremely difficult to break into their component parts in the environment, but organisms cannot easily metabolise them. They are readily absorbed into the body for most organisms given their water solubility. Also, unlike most water-soluble chemicals, they are difficult to remove from the body once taken in, at least for some organisms including humans. This combination means that they can build up inside organisms that are exposed – i.e. they bioaccumulate and biomagnify. Bioaccumulation is the gradual build-up of a chemical, such as PFOS, in an organism over time. Biomagnification is the increase in the concentration of a chemical as you move up the food chain. Both these processes occur when an organism absorbs the chemical faster than it is removed. The potential for PFAS to bioaccumulate and biomagnify is a

characteristic of these chemicals that makes them more likely to pose a risk to human health or the environment.

PFAS also behave differently to other chemicals where bioaccumulation is of concern, such as organochlorine pesticides like DDT and polychlorinated biphenyls (PCBs). Chemicals such as DDT or PCBs are not water soluble and so do not easily travel from where they were used. Such chemicals also accumulate in the lipids in organisms and tend to take quite some time to accumulate to high levels. For PFAS, their water solubility means they can easily move from areas where they have been used into off-airport areas. They accumulate by attaching to proteins in blood and other organs and this can occur quite rapidly, especially for aquatic organisms (days to weeks instead of years or decades for the other types of bioaccumulative chemicals discussed above).

There are a large number (thousands) of PFAS compounds, however, most reviews in the scientific literature have focused on perfluorooctane sulfonate (PFOS), perfluorooctanoate (PFOA) and, more recently, perfluorohexane sulfonate (PFHxS). The reasons why these PFAS have been the focus include:

- Many of the other PFAS compounds break down into one or more of these 3;
- These 3 PFAS are extremely difficult to break down any further and so are persistent;
- These 3 PFAS are found in the highest concentrations in the environment (water, soil and sediment);
- These 3 PFAS are known to be bioaccumulative, with PFOS usually of most concern from a bioaccumulation perspective; and
- Due to the above, these 3 PFAS are usually of most concern from a regulatory perspective.

Studies have investigated whether PFAS can be found in organisms (plants, animals and people). These studies have found that PFOS, PFOA and PFHxS are the PFAS chemicals most commonly reported to be present in organisms that people consume as food (e.g. fish).

On this basis, PFOS, PFHxS and PFOA have been identified as the chemicals of potential concern (CoPCs) for this HHERA.

Site investigations in the USA, Europe and Australia have shown that the main exposure pathway in both humans and animals for PFAS is the oral (also known as the ingestion or consumption) pathway. This pathway normally drives the evaluation of risk issues. Potential ingestion pathways include consumption of water (drinking, cooking, showering, swimming, boating, cleaning, etc.) and ingestion of soil or sediment. For PFAS, consumption of food also needs to be evaluated. Aquatic biota (fish and other aquatic organisms) can be exposed to these chemicals via direct uptake from the water in which they live or consuming water, or in sediment or food that has been affected.

PFAS are not volatile at environmental (neutral) pH, so the vapour inhalation/vapour intrusion pathway does not require assessment in a PFAS HHERA. Although the data is limited, there is scientific evidence to suggest that the dermal absorption is limited in comparison to the ingestion pathway.

## 2.4 Identified Potential PFAS Source Areas

In relation to Airport Rescue and Firefighting (ARFF) services, GHD (2018a) identified the following main PFAS source areas on-airport:

- The Fire Station: located to the north-west of the intersection of the two runways. The Fire Station was constructed in the 1950s;
- The Former Fire Training Ground (Former FTG): located in the south-east portion of the airport. Activities at the Former FTG ceased around 2000; and
- The Former Concrete Water Tank Area: located adjacent to the eastern boundary road directly west of Watson Avenue. Aqueous film forming foams (AFFF) were formerly stored and used in fire training activities in this area. Activities in this area ceased around 2000.

Other potential PFAS source areas identified by GHD (2018a) include:

- The Current Fire Training Ground (Current FTG): located in the south-east portion of the airport. The Current FTG was constructed in 2000;
- The former on-airport landfill: located in the south-eastern corner of the airport. The landfill is understood to be backfilled with sand and a peaty layer, with some building rubble. The former Deeds Road Landfill and the southern portion of the airport is also identified as a potential PFAS source area by Golder (2016), as distinct from the on-airport former landfill and the off-airport Deeds Road Landfill;
- The transmitter building complex at Netley (the location for most of the fire extinguisher training);
- The emergency services reporting point;
- Bay 8 Apron: a previous fuel spill occurred in 1997; and
- The area outside the perimeter gate near Morphett Road Gate 10.

In addition, GHD (2018a) indicates that some of the commercial areas located in the northern portion of the airport may have small (<20 L) tank systems containing AFFF. AFFF is also known to have been stored in the Exxon Mobil Joint Owned Storage Facility (JOSF) located in the Burbridge Commercial District in the north-west part of the airport. 'Crash remote' training was also undertaken at isolated locations around the airport.

AAL (2014) indicates that the Former and Current FTG are known to be impacted with PFOS and PFOA and ASA is responsible for remediating these areas.

The location of the potential PFAS source areas are shown on the plans in **Appendix A**.

Recent investigations undertaken by Golder (2018) has also indicated that groundwater migrating onto the airport from the east contains low concentrations of PFAS (PFOS + PFHxS in the range 0.1 to 1.9 µg/L and PFOA of 0.03 to 0.06 µg/L). The source of PFAS in groundwater upgradient of the airport has not been determined.

## Section 3. HHRA, Issue Identification: On-Airport

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### 3.1 General

This section of the report provides a more detailed review of the exposure pathways and individuals or groups of individuals relevant to PFAS compounds identified in environmental media on-airport, and if the PFAS concentrations are sufficiently elevated to require a detailed assessment of human health risk. The review presented here has considered data collected on-airport for the purpose of characterising PFAS risk issues.

The relevant data and plans have been extracted from the available investigation reports (where possible) and provided in **Appendix A**.

### 3.2 Potential for Exposure

The following human receptors have been identified in the context of the ongoing use of the airport.

- Airport workers;
- Other tenants; and
- Members of the general public (i.e. visitors).

Exposures by visitors will be less than for workers (including contractors) and tenants as visitors will be present for less time on-airport. Hence, this assessment has focused on risks to workers and tenants with the view that this will also be protective of visitors.

Further discussion of the relevant exposure pathways for airport workers and tenants is provided below.

PFAS are readily absorbed via the oral route of exposure, however they are not volatile at environmental pH and there is scientific evidence to suggest that the dermal absorption is limited in comparison to the ingestion pathway. Regardless, the potential for dermal exposure has been considered in the HHERA.

No edible products are grown and consumed on-airport.

#### ***Airport Workers***

Airport workers may encounter PFAS impacted soil, groundwater and surface water during operational activities including excavation works that extend into groundwater or maintenance of surface water collection structures. Where there are no exposures to PFAS in soil/sediment and/or water, there are no health risks from PFAS. This means there are no health risks from PFAS to office workers and workers who are not involved in activities where contact with PFAS in soil/sediment and/or water may occur.

With respect to potential exposures to PFAS by workers, the July 2016 AAL Guideline for PFAS Work Health and Safety specifies that PFAS exposures should be considered, and where necessary, included in JSAs, SWIs and Take 5 risk assessments prior to the commencement of works. Suggested control measures include dust control, the use of personal protective equipment (PPE) comprising gloves, dust masks and protective eyewear and the appropriate decontamination

of PPE following works. The Guideline notes that these control measures form part of controls already in place to manage existing risks.

In addition, the January 2016 Adelaide Airport Guideline for Construction Dewatering indicates that dewatering may be required if excavations associated with development works extend below the depth of the shallow groundwater aquifer or into surface water. Dewatering is only implemented when other controls (e.g. up-slope stormwater management measures) are not adequate to allow for the safe and effective completion of works. Where dewatering is required, contractors are required to submit a Dewatering Management Plan (DWMP) and Construction Environment Management Plan (CEMP) to AAL as part of the Building Approval Application.

ASA has indicated that the foam carried and used by ARFF services on-airport is and has been PFAS free since 2010. Hence, further assessment of potential risks to workers during firefighting training activities with AFFF has not been undertaken in this HHERA.

### **Tenants**

With the exception of the area in the north-east corner of the airport which is irrigated with recycled water from the GWTP, sampling for PFAS in non-operational areas of the airport has not been undertaken to date. Exposures to PFAS in non-operational areas of the airport are likely to be incomplete due to the following reasons:

- Access to all operational areas of the airport is restricted. Hence, except for ASA and AAL employees or contractors, tenants are unlikely to come into direct contact with soil that may be impacted with PFAS;
- Dust suppression measures are implemented to minimise exposure of aircraft to dust. Hence it is unlikely that tenants will be exposed to dust impacted with PFAS;
- No sensitive tenancies are present at the airport (all tenancies can be categorised as non-sensitive commercial/industrial land uses) except for a child care centre which is located upgradient of all potential and known PFAS impacted areas. There are no playground or general recreational areas at the airport.
- A reticulated (i.e. mains) water supply is available at the airport and groundwater is not used for any purpose at the airport; and
- Stormwater is used in the Terminal 1 air-conditioning system but not for any other purpose.

Recycled water from the GWTP is however utilised for irrigation, flushing of toilets and in water features. The use of recycled water from the GWTP for irrigation and in water features has been considered further in the HHERA as tenants may come into contact with the water during its use for irrigation or in the plaza water feature. Workers may encounter recycled water during maintenance of the irrigation systems.

**Table 3.1** presents a more detailed overview of the exposure pathways relevant to the assessment of human exposure on-airport. The table also outlines the data that is relevant to the assessment of these exposures and outcomes of the screening level assessment undertaken. Text shown in **blue** indicates that risks have been concluded to be acceptable while text shown in **purple** indicates that further assessment is required or recommended. Where data is available this further assessment has been presented in the HHERA.

**Table 3.1: Summary of Key Exposure Pathways – On-Airport**

Exposure Pathway/Media	Potentially Significant Pathway?	Comments	Screening Assessment <sup>4</sup>
<b>Airport Workers</b>			
Incidental ingestion of PFAS in soil	✓	Direct contact exposures (including incidental ingestion, dermal contact with soil and the inhalation of dust) may occur during above and below ground excavation activities that involve contact with soil. This may include works required for the installation of services or re-surfacing of paved areas.	Soil screening guidelines are available for commercial/industrial workers, based on the protection of ingestion, dermal contact and inhalation exposures. These criteria are also protective of exposures that may occur during excavation works. <sup>2</sup> The screening level assessment is presented in <b>Section 3.3</b> . <b>Soil concentrations in the Current and Former FTG and Fire Station exceed the adopted guidelines relevant to direct contact exposures by Airport Workers. Further assessment of potential exposures by Airport workers is required to be undertaken and is presented in Sections 5 to 7.</b>
Dermal contact with PFAS in soil <sup>1</sup>	✓		
Inhalation of PFAS in dust generated from the airport	✓		
Incidental ingestion of PFAS in water <sup>3</sup>	✓	Direct contact exposures (including incidental ingestion and dermal contact) may occur during excavation activities that intercept shallow groundwater and/or surface water. These activities may include the installation of services or the re-alignment of drains. Airport workers are unlikely to spend a significant amount of time wading or walking in water as part of the works as dewatering activities are undertaken where works may intercept shallow groundwater or surface water. Direct contact exposures with recycled water used for irrigation may also occur during maintenance of the irrigation systems. Inhalation exposures will not occur as PFAS are not volatile. In addition, while the irrigation of water may generate aerosols, these will be large enough to be	No current potable or recreational use of water on-Base. Hence the screening level assessment has considered guidelines more relevant to incidental contact. <b>Groundwater and/or surface water concentrations in the Current and Former FTG, the Fire Station and the Former Concrete Water Tank Area exceed the adopted guidelines relevant to direct contact exposures by Airport Workers. Further assessment of potential exposures by Airport workers is required to be undertaken and is presented in Sections 5 to 7.</b>
Dermal contact with PFAS in water <sup>1</sup>	✓		

Exposure Pathway/Media	Potentially Significant Pathway?	Comments	Screening Assessment <sup>4</sup>
		swallowed (and ingested) rather than inhaled into the lungs. <sup>3</sup>	
<b>Tenants</b>			
Incidental ingestion of PFAS in recycled water used for irrigation	✓	Incidental ingestion of a small amount of recycled water may occur during the use of recycled water for irrigation in the north-east portion of the airport near tenancies. This is most likely to occur through the inhalation of aerosols from spray drift.	Consistent with the assessment for airport workers, the screening level assessment has considered guidelines more relevant to incidental contact.
Dermal contact with PFAS in recycled water used for irrigation <sup>1</sup>	✓	<p>Dermal contact with PFAS in recycled water may occur if tenants inadvertently walk under or next to the sprinklers or put their hands in the plaza water fountain.</p> <p>Inhalation exposures will not occur as PFAS are not volatile. In addition, while the irrigation of water may generate aerosols, these will be large enough to be swallowed (and ingested) rather than inhaled into the lungs.<sup>3</sup></p>	<p>The screening level assessment is presented in <b>Section 3.6.</b></p> <p><b>No PFAS concentrations of concern identified in water relevant to incidental contact by tenants).</b></p>

**Notes for Table 3.1:**

- “✓” = Exposure pathway is considered to be potentially complete and has been assessed further in this HHERA.
- “✓” = Exposure pathway is considered to be limited, however has been assessed further in this HHERA for completeness.
- 1 = Dermal uptake of PFAS in soil and water is understood to be limited in comparison to the incidental ingestion pathways (refer below for further information) however further assessment has been provided in this HHERA for completeness
- 2 = The soil screening guidelines for commercial/industrial workers are protective of all exposures that would occur by excavation workers. For example, the health screening level for direct contact with non-volatile total recoverable hydrocarbons (TRH C16-C34) in soil is 27,000 mg/kg for a commercial/industrial worker and 85,000 mg/kg for an excavation worker (CRC CARE 2011). This is because although excavation workers may have a higher exposure to soil than commercial/industrial workers, this only occurs for a short period of time and on an infrequent basis.
- 3 = Potential risks associated with the generation of fine aerosols, that may be inhaled instead of ingested, have not been assessed in this HHERA. If activities that may generate fine aerosols from PFAS impacted water are proposed, a further assessment should be undertaken prior to the commencement of the activity. This further assessment should consider all relevant exposure pathways.
- 4 = A screening assessment is the process where by conservative guidelines are adopted for the assessment of human and ecological receptors. If concentrations of the contaminant in the environmental media is below the adopted screening guidelines, it can be concluded that no further assessment of risk issues is required. Where concentrations exceed the adopted screening guidelines, this does not mean that there is a risk to human or ecological health. Rather this means that a more detailed review of human health or ecological risk is required to be undertaken.

### 3.3 Available Data

#### 3.3.1 General

A number of investigations have been undertaken previously at the airport and some of these investigations included sampling for PFAS (refer to **Section 1.4**). PFAS investigations have been undertaken at the request of AAL and ASA and have considered the following:

- AAL is the primary tenant of the airport. Investigation works undertaken by and at the request of AAL have generally targeted the airport boundaries to assess whether PFAS in environmental media at the airport may be discharging off-airport. Investigations to assess the potential connection between groundwater and surface water have also been undertaken; and
- ASA is one of AAL's tenants and provides fire-fighting services to the airport. From a legal perspective, ASA are responsible for the assessment and remediation any pollution they cause. Under the Airport (Environmental Protection) Regulations 1997, AAL has responsibilities to ensure its tenants, including ASA, meet their regulatory obligations but the primary responsibility resides with the tenants. So, in relation to PFAS contamination on- and off-airport at Adelaide Airport, ASA are responsible under both State and Federal legislation, and accordingly, have been responsible for both the on- and off-airport investigations at Adelaide Airport.

Given the above, AAL commissioned the Golder (2016) *Site History and Qualitative Risk Assessment* and the LBW (2016) *PFAS Investigation* reports to assess potential receptors and exposure pathways to PFAS on- and off-airport and inform the need for further assessment, remediation and management. Results from automated stormwater sampling and a groundwater monitoring event undertaken by Golder in September 2016, are also available for review.

Copies of reports outlining PFAS investigations undertaken at the request of ASA (S&G 2004; GHD 2008; S&G 2009; S&G 2011; S&G 2012; S&G 2013; GHD 2017; GHD 2018a; GHD 2018b) were also requested by AAL for inclusion in this HHERA. Of the above reports, Golder (2016) and GHD (2018a) do not include any data for PFAS (as this was not the objective of the reports). Hence, these reports have not been included in the review of data provided below but have been considered in the development of the CSM.

Results from the PFAS investigations are discussed below, in relation to the main PFAS source areas, and other areas of the airport. Relevant extracts from the assessment reports are provided in **Appendix A**.

#### 3.3.2 Current and Former FTG

The Current and Former FTG have been grouped together for the purpose of the HHERA as they are both in the same part of the airport and are around 170 m apart. Sampling of groundwater well GW16\_04 located between these areas (to the south of the Current FTG and to the north of the Former FTG) indicates that PFAS impacts in groundwater likely extended between both areas.

Investigation works have been undertaken in the Former and Current FTG by GHD (2008), S&G (2009), S&G (2011), S&G (2012), S&G (2013), GHD (2017) and GHD (2018b). The scope of assessment works completed comprised the following:

- GHD (2008): collection of groundwater samples from two existing wells in the Current FTG (NGW1 and NGW2). Five test pits (TP01 to TP05) were installed in the Former FTG and groundwater samples were collected from five existing wells (GW01R, GW2, GW3, GW5 and GW6) in the Former FTG. Soil samples and groundwater samples were analysed for perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA).
- S&G (2009): installation of six soil bores (SB01 to SB06) in the Current FTG, with five soil samples analysed for PFOS and PFOA;
- S&G (2011): installation of eight soil bores (SB01 to SB08) in the Current FTG with five soil samples analysed for PFOS, PFOA and 6:2 fluorotelomer sulfonate (6:2 FtS);
- S&G (2012): installation of eight soil bores (SB01 to SB08) in the Current FTG and sampling of two existing groundwater wells (GW01 and GW02). Five soil samples and two groundwater samples were analysed for an extended PFAS suite;
- S&G (2013): installation of eight soil bores (SB01 to SB08) in the Current FTG and sampling of two existing groundwater wells (GW01 and GW02). Nine soil samples and two groundwater samples were analysed for an extended PFAS suite;
- GHD (2018b): installation of one soil bore (GW16\_05) in the current FTG and one soil between the Current FTG and the Former FTG (GW16\_04), with both bores subsequently converted to groundwater wells. One round of groundwater sampling was undertaken of the 2 new wells along with existing wells GW5 and GW6 in the Former FTG and soil and groundwater samples were analysed for an extended PFAS suite; and
- GHD (2017): groundwater sampling of wells GW01, GW02, GW16\_04 and GW16\_05, and surface water sampling at location CFTG\_SW. Groundwater samples and the surface water sample were analysed for an extended PFAS suite.

### **3.3.3 Former Concrete Water Tank Area**

GHD (2018b) included the installation of one soil bore (GW16\_01) within the Former Concrete Water Tank Area, which was subsequently converted to a groundwater well. One round of groundwater sampling was undertaken and soil and groundwater samples were analysed for an extended PFAS suite.

### **3.3.4 Fire Station**

GHD (2018b) included the installation of one soil bore (GW16\_07) within the Fire Station, which was subsequently converted to a groundwater well. One round of groundwater sampling was undertaken and soil and groundwater samples were analysed for an extended PFAS suite. One surface water sample (SW16\_03) was also collected and analysed for an extended PFAS suite.

GHD (2017) included the sampling of well GW16\_07. A surface water sample was also collected from location MFS-SW. The groundwater and surface water samples were analysed for an extended PFAS suite.

### 3.3.5 Other Areas of the Airport

LBW (2016) completed a PFAS investigation at the request of AAL to assess off-airport risks from PFAS. The investigation included the sampling of ten existing and six new groundwater wells with analysis of collected groundwater samples for an extended PFAS suite. Groundwater wells were located in four main areas of the airport:

- The western part of the airport, to the west of the Former and Current FTG and the Fire Station (six wells; GW1-PFC, GW2-PFC, GW4-PFC, HELI-GW, PFC5 and PFC6);
- The eastern part of the airport, to the east of the Former and Current FTG and the Fire Station (four wells; GW1, GW3-PFC, BGW1 and BGW2). GW1 was installed to target the former landfill and wells GW3-PFC, BGW1 and BGW2 are located on the eastern airport boundary;
- The north-east corner of the airport where recycled water is used for irrigation (five wells; WELL1-IRR, WELL2-IRR and GW13 to GW15); and
- The north-west corner of the airport (well BBP-GW1).

Wells GW4-PFC and WELL2-IRR were sampled on 2 occasions with the remaining wells sampled once. Composite surface soil samples (SS IRR 1, SS IRR 2 and SS IRR 3) were also collected from historical irrigation areas in the north-east corner of the airport. Samples collected by LBW were analysed by NMI at the request of AAL, and hence NATA reports are not provided in the LBW reports however these reports have been made available to enRiskS.

Golder (2017) sampled five groundwater wells (GW9R, GW12R, HELI-GW1, OTR-MW3 and WELL3) for PFAS as part of the annual GME at the airport. It is noted that well OTR-MW3 is well OTR-GW3 and well WELL3 is WELL3-IRR. Wells WELL3-IRR, GW9R and GW12R are located in the north-east corner of the airport where recycled water is used for irrigation. The remaining two wells are located in the western portion of the airport. Groundwater samples were analysed for an extended PFAS suite.

GHD (2016b) included the installation and one round of sampling of two additional groundwater wells on the western airport boundary (GW16\_02 and GW16\_03) and one additional groundwater well on the eastern airport boundary (GW16\_06). Three existing groundwater wells on the northern airport boundary (EW16\_01, EW16\_02 and EW16\_03) were also sampled on one occasion. Collected soil and groundwater samples were analysed for an extended PFAS suite. Seven surface water samples (SW16\_01, SW16\_02 and SW16\_04 to SW16\_08) were also collected and analysed for an extended PFAS suite.

Golder (2018a) comprised the sampling of 36 groundwater wells across the airport. Groundwater samples from wells GW9R, GW12R, Well3 and BBP-GW1 were analysed for an extended PFAS suite.

Tabulated and/or NATA endorsed laboratory results for surface water samples collected by AAL have also been provided for review. It is understood that surface water sampling is undertaken via automated samplers from nine locations at the airport (SW1, SW5, SW10, SW-US1, SW-US2, SW-USFS, SW-DSFS, BHC-1 and BHC-2). Surface water samples were collected between March 2016 and January 2017 and analysed for an extended PFAS suite.

### 3.3.6 Review of Adequacy and Completeness of Available Data

A summary of the quality assurance/quality control (QA/QC) procedures implemented during the collection of the available data is provided in **Table 3.2**.

**Table 3.2: Summary of QA/QC Procedures**

Investigation/ Reference (media sampled)	Analysing Laboratory	Comments
GHD (2008) (soil and groundwater)	Advanced Analytical Australia (AAA)	No field QC samples were analysed for soil. One field QC sample was analysed for groundwater. The overall adopted QA/QC procedures were reviewed by GHD however no conclusion relating to the overall quality of the assessment was presented.
S&G (2009) (soil)	Leeder Consulting	No field QC samples were analysed for soil. The overall QA/QC procedures were reviewed and concluded to be appropriate, although it is noted that the adopted procedures were not PFAS specific.
S&G (2011) (soil)	mgt-Labmark	One field QC sample was analysed for soil. The overall QA/QC procedures were reviewed and concluded to be appropriate, although it is noted that the adopted procedures were not PFAS specific.
S&G (2012) (soil and groundwater)	mgt-Labmark	No field QC samples were analysed for soil. One field QC sample was analysed for groundwater. The overall QA/QC procedures were reviewed and concluded to be appropriate, although it is noted that the adopted procedures were not PFAS specific.
S&G (2013) (soil and groundwater)	eurofins-mgt	One field QC sample was analysed for soil. The overall QA/QC procedures were reviewed and concluded to be appropriate, although it is noted that the adopted procedures were not PFAS specific.
LBW (2016) (groundwater)	Australian Government National Measurement Institute (NMI)	Four field QC samples (duplicates) was analysed for groundwater. A review of adopted QA/QC procedures and confirmed the data quality was adequate for the purposes of the assessment.
Golder (2017) (groundwater)	NMI	One duplicate sample and one rinsate sample analysed for an extended PFAS suite. The overall QA/QC procedures (including those for PFAS) were reviewed and considered to provide sufficient confidence in the primary data set for interpretative purposes.
GHD (2018b)	Australian Laboratory Services (ALS) and eurofins-mgt	Two field QC samples were collected for each of soil, groundwater and surface water. The overall QA/QC procedures were reviewed and concluded to be appropriate.
AAL Soil and Surface Water Data (2016/2017)	NMI	No information available. NB: surface water samples collected with automated samplers.
GHD (2017)	ALS and eurofins-mgt	One field duplicate, 1 field triplicate and 1 field blank were collected and analysed during groundwater sampling. No field QC samples were collected for surface water. The overall QA/QC procedures were reviewed and concluded to be appropriate. Note that there appear to be some discrepancies in Table 5 Appendix D of this report (summary of historical results). For this reason, this table has not been referenced in the HHERA.
Golder (2018a)	SGS Australia Pty Ltd and eurofins-mgt	One field duplicate and 1 field triplicate was collected and analysed during groundwater sampling. PFAS specific sampling procedures were adopted. The overall QA/QC procedures were reviewed and concluded to be appropriate.

**Table 3.2** indicates that except for the more recent (2016 onwards) GHD investigations, implemented QA/QC procedures, specifically the frequency of field duplicate and split samples, was not in accordance with AS4482.1. Most earlier assessments either did not analyse field QA/QC samples or only analysed duplicate samples. In addition, several different analysing laboratories have been used by the assessments. This is important as different laboratories are known to use different analysis methods for PFAS, which may have a direct effect on the concentrations reported. Without the analysis of field split samples, the potential variability between laboratories and effects on the results is difficult to assess.

Most assessment reports provide an overall assessment of the adequacy of the adopted QA/QC procedures, however only the later reports provide a PFAS specific discussion. Hence, it cannot be confirmed whether PFAS specific sampling procedures were adopted for the assessment.

Most of the assessments completed at the request of ASA are for the Current FTG, with the recent GHD (2018b) assessment including the installation and sampling of one soil bore and one groundwater well in the Fire Station and Former Concrete Water Tank Area. The installation and sampling of one soil bore/well in the Former FTG, alongside the sampling of two existing wells, was also undertaken as part of GHD (2018b) to supplement earlier information obtained for this area by GHD (2008). Groundwater and surface water in the Current FTG and Fire Station was re-sampled by GHD (2017).

As noted above, investigation works undertaken by and at the request of AAL have generally targeted the airport boundaries and background locations to assess whether PFAS in environmental media at the airport may be discharging off-airport. One sample of recycled water from the GWTP, and samples from groundwater wells in areas where recycled water is used for irrigation, have also been collected and analysed for PFAS. Well GW1 was also installed to target the former landfill in the south-east corner of the airport and has been sampled for PFAS on one occasion by LBW (2016). GHD (2018b) also included the collection of groundwater and surface water samples at the airport boundaries. This information can be used to evaluate potential risk issues across the remaining areas of the airport.

In summary, there is information available to assess PFAS concentrations in soil and groundwater in the main PFAS source areas (i.e. the Current and Former FTG, the Fire Station and the Former Concrete Water Tank Area), surface water at the Fire Station, and groundwater and surface water in other areas of the airport (including locations on the airport boundaries). However, there is limited specific information relating to concentrations of PFAS in the other identified PFAS source areas (refer to **Section 2.4**). There is also limited information relating to potential variability in reported PFAS concentrations. This variability may be due to the analysis of samples by different laboratories and sampling and analysis protocols. Data pertaining to variation in PFAS concentrations in the environment over time (i.e. seasonal variation) is also limited with the exception of surface water data from locations SW1, SW5 and SW10 (which have been sampled by automated samplers four to five times between March 2016 and January 2017).

The data gaps outlined above have been considered in the evaluation of overall HHERA outcomes.

### 3.4 Nature and Extent of PFOS, PFOA and PFHxS

Table 3.3 presents a summary of concentrations of PFAS in environmental media at the airport, based on a compilation and review of the data presented in the available reports (as listed in Section 1.4). Concentrations of PFOS, PFOA and PFHxS have been presented in this section as these three PFAS are the CoPC for the purpose of the HHERA.

**Table 3.3: Summary of PFOS, PFOA and PFHxS Concentrations Detected On-Airport**

Area/Media Investigated	Investigation/Reference	Reported Concentration Range		
		PFOS	PFHxS	PFOA
<b>Current and Former FTG</b>				
Soil (mg/kg)	GHD (2008)	5.3 – 140	No data	0.082 – 0.58
	S&G (2009)	0.63 - 13	No data	0.1 – 0.88
	S&G (2011)	0.093 – 4.5	No data	<0.005 – 0.046
	S&G (2012)	0.45 – 1.7	0.031 – 2.5	0.024 – 0.64
	S&G (2013)	0.43 – 3.55	0.06 – 0.72	0.02 – 0.25
	GHD (2018b)	0.24 – 0.31	0.008 – 0.57	0.002 – 0.044
Groundwater (µg/L)	GHD (2008)	3.5 - 98	No data	0.2 - 77
	GHD (2018b)	489 – 2,580	444 – 2,420	28.3 - 110
	S&G (2012)	0.065 – 3.5	19 - 110	2.9 - 26
	S&G (2013)	0.02 – 9.9	3.7 – 87.7	0.6 - 24.7
	GHD (2017)	0.48 – 1,180	2.86 – 4,790	0.11 - 174
Surface Water (µg/L)	GHD (2017)	0.18 - 222	0.09 – 45.2	0.03 – 5.82
<b>Fire Station</b>				
Soil (mg/kg)	GHD (2016b)	2.86 – 31.4	0.16 – 0.39	0.025 – 0.032
Groundwater (µg/L)	GHD (2016b)	4,130	861	77.3
Surface Water (µg/L)	GHD (2018b)	125	114	6.97
<b>Former Concrete Water Tank Area</b>				
Soil (mg/kg)	GHD (2018b)	0.19 – 0.74	0.12 – 0.53	0.013 – 0.037
Groundwater (µg/L)	GHD (2018b)	168	209	11
<b>Other Areas</b>				
Soil (mg/kg)	LBW (2016) <sup>1</sup>	<0.005 - 0.011	<0.005	<0.005
	GHD (2018b)	<0.0002 – 0.012	<0.0002 - 0.017	<0.0002 – 0.002
Groundwater (µg/L)	LBW (2016) <sup>1</sup>	<0.005 – 1.1	<0.005 – 9.6	<0.005 – 0.098
	Golder (2017)	0.026 – 0.051	<0.02 – 0.24	<0.02
	GHD (2018b)	<0.01 – 7.59	<0.02 – 52	<0.01 – 2.1
	Golder (2018a)	<0.01 – 0.023	0.028 – 0.09	<0.02
Surface Water (µg/L)	GHD (2018b)	0.05 – 14	<0.02 – 9.05	<0.01 – 0.34
	AAL	<0.005 - 26	<0.005 - 14	<0.005 – 1.5
<b>Recycled Water</b>				
Water from GWTP (Sample IW-PH) (µg/L)	AAL	0.046	0.0065	0.011
Soil (mg/kg) <sup>1</sup>	AAL	<0.005 – 0.011	<0.005	<0.005
Groundwater (µg/L) <sup>2</sup>	LBW (2016), Golder (2017)	0.072 – 0.4	0.11 – 0.24	<0.005 – 0.025

**Notes:**

1 = Samples SS IRR 1, SS IRR 2 and SS IRR 10.

2 = Wells WELL1-IRR, WELL2-IRR, WELL3-IRR, GW13 to GW15, GW9R and GW12R.

### 3.5 Review of Soil Data

#### 3.5.1 General

This section of the HHERA provides a review of the concentrations of PFOS, PFOA and/or PFHxS reported in soil on-airport against the adopted screening level guidelines for the protection of human health.

#### 3.5.2 Adopted Guidelines

The commercial/industrial guidelines from the PFAS NEMP (HEPA 2018) have been adopted for the review consistent with on-going use as an airport with no sensitive land uses near PFAS impacted areas.

#### 3.5.3 Screening Assessment

The review of PFAS concentrations in soil against the adopted screening level guidelines is presented in **Table 3.4**.

**Table 3.4: Summary and Review of PFAS Reported in Soil On-Airport, Human Health**

Area Investigated	Maximum Reported Concentration (mg/kg)	
	PFOS + PFHxS	PFOA
Current and Former FTG	140 <sup>2</sup>	0.58
Fire Station	31.8	0.032
Former Concrete Water Tank Area	0.86	0.037
Other Areas	0.011	0.002
Recycled Water Irrigation Area	0.011	<0.005
<b>Adopted Screening Guidelines<sup>1</sup></b>		
<b>Commercial/Industrial</b>	<b>20</b>	<b>50</b>

**Notes:**

Shading indicates an exceedance of the adopted guideline value.

FTG = Fire Training Ground.

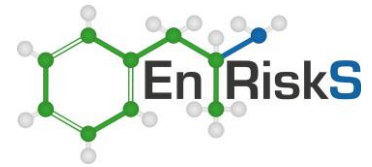
1 = Ref. HEPA (2018).

2 = PFOS only, no analysis for PFHxS.

ND = Not detected at the laboratory limit of reporting (0.005 mg/kg).

Review of **Table 3.4** indicates the following:

- Concentrations of PFOA in soil at all locations are below the adopted screening level guidelines relevant for airport workers and tenants. Hence, there are no health risk issues for PFOA that require further evaluation in this HHERA;
- Concentrations of PFOS + PFHxS in soil in the Former Concrete Water Tank Area, Other Areas and the Recycled Water Irrigation Area are below the adopted screening level guidelines relevant for airport works and tenants;
- Concentrations of PFOS + PFHxS in soil in the Current and Former FTG and the Fire Station exceed the adopted screening level guidelines. It is noted that the maximum PFOS concentration in soil (140 mg/kg; located in the Former FTG) was reported in a sample collected from a stockpile of approximately 20 m<sup>3</sup> soil by GHD (2008). ASA has indicated that this stockpile was sourced from a scrape of the Former FTG surface when the area was decommissioned, and the stockpile remains on-airport. Hence, the maximum concentrations reported in the stockpile by have been considered in the assessment.



Based on the above, further quantitative evaluation of potential exposures following incidental contact with soil by workers in the Former and Current FTG and Fire Station has been undertaken in this HHERA (refer to **Sections 5** to **Section 7**).

### 3.6 Review of Water Data

#### 3.6.1 General

In this section of the HHERA, PFOS, PFOA and/or PFHxS concentrations in groundwater, surface water in the on-airport stormwater drains, and recycled water have been compared against available screening level guidelines to determine if further evaluation is required in relation to incidental direct contact exposures that may occur by airport workers (including contractors) and tenants.

#### 3.6.2 Adopted Guidelines

Available screening level guidelines for PFOS, PFHxS and PFOA including drinking water guidelines and recreational water quality guidelines.

The Australian Drinking Water Guidelines (NHMRC 2011 updated 2018) are 0.07 µg/L for PFOS + PFHxS and 0.56 µg/L for PFOA. The drinking water guidelines are based on the most current toxicity reference values (TRV) of 0.02 µg/kg/day for PFOS + PFHxS and 0.16 µg/kg/day for PFOA (FSANZ 2017a).

The NHMRC (NHMRC 2019) has derived recreational water quality guidelines, that are approximately 20 to 30 times higher than drinking water guidelines. The recreational water quality guidelines are 2 µg/L for PFOS + PFHxS and 10 µg/L for PFOA. This accounts for the ingestion of a smaller volume of water during recreational activities as compared to potable water supply, and the assumption that recreational activities only occur on up to 150 days/year.

Airport workers and tenants will not be swimming in water used or present on-airport. Hence, an additional risk-based criteria (RBC) for incidental contact has been derived for use in the screening assessment. This is a project-specific guideline that more specifically relates to the frequency and duration of exposures that may occur during activities where incidental contact with water may occur. The use of management procedures, including appropriate health and safety plans and safe work practices that include personal protective equipment, have not been considered in the derivation of the site-specific guideline. Such practices will reduce exposures to PFAS in water and hence, the approach adopted is conservative.

If it is assumed that a worker comes into contact with PFAS impacted water for 2 hours per day on 96 days per year (2 days per working week) for 30 years, and they get their hands and forearms wet during this time and ingest 1 teaspoon of water, the RBC for PFOS + PFHxS is 200 µg/L and the RBC for PFOA is 1,800 µg/L. The derivation of the RBC is presented in **Table 3.5** and **Appendix B**.

**Table 3.5: Summary of Guidelines for PFOS + PFHxS and PFOA – Incidental Direct Contact with Water**

PFAS	Adopted Toxicity Reference Value (TRV) (µg/kg/day) <sup>1</sup>	Guideline Values (µg/L)		
		Drinking Water <sup>1</sup>	Primary Contact Recreation <sup>3</sup>	RBC for Incidental Direct Contact <sup>3</sup>
PFOS + PFHxS	0.02	0.07	2	200
PFOA	0.16	0.56	10	1,800

**Notes for Table 3.5:**

- RBC = Risk-based criteria.
- 1 = Ref. Department of Health (2017) and HEPA (2018).
- 2 = Ref. NHMRC (2019).
- 3 = Risk Based Criteria (RBC) derived for use in this HHRA (refer to **Appendix B** for details of assumptions adopted).

**3.6.3 Screening Assessment**

The review of maximum concentrations of PFOS + PFHxS and PFOA in groundwater, surface water and recycled water with the adopted screening level guidelines is presented in **Table 3.6** (for airport workers) and **Table 3.7** (for tenants).

**Table 3.6: Summary and Review of PFAS Reported in Water On-Airport, Health of Airport Workers**

Area/Media Investigated	Maximum Reported Concentration (µg/L)	
	PFOS + PFHxS	PFOA
Current and Former FTG, Groundwater	5,720	174
Current and Former FTG, Surface Water	267	5.82
Fire Station, Groundwater	4,991	77.3
Fire Station, Surface Water	239	6.97
Former Concrete Water Tank Area, Groundwater	377	11
Areas Irrigated with Recycled Water, Groundwater	0.6	0.025
Other Areas, Groundwater	59.6	2.1
Other Areas, Surface Water	40	1.5
Water from GWTP (Sample IW-PH)	0.053	0.011
<b>Adopted Screening Guidelines<sup>1</sup></b>		
<b>Incidental Direct Contact by Airport Workers (including Contractors)</b>	<b>200</b>	<b>1,800</b>

**Notes:**

Shading indicates an exceedance of the adopted guideline value.

- 1 = Risk Based Criteria (RBC) derived for use in this HHRA (refer to **Appendix B** for details of assumptions adopted).

**Table 3.7: Summary and Review of PFAS Reported in Water On-Airport, Health of Tenants**

Area/Media Investigated	Maximum Reported Concentration (µg/L)	
	PFOS + PFHxS	PFOA
Water from GWTP (Sample IW-PH)	0.053	0.011
<b>Adopted Screening Guidelines<sup>1</sup></b>		
<b>Incidental Direct Contact by Tenants</b>	<b>2</b>	<b>10</b>

**Notes:**

Shading indicates an exceedance of the adopted guideline value.

- 2 = Ref. NHMRC (2019).

Review of **Table 3.6** and **Table 3.7** indicates the following:

- Concentrations of PFOA in groundwater and surface water at all locations are below the adopted screening level guidelines for incidental direct contact exposures by airport workers and tenants. Hence, there are no health risk issues for PFOA that require further evaluation in this HHRA;
- Concentrations of PFOS + PFHxS in recycled water that may be used for irrigation are below the adopted screening level guidelines for incidental direct contact exposures by tenants;

- Concentrations of PFOS + PFHxS in groundwater and surface water are below the adopted screening level guidelines for incidental direct contact exposures by airport workers except for in the following PFAS source areas:
  - Current and Former FTG: groundwater and surface water
  - Fire Station: groundwater and surface water
  - Former Concrete Water Tank Area: groundwater

Given this, further quantitative evaluation of potential exposures following incidental contact with groundwater and surface water by workers in the Former FTG and Fire Station has been undertaken in this HHERA (refer to **Section 5** to **Section 7**).

### 3.7 Uncertainties

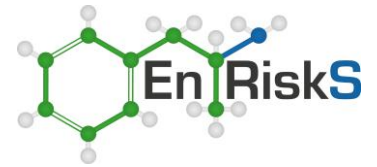
The on-airport sampling has targeted the main PFAS source areas at the airport, and other media (such as recycled water) which may contain PFAS and which receptors may be exposed to. The existing data is adequate for the purpose of the HHERA where maximum concentrations have been compared to conservative screening level guidelines to determine the need for further assessment. Further sampling and analysis of soil in the main PFAS source areas would allow risk calculations to be updated based on average or 95% UCL<sub>average</sub> soil concentrations which would provide a more realistic representation of likely exposures. The measurement of leachable concentrations would allow an assessment of the potential for impacts to act as an ongoing source to the environment.

Historical sampling for PFAS was primarily focused on PFOS and PFOA. In addition, there has been variability in sampling methodologies, adopted QA/QC procedures and adopted LORs over time (as laboratory analysis techniques have improved). However, more recent sampling undertaken by AAL and ASA has considered a broader range of PFAS compounds and the adopted LORs and QA/QC procedures are generally appropriate. Except for surface water sampling undertaken by AAL, data relating to seasonal variability in concentrations and the potential for interactions between groundwater and surface water (as could be investigated through the collection of co-located samples) is noted to be limited.

Only 1 sample has been collected and analysed for PFAS from the recycled water to date. Concentrations of PFOS + PFHxS in recycled water are around 40 times below the adopted screening level guideline and concentrations of PFOA in recycled water are around 900 times below the adopted screening level guideline. The adopted screening level guidelines assume that a tenant swims in the recycled water on 150 days/year. As discussed above, this is conservative for the assessment of the incidental direct contact exposures that may occur by tenants to recycled water.

Detectable concentrations of PFAS other than PFOS, PFOA and PFHxS (the “Other PFAS”) have been reported in soil, groundwater, surface water and recycled water at the airport. There are currently no regulatory guidelines for soil or water, or approved TRVs, in Australia for Other PFAS. This is primarily due to the limited amount of toxicological data for Other PFAS.

The key PFAS that normally drive HHERA outcomes are PFOS and PFHxS (refer to **Section 2.3**) and where data gaps or the potential for unacceptable risks/need for management measures are identified, any implemented strategies will address impacts from Other PFAS as well as PFOS and PFHxS. Concentrations of Other PFAS will only affect the outcomes of this HHERA where risks from PFOS, PFHxS and PFOA are concluded to be acceptable (i.e. concentrations are below



screening level guidelines). Where further evaluation for PFOS and PFHxS has not been triggered in this HHERA, concentrations are well below the adopted screening level guidelines. Given this, concentrations of Other PFAS have not been considered quantitatively in the further evaluation of potential exposures following incidental contact with soil, groundwater and surface by workers in this HHERA.

## Section 4. HHRA, Issue Identification – Off-Airport

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### 4.1 General

This section of the report provides a more detailed review of the exposure pathways and individuals or groups of individuals relevant to PFAS compounds identified in environmental media off-airport, and if the PFAS concentrations are sufficiently elevated to require a detailed assessment of risk. The review presented here has considered data collected off-airport for the purpose of characterising PFAS risk issues.

The relevant data and plans have been extracted from the available investigation reports (where possible) and provided in **Appendix A**.

### 4.2 Potential for Exposure

A review of Google Maps indicates the following land uses to the west (downgradient) of the airport, moving from south to north:

- Golf courses and Harbour Town. The following land uses are located between the golf courses/Harbour Town and the beach (on the western side of Military Road):
  - Sewage treatment plant
  - Surf lifesaving club/sailing club
  - Research centre
  - Recreational facilities including the West Beach Parks Resort and caravan park
  - Two blocks of low-density residential properties; and
- The remainder of the residential suburb of West Beach including the University of Adelaide.

The following human receptors have been identified in this context:

- Users of off-airport groundwater (adults and children); and
- Recreational users of Patawalonga Lake which is a part of the Patawalong (adults and children).

Further discussion is presented below. This HHERA has assumed that surface water from the Patawalonga Lakes System is not extracted for any use.

#### 4.2.1 Use of Off-Airport Groundwater

Environmental Projects (2019) identified the presence of 15 domestic/unknown bores to the west of the airport in the residential suburb of West Beach (refer to **Section 2.2.5** and **Figure 2**). Hence, this area was the focus of the further off-airport investigation works (including water use survey) undertaken by GHD (2019). The GHD (2019) survey and investigation works mainly targeted this area as it is down hydraulic gradient of on-airport boundary monitoring well GW16\_03, where PFAS concentrations above the drinking water guideline value have been reported.

The available information indicates that groundwater in this residential area is not currently used for potable water supply or for any non-potable uses except for irrigating lawns at 2 properties. This means that groundwater is not currently being used in a way that could result in the accumulation of PFAS into edible products that could be subsequently home consumed. This exposure pathway is currently incomplete, and where there is no exposure to PFAS in edible products, there are no

health risks from PFAS in edible products. No swimming pools have been identified. Hence, the only exposure pathway of concern in relation to the current use of groundwater in the off-airport residential area to the west of the airport is incidental direct contact during the non-potable use.

In relation to the potential for the future extraction and use of groundwater, except for wells GW16\_13 and GW16\_14, groundwater off-airport is not suitable for growing fruit/vegetables or watering chickens due to its high TDS content. In the area of GW16\_13 and GW16\_14, the future use of groundwater for watering fruit, vegetables and chickens is considered possible, noting also that 3 registered domestic/unknown bores are present in this area (refer to **Figure 2** and **Figure 3**). The future use of groundwater for filling swimming pools is also considered possible, as is the potential for incidental direct contact with groundwater during non-potable use.

#### 4.2.2 Use of Patawalonga Lake System

The Patawalonga Lake System is a man-made system that is 1.6 kilometres long and runs parallel to the coastline from Glenelg to West Beach. It is designed to stop flooding of urban areas by diverting storm water and is kept clean and healthy by tides flushing the lake with seawater. It also provides an area for water sports and aquatic life.<sup>3</sup>

On the western side of Tapley's Road, the System includes the Sturt River Weir, Diversion Pond, Northern Gates and Barcoo Outlet. Patawalong Lake is located to the west of the Sturt River Weir (refer to **Figure 4**; this is the area labelled Patawalonga Creek on **Figure 5**). Patawalonga Lake has an area of 18 hectares and supports activities including boating and fishing. Swimming is not specifically listed as an activity in Patawalonga Lake, and intentional swimming is considered unlikely given the proximity of the beach and the presence of the harbour at the mouth of the System. The Collection Pond is located to the north.

The airport's stormwater drainage network is self-contained, in that all stormwater from up gradient of the airport flows along the northern and southern airport boundaries and no stormwater flows from off-airport onto the airport. There are three main stormwater drains at and adjacent to the airport:

- The Airport Drain - this drain flows in two separate branches from the north-eastern and central portions of the airport and collects stormwater from these areas, including from the Fire Station. The northern branch of the drain flows south along the western boundary of the airport, joining the southern branch approximately three quarters of the way down the boundary. This drain is shown in blue on **Figure 6**;
- The Keswick-Brownhill Creek Drain – this drain collects stormwater from Keswick and Brownhill Creeks and flows along the eastern and southern boundary of the airport. This drain is shown in green on **Figure 6**; and
- The Cowandilla-Mile End Drain – this drain collects stormwater from up-gradient of the airport to the north and east, and flows along the northern and north-eastern airport boundary before branching off to the west to flow through the Patawalonga Creek Conservation Area (i.e. the PCCZ). This drain does not collect stormwater from the airport

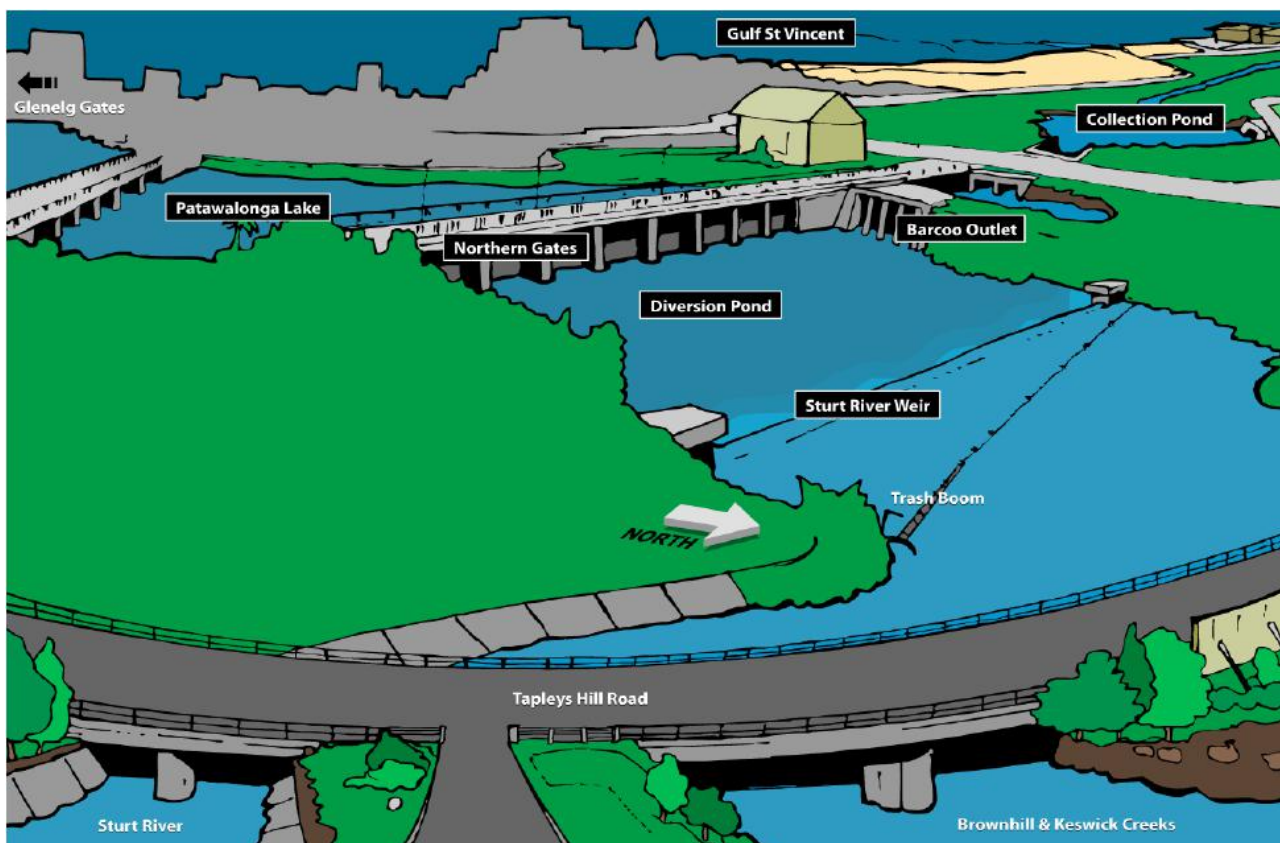
<sup>3</sup> <https://www.naturalresources.sa.gov.au/adelaidemtloftyranges/water/managing-water/stormwater/patawalonga-lake>

and is shown in red on **Figure 6**. There is no public access to the PCCZ except for occasional revegetation days.

Stormwater from the airport discharges to the Collection Pond (Airport Drain) and Diversion Pond (Keswick-Brownhill Creek Drain). These are stormwater management ponds that are discharged to the Gulf St Vincent 200 m offshore via Barcoo Outlet.

Stormwater from the airport flows via the Airport Drain into the Collection Pond, or via the Brownhill and Keswick Creeks into the Diversion Pond prior to discharge 200 m offshore via Barcoo Outlet. As a result, under most conditions, stormwater from the airport will not reach Patawalonga Lake, where the recreational activities occur. Stormwater is only allowed to discharge into Patawalonga Lake under exceptionally high flow conditions, for later discharge out to sea via the Glenelg Gates. It is noted that these conditions would also result in significant levels of dilution. Water within the Collection Pond or Diversion Pond is not accessible to the general public.

However, the potential interaction of shallow groundwater with Patawalonga Creek is not known. Hence, for the purpose of this assessment it has been assumed that there may be the potential for some discharge of stormwater from the Airport to occur to Patawalonga Creek.



**Figure 4. Schematic of Patawalonga Lakes System<sup>4</sup>**

<sup>4</sup> <https://www.naturalresources.sa.gov.au/adelaidemtloftyranges/water/managing-water/stormwater/patawalonga-lake>



Figure 5. Aerial Photograph of Patawalonga Lakes System (Google Maps 29 October 2019)

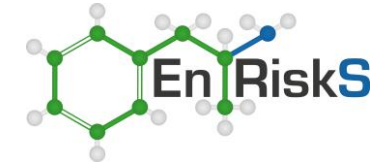


**Figure 6: Adelaide Airport Drainage Network and Approximate Stormwater Sampling Locations**

**Table 4.1** presents a more detailed overview of the exposure pathways relevant to the assessment of human exposures off-airport. The table also outlines the data that is relevant to the assessment of these exposures and outcomes of the screening level assessment undertaken. Text shown in **blue** indicates that risks have been concluded to be acceptable while text shown in **purple** indicates that further assessment is required or recommended. Where data is available this further assessment has been presented in the HHRA.

**Table 4.1: Summary of Key Exposure Pathways – Off-Airport**

Exposure Pathway/Mechanism	Potentially Significant Pathway?	Comments	Screening Assessment
<b>Residents</b>			
Potable use of groundwater	x	Groundwater to the west of the airport is unsuitable for use for potable water supply.	<b>Not required.</b>
Incidental ingestion of PFAS in groundwater	✓	Incidental direct contact exposures may occur during the current use of groundwater at off-airport residential properties for irrigating lawns, or the future use of groundwater for filling swimming pools.	The suitability of the use of groundwater for non-potable uses has been undertaken by comparing the relevant data against recreational water guidelines. This is presented in <b>Section 4.3.3</b> . <b>No PFAS concentrations of concern identified in surface water.</b>
Dermal contact with PFAS in groundwater <sup>1</sup>	✓		
Ingestion of home-grown produce (fruit and vegetables) (potential future use only)	✓	Where produce is grown on a residential site, where PFAS is reported in water used for irrigation, PFAS may accumulate in fruit, vegetables and/or chicken eggs that may be home-consumed by residents.	The screening level assessment for the use of groundwater for watering home-grown produce is presented in <b>Section 4.3.3</b> . <b>Groundwater in well GW16_14 is suitable for watering produce (based on TDS concentration) and contains concentrations of PFAS exceeding the screening level guidelines. Further evaluation is required in this HHERA and is presented in Section 5, Section 8 and Section 9.</b>
Ingestion of home-grown eggs from chickens (potential future use only) <sup>2</sup>	✓		
<b>Recreational Users of Patawalonga Lake (Including Residents)</b>			
Extraction and use of surface water	x	Surface water from the Patawalonga Lakes System is not extracted for any use.	<b>Not required.</b>
Incidental ingestion of PFAS in surface water	✓	Direct contact exposures (incidental ingestion and dermal contact) may occur during the recreational use of Patawalonga Lake	The suitability of the use of surface water for recreational activities has been undertaken by comparing surface water data against recreational water guidelines. This is presented in <b>Section 4.4</b> . <b>No PFAS concentrations of concern identified in surface water.</b>
Dermal contact with PFAS in surface water <sup>1</sup>	✓		
Incidental ingestion of PFAS in sediment	✓	Direct contact exposures (incidental ingestion and dermal contact) may occur during the recreational use of Patawalonga Lake	The screening level assessment is presented in <b>Section 4.5</b> . Soil screening guidelines are available to evaluate direct contact exposures to PFAS in sediment during recreational activities. <b>No PFAS concentrations of concern identified in sediment.</b>
Dermal contact with PFAS sediment <sup>1</sup>	✓		
Ingestion of fish	✓	Consumption of fish from Patawalonga Lake	A screening level assessment of PFAS reported in samples of edible fish collected from Patawalonga Lake has been undertaken and is presented in <b>Section 4.6</b> . <b>No PFAS concentrations of concern identified in fish.</b>



**Notes for Table 4.1:**

- “✓” = Exposure pathway is considered to be potentially complete. “
- “✓” = Exposure pathway is considered to be limited, however has been assessed further in this HHERA for completeness.
- “x” = Exposure pathway is considered to be incomplete and has not been assessed further in this HHERA.
- 1 = Dermal uptake of PFAS in soil and water is understood to be limited in comparison to the incidental ingestion pathways (refer below for further information) however further assessment has been provided in this HHRA for completeness.
- 2 = This relates to the home-consumption of produce. The assessment of risks following the sale of produce into the market is outside of the scope of this HHERA.

## 4.3 Nature and Extent of Impacts in Groundwater

### 4.3.1 Available Data

GHD (2019) installed 5 groundwater wells to the west of the airport, within the residential area. This HHERA has considered the data obtained from these locations. Groundwater from wells GW16\_11 to GW16\_13 was analysed for an extended PFAS suite and groundwater from wells GW16\_14 and GW16\_15 was analysed for PFOS, PFOA and PFHxS only. Historical data for western boundary well GW16\_03 has also been considered in this HHERA, noting that there are some residential properties between the western airport boundary and the first off-airport well.

### 4.3.2 Adopted Guidelines

The Australian Drinking Water Guidelines (NHMRC 2011 updated 2018) and the NHMRC recreational water quality guidelines (NHMRC 2019) have been adopted for the off-airport screening assessment for groundwater.

The recreational water quality guidelines are relevant for the assessment of the future use of groundwater for filling swimming pools, and for the assessment of incidental direct contact exposures with groundwater that may occur during the current use of groundwater for irrigating lawns, or other future non-potable uses of groundwater.

The drinking water guidelines have been adopted for the assessment of the future use of groundwater for watering fruit, vegetables and chickens, to confirm whether evaluation of the potential uptake into edible products (fruit, vegetables and eggs) is required.

Where concentrations are below drinking water guidelines, the use of this water for all uses including potable water supply, irrigation or crops and stock watering is considered suitable. This is because the drinking water guidelines are derived in a manner that allows for all exposures considered likely to occur during home use of water, including use of water for washing, food preparation, irrigation of gardens etc. It is considered that assuming consumption of 2L/day is sufficient to cover for the exposure pathway which people would be exposed to every day for their whole life. The drinking water guidelines also assume that only 10% of a person's exposure to the chemical comes from drinking water (90% is assumed to come from other pathways). From an overall perspective, the drinking water guideline represents the concentration of a chemical in water that the Australian Government has determined is safe to drink and use for any purpose commonly undertaken for domestic purposes for a lifetime. The assessment of risks following the sale of produce into the market is outside of the scope of this HHERA.

### 4.3.3 Screening Assessment

**Table 4.2** presents a review of maximum concentrations of PFOS + PFHxS and PFOA in groundwater on the western airport boundary or off-airport, with the adopted screening level guidelines.

**Table 4.2: Summary and Review of PFAS Reported in Groundwater, Off-Airport**

Well ID (Location) (Date Sampled)	Reported Concentration (µg/L)	
	PFOS + PFHxS	PFOA
GW16_03 (boundary) (August 2018)	0.46	ND
GW16_11 (off-airport) (November 2018)	ND	ND
GW16_12 (off-airport) (November 2018)	0.12	0.03
GW16_13 (off-airport) (November 2018)	0.04	0.06
GW16_14 (off-airport) (February 2019)	0.1	0.02
GW16_15 (off-airport) (February 2019)	ND	ND
<b>Adopted Screening Guidelines</b>		
<b>Uptake into Edible Products<sup>1</sup></b>	<b>0.07</b>	<b>0.56</b>
<b>Incidental Direct Contact by Residents<sup>2</sup></b>	<b>2</b>	<b>10</b>

**Notes:**

Shading indicates an exceedance of the adopted guideline value.

1 = Re. HEPA (2018).

2 = Ref. NHMRC (2019).

Review of **Table 4.2** indicates the following:

- Concentrations of PFOS + PFHxS and PFOA in groundwater are below the adopted recreational water quality guidelines. Hence, there are no health risk issues of concern in relation to the future use of groundwater for filling swimming pools, or current and future incidental direct contact exposures with groundwater during its non-potable use;
- Concentrations of PFOA in groundwater are below the adopted drinking water guidelines. Hence, there are no health risk issues of concern in relation to the uptake of PFOA in edible produce that may be home-consumed (where this occurs in the future); and
- Concentrations of PFOS + PFHxS in groundwater in wells GW16\_03 (western airport boundary), GW16\_12 (off-airport) and GW16\_14 (off-airport) exceed the adopted drinking water guidelines.

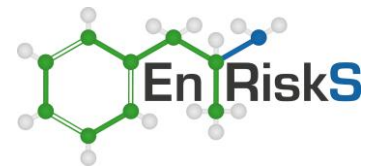
Groundwater in wells GW16\_03 and GW16\_12 not suitable for watering fruit, vegetables or chickens due to high TDS concentrations. Groundwater in well GW16\_14 is suitable for the irrigation of produce (based on TDS concentration). This is thought to be an artificial phenomenon caused by the irrigation of the adjacent playing fields with clean recycled water. Irrespective of the cause of the low TDS, water from this well is theoretically suitable for the irrigation of produce in the future where produce may be home consumed. Hence, an assessment of potential health risks following the consumption of home-grown fruit, vegetables and eggs from chickens has been undertaken in this HHERA, as provided in **Section 5**, **Section 8** and **Section 9**.

## 4.4 Nature and Extent of Impacts in Stormwater

### 4.4.1 Available Data

As discussed in **Section 3.3**, stormwater data has been collected from a number of locations across the airport by AAL and GHD (2016b). The majority of these locations are from within the on-airport stormwater system, with the following sampling locations closest to the point of discharge for stormwater from the airport to the Collection Pond:

- SW16\_06 and SW10; and
- SW16\_05.



In addition, GHD (2019) collected 16 surface samples from off-airport within the Patawalonga Lakes System, with 8 samples collected during dry weather and wet weather sampling respectively. The sampling locations were as follows (refer to **Figure 7**):

- Locations 2 and 3: Diversion Pond;
- Locations 1, 4, 5 and 6: Patawalonga Lake; and
- Locations 7 and 8: Barcoo Outlet.

Surface water samples were analysed for an extended PFAS suite.



Figure 7: GDH (2019) Surface Water and Sediment Sampling Locations

#### 4.4.2 Adopted Guidelines

The NHMRC recreational water quality guidelines (NHMRC 2019) have been adopted for the off-airport screening assessment for surface water in Patawalonga Lake, where recreational exposures may occur.

Data from all surface water samples collected has been reviewed against the above guidelines. No recreational activities occur in the Collection Pond and Diversion Pond, however this water it is ultimately released to Gulf St Vincent where recreational exposures may occur. Discharges to the Gulf St Vincent occur 200 m offshore so a significant amount of dilution would be expected to occur in this environment.

The screening level guidelines for water do not consider the uptake of PFAS into fish that may be caught from Patawalonga Lake and consumed by humans. Potential risks to human health following recreational fishing in Patawalonga Lake have been evaluated separately based on the fish sampling and analysis undertaken by SA EPA, with the assessment presented in **Section 4.6**.

#### 4.4.3 Screening Assessment

The review of PFOS + PFHxS and PFOA concentrations in stormwater with the adopted screening level guidelines is provided in **Table 4.3**.

All surface water data has been included in the evaluation to assist in the understanding of how concentrations in surface water may vary across the airport and also on a seasonal basis. Data from sampling locations closest to the point of discharge for stormwater from the airport is show in **bold**.

**Table 4.3: Summary and Review of PFAS Reported in Surface Water, On- and Off-Airport**

Well ID (Location) (Date Sampled)	Reported Concentration (µg/L)	
	PFOS + PFHxS	PFOA
<b>Keswick-Brownhill Creek Drain (East and South)</b>		
<b>Eastern Airport Boundary or Off-Airport East</b>		
SW-US2, AAL (March 2016)	<LOR	<LOR
BHC-1, AAL (June 2016)	0.0064	0.006
SW16_02, GHD (August 2016)	0.45	<LOR
<b>Southern Airport Boundary</b>		
BHC-2, AAL (June 2016) (Southern Airport Boundary)	0.03	0.008
SW16_04, GHD (August 2016) (Southern Airport Boundary)	0.75	<LOR
<b>SW16_05, GHD (August 2016)</b> (Southern Airport Boundary)	<b>1.84</b>	<b>&lt;LOR</b>
<b>Cowandilla-Mile End Drain &amp; Airport Drain (North and West)</b>		
<b>Northern Airport Boundary</b>		
SW-US1, AAL (March 2016)	<LOR	<LOR
SW16_01 / SW1, AAL (July 2016)	0.072	<LOR
SW16_01 / SW1, GHD (August 2016)	0.35	<LOR
SW16_01 / SW1, AAL (September 2016)	0.085	<LOR
SW16_01 / SW1, AAL (November 2016)	0.18	<LOR
SW16_01 / SW1, AAL (January 2017)	0.29	<LOR
SW16_08, GHD (August 2016)	0.05	<LOR
<b>On-Airport</b>		
SW-USFS, AAL (July 2016)	<LOR	<LOR
SW16_03 (Fire Station), GHD (August 2016)	239	6.97
SW-DSFS, AAL (July 2016)	1.07	0.014
<b>Western Airport Boundary</b>		
SW16_07 / SW5, AAL (March 2016)	0.17	0.022
SW16_07 / SW5, AAL (July 2016)	0.085	<LOR

Well ID (Location) (Date Sampled)	Reported Concentration (µg/L)	
	PFOS + PFHxS	PFOA
SW16_07 / SW5, GHD (August 2016)	0.36	<LOR
SW16_07 / SW5, AAL (September 2016)	0.27	<LOR
SW16_07 / SW5, AAL (November 2016)	0.5	<LOR
SW16_07 / SW5, AAL (January 2017)	0.4	0.023
<b>SW16_06 / SW10, AAL (March 2016)</b>	<b>11.9</b>	<b>0.28</b>
<b>SW16_06 / SW10, AAL (July 2016)</b>	<b>25</b>	<b>1.1</b>
<b>SW16_06 / SW10, GHD (August 2016)</b>	<b>23.05</b>	<b>0.34</b>
<b>SW16_06 / SW10, AAL (September 2016)</b>	<b>15.5</b>	<b>0.34</b>
<b>SW16_06 / SW10, AAL (November 2016)</b>	<b>40</b>	<b>1.5</b>
<b>SW16_06 / SW10, AAL (January 2017)</b>	<b>7.1</b>	<b>0.38</b>
<b>Patawalonga Lakes System, Wet Weather Event</b>		
Diversion pond and Barcoo Inlet (Locations 2, 3, 7 and 8)	0.02 – 1.47	ND – 0.06
Patawalonga Lake (Locations 1, 4, 5 and 6)	ND	ND
<b>Patawalonga Lakes System, Dry Weather Event</b>		
Diversion Pond and Barcoo Inlet (Locations 2, 3, 7 and 8)	ND – 0.66	ND – 0.01
Patawalonga Lake (Locations 1, 4, 5 and 6)	ND	ND
<b>Adopted Screening Guidelines</b>		
<b>Recreational Exposures<sup>1</sup></b>	<b>2</b>	<b>10</b>

**Notes:**

Shading indicates an exceedance of the adopted guideline value.

LOR = Laboratory Limit of Reporting (LOR) in the range <0.005 to <0.05 µg/L.

1 = Ref. NHMRC (2019).

Review of **Table 4.3** indicates that concentrations of PFOS + PFHxS in surface water at location SW16\_06, which is within the on-airport drainage channels but closest to the point of discharge to the Diversion Pond, consistently exceed the adopted recreational water quality guidelines. Maximum concentrations are 20 times above the adopted guideline value. PFOS + PFHxS was detected in water in the Diversion Pond and Barcoo Inlet (which ultimately discharges to Gulf St Vincent), however reported concentrations were below the adopted recreational guidelines (relevant to Gulf St Vincent).

However, PFOS + PFHxS was not detected in water in Patawalonga Lake, where recreational activities (and potential exposures to PFAS) occur. Concentrations of PFOA in surface water in the on-airport drainage channels are below the adopted recreational guidelines. PFOA was not detected in surface water in Patawalonga Lake.

On this basis, there are no human health risks issues for PFAS in surface water that require further review in this HHERA, in relation to recreational exposures within Patawalonga Lake or Gulf St Vincent.

## 4.5 Nature and Extent of Impacts in Sediment

### 4.5.1 Available Data

GHD (2019) collected 16 sediment samples from off-airport within the Patawalonga Lakes System, with 8 samples collected during dry weather and wet weather sampling respectively. The sampling locations were as follows (refer to **Figure 7**):

- Locations 2 and 3: Diversion Pond;

- Locations 1, 4, 5 and 6: Patawalonga Lake; and
- Locations 7 and 8: Barcoo Outlet.

Sediment samples were analysed for an extended PFAS suite.

#### 4.5.2 Adopted Guidelines

The screening level guidelines for soil for a public open space land use from the PFAS NEMP have been adopted for the assessment of sediment, as there are no screening level guidelines for PFAS in sediment. This approach assumes that someone is exposed to sediment in a similar manner as to soil and is consistent with the approach adopted by enRiskS at other PFAS impacted sites in Australia. Exposures to soil and sediment (where sediment is not covered in water) are expected to be similar as individuals may come into direct contact with sediment e.g. on the banks of waterways during recreational use of Patawalonga Lake. Sediment may be wetter than soil, and therefore may adhere more to exposed skin, however in this instance it is also likely to be washed off skin sooner. Hence the adoption of the soil guidelines for sediment is appropriate.

#### 4.5.3 Screening Assessment

The review of PFOS + PFHxS and PFOA concentrations in sediment with the adopted screening level guidelines is provided in **Table 4.4**.

**Table 4.4: Summary and Review of PFAS Reported in Sediment, Off-Airport**

Well ID (Location) (Date Sampled)	Reported Concentration (mg/kg)	
	PFOS + PFHxS	PFOA
<b>Patawalonga Lakes System, Wet Weather Event</b>		
Diversion pond and Barcoo Inlet (Locations 2, 3, 7 and 8)	0.0011 – 0.26	ND – 0.0022
Patawalonga Lake (Locations 1, 4, 5 and 6)	ND – 0.0024	ND
<b>Patawalonga Lakes System, Dry Weather Event</b>		
Diversion Pond and Barcoo Inlet (Locations 2, 3, 7 and 8)	0.0013 – 0.26	ND – 0.0016
Patawalonga Lake (Locations 1, 4, 5 and 6)	ND – 0.003	ND
<b>Adopted Screening Guidelines</b>		
<b>Recreational Exposures<sup>1</sup></b>	<b>1</b>	<b>10</b>

**Notes:**

Shading indicates an exceedance of the adopted guideline value.

LOR = Laboratory Limit of Reporting (LOR) of <0.0002 mg/kg.

1 = Ref. NHMRC (2019).

Review of **Table 4.4** indicates that concentrations of PFOS + PFHxS and PFOA in sediment are well below the adopted recreational guidelines. Concentrations of PFAS in sediment along Patawalonga Lake, where recreational exposures may occur, were lower than those in Barcoo Inlet and the Diversion Pond. Human receptors are not expected to come into contact with PFAS in sediment that is discharged 200 m offshore via Barcoo Inlet.

On this basis, there are no human health risks issues for PFAS in sediment that require further review in this HHERA, in relation to recreational exposures along Patawalonga Lake or in Gulf St Vincent.

## 4.6 Nature and Extent of Impacts in Fish

### 4.6.1 Available Data

Tabulated results and laboratory analysis reports for concentrations of PFAS in fish caught from Patawalonga Creek during sampling by SA EPA in September 2012 has been provided by AAL for use in the HHERA.

SA EPA have indicated the following with respect to the methodology adopted for the sampling program:

- Black bream from selected estuarine habitats were targeted to provide an indication if PFAS were accumulating in a resident fish species at the end point for urban and agricultural catchments including Patawalonga Creek;
- SA EPA aimed to collect adult fish using a three to six fish per sample strategy;
- Caught fish were filleted for laboratory analyses of the edible portion of fish and the remaining fish frames;
- Two samples of fish were collected with each comprising three to six composited fish from the same collection date; and
- Bream were hard to collect in Patawalonga Creek and problems with stormwater pulses were encountered making it hard to find these fish. Given this, only two samples were collected.

### 4.6.2 Adopted Guidelines

In April 2017, FSANZ released proposed trigger points for investigation for PFOS + PFHxS and PFOA in food products (FSANZ 2017a). Trigger points are provided for PFOS + PFHxS and PFOA in finfish fillets, finfish liver and crustaceans

The trigger points are stated to be the maximum concentration of the chemical that could be present in individual foods or food groups so even high consumers of these foods would not have dietary exposures exceeding the relevant TRV. The trigger points are lower for those foods that are normally consumed in larger amounts. Trigger points are not provided for PFAS other than PFOS, PFOA and PFHxS.

### 4.6.3 Screening Assessment

The review of PFOS concentrations in fish with the adopted screening level guidelines is provided in **Table 4.5**. PFOA was not detected at a concentration below the trigger levels. No analysis for PFHxS was undertaken. The laboratory reports for fish samples are provided in **Appendix A**.

**Table 4.5: Summary and Review of PFAS Reported in Fish, Off-Airport from Patawalonga Lake**

Sample ID	Sample Type	PFOS (ng/g)
PAT1A	Fish Frames	3.7
PAT2A	Fish Frames	<2
Laboratory Duplicate	Fish Frames	3.9
PAT1B	Fish Fillets	0.94
PAT2B	Fish Fillets	<0.8
Laboratory Duplicate	Fish Fillets	0.97
<b>Adopted Screening Guidelines<sup>1</sup></b>		
<b>Finfish Fillets</b>		<b>5.2</b>

**Notes:**

Shading indicates an exceedance of the adopted guideline value based on the maximum concentration.

1 = Ref. FSANZ (2017). These trigger levels assume that all (100%) of the tolerable daily intake is sourced from either fish or crustaceans (i.e. they do not consider exposures from multiple pathways).

Review of **Table 4.5** indicates that maximum concentrations of PFOS in fish fillets and fish frames from Patawalonga Creek are below the trigger points for finfish. Concentrations reported in fish frames were around 4 times higher than concentrations reported in fillets, with concentrations in fillets 5 times below the trigger level. Given this, the lack of data for PFHxS is not considered to be a significant data gap for the HHERA.

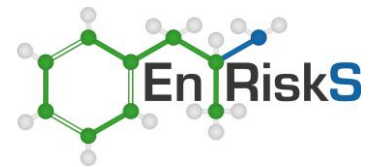
The FSANZ trigger levels assume that all (100%) of the tolerable daily intake is sourced from either fish or crustaceans (i.e. they do not consider exposures from multiple pathways). Concentrations of PFOS + PFHxS and PFOA in surface water and sediment in Patawalonga Lake are below the adopted screening level guidelines, which are sufficiently conservative to consider multiple exposure pathways. On this basis, no further consideration of multiple exposures within Patawalonga Lake is required in this HHERA.

## 4.7 Uncertainties

The off-airport groundwater sampling program has targeted the residential area within 500 m of the western airport boundary within the suburb of West Beach. The targeting of this area (and not other areas to the north-west or south-west of the airport) makes sense as bores registered for domestic or unknown uses have been identified in these general areas. The only identified use of groundwater within 500 m of the western airport boundary was for watering lawns.

It is noted that GHD (2019) indicates that “*The small number of respondents who have bores compared to the total number of registered bores in the investigation area may not be a reliable representation of groundwater use in the area*”. It is understood that this sentence was intended to convey the following:

- Residents within the targeted area were surveyed but there were not many who indicated any form of extraction (registered or otherwise), and those who extracted did not use the water for sensitive beneficial purposes (e.g. drinking, pool filling, watering of veggie patches etc), only for lawn watering; and
- There is no information as to whether the residents within the targeted area are typical of the residents in the broader area. Given the quality of the water, the survey undertaken is likely to be representative of utilisation of unregistered bores within the wider area, but this still would need to be shown through a wider survey.



This supports the need for the further assessment of potential risks following the extraction and use of off-airport groundwater, including the irrigation of edible products, as undertaken in this HHERA. However, this is not a current use of groundwater and the assumption that a resident may extract and use groundwater for watering fruit, vegetables or chickens in the future is conservative based on the high TDS concentrations reported in groundwater off-airport, the presence of rainwater tanks and the availability of a reticulated water supply.

The GHD (2019) investigation only included one round of sampling of off-airport groundwater wells. This uncertainty has been considered further in the calculations presented in later sections of this HHERA. It is also understood that ASA has engaged GHD to undertake quarterly GMEs for the next 2 years, covering on- and off-airport wells.

Data is available for 2 rounds of surface water and sediment sampling (1 wet weather and 1 dry weather) within the Patawalonga Lakes System. PFOS + PFHxS and PFOA concentrations were low to not detected within the Lake itself. Low concentrations, well below the adopted screening level guidelines were reported in water that may be discharged into Gulf St Vincent. Given this, the 2 rounds of sampling undertaken is considered adequate for the HHERA.

PFOS and PFDoA were the only PFAS detected in fish from Patawalonga Lake. Similar concentrations of PFOS and PFDoA were reported in fish and there are no screening level guidelines for PFDoA in fish. In addition, no analysis was undertaken for PFHxS. Total concentrations of PFOS and PFDoA in fish fillets were reported up to 2 µg/kg, which is less than 50% of the adopted screening level guideline (5.2 µg/kg for PFOS + PFHxS in fish fillets). Given this, the available fish data is adequate to provide an indication of the potential health risks from consumption of fish from Patawalonga Lake by recreational fishers.

## Section 5. HHRA, Toxicity of PFAS to Humans

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### 5.1 Approach

This section outlines the approach used to assess the toxicity of PFAS to human health. The quantitative assessment of potential risks to human health for any chemical requires the consideration of the health end-points and where carcinogenicity is identified; the mechanism of action needs to be understood.

For chemicals that do not cause cancer (are not carcinogenic), a threshold exists below which there are no adverse effects. This threshold is known as a toxicity reference value (TRV). Other names for a TRV include Health Based Guideline Value (HBGV), tolerable daily intake (TDI) or acceptable daily intake (ADI). The TRV typically adopted in risk calculations, including those in this HHERA, is based on the lowest no observed adverse effect level (NOAEL; typically from animal or human e.g. occupational studies), and the application of several safety or uncertainty factors (UF). The adoption of the NOAEL along with the addition of UF adds conservatism into the TRV. Hence, intakes/exposures lower than the TRV are considered safe, or not associated with an adverse health risk (NHMRC 1999).

There are two general groups of chemicals that cause cancer (called carcinogens) (NEPC 1999 amended 2013b):

- Genotoxic carcinogens for which, in theory, any level of exposure could result in a response as the chemical has the ability to interact directly with our DNA; and
- Non-genotoxic carcinogens, for which there is a threshold below which exposure is not expected to result in adverse health effects.

PFAS do not possess the chemical/physical properties typically associated with direct genotoxicity and are not considered to be genotoxic from an overall perspective (deWitt. J.C. 2015). Hence, in this HHERA, TRVs relevant to the characterisation of potential health effects associated with exposure to PFAS have been selected from credible peer-reviewed sources using the process outlined in enHealth and NEPC (enHealth 2012a; NEPC 1999 amended 2013b).

The toxicology of PFAS is complex and not well understood despite a significant amount of research in the last five to 10 years. **Appendix B** presents a summary of the human toxicity of PFOS and PFHxS, with the following providing a summary of the key aspects considered in this assessment.

### 5.2 PFAS Compounds

#### 5.2.1 General

PFAS compounds are widely distributed throughout the environment and can be highly persistent in the body and present in many products and foods. FSANZ (FSANZ 2017a) provides a recent current evaluation of PFAS toxicity, for the purpose of establishing Australian guidelines for these compounds in edible produce to protect human health. The Australian Government also convened an Expert Health Panel for PFAS in 2018 (Australian Government Department of Health 2018). From an international perspective, the US Interstate Technology and Regulatory Council (ITRC)

provides several well written PFAS fact sheets.<sup>5</sup> Some of the key aspects of PFAS toxicology are outlined below, with a focus on PFOS + PFHxS which are the key PFAS that require further evaluation in this HHERA. Further information is provided in **Appendix C**.

### 5.2.2 PFOS

The following provides a general summary of health effects that have been associated with PFOS and PFOA (Rumsby, McLaughlin & Hall 2009):

- Although the acute toxicity of PFAS is moderate, their persistence in the body has led to increasing concerns over long-term effects. The toxicity of PFOS is not clearly understood at present. Different animal species appear to have different sensitivities to these compounds, which makes interpretation of experiments difficult (e.g. Rhesus monkeys are more sensitive to PFOS than rats, while mice are the least sensitive). The species variability may be due to the different handling of these compounds in the body;
- At present, the mechanism for PFOS activity is unclear, and high and low doses may differ in their toxic effects. High-dose studies on animals have indicated that cancer, developmental delays, endocrine disruption, immunotoxicity and neonatal mortality are potential toxic endpoints; and
- Recent research has also suggested that receptor binding may be an important general mechanism. PFOS binds to peroxisomal proliferator-activated receptors (PPAR). Activation of such receptors may alter fatty acid metabolism and play a role in cancer, foetal growth, hormone and immune function.

The toxicity of PFAS to humans can be inferred from animal toxicity studies as well as occupational exposure studies. The occupational exposure studies consider workers who handle or make PFAS, where the exposure levels are high. These studies have been undertaken in the US and Belgium, and have evaluated a range of health effects based on blood serum levels of PFAS in workers. These studies have identified some associations between altered cholesterol, triglyceride and high-density lipoprotein production (for PFOS > 6 mg/L in serum) and PFAS exposure. Review of these studies (ToxConsult 2014) identified that a no effect level of 2 mg/L (in serum) can be established for adult workers.

In general, observations from toxicological studies undertaken in animals with PFOS include irritation of eyes, skin and nose; loss of appetite, reductions in body-weight and weight gain, changes in the liver (including increases in liver weight [characterised by increased centrilobular hepatocellular hypertrophy]), mild-to-moderate peroxisome proliferation in rats, increased incidence of hepatocellular adenomas in rats (non-genotoxic), and hypo-cholesterolemia (ATSDR 2018). Effects identified appear to be related to a threshold body burden and often are observed with a steep dose–response (i.e. after the threshold the potential for adverse effects increases rapidly with increasing exposure level) (ToxConsult 2014).

Data from epidemiological studies with occupationally exposed workers at 3M manufacturing facilities (Alabama, USA and Belgium), communities exposed to contaminated drinking water (USA)

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<sup>5</sup> <https://pfas-1.itrcweb.org/>

and general populations (USA, UK and Scandinavia) are also available. It is noted that concentrations of PFAS in occupationally exposed workers are higher than those in the general populations. Despite this, epidemiology studies have generally failed to draw conclusive links between exposure to PFOS and adverse health effects. Associations between exposure and the following health effects have been suggested:

- Changes in serum lipid levels e.g. increase total cholesterol levels;
- Changes in serum liver enzymes levels;
- Kidney disease;
- Effects on fertility, pregnancy, lactation, and birth outcomes;
- Effects on thyroid and immune function;
- Endocrine effects (e.g. elevated thyroxine levels and increased risk of thyroid disease, diabetes mellitus and early onset menopause);
- Cardiovascular disease; and
- Cancer.

Overall, the evidence for adverse effects in humans following exposure is inconsistent from the epidemiological studies. In addition, the biological significance of some of the observed effects has been questioned (i.e. just because an effect is observed it does not mean it is, or will lead to, an adverse effect) and there is the potential that observed effects may be due to confounding factors e.g. exposure to other contaminants or diet.

### 5.2.3 Characterising toxicity for PFOS and PFHxS

Consistent with reviews by other authorities (EFSA 2008; enHealth 2016; USEPA 2016b, 2016a), FSANZ has determined a tolerable daily intakes (TDI) for PFOS on the basis of data derived from animal studies, that show exposure to these compounds can cause liver toxicity and tumours and reproductive and developmental effects. The available epidemiological studies have not provided sufficient evidence of a link between exposure to PFOS and PFHxS and any cancer type in human beings.

In relation to PFHxS, FSANZ determined there was insufficient information to establish a TDI for PFHxS. In the absence of a TDI, FSANZ agrees with enHealth (enHealth 2016) that using the TDI for PFOS is likely to be conservative and protective of public health. This means that PFHxS and PFOS should be summed for the purposes of exposure assessment and risk characterisation. The TDIs adopted by FSANZ for the assessment PFOS + PFHxS are summarised in **Table 5.1**. This table also includes the background intakes adopted for the HHRA, which are based on the review presented by ToxConsult (ToxConsult 2016a).

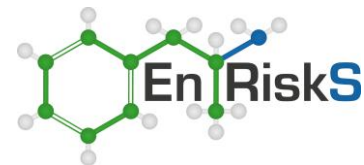
**Table 5.1: Summary of toxicity reference values adopted for PFOS + PFHxS and PFOA**

PFAS Compound	TDI	Adopted Background intake	Reference
PFOS + PFHxS	0.02 µg/kg/day	0.0014 µg/kg/day (7% of the TDI)	(ToxConsult 2016a)

**Notes:**

Refer to **Appendix B** for further information

It is noted that the human health screening criteria adopted in this review (and presented in **Section 3** and **Section 4**) are based on the TDIs identified above.



### 5.3 Uncertainties

In general, the available scientific information is insufficient to provide a thorough understanding of all the potential toxic properties of chemicals to which humans may be exposed. It is necessary, therefore, to extrapolate these properties from data obtained under other conditions of exposure and involving experimental laboratory animals. Most of the toxicological knowledge of chemicals comes from experiments with laboratory animals, although there may be interspecies differences in chemical absorption, metabolism, excretion and toxic response, as is particularly the case for PFAS compounds. There may also be uncertainties concerning the relevance of animal studies using exposure routes that differ from human exposure routes. In addition, the frequent necessity to extrapolate results of short-term or sub-chronic animal studies to humans exposed over a lifetime has inherent uncertainty. The uncertainties inherent in the toxicological values adopted are considered likely to result in an overestimation of actual risk assessed for long-term or chronic exposures.

Overall, it can be concluded that the toxicology of PFAS is complex and not well understood despite a significant amount of research in the last five to 10 years. Although the epidemiological studies have not provided convincing evidence of a correlation between exposure to PFAS and adverse health effects in humans (FSANZ 2017a), there is evidence of adverse effects in experimental animals exposed to PFOS and PFOA. The potential interspecies differences, including in the activation of PPAR $\alpha$ , between animals and humans are acknowledged. However, it is noted that PFOS and PFOA are known to interact with other receptors, and the effects of activating these other receptors in animals and humans has not yet been determined.

The use of toxicity data from laboratory experiments with animals is the recognised approach in Australia and overseas for the assessment of toxicity to humans in the absence of more relevant experimental data for humans (i.e. epidemiological studies). This is because the use of this animal toxicity data (and the overall approach) is established and precautionary. This applies equally to PFAS, as it does to any other chemical where it is suspected that exposure may lead to adverse health effects.

It is also noted that the European Food Safety Authority (EFSA) and the ATSDR have recently derived draft toxicity guidelines that are lower than those derived by FSANZ. The updated ATSDR toxicity guidelines were based on applying an additional safety factor. The updated EFSA guidelines were based on further consideration of the epidemiological data. Both newly derived guidelines are still considered draft by the organisations that developed them, so they are still subject to change. FSANZ has indicated that they are not considering changes to the Australian HBGVs until the additional assessment being undertaken by EFSA has been completed.<sup>6</sup>

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<sup>6</sup> <http://www.foodstandards.gov.au/consumer/chemicals/Pages/Perfluorinated-compounds.aspx>

## Section 6. HHRA, Exposure Assessment: On-Airport

### 6.1 General

This section provides a discussion on the human receptors of potential significance that warrant quantification in this assessment. The potential for exposure has been quantified using industry best practice and guidance available from USEPA (1989, 2002 and 2009) and Australia (NEPC 1999 amended 2013a). Where specific guidance is not available, parameters comprise industry standard values that have been demonstrated to be acceptable in the Australian regulatory context.

### 6.2 Exposure Assumptions

The assessment presented has calculated for a Reasonable Maximum Exposure (RME) scenario estimated by chemical concentrations that define the highest exposure that is reasonably likely to occur on-airport. The RME is likely to provide a conservative or overestimate of total exposure and therefore health risk.

The magnitude of the exposure is a function of a number of variables, termed exposure parameters, which describe the site-specific physical and behavioural parameters relevant to the potentially exposed population. Where available, and where relevant to the site-specific assessment conducted, additional exposure data has been obtained from Australian sources (enHealth 2012a, 2012b; NEPC 1999 amended 2013d).

**Table 6.1** presents a summary of the parameters adopted for the quantification of human exposures to PFOS + PFHxS in soil and water, based on the information currently available. The exposure parameters are also presented in the risk calculations provided in **Appendix D**.

As noted above, the July 2016 AAL Guideline for PFAS Work Health and Safety specifies that PFAS exposure risks should be considered and where necessary, and included in JSAs, SWIs and Take 5 risk assessments prior to the commencement of works. Suggested control measures include dust control, the use of PPE comprising gloves, dust masks and protective eyewear and the appropriate decontamination of PPE following works. The Guideline notes that these control measures form part of controls already in place to manage existing risks.

Regardless, this HHERA (and **Table 6.1**) has assumed that exposures to PFAS do occur to assess the magnitude of likely risks to health should control measures not be implemented adequately and inform the need for additional management measures.

**Table 6.1: Summary of Exposure Parameters – Airport Workers**

Exposure	Airport Worker
Exposure Duration	30 years (conservative value). (Note, as PFOS and PFOA act via a threshold mechanism, the assumption of a 1 year or 30-year exposure duration does not affect the risk calculations as this value cancels out).
Exposure Frequency	60 days per year (assumes a worker is in contact with PFAS impacted soil and water for 60 days per year) (conservative based on the existing management controls at the airport).
Body weight	70 kg (average adult body weight) (enHealth 2012b)
Averaging Time (non-carcinogenic)	Exposure duration x 365 days
Bioavailability	100% (maximum possible)

Exposure	Airport Worker
<b>Direct Contact with Soil (Oral, Dermal and Inhalation of Dust)</b>	
Ingestion Rate	100 mg/day (relevant for excavation works)
Skin Surface Area	6,300 cm <sup>2</sup> (NEPC 1999 amended 2013a)
Soil Adherence Factor	0.9 (higher soil adherence factor for wetter soil that may have been in contact with groundwater) (CRC CARE 2011)
Fraction of Day Exposed	0.5 (assumes the workers remains dirty for 12 hours)
Time Spent Outdoors	10 hrs/day (assumed maximum)
Lung Retention Factor	0.375 (NEPC 1999 amended 2013d)
Dermal Absorption	0.05% (assumes negligible dermal absorption) (ATSDR 2015)
Particulate Emission Factor	4.4x10 <sup>8</sup> (m <sup>3</sup> /kg) (value relevant for intrusive activities (CRC CARE 2011)
<b>Incidental Contact with Water</b>	
Gastrointestinal Absorption	100% (maximum possible)
Ingestion Rate	0.005 L/day (industry standard value for contaminated site risk assessments in Australia, assumes 5 mL of water or 1 teaspoon is ingested including water droplets/mist in air)
Time Spent Wet	2 hrs/day (assumed time workers may be wet)
Skin Surface Area	6,300 cm <sup>2</sup> (NEPC 1999 amended 2013a)
Dermal Permeability to Water	3.25x10 <sup>-5</sup> cm/hour (dermal permeability value for PFOA from ATSDR (2015) for mouse skin (more conservative than human skin), adopted for PFOS + PFHxS and PFOA in the absence of chemical specific data)

## 6.3 Quantification of Exposures

### 6.3.1 Incidental Ingestion of Soil

Ingestion of soil is a key pathway of exposure relevant for Airport workers.

The potential intake of PFOS+ PFHxS in soil via incidental ingestion has been undertaken using the following equation:

$$\text{Daily Chemical Intake}_{\text{CS}} = C_s \cdot \frac{IR_s \cdot FI \cdot B \cdot CF \cdot EF \cdot ED}{BW \cdot AT} \quad (\text{mg/kg/day})$$

where:

- Cs = Concentration of PFAS in soil (mg/kg)
- IRs = Ingestion rate of soil (mg/day)
- FI = Fraction of daily ingestion that is derived from contamination source (unitless), taken as 1
- B = Bioavailability or absorption of chemical via ingestion (unitless)
- CF = Conversion factor of 1x10<sup>-6</sup> to convert mg to kg
- EF = Exposure frequency (days/year)
- ED = Exposure duration (years)
- BW = Body weight (kg)
- AT = Averaging time for threshold exposures, (=ED x 365 days)

This calculation assumes that all soil ingested over the day is impacted with PFAS.

The assumptions adopted for the quantification of potential intakes via incidental ingestion of soil are presented in **Table 6.1**. All calculations are presented in **Appendix D**.

### 6.3.2 Dermal Contact with Soil

Dermal absorption of chemicals from soil depends on the area of skin in contact with the soil, the concentration of PFOS+ PFHxS in the soil, duration of contact with the soil, how tightly the chemical is bound into the soil and the ability of the chemical to penetrate the skin. Assessing potential dermal adsorption of PFOS+ PFHxS has been generally undertaken using the approach presented by the USEPA. The USEPA define a simple approach to the evaluation of dermal adsorption associated with soil contact (USEPA 1989, 1991, 2004).

This is presented in the following equation:

$$\text{Daily Chemical Intake} = C_s \cdot \frac{SAs \cdot AF \cdot FE \cdot ABS \cdot CF \cdot EF \cdot ED}{BW \cdot AT} \quad (\text{mg/kg/day})$$

where:

- Cs = Concentration of PFAS in soil (mg/kg)
- SAs = Surface area of body exposed to soil per day (cm<sup>2</sup>/day)
- AF = Adherence factor, amount of soil that adheres to the skin per unit area which depends on soil properties and area of body (mg/cm<sup>2</sup> per event)
- FE = Fraction of day exposed before washing soil off skin
- ABS = Dermal absorption fraction (unitless)
- CF = Conversion factor of 1x10<sup>-6</sup> to convert mg to kg
- EF = Exposure frequency (days/year)
- ED = Exposure duration (years)
- BW = Body weight (kg)
- AT = Averaging time for threshold exposures, (=ED x 365 days)

The assumptions adopted for the quantification of potential intakes via dermal contact with soil are presented in **Table 6.1**. All calculations are presented in **Appendix D**.

### 6.3.3 Inhalation of Dust

Inhalation of dust depends on the site surface cover and wind speed, the time a receptor spends at the site and the amount of dust that reaches and penetrates into the lungs following inhalation.

In this HHERA, the potential concentration of PFOS+ PFHxS in dust that might be in air as a result of wind erosion has been estimated using a Particulate Emission Factor (PEF). A PEF is a ratio of the concentration of contaminants in soil (mg/kg) to the concentration of contaminants in air (mg/m<sup>3</sup>). The PEF for an intrusive maintenance worker from CRC CARE (2011) has been adopted.

The quantification of inhalation exposures has been undertaken in accordance with guidance provided by the USEPA (USEPA 2009). This guidance does not require the calculation of a daily chemical intake, rather the approach requires calculation of an inhalation exposure concentration using the following equation:

$$\text{Inhalation Exposure Conc}_p = C_a \cdot \frac{ET \cdot DF \cdot CC \cdot FI \cdot EF \cdot ED}{AT} \quad (\text{mg/m}^3)$$

where:

- Ca = Concentration of PFAS in air (mg/m<sup>3</sup>)
- ET = Exposure time (hours/day)

- DF = Deposition fraction, fraction of inhaled dust retained in the respiratory tract (not exhaled), taken to be 75% (0.75) as per enHealth (2004) and the ASC NEPM (unitless)
- CC = Ciliary clearance factor, fraction of the inspirable dust that is small enough to reach the pulmonary alveoli, taken to be 50% (or 0.5) as per enHealth (2004) and ASC NEPM (unitless)
- FI = Fraction inhaled from contaminated source (unitless)
- EF = Exposure frequency (days/year)
- ED = Exposure duration
- AT = Averaging time for threshold exposures, (=ED x 365 days x 24 hours)

The assumptions adopted for the quantification of potential intakes following the inhalation of dust are presented in **Table 6.1**. All calculations are presented in **Appendix D**.

### 6.3.4 Incidental Ingestion of Water

Ingestion of water is a key pathway of exposure relevant for Airport workers.

The potential intake of PFOS+ PFHxS in water via incidental ingestion has been undertaken using the following equation:

$$\text{Daily Chemical Intake}_{W} = C_w \cdot \frac{IR_w \cdot FI \cdot B \cdot EF \cdot ED}{BW \cdot AT} \quad (\text{mg/kg/day})$$

where:

- Cs = Concentration of PFAS in water (mg/L)
- IRw = Ingestion rate of water (L/day)
- FI = Fraction of daily ingestion that is derived from contamination source (unitless), taken as 1
- B = Bioavailability or absorption of chemical via ingestion (unitless) (assumed to be 100%)
- EF = Exposure frequency (days/year)
- ED = Exposure duration (years)
- BW = Body weight (kg)
- AT = Averaging time for threshold exposures, (=ED x 365 days)

The assumptions adopted for the quantification of potential intakes via incidental ingestion of water are presented in **Table 6.1**. All calculations are presented in **Appendix D**.

### 6.3.5 Dermal Contact with Water

The potential intake of PFOS+ PFHxS in water via dermal absorption has been undertaken using the following equation:

$$\text{Daily Chemical Intake} = C_w \cdot \frac{SA_w \cdot ET \cdot DP \cdot CF \cdot EF \cdot ED}{BW \cdot AT} \quad (\text{mg/kg/day})$$

where:

- Cw = Concentration of PFAS in water (mg/L)
- SAw = Surface area of body exposed to water per day (cm<sup>2</sup>)
- ET = Exposure time to PFAS in water (hr/day)
- DP = Dermal permeability (cm/hr)
- CF = Conversion factor of 1x10<sup>-3</sup> (L/cm<sup>3</sup>)
- EF = Exposure frequency (days/year)
- ED = Exposure duration (years)
- BW = Body weight (kg)
- AT = Averaging time for threshold exposures, (=ED x 365 days)

The assumptions adopted for the quantification of potential intakes via dermal absorption following contact with water are presented in **Table 6.1**. All calculations are presented in **Appendix D**.

## 6.4 Adopted Concentrations

**Table 6.2** outlines the concentrations of PFOS + PFHxS that are assumed to be present in soil and water at the airport. The HHERA has assumed that Airport workers may be exposed to these concentrations in accordance with the exposure parameters outlined in **Table 6.1**.

These concentrations are the maximum concentrations reported in each media/area from the available assessment data. This approach is conservative, as airport workers will be exposed to average and not maximum concentrations, however there is not sufficient data available to refine the assessment (e.g. through the use of statistics).

**Table 6.2: Summary of Input Concentrations for HHERA**

	PFOS+ PFHxS		
	Soil (mg/kg)	Groundwater (µg/L)	Surface Water (µg/L)
Current and Former FTG	140	5,720	267
Fire Station	31.8	4,991	239
Former Concrete Water Tank Area	--	377	--

**Notes:**

"--" = Not a CoPC for this area of the airport.

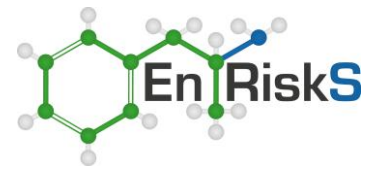
## 6.5 Uncertainties

The values adopted for the purpose of quantifying exposure are point values that are derived from a wide range of physiological or behavioural values that are better defined using a distribution. However, it is overly complex to present the assessment based on distributions and the point values adopted in this HHERA provide a reasonable approximation of potential exposure.

The quantification of exposure has adopted a number of conservative assumptions regarding activities that Airport workers may undertake and how these activities may result in exposure to impacted soil and water. Many of the parameters adopted for the assessment of exposures are considered to be an overestimate of actual exposures. For example, it has been assumed that a worker is exposed to soil, groundwater and/or surface water impacted with maximum PFAS concentrations for 60 days/year. Hence the risk calculations presented in this report are expected to be conservative from an overall exposure point of view.

In addition, the HHERA has assumed that PFOS + PFHxS and PFOA have the ability to penetrate through human skin and result in adverse health effects which is conservative based on the information in the scientific literature (de Witt 2015). Effects in animals that have been correlated with dermal exposure to PFAS include (ATSDR 2018):

- Hepatic changes in rats;
- Mild skin irritation and acute necrotizing dermatitis in rats;
- Conjunctival irritation in rabbits;
- Transient weight loss changes in rats; and
- Increase the IgE response to environmental allergens in mice.



ATSDR (2018) indicates that relevance of the above effects in animals to human is questionable given the severity of effects reported and that animals are generally thought to be poor surrogates for humans when assessing PFAS toxicology. Significant adverse health effects have also not been associated with long term dermal exposure to PFAS by workers. It is also interesting to note that when the dermal absorption of PFOS was studied in rabbits, absorption was not actually detected at an applied concentration of 0.3 mg/kg potassium PFOS. This indicates that PFOA, and not PFOS, may be more important when assessing dermal contact in animals. Notwithstanding the above, systemic effects have been reported in rats following exposure to PFOA and hence the HHERA has conservatively assumed that the dermal exposure pathway is complete for PFOS.

In this HHERA, the upper bound experimental value for PFOA and rat skin (which is likely to be protective of human skin) has been adopted for PFOS and PFHxS. No experimental values are available for PFOS/PFHxS however in the absence of specific experimental data, chemical behaviour is often inferred based on a similarity (or lack thereof) in chemical form and structure. Both perfluoroalkyl carboxylates (e.g. PFOA) and sulfonates (e.g. PFOS) are made of a long perfluorocarbon tail (that is both hydrophobic and oleophobic) and a charged end that is hydrophylic. This is what gives PFAS their unique surfactant properties. The molecular weight of PFOA is similar to PFOS and PFHxS (PFOS at 500.03 g/mol, PFHxS at 400.02 g/mol and PFOA at 414.07 g/mol). All three PFAS are expected to be present in ionic form at environmental pH.

Therefore, based on the similarities in chemical form and structure between PFOS/PFHxS and PFOA, and the available experimental data which suggests skin may be most permeable to PFOA, the adoption of experimental values for PFOA for PFOS and PFHxS is considered reasonable.

## Section 7. HHRA, Risk Characterisation: On-Airport

### 7.1 Approach

Risk characterisation is the final step in a quantitative risk assessment. It involves the incorporation of the exposure and toxicity assessment to provide a quantitative evaluation of risk. In this HHRA, the quantification of potential exposure and threshold risks to human health associated with the presence of PFOS + PFHxS and PFOA in soil and water at the airport has been undertaken by comparing the estimated intake (or exposure concentration) with the threshold values adopted that represent a tolerable intake (or concentration), with consideration for background intakes. The calculated ratio is termed a Hazard Index (HI), which is the sum of all ratios (termed Hazard Quotients [HQ]) over all relevant pathways of exposure. These are calculated using the following equations:

$$\text{Hazard Quotient [HQ] (oral or dermal)} = \frac{\text{Daily Chemical Intake}}{(\text{ADI, TDI, RfD} - \text{Background})}$$

$$\text{Hazard Quotient [HQ] (inhalation)} = \frac{\text{Exposure Concentration in Air}}{(\text{TC, RfC} - \text{Background}) \text{ or TWA}}$$

$$\text{Hazard Index (HI)} = \sum_{\text{All pathways}} \text{HQ}$$

The interpretation of an acceptable HI needs to recognise an inherent degree of conservatism that is built into the establishment of appropriate guideline (threshold) values (using many uncertainty factors) and the exposure assessment. Hence, in reviewing and interpreting the calculated HI the following is noted:

- A HI less than or equal to a value of 1 (where intake or exposure is less than or equal to the threshold) represents no cause for concern (as per risk assessment industry practice, supported by protocols outlined in ASC NEPM and USEPA guidance); and
- A HI greater than 1 requires further consideration within the context of the assessment undertaken, particularly with respect to the level of conservatism in the assumptions adopted for the quantification of exposure and the level of uncertainty within the toxicity (threshold) values adopted.

### 7.2 Calculated Risks

**Table 7.1** presents a summary of the threshold HQ and the total HI calculated for the exposures evaluated. The values presented in **Table 7.1** (and all other risk calculations) are rounded to 1 or 2 significant figures reflecting the level of certainty inherent in risk calculations. Detailed calculations are presented in **Appendix D**.

**Table 7.1: Summary of Risk Estimates, On-Airport**

Potential Exposures by Airport Workers	Threshold Risk (HQ/HI)		
	Current and Former FTG	Fire Station	Former Concrete Water Tank Area
- Ingestion of Soil	1.8	0.4	--
- Dermal Contact with Soil	0.03	0.01	--
- Inhalation of Dust	0.0001	0.00003	--
<b>Total Soil</b>	<b>2</b>	<b>0.4</b>	<b>--</b>
- Ingestion of Groundwater	3.7	3.3	0.2
- Dermal Contact with Groundwater	0.3	0.3	0.02
<b>Total Groundwater</b>	<b>4</b>	<b>4</b>	<b>0.3</b>
- Ingestion of Surface Water	0.18	0.16	--
- Dermal Surface Water	0.01	0.01	--
<b>Total Surface Water</b>	<b>0.19</b>	<b>0.17</b>	<b>--</b>
<b>Total for All Applicable Media</b>	<b>6</b>	<b>5</b>	<b>0.3</b>
<b>Acceptable Risk</b>	<b>≤1</b>		

**Notes:**

Risks greater than the acceptable level are shown in **bold**.

"--" = Not a CoPC for this area of the airport.

**Table 7.1** indicates that overall risks to workers who may come into contact with PFAS impacted media in the Current and Former FTG and Fire Station have the potential to be unacceptable, by 2 to 5 times. Potential risks from direct contact with groundwater in the Former Concrete Water Tanks Area are low and acceptable.

With respect to the uncertainty identified in the calculations presented the following is noted:

- Other PFAS have been detected in soil, groundwater and surface water at the airport (refer to **Section 3.8**). While these other PFAS are generally considered to be less toxic to human health than PFOS, PFOA and PFHxS (with a few exceptions), toxicity information for other PFAS is limited and some PFAS (e.g. PFBA, PFBS, PFPeA, PFPeS, PFHxA, PFHpA and PFHpS) have been reported in groundwater at concentrations in the range 40 to 900 µg/L and in surface water at concentrations in the range 2 to 20 µg/L;
- There is limited data available to characterise PFAS concentrations in some areas of the airport, limited data to assess variability in reported concentrations (especially for groundwater which contributes between 70 to 80% of the calculated risks in the Current and Former FTG and the Fire Station), no data is available for some identified PFAS source areas and the degree of interaction between groundwater and surface water has not been determined; and
- No analysis for PFHxS was undertaken for soil in the Former FTG and Current FTG where maximum PFOS concentrations were reported. When samples have been analysed for both PFOS and PFHxS in later assessments, relative concentrations of PFOS and PFHxS have been variable. This variability may be a reflection of different mobilities for PFOS and PFHxS, with PFHxS considered more mobile than PFOS. This difference has been observed in data reported from GW16, with the ratio of PFOS:PFHxS higher in surface than at depth. As a result, it would not be unexpected for some soil to contain higher concentrations of PFHxS than PFOS.

Given this, the management measures outlined in the AAL Guideline for PFAS Work Health and Safety are supported and should be applied to all potential PFAS source areas at the airport. If works may intercept groundwater, the list of required PPE should be expanded to include long sleeves and long trousers, and waterproof boots if workers may get their feet wet in the course of activities.

### 7.3 Uncertainties

Uncertainty in any assessment refers to a lack of knowledge (that could be better refined through the collection of additional data or conduct of additional studies) and is an important aspect of the risk assessment process. An assessment of uncertainty is a qualitative process relating to the selection and rejection of specific data, estimates or scenarios within the risk assessment.

In general, the uncertainties and limitations of the risk assessment can be classified into the following categories, where uncertainties relevant to each have been addressed within the report (as noted):

- Identification of risk issues (addressed in **Section 3.7**);
- Toxicological assessment (addressed in **Section 5.3**); and
- Exposure assessment (addressed in **Section 6.5**).

Given it is not possible to fully define all exposures to PFAS that might occur at the airport, a further quantitative sensitivity analysis has been undertaken, as outlined below. The quantitative sensitivity analysis has considered the likely exposure frequency to soil in the Current and Former FTG and the Fire Station. The original HHERA calculations (**Table 7.1**) assumed that workers are exposed to maximum PFAS concentrations in soil on 60 days per year. Where this is reduced to 20 days per year (for 1/3 of the original assumed time), health risks will decrease accordingly to 1/3 of the original risk estimates. In this instance:

- Health risks from PFAS in soil in all areas are calculated to be acceptable;
- Health risks from PFAS in surface water in the Current and Former FTG and Fire Station remain acceptable; and
- Health risks from PFAS in groundwater in the Former Concrete Water Tank Area remain acceptable;
- Health risks from PFAS in groundwater in the Current and Former FTG and Fire Station are still potentially unacceptable by around 1-2 times; and
- Overall risks to airport workers exposed to soil, surface water and groundwater in the Current and Former FTG and Fire Station are potentially unacceptable by 1-2 times.

This supports the recommendations for management measures in the Current and Former FTG and the Fire Station.

## Section 8. HHRA, Exposure Assessment: Off-Airport

### 8.1 General

This section provides a discussion on the human receptors of potential significance that warrant quantification in this assessment. The potential for exposure has been quantified using industry best practice and guidance available from USEPA (1989, 2002 and 2009) and Australia (NEPC 1999 amended 2013a). Where specific guidance is not available, parameters comprise industry standard values that have been demonstrated to be acceptable in the Australian regulatory context.

### 8.2 Exposure Assumptions

Based on the review of risk issues presented in **Section 4**, the following exposure scenarios require a more detailed assessment of potential risks to human health, in relation to the presence of PFAS in groundwater off-airport:

- Consumption of home-grown fruit and vegetables; and
- Consumption of home-grown chicken eggs.

These are the exposure pathways where concentrations of PFAS exceeded the adopted screening level guidelines and hence further, more detailed, evaluation is required in the HHERA.

These exposure scenarios are potential future exposure scenarios, off-airport groundwater has not been identified to be currently used for growing edible products.

Exposures that may occur for the above scenarios have been calculated for adults and young children, noting that children aged 2 to 3 years are considered to be most sensitive (NEPC 1999 amended 2013b), as their behaviour and activities result in higher levels of intake, compared with adults. In addition, young children have a lower body weight, so their intake per unit body weight is higher.

Risks following the sale of edible products into the market have not been quantitatively assessed in this HHERA.

#### 8.2.1 Home-Consumption of Chicken Eggs

Exposure parameters adopted for the assessment of intakes from eggs are presented **Table 8.1**.

The modelled PFOS + PFHxS concentrations in eggs, including the adopted transfer factors (TF), are presented in **Appendix E**.

**Table 8.1: Exposure Parameters for Estimating Intakes from Home Consumption of Eggs**

Parameter	Units	Value		Basis/comment
		Adult	Child	
C <sub>e</sub>	µg/kg	Modelled		Refer to <b>Appendix E</b>
IR – eggs	kg/day	0.06		Assumes the consumption of one large egg per day by both adults and children. This is more conservative than the estimates presented in the ABS 2011-2012 NNPAS (FSANZ 2017d). The consumption of 1 large egg per day includes regularly eating eggs as well as regularly cooking with eggs.

Parameter	Units	Value		Basis/comment
		Adult	Child	
FI	unitless	1		This assumes that 100% of all eggs consumed will be from the property.
Bo	unitless	1		Assumed to be 100%.
EF	days/ year	365		Assumed to occur every day.
ED	years	35	5	Average and 95 <sup>th</sup> percentile values for the duration at a residence in Australia (enHealth 2012b). The duration of exposure as a child relates to the time spent as a child aged 1-6 years.
AT	days	= ED x 365		Equal to exposure duration.
BW	kg	70	15	ASC NEPM, relevant to children aged 2-3 years.

### 8.2.2 Home-Consumption of Fruit and Vegetables

Exposure parameters adopted for the assessment of intakes from fruit and vegetables are presented **Table 8.2** and **Table 8.3**.

The modelled PFOS + PFHxS concentrations in fruit and vegetables, including the adopted TF, are presented in **Appendix E**.

**Table 8.2: Exposure Parameters for Estimating Intakes from Home Consumption of Fruit/Vegetables**

Parameter	Units	Value		Basis/comment
		Adult	Child	
C <sub>fv</sub>	µg/kg	Modelled		Refer to <b>Appendix E</b>
IR – fruit and vegetables	kg/day	Refer to <b>Table 8.3</b>		Based on the P90 values for consumers from FSANZ (2017g)
FI	unitless	0.01		This assumes that 10% of all fruit/vegetables consumed will be from the property.
Bo	unitless	1		Assumed to be 100%.
EF	days/ year	365		Assumed to occur every day.
ED	years	35	5	Average and 95 <sup>th</sup> percentile values for the duration at a residence in Australia (enHealth 2012b). The duration of exposure as a child relates to the time spent as a child aged 1-6 years.
AT	days	= ED x 365		Equal to exposure duration.
BW	kg	70	15	ASC NEPM, relevant to children aged 2-3 years.

**Table 8.3: Assumed Ingestion Rate for Fruit and Vegetables (FSANZ 2017g; P90 for Consumers)**

Parameter	Produce Group		
	Green and Fruiting Vegetables	Root and Tuber Vegetables	Fruit
Consumption Rate – Adult (kg/day)	0.37	0.27	0.86
Consumption Rate – Child (kg/day)	0.3	0.16	0.59

### 8.3 Quantification of Exposures

Intakes of PFOS from the consumption of fruit, vegetables and eggs from chickens have been calculated based on the following equation:

$$\text{Intake}_p = \frac{C_p \times IR_p \times FI \times B_o \times EF \times ED}{BW \times AT} \quad \dots \text{Equation 8.1}$$

Where

Intake<sub>p</sub> = Daily intake of PFAS from produce (µg/kg/day)

C<sub>p</sub> = PFAS concentration in produce (µg/kg)

IR<sub>p</sub> = Produce ingestion rate (kg/day)

FI = Fraction ingested from contaminated source (unitless)

B<sub>o</sub> = Oral bioavailability (unitless)

EF = Exposure frequency (days/year)

ED = Exposure duration (years)

AT = Averaging time (days)

BW = Body weight (kg)

### 8.4 Adopted Concentrations

Off-airport groundwater well GW16\_14 is the well that has a TDS concentration that may make it suitable for irrigating produce and contains concentrations of PFOS + PFHxS exceeding the adopted screening level (drinking water guideline). The PFOS + PFHxS concentration in this well is 0.1 µg/L where all of the concentration is PFHxS (no PFOS was detected).

It is noted that well GW16\_12 reported very similar PFOS + PFHxS concentrations (0.12 µg/L), or which 0.09 µg/L was PFHxS and 0.03 µg/L was PFOS. Given the inherent uncertainties associated with sampling and analysis for PFAS, and that PFOS is more bioaccumulative than PFHxS, the calculations presented in this HHERA are based on water containing:

- PFHxS of 0.09 µg/L; and
- PFOS of 0.03 µg/L.

These are the maximum concentrations reported in off-airport groundwater.

### 8.5 Uncertainties

Consistent with the on-airport HHERA, the quantification of exposures off-airport has adopted a number of conservative assumptions regarding activities that residents may undertake in the future. This HHERA has assumed that a resident keeps a enough chickens to be able to consume 1 egg per day for the whole year, and also sources 10% of the fruit and vegetables they consume each year from their property. All produce is assumed to be grown using only water containing maximum concentrations of PFAS reported in groundwater off-airport. 90<sup>th</sup> percentile fruit and vegetable consumption rates have been adopted for the HHERA. These assumptions are conservative and will overestimate exposures that may occur in the future.

## Section 9. HHRA, Risk Characterisation: Off-Airport

### 9.1 Approach

The risk characterisation approach is outlined in **Section 7.1**.

### 9.2 Calculated Risks

**Table 9.1** presents a summary of the threshold HQ and the total HI calculated for the exposures evaluated. The values presented in **Table 9.1** (and all other risk calculations) are rounded to 1 or 2 significant figures reflecting the level of certainty inherent in risk calculations. Detailed calculations are presented in **Appendix E**.

**Table 9.1: Summary of Risk Estimates, Off-Airport**

Potential Exposures by Residents	Threshold Risk for Resident (HQ/HI)	
	Adult	Child
Consumption of Eggs	0.02	0.1
Consumption of Fruit	0.01	0.03
Consumption of Vegetables	0.03	0.07
Total for all Produce	0.05	0.2
<b>Acceptable Risk</b>	<b>≤1</b>	

**Notes:**

Risks greater than the acceptable level are shown in **bold**.

**Table 9.1** indicates that overall risks to residents who may home-consume fruit, vegetables and eggs from chickens, that are watered with groundwater containing PFAS, are low and acceptable.

### 9.3 Uncertainties

#### 9.3.1 General

The modelling of the uptake of PFOS + PFHxS into eggs, fruit and vegetables presented in this HHRA is based the use of TF that describe how much of the PFAS in the water may accumulate in the edible produce. The units for TF are µg/kg plant (wet weight) to µg/L water (units are not quoted hereafter for readability).

Data is available from a relatively robust study for eggs. The uptake of PFAS into fruit and vegetables has been less well studied and the range of available TF for uptake of PFOS + PFHxS from water into fruit/vegetables is summarised in **Appendix E (Table E3)**. The maximum reported TF for fruit and root vegetables has been adopted in this HHRA. Hence, the assessment presented is appropriate for the assessment of these edible produce types (eggs, fruit and root vegetables).

For green and fruiting vegetables, where there is more information available, average values have been used. For most studies, the maximum value has been adopted to calculate the average. The exception is the AECOM (2017) study where average TF for each produce type have been determined. This average has been used to calculate the overall average for green and fruiting vegetables. The TF used in the HHRA calculations are 2.0 for PFOS and 2.1 for PFHxS.

It is noted that there is some variability in the TF reported by the AECOM (2017) study, and that the highest TF were reported for this study. This study was undertaken as part of the RAAF Williamtown investigation. This study was a 120-day greenhouse trial that investigated the uptake of PFAS into 7 horticultural crops comprising alfalfa, beet, cucumber, radish, lettuce, strawberry and tomatoes. The crops were housed in 4 different greenhouses and were irrigated with test solutions containing 0 µg/L, 1 µg/L, 10 µg/L and 100 µg/L of PFOS, PFHxS, PFOA and PFHxA (AECOM 2017).

AECOM (2017) concluded that uptake of PFAS into plants was directly correlated to PFAS concentration in water (with a linear relationship) where irrigation water was artificially modified with PFAS. There were also some experimental issues with raising the tomatoes, strawberries and cucumbers which means that the TF were not statistically significant for strawberries and cucumbers and no TF was derived for tomatoes. Overall, it is generally considered that the data from the AECOM (2017) study supports other studies from the literature but does not provide robust individual TF for use in a HHERA.

If the AECOM (2017) data is excluded from the HHERA, the revised TF are 1.4 for PFOS and 1.9 for PFHxS. If the maximum TF for each produce type from AECOM (2017) are used to calculate the average for green and fruiting vegetables, the revised TF are 3.1 for PFOS and 3.0 for PFHxS. There is no change in HHERA outcomes based on either set of revised TF.

As discussed in **Section 4.7**, there is only one round of sampling data for the off-airport groundwater wells. Variability in PFAS concentrations between sampling rounds is not uncommon, however, concentrations would need to increase by 5 times before calculated risks are at the acceptable level. However, as the variability in groundwater concentrations is not known, an additional sensitivity analysis has been undertaken and presented below. The sensitivity analysis has considered PFAS concentrations at western boundary well GW16\_03 and the presence of PFAS other than PFOS, PFHxS and PFOA.

### 9.3.2 Sensitivity Analysis 1, Well GW16\_03

It is noted that higher concentrations of PFOS + PFHxS of 0.46 µg/L were reported in western boundary well GW16\_03 (GHD 2019; noting this well was last sampled in August 2018). The PFOS concentration in this well was 0.46 µg/L and no PFHxS was detected.

The calculated risks for the home-consumption of produce watered with groundwater from GW16\_03 are shown in **Table 9.2**. As discussed above, the TDS concentration in this well is not suitable for the irrigation of edible produce. Hence, this scenario is conservative.

**Table 9.2: Summary of Risk Estimates, Sensitivity Analysis 1, GW16\_03**

Potential Exposures by Residents	Threshold Risk for Resident (HQ/HI)	
	Adult	Child
Consumption of Eggs	0.09	0.4
Consumption of Fruit	0.02	0.08
Consumption of Vegetables	0.06	0.19
Total for all Produce	0.2	0.7
<b>Acceptable Risk</b>	<b>≤1</b>	

**Notes:**

Risks greater than the acceptable level are shown in **bold**.

**Table 9.2** indicates that overall risks to residents from using groundwater at well GW16\_03 to irrigate edible produce, assuming this is possible based on the TDS concentration in groundwater, are below the acceptable level. Risk calculations are provided in **Appendix E**.

### 9.3.3 Sensitivity Analysis 2, Other PFAS

PFOS + PFHxS concentrations comprised 13% of total PFAS concentrations reported in off-airport groundwater. The other PFAS detected in the wells analysed for an extended PFAS suite (where PFAS was detected), and the relative concentrations, are summarised in **Table 9.3**.

**Table 9.3: Summary of Other PFAS Detected in Off-Airport Groundwater, Sensitivity Analysis 2**

PFAS Detected	Concentration (µg/L) (% of Total)	
	GW16_12	GW16_13
PFOS + PFHxS	0.12 (13%)	0.04 (13%)
PFOA	0.03 (3%)	0.06 (20%)
PFPeA	0.02 (2%)	0.03 (10%)
PFHxA	0.03 (3%)	0.04 (13%)
PFHpA	ND	0.06 (20%)
PFBS	0.04 (4%)	ND
PFPeS	0.02 (2%)	ND
6:2 FtS	0.68 (72%)	0.07 (23%)
<b>Total PFAS</b>	<b>0.94</b>	<b>0.3</b>

At well GW16\_12, the main other PFAS detected was 6:2 FtS. At well GW16\_13, no PFAS was dominant. The other PFAS detected were the short chain (C5 to C7) carboxylic acids, the C4 and C7 sulfonates and 6:2 FtS. Although the available information is limited, it is generally considered that these other PFAS are less toxic to humans than PFOS (and hence PFHxS) by around 10 to 100 times (Borg et.al. 2013; CONCAWE 2016; deWitt. J.C. 2015; ESG 2015; Gomis et al. 2018; RIVM 2018; ToxConsult 2016b, 2016a; Valsecchi et al. 2017; Wilhelm et. al. 2010). Note that this statement does not apply to a handful of PFAS including PFNA (which may be more toxic to humans than PFOS/PFHxS) and the >C8 carboxylic acids (for which there is no information on human toxicology). PFNA and the >C8 carboxylic acids have not been detected in groundwater off-airport.

The main PFAS detected at GW16\_12 (the key groundwater well considered in this HHERA) was 6:2 FtS. Some toxicity data is available for this PFAS as summarised in **Table 9.4**.

**Table 9.4: Summary of Toxicity Data Relevant to 6:2 FTS**

Test Material	Study Type	Study Details	Effects Reported	Reported NOAEL (mg/kg bw/day)
Forafac 1157 (fluorotelomer foam) (Dupont, unpublished)	Developmental toxicity study with rats	Rats. Dose levels set at 0, 25, 150 or 1,000 mg/kg-day during gestation (days 6-20).	No maternal mortality or other clinical observations reported. Reduction in body weight gain at 1,000 mg/kg-day (17% lower than control group). Reduction in food consumption also observed however not considered adverse (small & transient).	150

Test Material	Study Type	Study Details	Effects Reported	Reported NOAEL (mg/kg bw/day)
6:2 FTS with some 8:2 FTS (Dupont, unpublished)	Repeated dose toxicity study	Rats. Dose levels of 15, 50 and 150 mg/kg/day for 28 consecutive days.	Effects reported at 50 and 150 mg/kg/day including lower body weight gain & food consumption. Anaemia, inflammation and signs of kidney/liver toxicity, lower weights for other organs (heart, spleen, reproductive organs) also reported.	15
Commercial fluorotelomer-based urethane polymeric dispersion (Stadler et. al. 2008)	Sub-chronic, reproduction, and developmental toxicity study	Rats. Dose levels of 0, 50, 250, or 1,000 mg/kg/day.	Reported effects included nasal olfactory epithelial degeneration and necrosis, liver enzyme alterations and decrease in thyroid weight and fetal weight.	Sub-chronic toxicity: 50 Developmental toxicity: 250

**Notes:**

NOAEL = No Observed Adverse Effect Level

The available toxicity data indicates NOAELS in the range 15 to 250 mg/kg bw/day. The adoption of the lowest NOAEL with a high uncertainty factor of 1,000 (based on 10x intraspecies variation, 3x adequacy of database, 3x sub-chronic to chronic and 10 x interspecies variation) results in a toxicity value for 6:2 FtS of 15 µg/kg bw/day. This is in the range of toxicity values for 6:2 FtS adopted at other contaminated sites in Australia (range of 5 to 30 µg/kg bw/day). This also means that 6:2 FtS is 750 times less toxic to humans than PFOS and PFHxS (toxicity value of 0.02 µg/kg/day; refer to **Section 5.2.3**).

If 6:2 FtS is added into the HHERA calculations based on a groundwater concentration of 0.68 µg/L (maximum), a toxicity value of 15 µg/kg bw/day and the highest TF for either PFOS or PFHxS, there is no change in HHERA outcomes. Risk calculations are provided in **Appendix E**.

## Section 10. Screening Level ERA – On-Airport

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### 10.1 General

This section presents a screening level assessment of potential ecological risks relevant to the on-airport environment.

This assessment is a screening level assessment, as it is based on the comparison of PFOS and PFOA concentrations reported in various media with screening level guidelines, available and relevant to the protection of the terrestrial ecosystems. Screening level guidelines are only available for PFOS and PFOA. There is limited information available to assess terrestrial and aquatic effects from PFAS other than PFOS and PFOA, including PFHxS, hence there are no screening level guidelines for these other PFAS. For this reason, the focus of this ERA is PFOS and PFOA. This is in accordance with the requirements of the PFAS NEMP which indicates that the guideline levels for PFOS and PFOA are “*intended to identify PFAS levels protective of wildlife, based on scientific evidence*”.

In relation to the assessment of potential ecological risk issues relevant to PFOS and PFOA, it is important to note that PFAS are chemically and biologically stable in the environment, are mobile (in water and can easily leach from soil to water) and are persistent and bioaccumulative. Hence the assessment presented has considered issues relevant to the direct toxicity of PFAS, as well as the potential for bioaccumulation and secondary poisoning (i.e. where predators are harmed through the consumption of prey or food sources that contain PFAS).

### 10.2 Receptors and Exposure Pathways

The airport’s Environmental Management Strategy (EMS), including current environmental status and areas of environmental significance, are identified in AAL (2014) alongside proposed measures to prevent, control or reduce environmental impacts associated with airport operations. An Environmental Management Plan (EMP) provides further detail to the EMS and the EMP is reviewed annually and supported by various plans.

Sources of environmental impacts at the airport are listed in Section 10.5 of AAL (2014) and include aviation, non-aviation commercial and airport management and historic activities (e.g. fuel storage and supply, aircraft operations and maintenance, steel fabrication, road maintenance, landfills, herbicide/pesticide application etc.).

AAL (2014) indicates that there are two areas of environmental interest at the airport:

- The Patawalonga Creek Conservation Zone (PCCZ). The PCCZ is located to the west of the airport and includes a remnant reach of Patawalonga Creek (Delta 2016); and
- Tapleys Conservation Zone (TCZ).

The above zones are noted to provide habitat for vegetation communities, isolated flora and uncommon fauna. Biodiversity in both of these zones is managed by AAL. It is understood that the Draft Adelaide Airport Master Plan proposes that the TCZ be incorporated into the PCCZ.

AAL (2014) indicates that there are no threatened ecological communities or species listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) at

the airport. With respect to fauna, the airport is noted to provide limited habitat for birds. There are no EPBC listed birds at the airport however the Little Egret, Peregrine Falcon and Letter Winged Kite, listed in the *State National Parks and Wildlife Act 1972* (SNPWA Act), have been identified. AAL (2014) indicates that a comprehensive wildlife management program balances the dual interests of aviation safety and wildlife conservation. No indigenous artefact sites or sites of heritage significant have been identified to date.

Vegetation surveys undertaken in November 1999 and August 2002 (BUSH-ANEW 1999; 2002) have identified a number of areas at the airport where indigenous plants are present including:

- Patawalonga Creek and adjacent samphire flats;
- The undershoot of runway 23; and
- The area south of the new Bureau of Meteorology building (partially bounded by the TCZ).

AAL has indicated that the other areas where indigenous plants were identified during vegetation surveys have since been developed or modified since the surveys were undertaken, with ecological offsets established within the PCCZ or the TCZ.

A more recent survey of flora biodiversity within the Airport East precinct was undertaken by Delta (2010). The survey confirmed that there were no flora species listed under the EPBC Act or the SNPWA Act. A total of ten species of conservation significance in the St Vincent region were recorded, with conservation ratings ranging from vulnerable to critically endangered and data deficient. The weather at the time of the survey was hot and evidence of fauna was scarce (observations included galah feathers and several fox holes).

An assessment of the vegetation within the PCCZ was undertaken by Delta (2017) to identify changes in vegetation type and distribution and assess the success of revegetation efforts. The assessment identified significant changes in vegetation distributions with some areas identified to have a good diversity and coverage of native plants and movement towards a greater density of exotic species in other areas. The remnant population of *Melaleuca halmaturorum* within the PCZ is actively managed by AAL, with an increase in the density of the species reported between 1989 and 2016 (Delta 2016).

The above information indicates that, with the exception of the PCCZ, TCZ and some areas of remnant indigenous vegetation outside of the conservation zones, the airport has limited ecological value and lacks sensitive environmental receptors. This is unsurprising given the former and ongoing use as an airport.

### **10.3 Review of Potential Risks to Terrestrial Environments**

Given this, a complete exposure pathway between PFAS impacts in soil at the airport and sensitive ecological receptors (i.e. flora) has not been identified. Regardless, a screening assessment for soil and ecological health has been included in the HHERA for completeness and to inform the need for any further management e.g. future management or revegetation of now disused operational areas.

The review of PFAS concentrations in soil against the adopted screening level guidelines for the protection of ecological health is presented in **Table 10.1**. It is noted that screening level guidelines

for ecological receptors are only available for PFOS (for direct toxicity and bioaccumulation) and PFOA (for direct toxicity only).

**Table 10.1: Summary and Review of PFAS Reported in Soil On-Airport, Ecological Health**

Area Investigated	Maximum Reported Concentration (mg/kg)	
	PFOS	PFOA
Former FTG	140	0.58
Current FTG	13	0.88
Fire Station	31.4	0.032
Former Concrete Water Tank Area	0.74	0.037
Other Areas	0.012	0.002
Recycled Water Irrigation Area	0.011	<0.005
<b>Adopted Screening Guidelines<sup>1</sup></b>		
<b>Bioaccumulation – Industrial/Commercial</b>	<b>0.14</b>	<b>--</b>
<b>Direct Toxicity – Industrial/Commercial</b>	<b>1</b>	<b>10</b>

**Notes:**

Shading indicates an exceedance of the adopted guideline value.

**Table 10.1** indicates that concentrations of PFOS and PFOA in soil at in the PFAS source areas at the airport are above the adopted guideline value for the protection of terrestrial ecosystems.

Given this, recommendations for the management of these areas have been provided for when they are no longer required for operational purposes. It is also recommended that further sampling and analysis for PFAS in soil be undertaken within the PCCZ, TCZ or areas of remnant indigenous vegetation, if there is evidence to suggest that soil within these areas may be impacted with PFAS. No further assessment of the potential for ecological risks is presented in this HHERA.

#### **10.4 Review of Potential Risks to Aquatic Environments**

In relation to potential risks to ecological receptors, the stormwater drains at the airport do not support an aquatic environment (sediment dwelling organisms or aquatic species) and therefore this potential exposure pathway is incomplete and no assessment of potential risks to ecological receptors within the drains has been undertaken in this HHERA. These drains discharge directly into the Collection Pond and Diversion Pond (located off-airport). These are stormwater management ponds that are discharged directly (200 m offshore) to the Gulf St Vincent via Barcoo Outlet. The marine environment at the point of discharge is a sensitive aquatic environment. Potential risks to be marine environment are assessed in **Section 11**.

## Section 11. Screening Level ERA – Off-Airport

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### 11.1 General

This section presents a screening level assessment of potential ecological risks relevant to the off-airport environments of the Patawalonga Creek System and Gulf St Vincent. The environments of the Collection and Diversion Ponds have been used as indicators of potential ecological issues associated with the offshore discharge of stormwater to Gulf St Vincent.

This assessment is a screening level assessment, as it is based on the comparison of PFOS and PFOA concentrations reported in various media with screening level guidelines, available and relevant to the protection of aquatic ecosystems. Screening level guidelines are only available for PFOS and PFOA. There is limited information available to assess terrestrial and aquatic effects from PFAS other than PFOS and PFOA, including PFHxS, hence there are no screening level guidelines for these other PFAS. For this reason, the focus of this ERA is PFOS and PFOA. This is in accordance with the requirements of the PFAS NEMP which indicates that the guideline levels for PFOS and PFOA are “*intended to identify PFAS levels protective of wildlife, based on scientific evidence*”.

In relation to the assessment of potential ecological risk issues relevant to PFOS and PFOA, it is important to note that PFAS are chemically and biologically stable in the environment, are mobile (in water and can easily leach from soil to water) and are persistent and bioaccumulative. Hence the assessment presented has considered issues relevant to the direct toxicity of PFAS, as well as the potential for bioaccumulation and secondary poisoning (i.e. where predators are harmed through the consumption of prey or food sources that contain PFAS).

### 11.2 Review of Potential Risks to Aquatic Environments

This section provides a review of concentrations of PFOS and PFOA in surface water and fish from Patawalonga Lake, with the relevant screening guidelines for the protection of aquatic ecosystems. The 95% species protection values from the PFAS NEMP have been adopted in accordance with the advice from SA EPA to AAL (e-mail dated 15 July 2019)<sup>7</sup>. The 95% species protection values are as follows:

- 0.13 µg/L for PFOS; and
- 220 µg/L for PFOA.

Comparison of PFOS and PFOA concentrations with the 95% species protection values is provided in **Table 11.1**.

The HEPA (2018) guidelines for birds and mammals consuming aquatic biota have also been adopted for the assessment of effects due to bioaccumulation. Comparison of PFOS concentrations in biota against the Environment Canada guidelines is presented in **Table 11.2**.

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<sup>7</sup> The reader is directed to SA EPA should additional information be required in relation to the adoption of the 95% species protection values.

It is noted that there are some deficiencies in the study data supporting the avian guidelines, and there may be differences in feeding patterns between the species studied (including the mallard, quail and bobwhite) and the aquatic birds present in the vicinity of the airport (e.g. the osprey). Regardless, these values have been adopted in the HHERA in the absence of any other Australian or international guidelines.

**Table 11.1: Review of PFOS and PFOA Reported in Surface Water and Groundwater, Off-Airport**

Area Investigated <sup>2</sup>	Maximum Reported Concentration (µg/L)	
	PFOS	PFOA
Groundwater, Off-Airport	0.03	0.06
Surface Water, Patawalonga Lake	ND	ND
Surface Water, Diversion Pond and Barcoo Inlet	0.89	0.06
<b>Adopted Screening Guidelines<sup>1</sup></b>		
<b>95% Species Protection</b>	<b>0.13</b>	<b>220</b>

**Notes:**

- 1 = As agreed with SA EPA (AAL *pers. comm*). Note: contact SA EPA should further information in relation to the adoption of this guideline be required.
- 2 = Concentrations at the sampling location closest to the point of discharge.

**Table 11.2: Summary and Review of PFOS Reported in Fish, Patawalonga Lake**

Biota Species	PFOS Concentration (µg/kg wet weight)
Fish Frames	<2 – 3.9
Fish Fillets	<0.8 – 0.97
<b>Adopted Screening Guidelines<sup>1</sup></b>	
<b>Birds (Consumption of Aquatic Biota)</b>	<b>8.2</b>
<b>Mammals (Consumption of Aquatic Biota)</b>	<b>4.6</b>

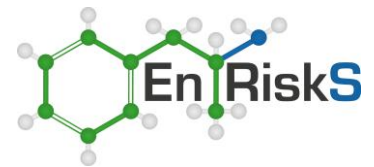
**Notes:**

Shading indicates an exceedance of the adopted guideline value.

- 1 = Ref. HEPA (2018).

Review of **Table 11.1** and **Table 11.2** indicates that maximum concentrations of PFOS and PFOA in groundwater off-airport, surface water in Patawalonga Lake and fish in Patawalonga Lake are below the adopted guidelines relevant to the protection of aquatic ecosystems.

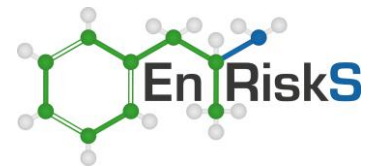
**Table 11.1** indicates that maximum concentrations of PFOS in surface water in the Diversion Pond and Barcoo Inlet are around 7 times above the adopted guideline relevant to the protection of aquatic ecosystems from direct toxicity. The concentration range across the 4 locations sampled in wet and dry weather (8 samples in total) was 0.02 to 0.89 µg/L, with concentrations in 3 of 8 samples exceeding the adopted guideline. The average concentration across each round was 0.08 µg/L (wet weather event) and 0.3 µg/L (dry weather event), with the average dry weather concentration around 2 times the adopted guideline. As noted above, the Diversion Pond and Barcoo Inlet ultimately discharge to Gulf St Vincent around 200 m offshore where a significant amount of dilution is expected to occur. Given this, and the low magnitude of the guideline exceedance in the dry weather event only, adverse effects due to direct toxicity in Gulf St Vincent are considered unlikely. Concentrations of PFOA in surface water in the Diversion Pond and Barcoo Inlet were below the adopted guideline relevant to the protection of aquatic ecosystems from direct toxicity.



It is noted that the HEPA (2018) biota guidelines apply to whole fish that may be consumed by birds. It is not possible to calculate the concentration of PFOS in a whole fish in Patawalonga Lake, as fish fillets and fish frames have been analysed separately and no information on sample weights is available. Based on enRiskS' experience with other projects<sup>8</sup>, concentrations of PFOS in the whole fish can be 1-2 times the concentration measured in the fillets. If this is assumed, concentrations of PFOS in whole fish are still below the HEPA (2018) screening level guidelines for bioaccumulation.

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<sup>8</sup> <https://www.defence.gov.au/Environment/PFAS/Wagga/publications.asp>



## Section 12. Conclusions

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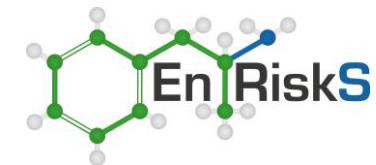
On the basis of data outlined in **Section 1.4**, Environmental Risk Sciences Pty Ltd has undertaken a human health and ecological risk assessment in relation to the presence of per- and polyfluoroalkyl substances at Adelaide Airport, South Australia (the “airport”).

The HHERA has addressed human health and environmental risk issues relevant to PFAS in soil, sediment, groundwater and/or surface water at Adelaide Airport and off-airport. The assessment has not addressed human health or environmental risk issues associated with other chemicals or any other environmental media.

**Table 12.1** provides an overview of the ways in which on- and off-airport receptors (including members of the community and the terrestrial and aquatic environments) may be exposed to PFAS, derived from the airport, and the conclusions and recommendations relevant to these areas. The conclusions and recommendations are made based on the available data, and with consideration of the available information on the existing land use patterns on-airport and off-airport, and the uncertainties identified in this assessment.

**Table 12.1: Conclusions and Recommendation, Risks to Human Health and the Environment from PFAS**

How the Community May be Exposed	Potential Risks to Human Health and the Environment <sup>1</sup>	Areas where Potential Risk Issues Identified <sup>1</sup>	Recommendations <sup>1</sup>
<b>Human Health – On-Airport, Current Exposures</b>			
Direct contact with PFAS in soil by Airport Workers	Low and acceptable except for 1 area.	Former and Current Fire Training Ground	Management measures outlined in the AAL Guideline for PFAS Work Health and Safety are supported and should be applied to all potential PFAS source areas at the airport. If works may intercept groundwater or surface water, the list of required personal protective equipment should be expanded to include long sleeves and long trousers, and waterproof boots if workers may get their feet wet in the course of activities.
Direct contact with PFAS in groundwater by Airport Workers.	Low and acceptable except for 2 areas.	Former and Current Fire Training Ground Fire Station	
Direct contact with PFAS in surface water by Airport Workers.	Low and acceptable.	NA	
Direct contact with recycled water by Airport workers and tenants.	Low and acceptable.	NA	
<b>Human Health – Off-Airport, Current Exposures</b>			
Non-potable use of groundwater with PFAS where exposures occur via direct contact	Low and acceptable.	NA	NA
Recreational use of Patawalonga Lake	Low and acceptable.	NA	NA
Consumption of fish caught from Patawalonga Lake	Low and acceptable.	NA	NA
<b>Human Health – Off-Airport, Potential Future Exposures</b>			
Use of groundwater with PFAS for filling swimming pools where exposures occur via direct contact	Low and acceptable.	NA	NA
Consumption of eggs from chickens on properties where PFAS is present in groundwater used for stock watering	Low and acceptable.	NA	NA
Ingestion of homegrown fruit and vegetables on properties where water containing PFAS is used for irrigation	Low and acceptable.	NA	NA



How the Community May be Exposed	Potential Risks to Human Health and the Environment <sup>1</sup>	Areas where Potential Risk Issues Identified <sup>1</sup>	Recommendations <sup>1</sup>
<b>Environment – On-Airport</b>			
<b>Terrestrial Environment</b>			
Direct toxicity and effects on higher order consumers due to bioaccumulation	Potential for adverse effects to the environment cannot be excluded in the investigated PFAS source areas	Former and Current Fire Training Ground Fire Station Former Concrete Water Tank Area	These areas may require management when they are no longer required for operational purposes. Further sampling and analysis for PFAS in soil is recommended within the PCCZ, TCZ or areas of remnant indigenous vegetation, if there is evidence to suggest that soil within these areas may be impacted with PFAS.
<b>Environment – Off-Airport</b>			
<b>Aquatic Environment</b>			
Direct toxicity and effects on higher order consumers due to bioaccumulation	Low and acceptable.	NA	NA

**Notes:**

1 = The conclusions of the HHERA are based on the available sampling and analysis results.

## Section 13. References

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### **Assessment Consultant Reports**

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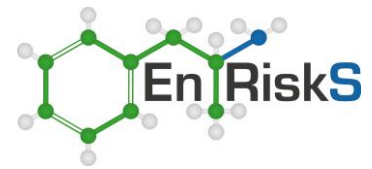
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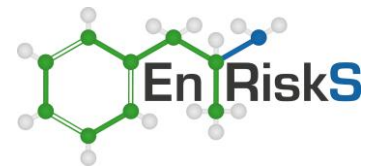
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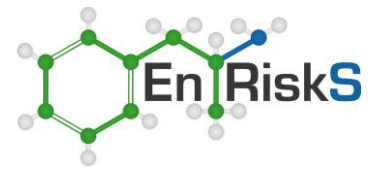
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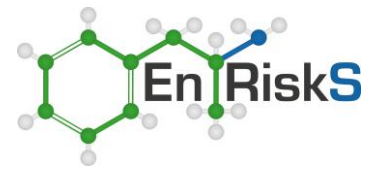
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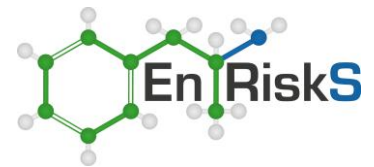
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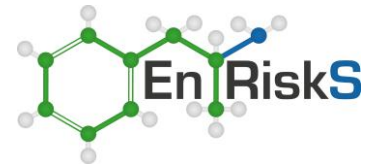
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## **Appendix A Extracts of Assessment Data**

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**Groundwater PFOS + PFHxS**

- Non detect
- Below FSANZ DW (0.07µg/L)
- Below FSANZ recreational (0.7µg/L)
- Below incidental contact (7µg/L)
- Exceeds 7µg/L
- Master Plan Precincts

**Notes**

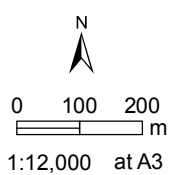
1. 0.07g/L is the current Australian drinking water guideline.
2. **Red text** indicates AirServices monitoring wells and **black text** represents AAL wells.
3. Incidental contact derived by enRisks, human health and ecological risk assessment consultants.



- Well
- ➔ Ground water flow direction
- Ground water elevation (10cm intervals)



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 Imagery: NearMap  
 Data source:  
 Environmental Projects  
 Projection:  
 GDA 1994 MGA Zone 54  
 Date: 30/10/2012

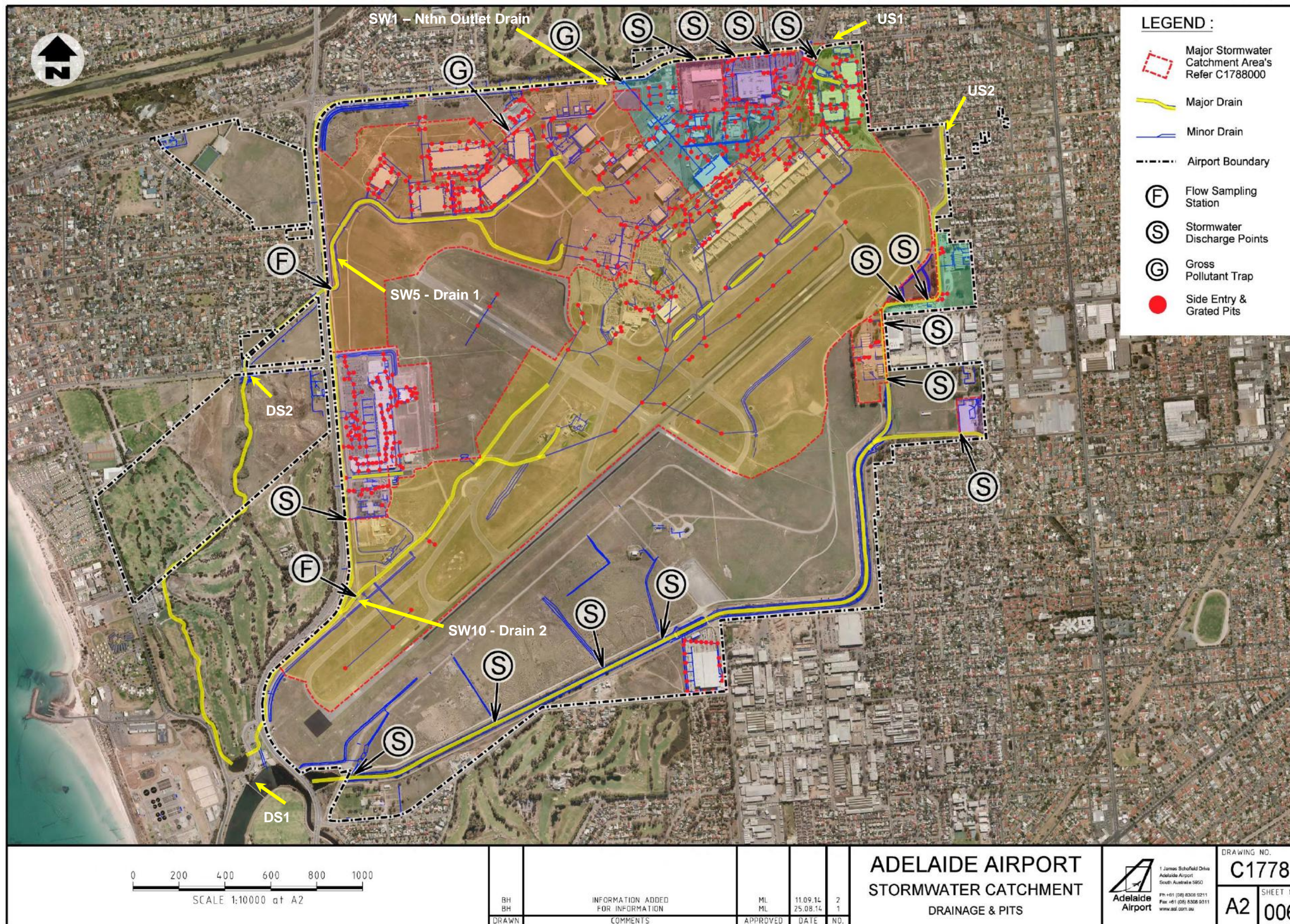
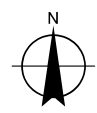
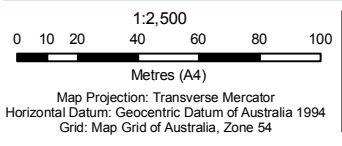
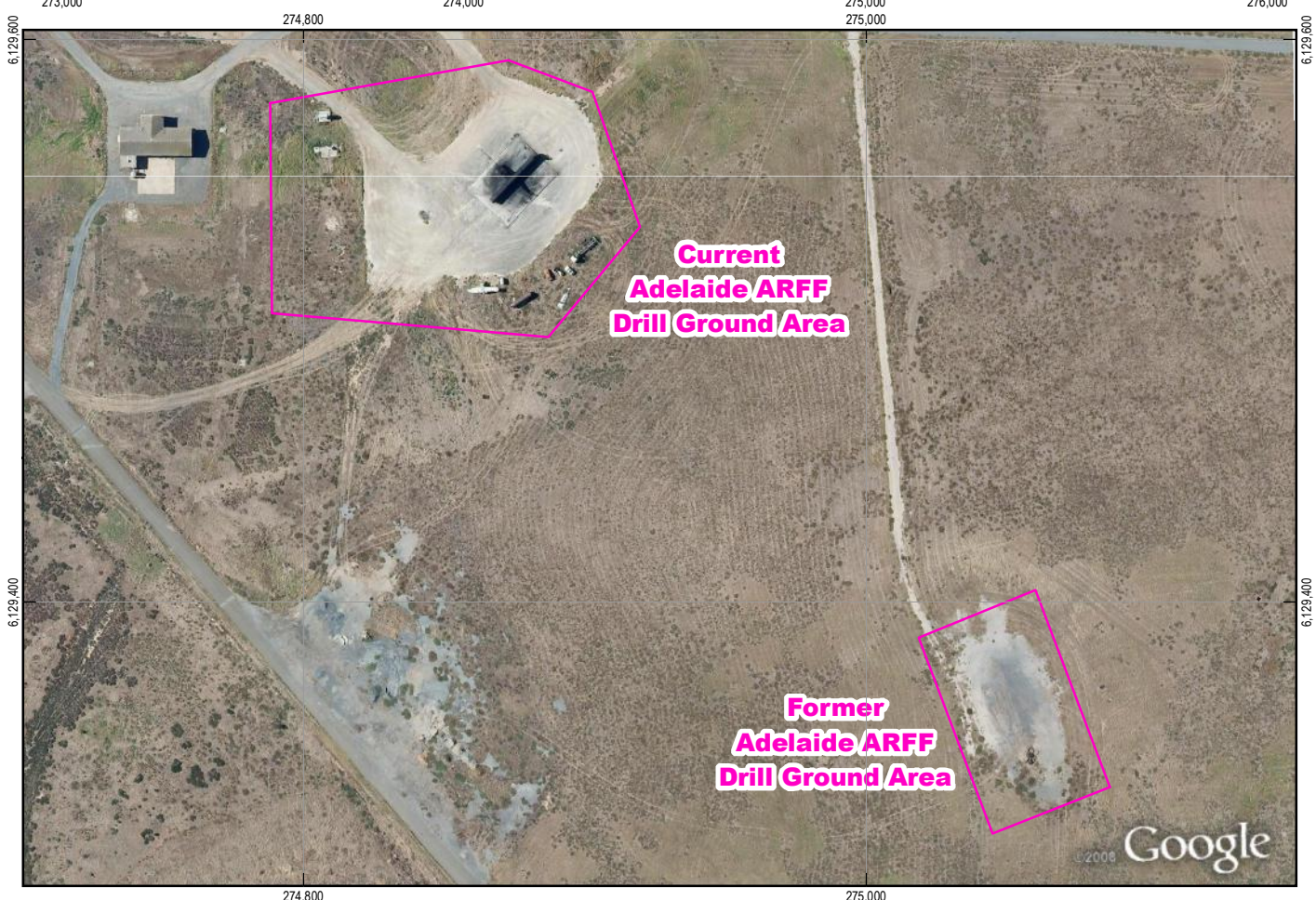
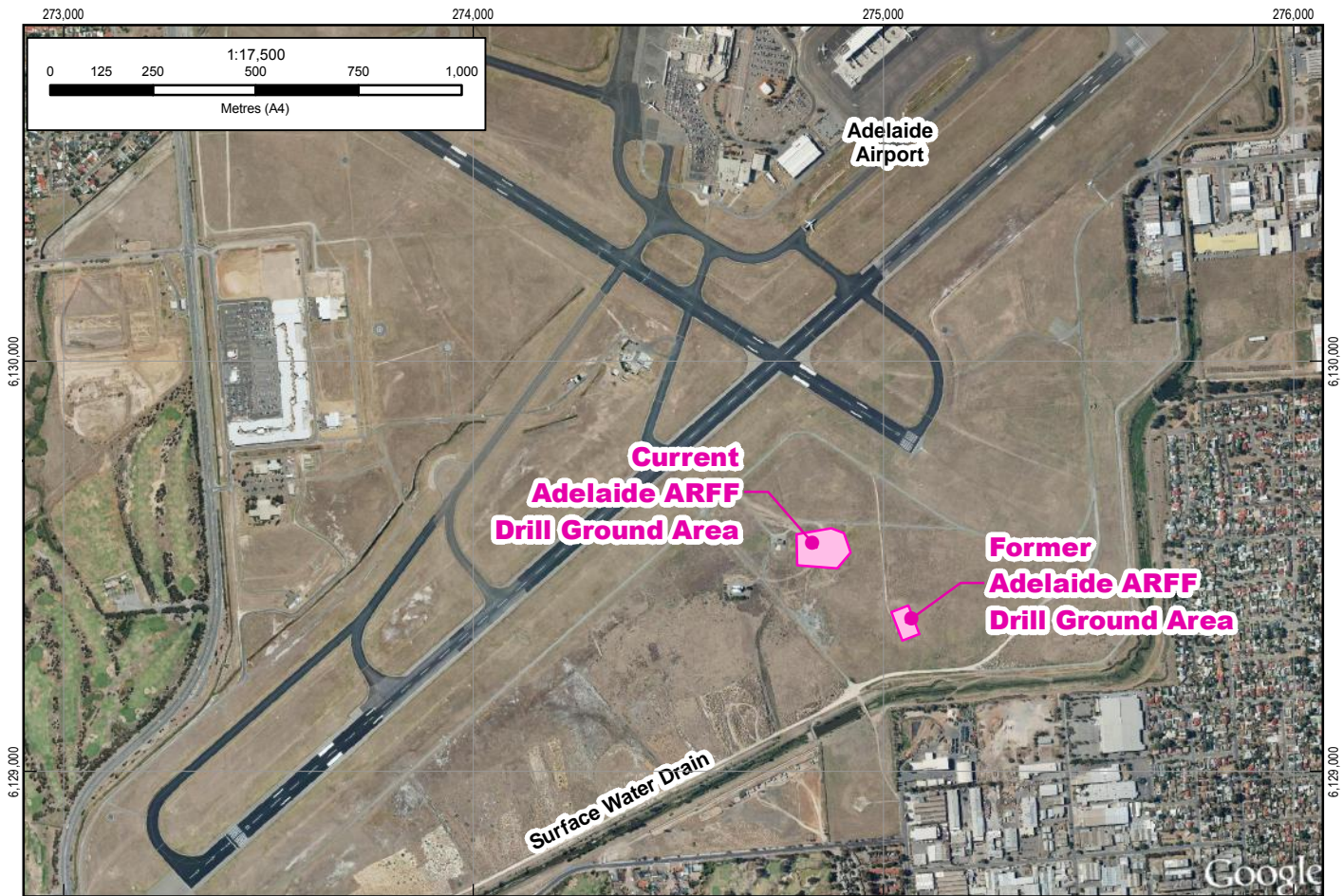


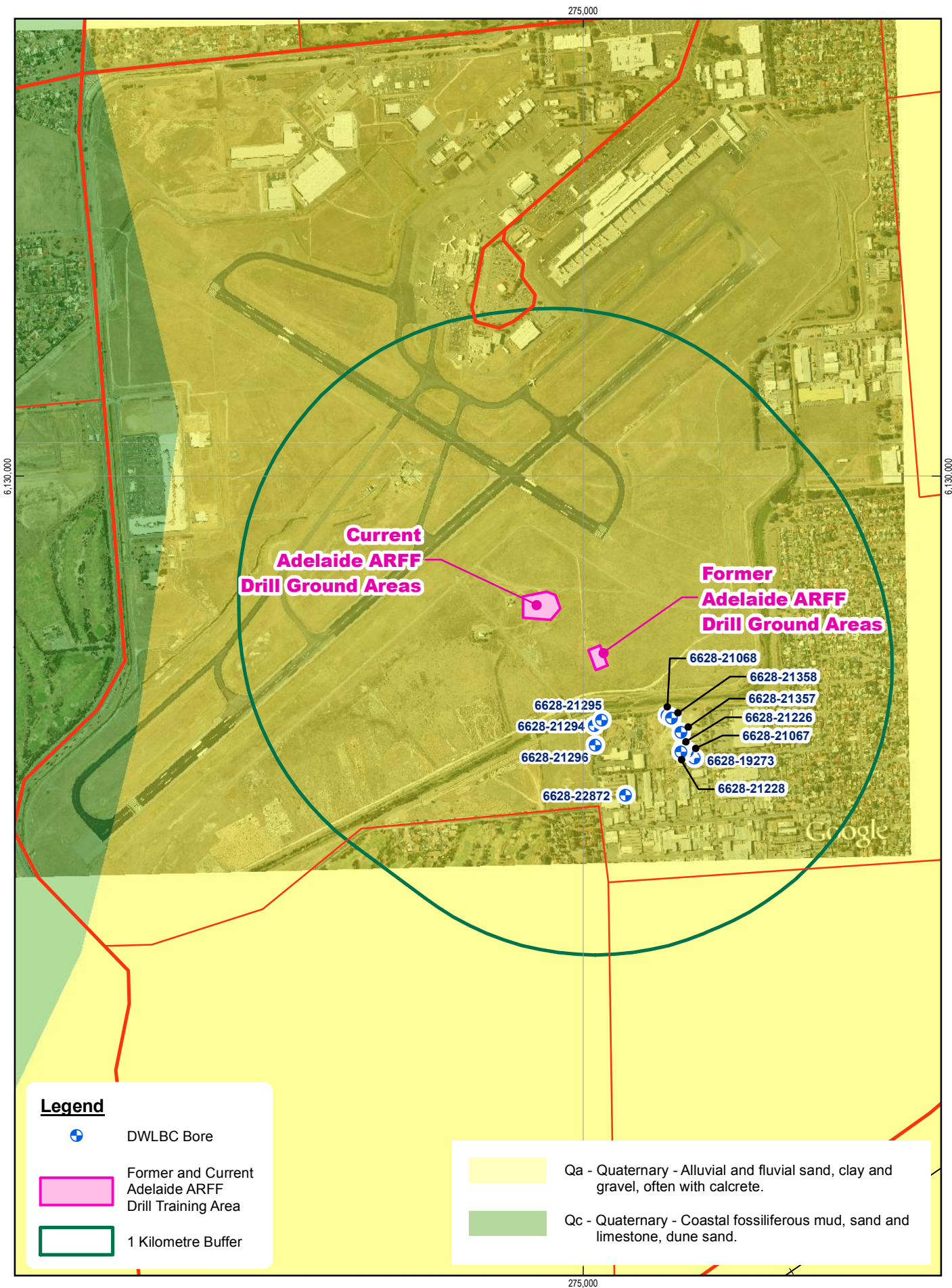
Figure 1: Adelaide Airport Drainage Map






AIRSERVICES AUSTRALIA  
 ARFF National Testing Project  
 Preliminary Site Contamination Assessment  
 Former Adelaide ARFF Drill Ground  
 LOCALITY MAP



Job Number 41-20219  
 Revision A  
 Date 29 August 2008

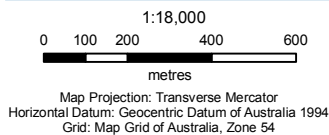
Figure 1



**Legend**

-  DWLBC Bore
-  Former and Current Adelaide ARFF Drill Training Area
-  1 Kilometre Buffer

-  Qa - Quaternary - Alluvial and fluvial sand, clay and gravel, often with calcrete.
-  Qc - Quaternary - Coastal fossiliferous mud, sand and limestone, dune sand.



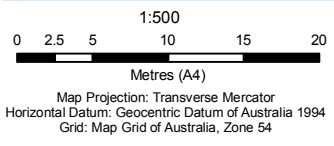
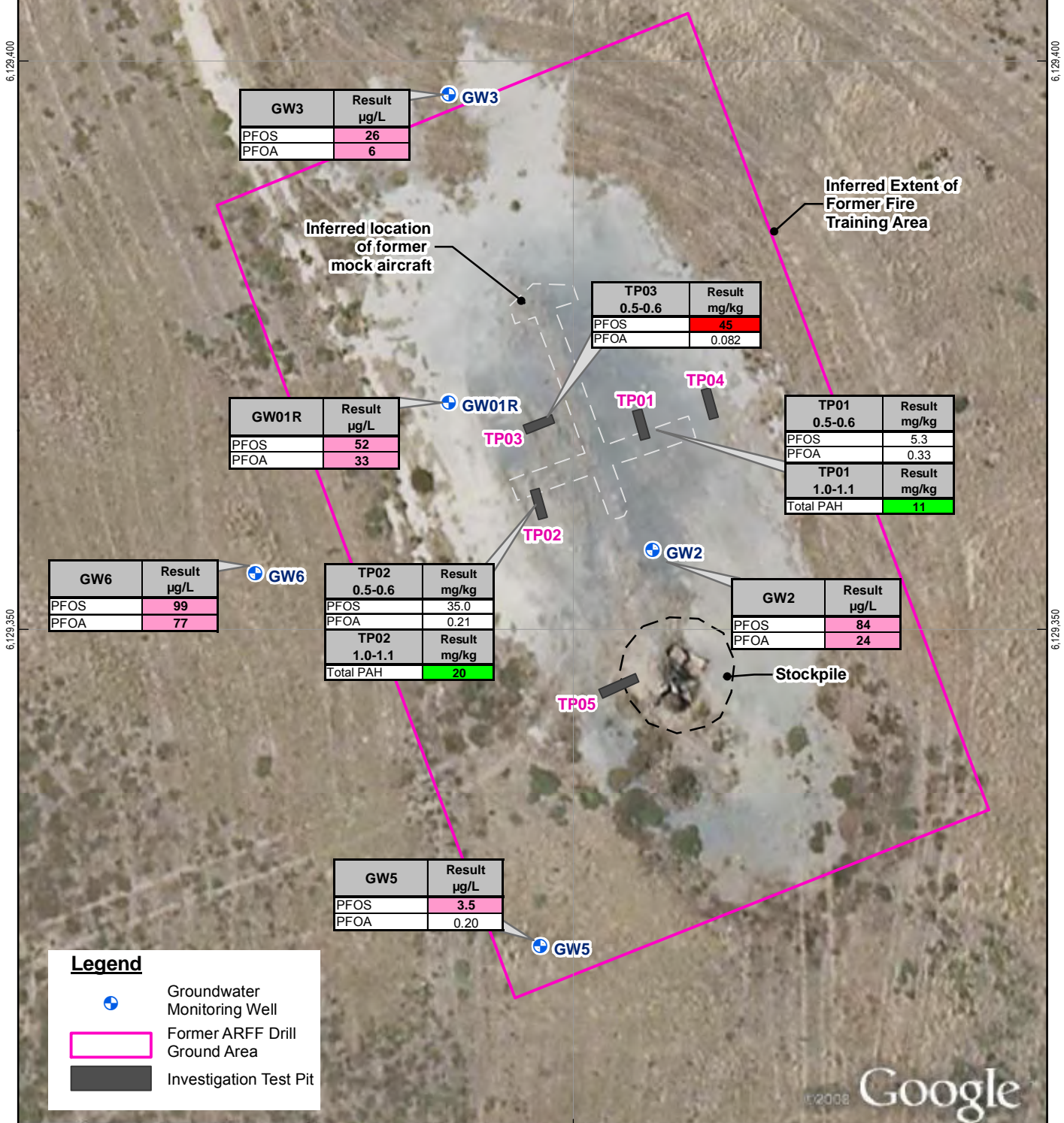
AIRSERVICES AUSTRALIA  
 ARFF National Testing Project  
 Preliminary Site Contamination Assessment  
 Former Adelaide ARFF Drill Ground  
 REGIONAL GEOLOGY

Job Number 41-20219  
 Revision A  
 Date 29 August 2008

**Figure 2**

**NOTES FOR RESULT INFORMATION**

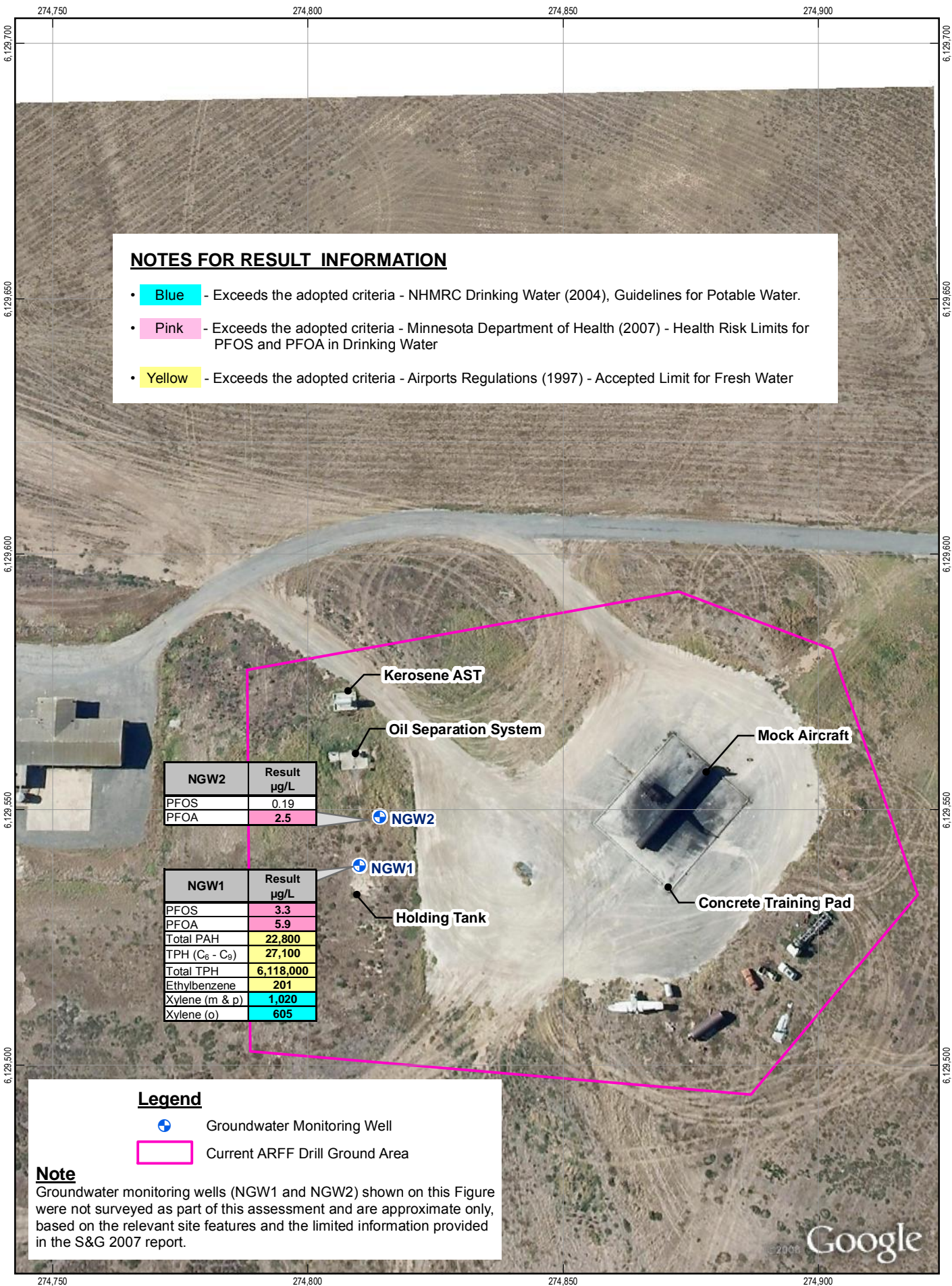
- **Pink** - Exceeds the adopted criteria - Minnesota Department of Health (2007) - Health Risk Limits for PFOS and PFOA in Drinking Water
- **Red** - Exceeds the adopted criteria - Minnesota Department of Health (2005) - Industrial Soil Screen Criteria
- **Green** - Exceeds the adopted criteria - Exceeds the adopted criteria 'Airport Regulation 1997, Areas of Environmental Significance



AIRSERVICES AUSTRALIA  
ARFF National Testing Project  
Preliminary Site Contamination Assessment  
Former Adelaide ARFF Drill Ground  
SITE DETAIL and SAMPLING

Job Number 41-20219  
Revision A  
Date 29 August 2008

**Figure 3**



**NOTES FOR RESULT INFORMATION**

- Blue** - Exceeds the adopted criteria - NHMRC Drinking Water (2004), Guidelines for Potable Water.
- Pink** - Exceeds the adopted criteria - Minnesota Department of Health (2007) - Health Risk Limits for PFOS and PFOA in Drinking Water
- Yellow** - Exceeds the adopted criteria - Airports Regulations (1997) - Accepted Limit for Fresh Water

NGW2	Result µg/L
PFOS	0.19
PFOA	2.5

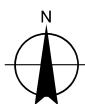
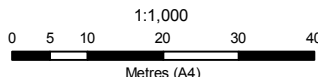
NGW1	Result µg/L
PFOS	3.3
PFOA	5.9
Total PAH	22,800
TPH (C <sub>6</sub> - C <sub>9</sub> )	27,100
Total TPH	6,118,000
Ethylbenzene	201
Xylene (m & p)	1,020
Xylene (o)	605

**Legend**

- Groundwater Monitoring Well
- Current ARFF Drill Ground Area

**Note**


Groundwater monitoring wells (NGW1 and NGW2) shown on this Figure were not surveyed as part of this assessment and are approximate only, based on the relevant site features and the limited information provided in the S&G 2007 report.




AIRSERVICES AUSTRALIA  
ARFF National Testing Project  
Preliminary Site Contamination Assessment  
Current Adelaide ARFF Drill Ground  
SITE DETAIL and SAMPLING

Job Number 41-20219  
Revision A  
Date 29 August 2008

**Figure 4**

 CLIENTS   PEOPLE   PERFORMANCE AirServices Australia ARFF National Testing Project - Soil Results Summary Table		Perfluorochemicals			Poly Aromatic Hydrocarbons (PAH)																Total Petroleum Hydrocarbons						
		Perfluorooctanesulfonate (PFOS)	Perfluorooctanoate Acid (PFOA)	Moisture Content	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(e)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene	Total PAH	TPH C 6 - C 9 Fraction	TPH C10 - C14 Fraction	TPH C15 - C28 Fraction	TPH C29-C36 Fraction	TPH+C10 - C36 (Sum of total)	
																											mg/kg
LOR	0.0005	0.0005		0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	10	50	100	100	-	
Minnesota Department of Health (2005) Residential*	6	30																									
Minnesota Department of Health (2005) Industrial**	40	200																									
Airports Regulations (1997) - Areas of Environmental Significance																					5	100			1,000		
Site / Sample ID	Sampled Date		Laboratory Results																								
Adelaide																											
TP01 0.5-0.6	26/06/2008	5.3	0.33	14.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<10	<50	<100	120	120	
TP01 1.0-1.1	26/06/2008	-	-	-	<0.5	<0.5	<0.5	1	1.2	1.6	1	0.6	0.9	<0.5	1.6	<0.5	0.8	<0.5	0.5	1.8	11	<10	270	240	110	620	
TP01 1.5-1.6	26/06/2008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<10	120	150	160	430	
TP01 1.9-2.0	26/06/2008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<10	80	<100	<100	80	
TP01 2.9-3.0	26/06/2008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<10	<50	<100	<100	<LOR	
TP01 3.9-4.0	26/06/2008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<10	<50	<100	<100	<LOR	
TP02 0.5-0.6	26/06/2008	35	0.21	11.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
TP02 1.0-1.1	26/06/2008	-	-	-	<0.5	0.5	0.5	1.7	1.9	2.2	1.2	0.9	1.6	<0.5	3.6	<0.5	1	<0.5	1.4	3.5	20	<10	<50	<100	190	190	
TP03 0.0-0.1	26/06/2008	-	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<LOR	22	540	<100	<100	540	
TP03 0.5-0.6	26/06/2008	45	0.082	10.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<10	<50	<100	<100	<LOR	

NOTES:  
 □ Minnesota Department of Health (2005) - Residential Soil Screen Criteria  
 □ Minnesota Department of Health (2005) - Industrial Soil Screen Criteria  
 <LOR - Less than the Laboratory's Limit of Reporting  
 - Not Tested

 CLIENTS   PEOPLE   PERFORMANCE AirServices Australia ARFF National Testing Project - Groundwater Results Summary Table		Perfluorochemicals			Poly Aromatic Hydrocarbons (PAH)																Total Petroleum Hydrocarbons					BTEX					
		Perfluorooctanesulfonate (PFOS)	Perfluorooctanoate Acid (PFOA)	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(e)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene	Total PAH	TPH C 6 - C 9 Fraction	TPH C10 - C14 Fraction	TPH C15 - C28 Fraction	TPH C29-C36 Fraction	TPH+C10 - C36 (Sum of total)	Benzene	Ethylbenzene	Toluene	Xylene (m & p)	Xylene (o)	
																															g/L
LOR	0.05	0.05	1	1	1	1	0.5	1	1	1	1	1	1	1	1	1	1	1	1	20	50	100	50	100	1	2	2	2	2		
Minnesota Department of Health (2007) Health Risk Limits*	0.3	0.5																		3	150			600	300	140	300				
Airports Regulations (1997) - Accepted Limit for Fresh Water																				3				300							
Airports Regulations (1997) - Accepted Limit for Marine Water																				3				300							
NHMR Drinking Water (2004) Potable water							0.01													3				600	1	300	800	600			
SA EPA, Freshwater (2003)																				3				300			300				
Site / Sample ID	Sampled Date		Laboratory Results																												
Adelaide																															
G01 01R (Former Drill Ground)	26/06/2008	52	33	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<LOR	<20	<50	200	<50	200	-	-	-	-	-
G02 2 (Former Drill Ground)	26/06/2008	84	24	<5	<5	<5	<5	<2.5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<LOR	-	90	300	90	480	-	-	-	-	-
G03 3 (Former Drill Ground)	26/06/2008	26	6	<10	<10	<10	<10	<5	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<LOR	<20	<50	200	<50	200	-	-	-	-	-
G05 5 (Former Drill Ground)	26/06/2008	3.5	0.20	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<LOR	<20	<50	200	90	290	-	-	-	-	-
G06 6 (Former Drill Ground)	26/06/2008	99	77	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<LOR	<20	<50	100	<50	100	-	-	-	-	-
NG01 1 (New Drill Ground)	26/06/2008	3.3	5.9	<1,200	<1,200	<1,200	<1,200	<600	<1,200	<1,200	<1,200	<1,200	<1,200	<1,200	<1,200	22,800	<1,200	<1,200	22,800	27,100	5,750,000	338,000	<30,000	6,118,000	<100	201	118	1,020	605		
NG02 2 (New Drill Ground)	26/06/2008	0.19	2.5	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<LOR	<20	<50	<100	<50	<LOR	<1	<2	<2	<2	<2
C1-G1	26/06/2008	98	52	<1	<1	<1	<1	<0.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<LOR	<20	60	200	50	310	-	-	-	-	-

NOTES:  
 □ Minnesota Department of Health (2007) - Health Risk Limits for PFOS and PFOA in Drinking Water

Summary of Stockpiled Soil Analytical Results

Characteristics / Description	Adopted Soil Disposal Criteria				Sample ID		NAWMA Soil Waste Disposal Criteria		
	units are in mg/kg unless stated otherwise	NEPM HL.F (Commercial/Industrial)	NEPM Interim Urban EL	Airports Regulations 1997	MOH (2005)*	LOR	TPO5: 0.5-0.6	Waste Fill (mg/kg)	Intermediate Landfill Cover (mg/kg)
Sample Date									
Laboratory									
Assumed Depth (m bg)									
Sample Type									
Soil Type									
Moisture (%)									
PH (ppm)									
TPH									
C3-C9									
C10-C14									
C15-C28									
C29-C36									
Total TPH (C15-C36)									
PAH/Phenols									
2,4,5-trichlorophenol									
2,4-dichlorophenol									
2,4-dimethylphenol									
2-chlorophenol									
2-methylphenol									
3,4-methylphenol									
2,4,6-trichlorophenol									
2,6-dichlorophenol									
2-nitrophenol									
4-chloro-3-methylphenol									
Pentachlorophenol									
Acenaphthene									
Acenaphthylene									
Anthracene									
Benz(a)anthracene									
Benz(a)pyrene									
Benz(b)fluoranthene									
Benz(g,h,i)perylene									
Benz(k)fluoranthene									
Chrysene									
Dibenz(a,h)anthracene									
Fluoranthene									
Fluorene									
Indeno(1,2,3-c,d)pyrene									
Naphthalene									
Phenanthrene									
Phenol									
Pyrene									
PAH (Total)									
BTEX									
Benzene									
Ethylbenzene									
Toluene									
Xylene (m,p)									
Xylene (o)									
Inorganics									
Cyanide Total									
Fluoride									
Metals									
Arsenic									
Cadmium									
Chromium (III+VI)									
Cobalt									
Copper									
Mercury									
Molybdenum									
Nickel									
Selenium									
Tin									
Lead									
4,4-DDE									
a-BHC									
Aldrin									
b-BHC									
Chlordane (cis)									
Chlordane (trans)									
d-BHC									
DDD									
DDT									
Dieldrin									
Endosulfan I									
Endosulfan II									
Endosulfan sulphate									
Endrin									
Endrin aldehyde									
Endrin ketone									
g-BHC (Lindane)									
Heptachlor									
Heptachlor epoxide									
Hexachlorobenzene									
Methoxychlor									
1,2,4-trimethylbenzene									
1,3,5-trimethylbenzene									
Isopropylbenzene									
n-butylbenzene									
n-propylbenzene									
p-isopropyltoluene									
sec-butylbenzene									
Styrene									
tert-butylbenzene									
Perfluorohexamates									
PFOS*									
PFDA*									

Notes:

- indicates there is no criteria available
- <LOR indicates that the analyte concentrations were less than the laboratory limit of reporting
- Airports (Environmental Protection) Regulations Regulations 1997 - Accepted Soil Pollution Limits - Areas of Environmental Significance
- Adopted Guideline - Minnesota Department of Health (2005) - Industrial Soil Screen Criteria
- Northern Adelaide □ Waste Management Authority (NA) MA(2006) Disposal of □ Waste Soils □ Waste Fill guidelines
- Northern Adelaide □ Waste Management Authority (NA) MA(2006) Disposal of □ Waste Soils: Intermediate Landfill Cover (LC) Guidelines
- Bold and Shaded** Exceeds the Airports (Environmental Protection) Regulations Regulations 1997 - Accepted Soil Pollution Limits - Areas of Environmental Significance
- Bold and Shaded** Exceeds the Minnesota Department of Health (2005) - Industrial Soil Screen Criteria
- Bold and Shaded** Exceeds the NEPM HL.F investigator guidelines for Commercial/Industrial land use
- Bold and Shaded** Exceeds the NEPM EL guidelines
- Bold and Shaded** Exceeds the NA MA □ Waste Fill Criteria
- Bold and Shaded** Exceeds the NA MA Intermediate Landfill Cover criteria



**Summary of Groundwater Field QA/QC Laboratory Analytical Results**

				QA Sampling and Relative Percentage Difference (RPD)		
	units are in µg/L unless stated otherwise	LOR	Units	GW2	QC1-GW	RPD
Characteristics / Description	Sample Date			24/06/2008	25/06/2008	
	Laboratory			ALS/AAA	ALS/AAA	
	Assumed Depth (m bgl)			-	-	
	Moisture (%)			-	-	
TPH	C6-C9	10	µg/L	-	<20	NA
	C10-C14	50	µg/L	90	60	40
	C15-C28	100	µg/L	300	200	40
	C29-C36	100	µg/L	90	50	57
	Total TPH (C10-C36)	100	µg/L	480	310	43
PAHs	Acenaphthene	0.5	µg/L	<5	<1	NA
	Acenaphthylene	0.5	µg/L	<5	<1	NA
	Anthracene	0.5	µg/L	<5	<1	NA
	Benzo(a) Anthracene	0.5	µg/L	<5	<1	NA
	Benzo(a) Pyrene	0.5	µg/L	<2.5	<0.5	NA
	Benzo(b) Fluoranthene	0.5	µg/L	<5	<1	NA
	Benzo(g,h,i) perylene	0.5	µg/L	<5	<1	NA
	Benzo(k) Fluoranthene	0.5	µg/L	<5	<1	NA
	Chrysene	0.5	µg/L	<5	<1	NA
	Dibenzo(a,h) Anthracene	0.5	µg/L	<5	<1	NA
	Fluoranthene	0.5	µg/L	<5	<1	NA
	Fluorene	0.5	µg/L	<5	<1	NA
	Indeno (1,2,3-c,d) Pyrene	0.5	µg/L	<5	<1	NA
	Naphthalene	0.5	µg/L	<5	<1	NA
	Phenanthrene	0.5	µg/L	<5	<1	NA
Pyrene	0.5	µg/L	<5	<1	NA	
PAH (Total)	-	µg/L	<LOR	<LOR	NA	
Perfluorochemicals	PFOS	0.05	µg/L	84	98	15
	PFOA	0.05	µg/L	24	52	74

**Notes:**

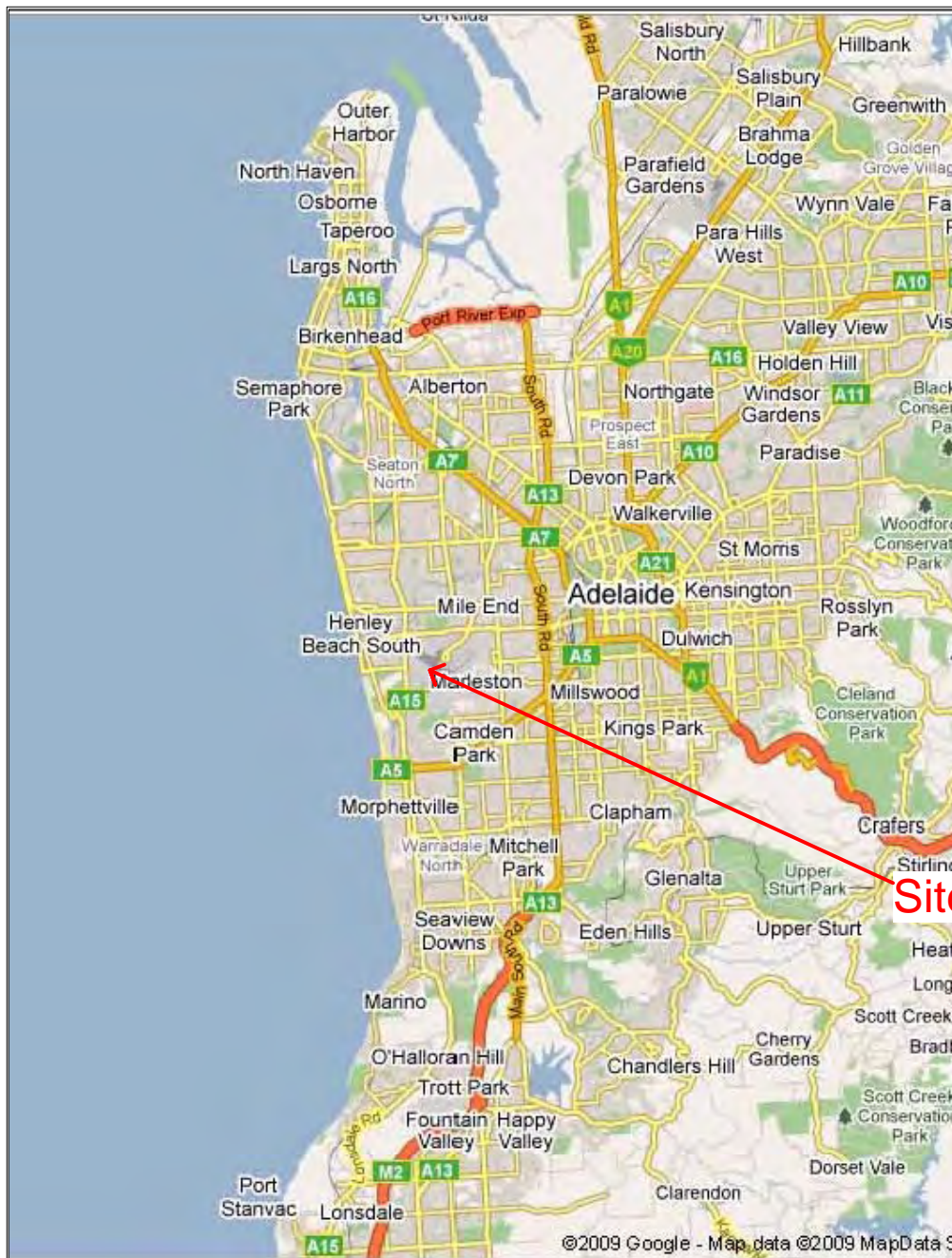
<LOR indicates that the analyte concentrations were less than the laboratory limit of reporting

PAHs: Polycyclic Aromatic Hydrocarbons

TPH: Total Petroleum Hydrocarbons

RPD: Relative Percentage Difference

NA: Not Applicable



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207 The Parade Norwood SA 5067  
 PO Box 3166 Norwood SA 5067  
 T: 08 8431 7113 F: 08 8431 7115

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 Checked: AKW  
 File Name: Figure 1.wor

Date: 19 October 2009  
 Date: 19 October 2009  
 Scale: As Shown

Job No.: SG091  
 Title: ADELAIDE AIRPORT  
 SITE LOCATION PLAN

Project: AIR SERVICES - ADELAIDE AIRPORT



**Fire Department**

SB08

SB07



**Moc Plane**



SB01

SB02

SB03

SB04

GW02

GW01

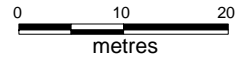
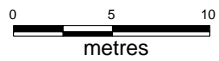
SB06

SB05

**LEGEND**

⊕ Soil Bore Location

● Groundwater Well Location



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207 The Parade Norwood SA 5067  
 PO Box 3166 Norwood SA 5067  
 T: 08 8431 7113 F: 08 8431 7115



Drawn: SPT

Date: 19 October 2009

Job No.: SG091

Project: AIR SERVICES - SITE INVESTIGATION

Checked: AKW

Date: 19 October 2009

**ADELAIDE AIRPORT SITE INVESTIGATION**  
**INVESTIGATION REPORT**

Sheet 1 of 1

File Name: Figure 2.wor

Scale: As Shown

A4

**FIGURE 2**

**SUMMARY OF FIELD RESULTS (mg/g)**



Sample ID	Depth (m top of sample)	Date	Batch #	TPH				BTEX				Perfluorooctane sulfonate	Perfluorododecanoic Acid
				TRH C6-C9 Fraction by GC	TRH C10-C14 Fraction by GC	TRH C15-C28 Fraction by GC	TRH C29-C36 Fraction by GC	Benzene	Ethylbenzene	Toluene	Xylenes(ortho,meta and para)		

**ES: IGA: LE: ELS**

Soil Pollution Limits - areas of an airport generally*	800	<-----5000----->	1	50	130	25		
Soil Pollution Limits - Sensitive Areas*	100	<-----1000----->	0.5	3	5	5		
Minnesota Department of Health - Residential**							2	2
Minnesota Department of Health - Industrial**							14	13
Ecotoxicity***							1.5	

**RESULTS**

Sample ID	Depth (m)	Date	Batch #	TRH C6-C9	TRH C10-C14	TRH C15-C28	TRH C29-C36	Benzene	Ethylbenzene	Toluene	Xylenes	PFOS	PFDA
SB01_0.0	0.0	19/10/09	253989	< 20	< 50	< 100	< 100	< 0.05	< 0.05	< 0.05	< 0.05	7.3	0.76
SB02_0.0	0.0	19/10/09	253989	< 20	< 50	< 100	< 100	< 0.05	< 0.05	< 0.05	< 0.05	7.9	0.52
SB03_0.0	0.0	19/10/09	253989	< 20	< 50	< 100	< 100	< 0.05	< 0.05	< 0.05	< 0.05	8.1	0.5
SB04_0.0	0.0	19/10/09	253989	< 20	< 50	< 100	< 100	< 0.05	< 0.05	< 0.05	< 0.05	13	0.88
SB05_0.0	0.0	19/10/09	253989	< 20	< 50	< 100	120	< 0.05	< 0.05	< 0.05	< 0.05	0.63	0.1
SB06_0.0	0.0	19/10/09	253989	170	3900	590	< 100	< 0.05	0.22	0.14	8.7	-	-
SB06_0.8	0.0	19/10/09	253989	330	14000	980	< 100	0.08	8.3	1	61	-	-
SB06_2.2	0.0	19/10/09	253989	< 20	< 50	< 100	< 100	< 0.05	0.1	< 0.05	0.39	-	-
SB06_2.8	0.0	19/10/09	253989	< 20	< 50	< 100	< 100	< 0.05	< 0.05	< 0.05	< 0.05	-	-
SB07_0.0	0.0	19/10/09	253989	< 20	< 50	< 100	130	< 0.05	< 0.05	< 0.05	< 0.05	-	-
SB08_0.0	0.0	19/10/09	253989	< 20	< 50	< 100	< 100	< 0.05	< 0.05	< 0.05	< 0.05	-	-

**QUALITY CONTROL**

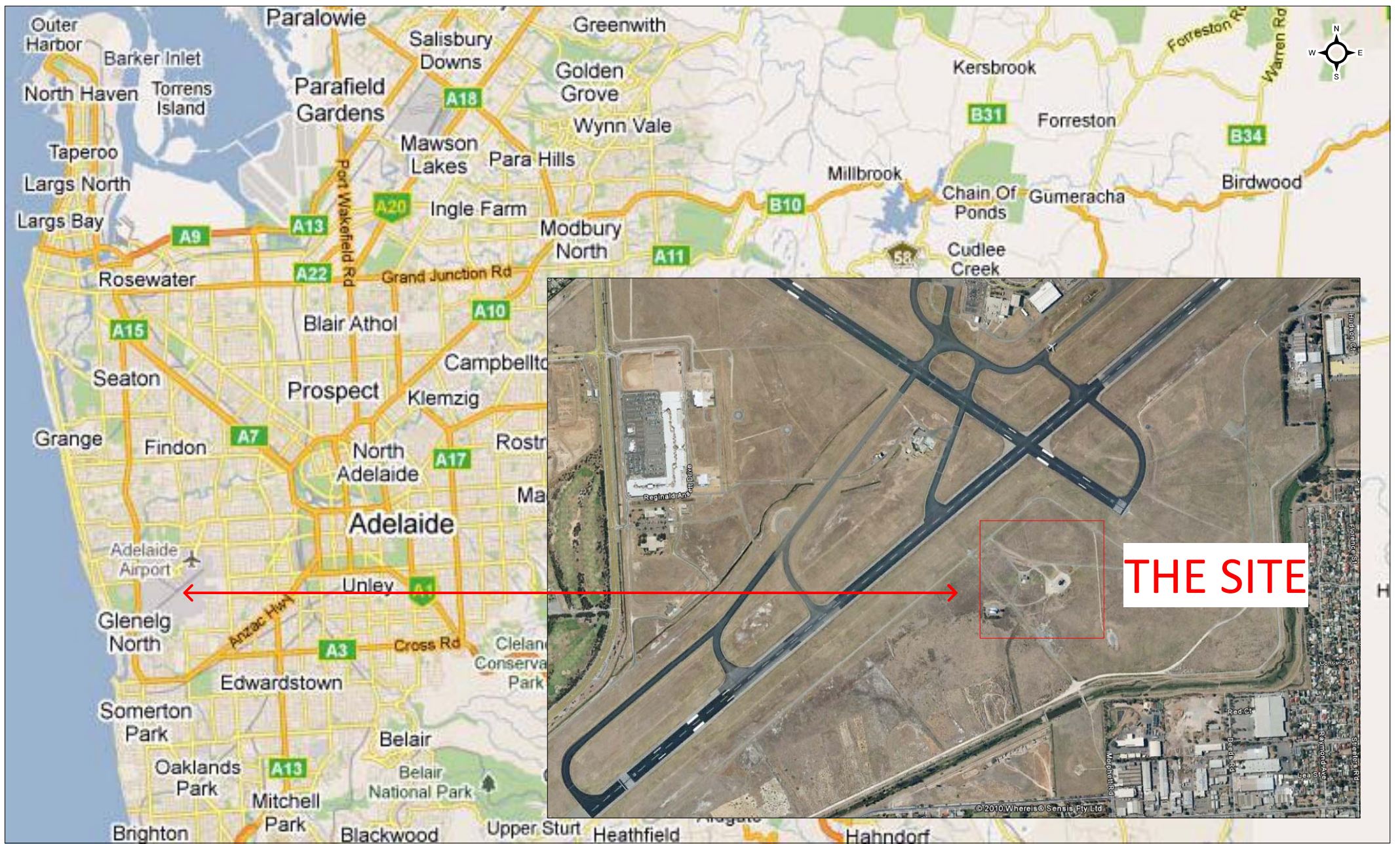
Intra-Laboratory													
SB03_0.0	0.0	19/10/09	253989	< 20	< 50	< 100	< 100	< 0.05	< 0.05	< 0.05	< 0.05		
D1	0.0	19/10/09	253989	< 20	< 50	< 100	< 100	< 0.05	< 0.05	< 0.05	< 0.05		
RPD (%)				-	-	-	-	-	-	-	-		

Inter-Laboratory													
SB06_0.0	0.0	19/10/09	253989	170	3900	590	< 100	< 0.05	0.22	0.14	8.7		
D3	0.0	19/10/09	EM0910490	118	3930	480	< 100	< 0.2	< 0.5	< 0.5	< 0.5		
RPD (%)				36.1	0.8	20.6	-	-	-	-	-		

\* - Airports (Environmental Protection) Regulations 1997 - Soil Pollution Limit

\*\* - Minnesota Department of Health, Health Based Criteria

\*\*\* - Beach S.A., Newstead J.L., Coady K., Giesy J.P. (2006) Exotoxicological evaluation of perfluorooctanesulfonate (PFOS). Rev Environ Contam Toxicol. 2006;186:133.



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 PO Box 3166 Norwood SA 5067  
 T: 08 8431 7113 F: 08 8431 7115

File Name: Figure 1.wor

Version: Revision 0

Datum: MGA Zone 54 (GDA 94)

Baseplan: Photomaps by Nearmap

Job No.: **SG101874**

Title:

Drawn: **RHP**

Project: **ASA - Adelaide Airport Fire Training Facility**

**SITE LOCATION PLAN**

Checked: **AKW**

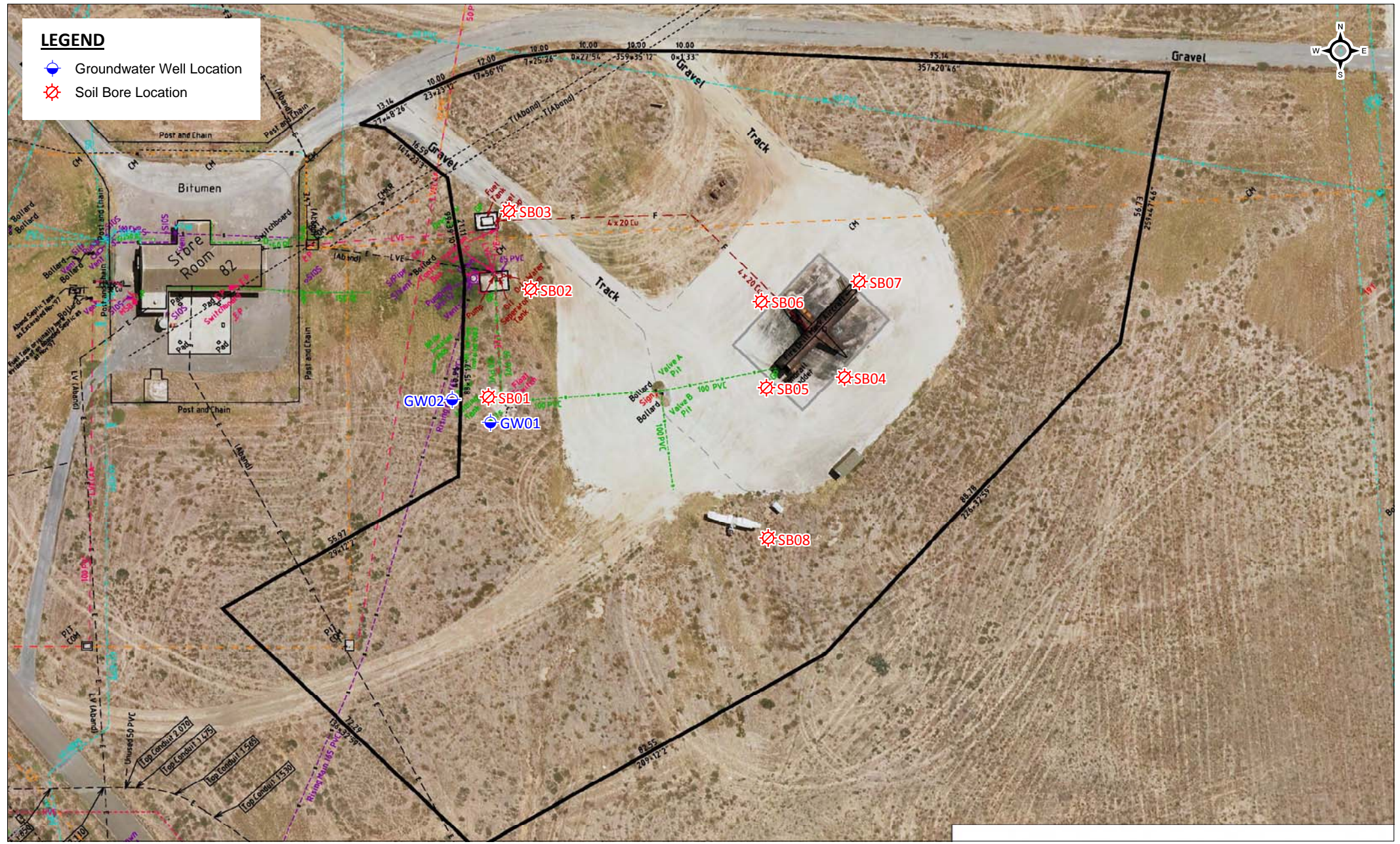
Date: **2 February 2011**

Sheet **1 of 1**

SCALE NOT SHOWN

A4

**FIGURE 1**



**Soil & Groundwater Consulting**  
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File Name: Figure 2.wor  
 Version: Revision 0  
 Datum: MGA Zone 54 (GDA 94)

Job No.: **SG101874**  
 Title: **SITE PLAN SHOWING INVESTIGATION LOCATIONS**  
 Project: **ASA - Adelaide Airport Fire Training Facility**  
 Drawn: RHP  
 Checked: AKW  
 Date: 2 February 2011

Scale: 1 : 1,000  
 0 20 40 metres  
**FIGURE 2**

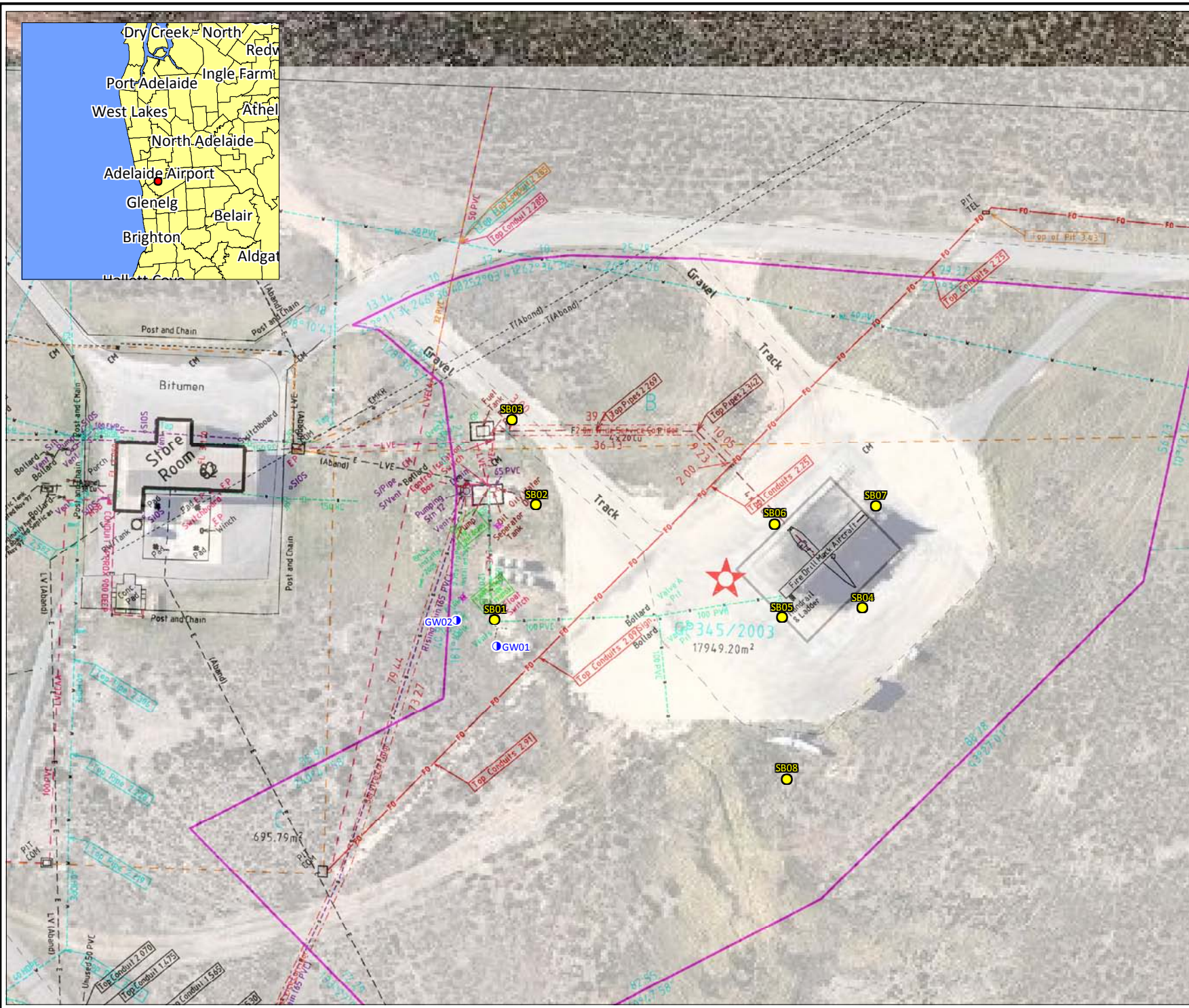
SUMMARY OF FIELD RESULTS (mg/g)



Sample ID	Depth	Date	Batch #	% Moisture	TPH					BTEX					Polycyclic Aromatic Hydrocarbons																						
					TRH C16C9 Fraction by GC	TRH C18C14 Fraction by GC	TRH C15C28 Fraction by GC	TRH C19C36 Fraction by GC	TRH C10C36 (Total)	Benzene	Ethylbenzene	Toluene	p-Xylene	Total m,p-Xylenes	Xylenes (ortho meta and para)	PFOS (linear)	Perfluorooctanoic PFOA	PFOS (Total)	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(b)fluoranthene	Benzo(k)fluoranthene	Benzo(a)pyrene	Benzo(a)anthracene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene	Naphthalene	Phenanthrene	Pyrene	Total PAH		
<b>ES IGA   LE ELS</b>																																					
Airports Soil Pollution Accepted limits (general areas)*					800	<-----5000----->	5000	1	50	130	-	25	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	100		
Airports Soil Pollution Accepted limits (areas of environmental significance)**					100	<-----1000----->	1000	0.5	5	3	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5			
US EPA Region 4 Soil Screening Levels for PFOA and PFOS**					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Minnesota Department of Health - Residential***					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Minnesota Department of Health - Industrial***					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Ecotoxicity - Terrestrial Plants****					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Ecotoxicity - Soil Invertebrates****					-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
<b>RESULTS</b>																																					
SB017	1.05-1.2	17/01/2011	287907	20	160	1500	730	< 100	2200	< 0.05	0.28	< 0.05	1.5	1.5	3.1	0.093	< 0.005	< 0.005	< 0.1	< 0.2	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.3	< 0.1	14	0.2	< 0.1	15
SB018	1.6-1.8	17/01/2011	289614	21	< 20	< 50	< 100	< 100	< 100	< 0.05	< 0.05	< 0.05	< 0.05	< 0.1	< 0.15	-	-	-	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
SB021	0.0-0.15	17/01/2011	287907	9.3	< 20	< 50	< 100	< 100	< 100	< 0.05	< 0.05	< 0.05	< 0.05	< 0.1	< 0.15	-	-	-	< 0.1	< 0.1	< 0.1	0.2	0.2	0.1	0.1	< 0.1	0.2	< 0.1	0.2	< 0.1	0.2	< 0.1	0.1	< 0.1	< 0.1	0.2	1.3
SB031	0.0-0.10	17/01/2011	287907	7	< 20	< 50	< 100	< 100	< 100	< 0.05	< 0.05	< 0.05	0.07	0.11	0.17	-	-	-	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
SB041	0.0-0.15	17/01/2011	287907	4.7	< 20	< 50	< 100	< 100	< 100	< 0.05	< 0.05	< 0.05	< 0.05	< 0.1	< 0.15	2.6	0.023	0.024	< 0.1	< 0.1	< 0.1	0.2	0.2	0.1	0.2	0.2	0.2	< 0.1	0.3	< 0.1	0.1	< 0.1	< 0.1	< 0.1	0.3	1.8	
SB051	0.0-0.10	17/01/2011	287907	5.1	< 20	< 50	< 100	< 100	< 100	< 0.05	< 0.05	< 0.05	< 0.05	< 0.1	< 0.15	-	-	-	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	
SB061	0.0-0.15	17/01/2011	287907	5	< 20	< 50	< 100	< 100	< 100	< 0.05	< 0.05	< 0.05	< 0.05	< 0.1	< 0.15	1.3	0.01	0.011	< 0.1	< 0.1	< 0.1	0.1	0.1	< 0.1	0.1	0.1	0.1	< 0.1	0.2	< 0.1	< 0.1	< 0.1	0.1	0.2	1		
SB071	0.0-0.15	17/01/2011	287907	4.9	< 20	< 50	< 100	< 100	< 100	< 0.05	< 0.05	< 0.05	< 0.05	< 0.1	< 0.15	4.4	0.046	0.025	< 0.1	< 0.1	< 0.1	0.4	0.4	0.2	0.3	0.3	< 0.1	0.5	< 0.1	0.3	< 0.1	0.2	0.5	3.4			
SB081	0.0-0.15	17/01/2011	287907	4.3	< 20	< 50	< 100	< 100	< 100	< 0.05	< 0.05	< 0.05	< 0.05	< 0.1	< 0.15	0.45	< 0.005	< 0.005	< 0.1	0.1	0.2	0.8	0.9	0.8	0.7	0.5	0.8	0.2	1.3	< 0.1	0.5	< 0.1	0.5	1.3	8.6		
SB082	0.15-0.3	17/01/2011	289614	8.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	< 0.1	< 0.1	< 0.1	0.7	0.8	0.9	0.5	0.4	0.6	< 0.1	0.7	< 0.1	0.4	< 0.1	0.2	0.8	6		
<b>UALL   CL   RL</b>																																					
<b>Intra-Laboratory</b>																																					
SB071	DUP4		287907	4.9	< 20	< 50	< 100	< 100	< 100	< 0.05	< 0.05	< 0.05	< 0.05	< 0.1	< 0.15	4.4	0.046	0.025	< 0.1	< 0.1	< 0.1	0.4	0.4	0.2	0.3	0.3	< 0.1	0.5	< 0.1	0.3	< 0.1	0.2	0.5	3.4			
RPD (%)			287907	6.5	< 20	< 50	< 100	< 100	< 100	< 0.05	< 0.05	< 0.05	< 0.05	< 0.1	< 0.15	4.5	0.039	0.023	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
			287907	28.1	-	-	-	-	-	-	-	-	-	-	-	2.2	16.5	8.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		

\* - Airports (Environmental Protection) Regulations 1997 - Soil Pollution Limits  
 \*\* - US EPA Region 4 Soil Screening Levels for Perfluorooctanoic Acid (PFOA) and Perfluorooctyl Sulfonate (PFOS) 2009  
 \*\*\* - Minnesota Department of Health, Health Based Criteria  
 \*\*\*\* - Beach S.A., Newstead J.L., Coady K., Giesy J.P. (2006) Exotoxicological evaluation of perfluorooctanesulfonate (PFOS). Rev Environ Contam Toxicol. 2006;186:133-74

NC = Not Calculated  
 RPD = Relative Percentage Difference (%)  
 Bolding of RPDs refers to an exceedance of 50%  
 Shading of analytical results refers to an exceedance of an assessment criteria



**Legend**

- Groundwater Monitoring Well - Existing
- Proposed Soil Borehole

**Soil & Groundwater Consulting**



Job No.: SG1211030

Client: Air Services Australia

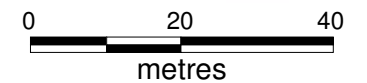
Version: Final

Date: 31 July 2012

Drawn By: TB

Checked By: ZD

Scale: 1 : 1,000 at A4



Data Source: Nearmaps and ABS

Coord. Sys.: MGA Zone 54 (GDA 94)

**Adelaide Airport Fire Training Facility,  
1 James Schofield Drive, Adelaide Airport,  
South Australia**

**SERVICE PLAN**

**FIGURE 1**

## SOIL SUMMARY TABLE

ALL UNITS IN MG/KG UNLESS SHOWN OTHERWISE



Field ID	Sample Date	Lab Report Number	Perfluoroalkylsulfonic acids				Perfluoroalkylcarboxylic acids						Other PFC's				Other																				
			Perfluorobutanesulfonic acid	Perfluorohexanesulfonic acid	Perfluorooctanesulfonic acid (PFOS)****	Perfluorodecane sulfonic acid	Perfluorohexanoic acid	Perfluoroheptanoic acid	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid	Perfluorodecanoic acid	Perfluoroundecanoic acid	Perfluorododecanoic acid	Perfluorooctanesulfonamide	N-ethyl-perfluorooctanesulfonamidoacetic acid	N-methyl-perfluorooctanesulfonamidoacetic acid		1H,1H,2H,2H-perfluorooctanesulfonic acid	1H,1H,2H,2H-perfluorodecane sulfonic acid																		
			mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%																		
EQL																				0.001	0.001	0.1	-	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.004	0.004	0.002	0.4	0.1	
NEPM 1999 HIL A - Residential Standard																																					
NEPM 1999 HIL F - Commercial/Industrial																																					
Airports Soil Pollution Accepted limits (general areas)*																																					
Airports Soil Pollution Accepted limits (areas of environmental significance)*																																					
US EPA Region 4 Soil Screening Levels for PFOA and PFOS**																						6			16												
Minnesota Department of Health - Residential***																						2			2												
Minnesota Department of Health - Industrial***																						14			13												
Ecotoxicity - Terrestrial Plants****																						1.5			-												
Ecotoxicity - Soil Invertebrates****																						33			-												
SB01/1 0-0.1	4/05/2012	336082	0.0032	0.031	0.45	NQ	0.018	0.022	0.053	0.028	0.021	0.0093	0.0085	ND	ND	ND	ND	ND	11																		
SB01/5 1.4-1.5	4/05/2012	336082	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	21																		
SB02/1 0-0.1	4/05/2012	336082	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15																		
SB02/6 1.5-1.6	4/05/2012	336082	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25																		
SB03/1 0-0.15	4/05/2012	336082	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.4																		
SB04/1 0-0.15	4/05/2012	336082	0.017	0.140	0.910	NQ	0.160	0.036	0.110	0.033	0.032	0.010	0.010	0.0087	ND	ND	0.033	0.810	4.6																		
SB05/1 0-0.15	4/05/2012	336082	0.010	0.210	0.990	NQ	0.071	0.015	0.047	0.0079	0.0055	0.0022	0.0024	0.011	ND	ND	0.029	ND	5.9																		
SB06/1 0-0.15	4/05/2012	336082	0.0015	0.049	0.580	NQ	0.019	0.0088	0.024	0.012	0.0089	0.0029	0.0029	0.0047	ND	ND	0.0080	ND	4.2																		
SB07/1 0-0.15	4/05/2012	336082	0.17	2.5	1.7	NQ	0.27	0.14	0.64	0.025	0.015	0.0048	0.0053	0.015	ND	ND	ND	0.41	4.5																		
SB08/1 0-0.15	4/05/2012	336082	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15																		
DUP2	4/05/2012	336082	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11																		

**Comments**

\* - Airports (Environmental Protection) Regulations 1997 - Soil Pollution Limits  
 \*\* - US EPA Region 4 Soil Screening Levels for Perfluorooctanoic Acid (PFOA) and  
 \*\*\* - Minnesota Department of Health, Health Based Criteria  
 \*\*\*\* - Beach S.A., Newstead J.L., Coady K., Giesy J.P. (2006) Ecotoxicological evalu  
 \*\*\*\*\*The result for PFOS also includes its salts and perfluorooctanesulfon

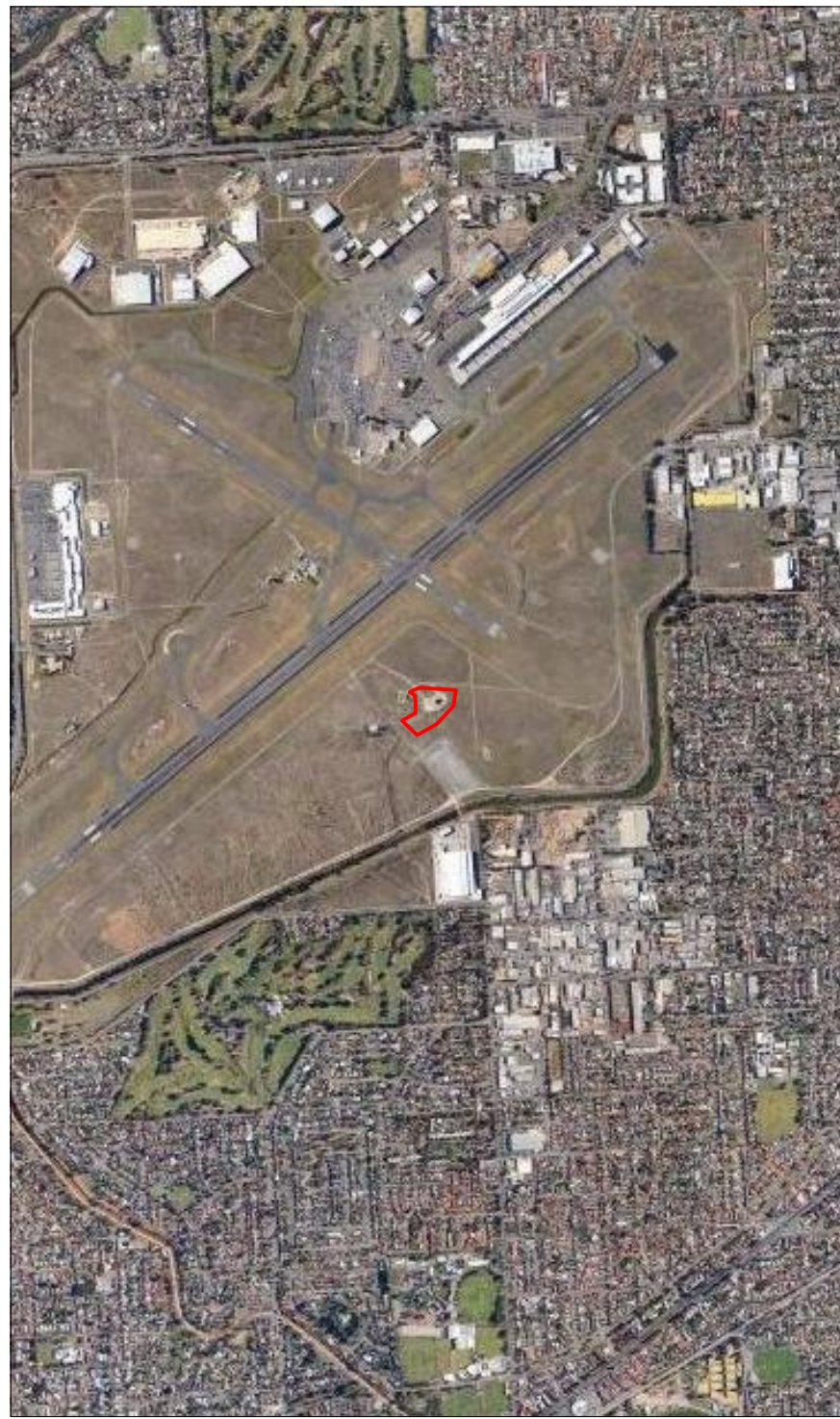
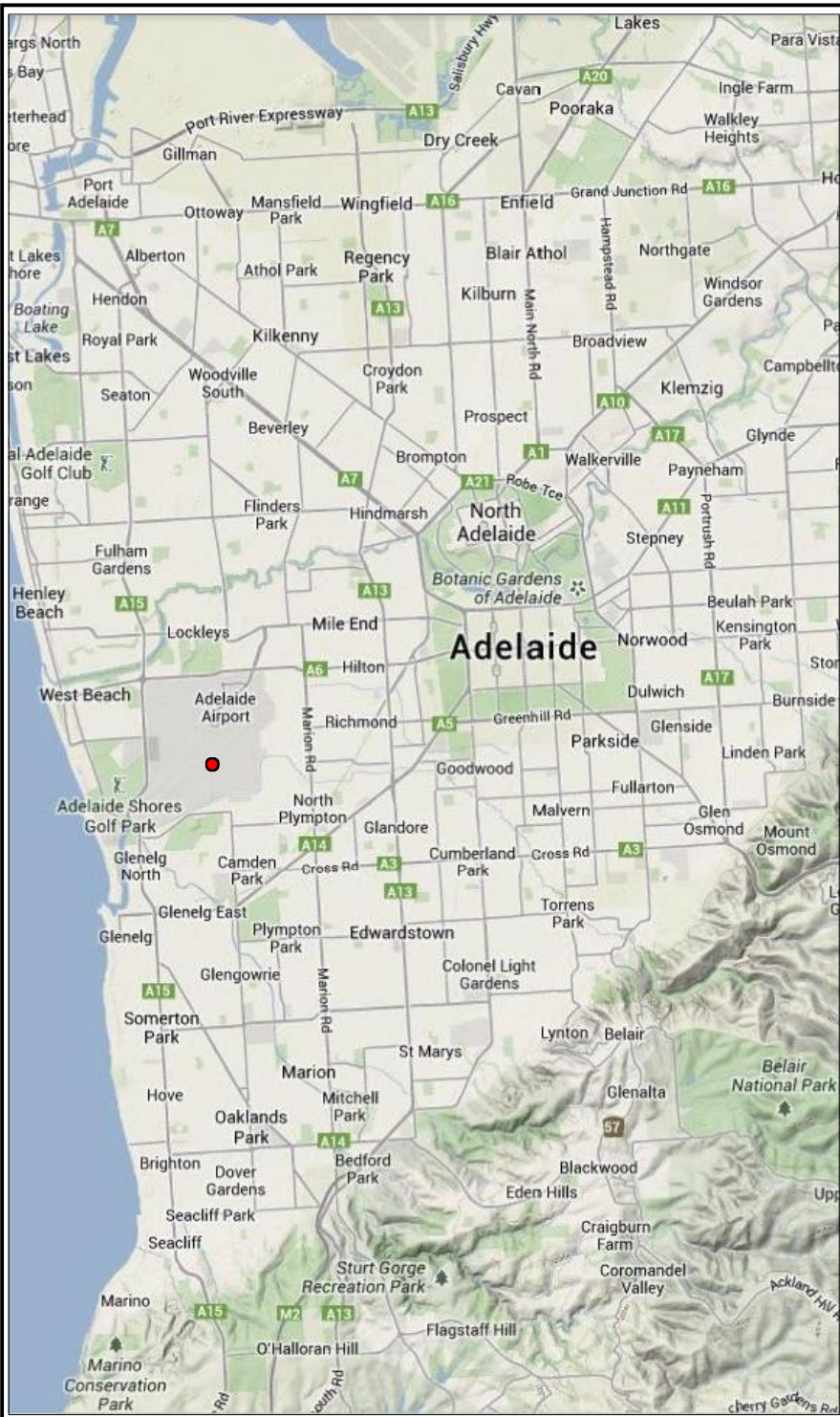
# GROUNDWATER SUMMARY TABLE

## ALL UNITS IN MG/L UNLESS SHOWN OTHERWISE



Field ID	Sample Date	Lab Report Number	Perfluoroalkylsulfonic acids				Perfluoroalkylcarboxylic acids						Other PFCs												
			Perfluorobutanesulfonic acid	Perfluorohexanesulfonic acid	Perfluorooctanesulfonic acid (PFOS)**	Perfluorodecanesulfonic acid	Perfluorohexanoic acid	Perfluoroheptanoic acid	Perfluorooctanoic acid(PFOA)	Perfluorononanoic acid	Perfluorodecanoic acid	Perfluoroundecanoic acid	Perfluorododecanoic acid	Perfluorooctanesulfonamide	N-ethyl-perfluorooctanesulfonamidoacetic acid	N-methyl-perfluorooctanesulfonamidoacetic acid	1H,1H,2H,2H-perfluorohexanesulfonic acid	1H,1H,2H,2H-perfluorooctanesulfonic acid	1H,1H,2H,2H-perfluorodecanesulfonic acid						
EQL			ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Airports 1997			0.5	0.5	0.005	0.02	0.5	0.5	1	0.01	0.01	0.01	0.01	0.01	0.02	30	10	30	20						
US EPA Region 4					0.2			0.4																	
Dutch Intervention TPH																									
EPP Agriculture/Aquaculture - Aquaculture																									
EPP Freshwater ecosystem																									
EPP Marinewater ecosystem																									
EPP Potable																									
GW01	26/04/2012	334968	62	110	3.5	<0.5	140	24	26	0.59	0.26	0.024	<0.01	0.012	<0.02	<0.03	<0.01	0.44	1.8						
GW02	26/04/2012	334968	13	19	0.065	<0.005	30	3	2.9	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.03	<0.01	<0.03	<0.02						
DUP1	26/04/2012	334968	52	92	2.7	<0.5	120	22	22	0.54	0.23	0.017	<0.01	<0.01	<0.02	<0.03	<0.01	0.45	1.7						

Comments  
 \*\*The result for PFOS also includes its salts and perfluorooctanesulfo



**Legend**

- Approximate Site Location
- Approximate Investigation Area

**S&G Environmental Consulting**



Job No.: SG1311129

Client: Air Services Australia

Version: Draft

Date: 18 June 2013

Drawn By: AS

Checked By: ZD

Not to Scale



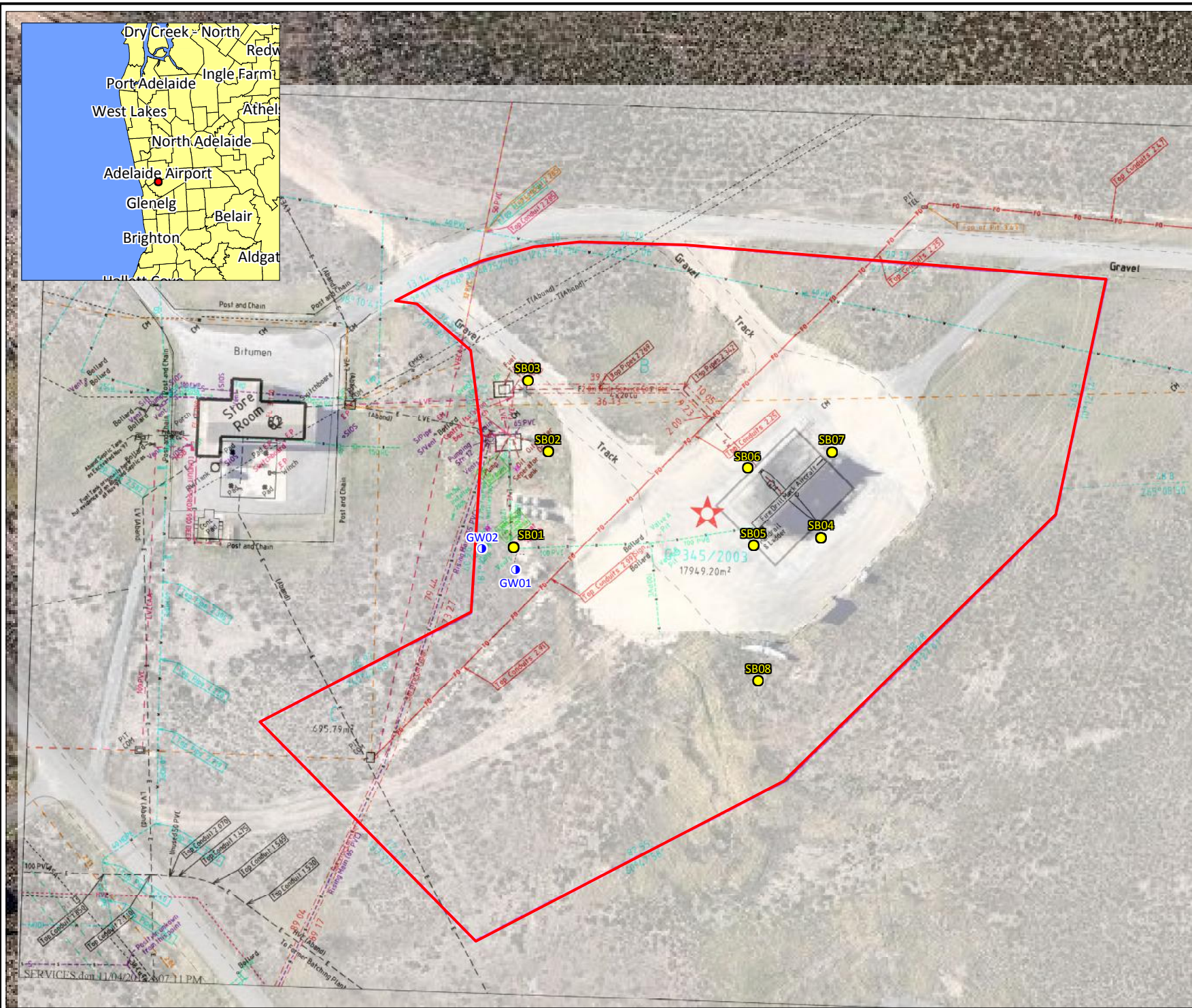
Data Source: Nearmaps and Google Maps

Coord. Sys.: MGA Zone 54 (GDA 94)

**Adelaide Airport Fire Training Facility,  
1 James Schofield Drive, Adelaide  
Airport, South Australia**

**SITE LOCATION**

**FIGURE 1**



**Legend**

- Approximate Investigation Area
- Groundwater Monitoring Well
- Soil Borehole

---

**S&G Environmental Consulting**

Job No.: SG1311129

Client: Air Services Australia

Version: Draft	Date: 18 June 2013
Drawn By: AS	Checked By: ZD

Scale: 1 : 1,200 at A4

0                      25                      50  
metres

Data Source: Nearmaps and ABS

Coord. Sys.: MGA Zone 54 (GDA 94)

**Adelaide Airport Fire Training Facility,  
1 James Schofield Drive, Adelaide  
Airport, South Australia**

**SOIL AND GROUNDWATER  
INVESTIGATION LOCATIONS**

---

**FIGURE 2**



### SOIL SUMMARY TABLE ALL UNITS IN MG/KG UNLESS SHOWN OTHERWISE

Field ID	Sample Date	Lab Report Number	Perfluoroalkylsulfonic acids			Perfluoroalkylcarboxylic acids							Other PFCs		Other Moisture Content (dried @ 103°C)	
			Perfluorobutanesulfonic acid	Perfluorohexanesulfonic acid	Perfluorooctanesulfonic acid (PFOS) <sup>§</sup>	Perfluorobutanoic acid	Perfluoropentanoic acid	Perfluorohexanoic acid	Perfluoroheptanoic acid	Perfluorooctanoic acid	Perfluorononanoic acid	Perfluorodecanoic acid	6:2 Fluorotelomer sulfonate	Total PFC		
			ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	%
EQL														2.9	0.1	
Airports Soil Pollution Accepted limits (general areas)*																
Airports Soil Pollution Accepted limits (areas of environmental significance)*																
US EPA Region 4 Soil Screening Levels for PFOA and PFOS**					6000						16,000					
Minnesota Department of Health - Residential***					2000						2000					
Minnesota Department of Health - Industrial***					14,000						13,000					
Ecotoxicity - Terrestrial Plants****					1500						-					
Ecotoxicity - Soil Invertebrates****					33,000						-					
SB01/1_0-0.4	11/04/2013	375521	24.6	61.2	426	23.7	21	64	11.1	20.3	8.3	4.6	<2.9	665	9	
SB02/1_0-0.3	11/04/2013	375521	47.6	163	777	19.5	17.8	71.3	11.8	24.2	5.7	2.1	<3.1	1140	7.8	
SB03/1_0-0.4	11/04/2013	375521	-	-	-	-	-	-	-	-	-	-	-	-	6.2	
SB04/1_0-0.2	11/04/2013	375521	-	-	-	-	-	-	-	-	-	-	-	-	4.3	
SB04/2_0.2-1.0	11/04/2013	375521	18.9	715	841	14.6	23	99.3	57.7	254	7	2.5	24	2060	6.3	
SB05/2_0.05-0.65	11/04/2013	375521	-	-	-	-	-	-	-	-	-	-	-	-	9	
SB06/1_0-1.1	11/04/2013	375521	56.1	203	1110	36	55.1	271	68.2	72.1	6.7	4.6	6.7	1890	8.5	
SB07/1_0-0.4	11/04/2013	375521	18.2	623	3550	19.9	17.2	86.5	29.9	217	5	2.3	56.2	4630	5.7	
SB08/1_0-0.5	11/04/2013	375521	27	425	574	7.3	13.5	88.6	18.4	107	3.1	<2.3	<3.4	1260	7.5	
SB04/2_0.2-1.0	11/04/2013	375521	18.9	715	841	14.6	23	99.3	57.7	254	7	2.5	24	2060	6.3	
DUP 5	11/04/2013	375521	15.3	626	693	9.8	15.8	71.1	42.6	206	5.4	2.5	15.1	1700	6.5	
		<b>RPD</b>	21	13	19	39	37	33	30	21	26	0	46	19	3	

**Comments**  
 \* - Airports (Environmental Protection) Regulations 1997 - Soil Pollution Limits  
 \*\* - US EPA Region 4 Soil Screening Levels for Perfluorooctanoic Acid (PFOA) and Perfluorooctyl Sulfonate (PFOS) 2009  
 \*\*\* - Minnesota Department of Health, Health Based Criteria  
 \*\*\*\* - Beach S.A., Newstead J.L., Coady K., Giesy J.P. (2006) Ecotoxicological evaluation of perfluorooctanesulfonate (PFOS). Rev Environ Contam Toxicol. 2006;186:133-74



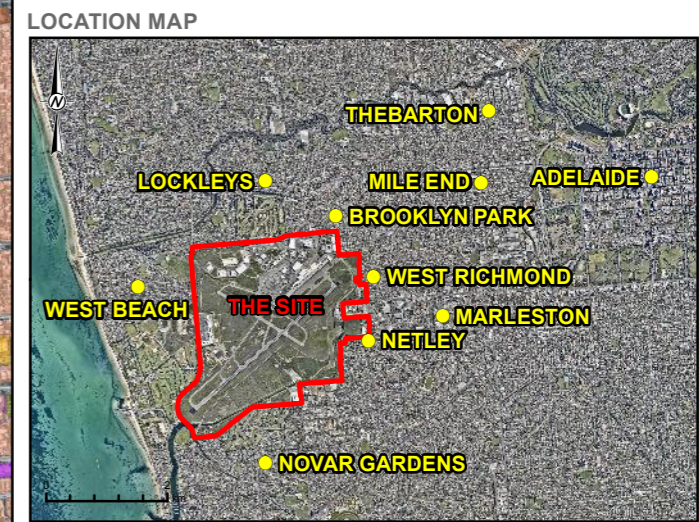
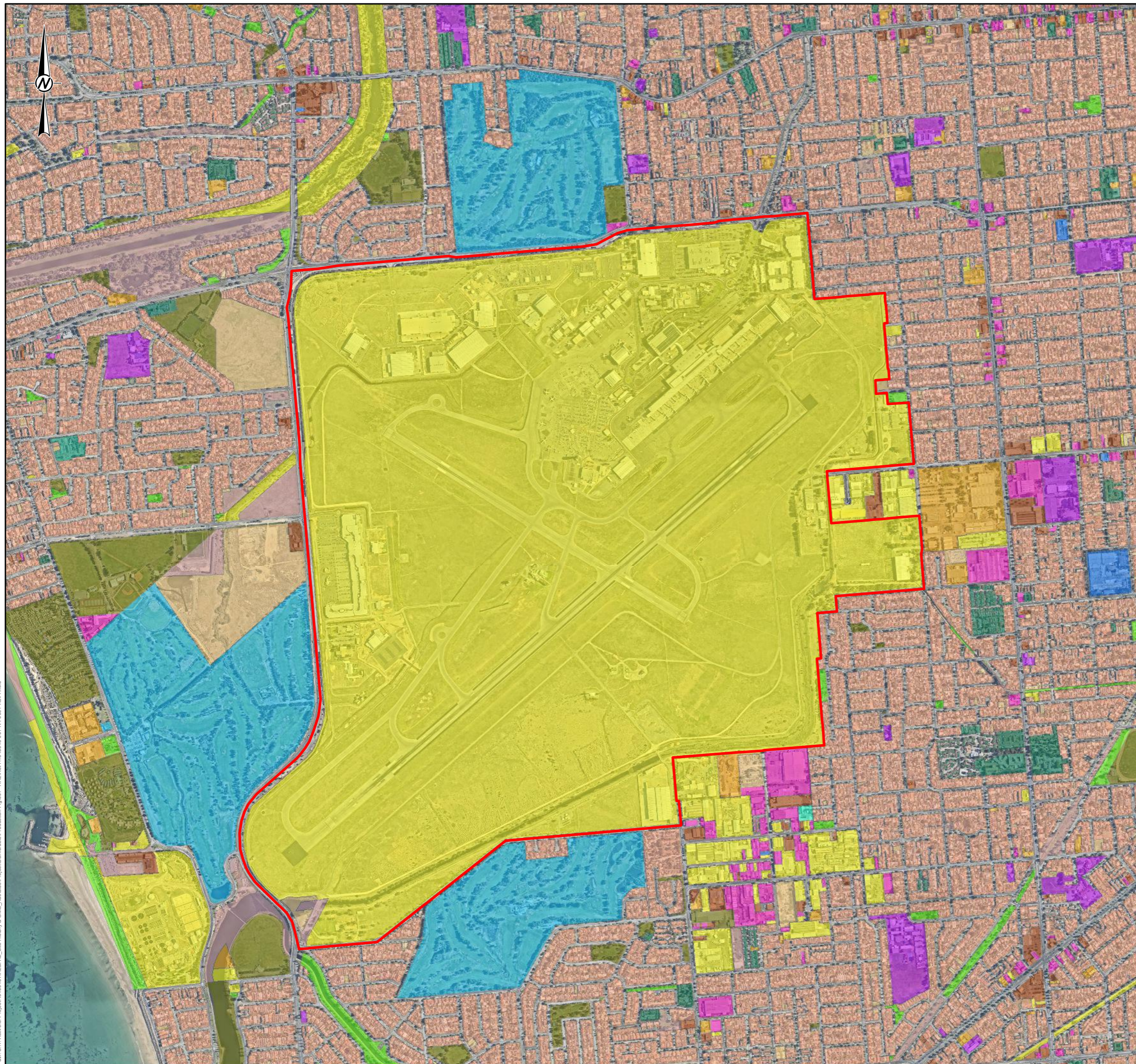
**GROUNDWATER SUMMARY TABLE**  
**ALL UNITS IN MG/L UNLESS SHOWN OTHERWISE**

Field ID	Sample Date	Lab Report Number	Perfluoroalkylsulfonic acids			Perfluoroalkylcarboxylic acids						Other PFCs			
			Perfluorobutanesulfonic acid	Perfluorohexanesulfonic acid	Perfluorooctanesulfonic acid (PFOS) <sup>#2</sup>	Perfluorobutanoic acid	Perfluoropentanoic acid	Perfluorohexanoic acid	Perfluoroheptanoic acid	Perfluorooctanoic acid	Perfluorononanoic acid	Perfluorodecanoic acid	6:2 Fluorotelomer sulfonate	Total PFC	
			ug/L	ug/L	ug/L	ug/L	ug/l	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
EQL															
Airports 1997															
US EPA Region 4															
GW01	11/04/2013	375521	64.1	87.7	9.9	32.2	52.7	136	19.6	24.7	1	0.7	0.8	430	
GW02	11/04/2013	375521	2.7	3.7	0.02	1.7	2.6	6.2	0.9	0.6	<0.005	<0.005	<0.005	18.4	

**Comments**

#1 The LORs have been raised due to matrix interference  
#2The result for PFOS also includes its salts and perfluorooctanesulfonyl fluoride (PFOSF).

DRAFT



**LEGEND**

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<span style="display:inline-block; width:15px; height:15px; background-color: #8A2BE2; border:1px solid black;"></span> Education	<span style="display:inline-block; width:15px; height:15px; background-color: #4DB6AC; border:1px solid black;"></span> Rural Residence
<span style="display:inline-block; width:15px; height:15px; background-color: #42A5F5; border:1px solid black;"></span> Food Industry	<span style="display:inline-block; width:15px; height:15px; background-color: #FFF176; border:1px solid black;"></span> Utility Industry
<span style="display:inline-block; width:15px; height:15px; background-color: #81D4FA; border:1px solid black;"></span> Golf	<span style="display:inline-block; width:15px; height:15px; background-color: #F08080; border:1px solid black;"></span> Vacant
<span style="display:inline-block; width:15px; height:15px; background-color: #40E0D0; border:1px solid black;"></span> Livestock	<span style="display:inline-block; width:15px; height:15px; background-color: #F5DEB3; border:1px solid black;"></span> Vacant Residence
<span style="display:inline-block; width:15px; height:15px; background-color: #FFD700; border:1px solid black;"></span> Public Institution	
<span style="display:inline-block; width:15px; height:15px; background-color: #8FBC8F; border:1px solid black;"></span> Recreation	
<span style="display:inline-block; width:15px; height:15px; background-color: #90EE90; border:1px solid black;"></span> Reserve	
<span style="display:inline-block; width:15px; height:15px; background-color: #FFC0CB; border:1px solid black;"></span> Residential	
<span style="display:inline-block; width:15px; height:15px; background-color: #A0522D; border:1px solid black;"></span> Retail / Commercial	

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2. Roads data sourced from DPTI, Department for Transport Energy and Infrastructure, South Australian Government, sourced <http://www.dptiapps.com.au/dataportal/Roads.zip>, sourced 19.06.2014.
3. Suburb data sourced from MapInfo StreetPro.
4. General landuse data source from Data.SA, South Australian Government Data Directory, sourced 01.04.2016.



REFERENCE SCALE: 1:17,500 (at A3)  
 PROJECTION: GDA 1994 MGA Zone 54

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**ADELAIDE AIRPORT LIMITED**

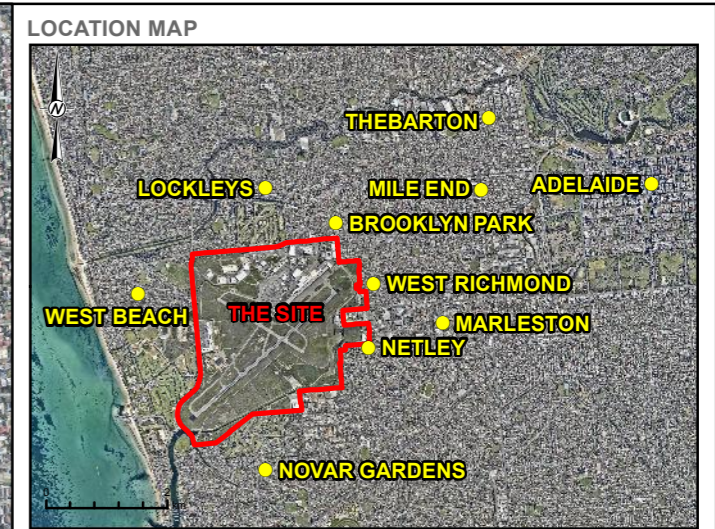
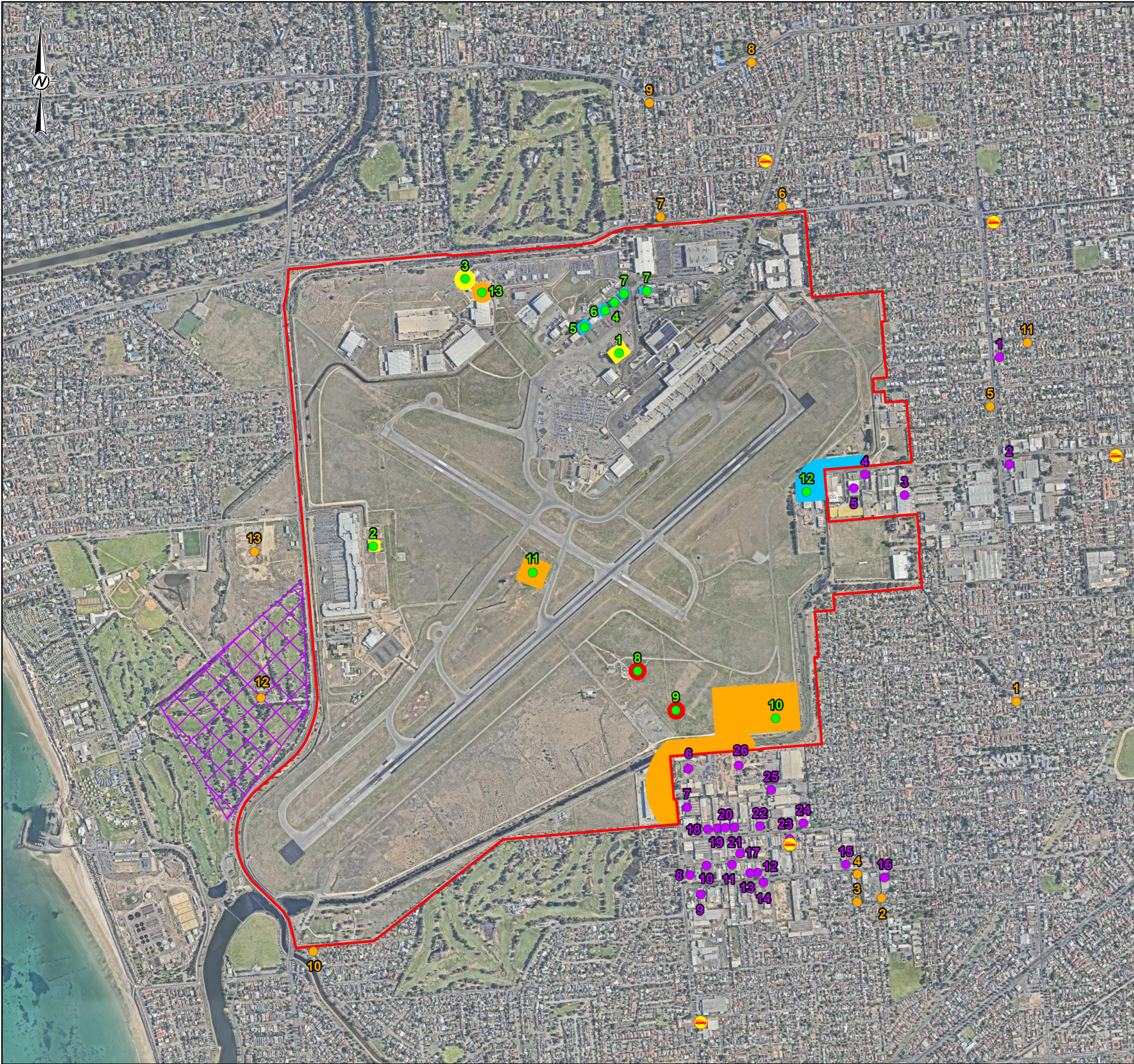
PROJECT  
 SITE HISTORY AND QUALITATIVE RISK ASSESSMENT OF PERFLUORINATED CHEMICAL SOURCES - ADELAIDE AIRPORT

TITLE  
**GENERAL LAND USE ZONES**

CONSULTANT	YYYY-MM-DD	2016-04-15
	PREPARED	KB
	DESIGN	-
	REVIEW	MP
	APPROVED	JC

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THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN ON THE SHEET SIZE HAS BEEN ADJUSTED FROM 28mm



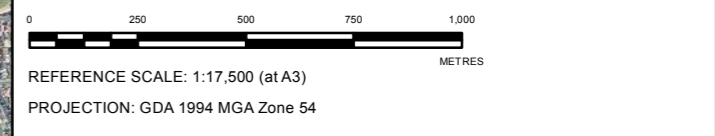
- LEGEND**
- Current On-Site Features of Interest (Approximate Location)
  - Current Off-Site Features of Interest (Approximate Location)
  - Historical Off-Site Features of Interest (Approximate Location)
  - Approximate Fire Station / Fire Services Location

- Potential PFC Risk**
- High Risk
  - Moderate Risk
  - Low Risk
  - Very Low Risk
  - Approximate Extent of Former Landfill
  - Approximate Site Boundary

**NOTES**  
Refer to following table for Site Feature Details.

**COPYRIGHT**

1. Aerial image sourced from Nearmap Pty. Ltd, aerial dated 06.02.2016, sourced 15.02.2016.
2. Roads data sourced from DPTI, Department for Transport Energy and Infrastructure, South Australian Government, sourced <http://www.dptiapps.com.au/dataportal/Roads.zip>, sourced 19.06.2014.
3. Suburb data sourced from MapInfo StreetPro.



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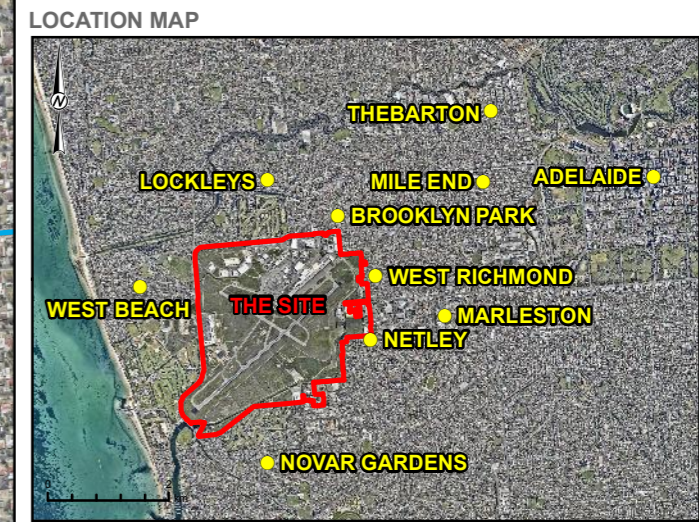
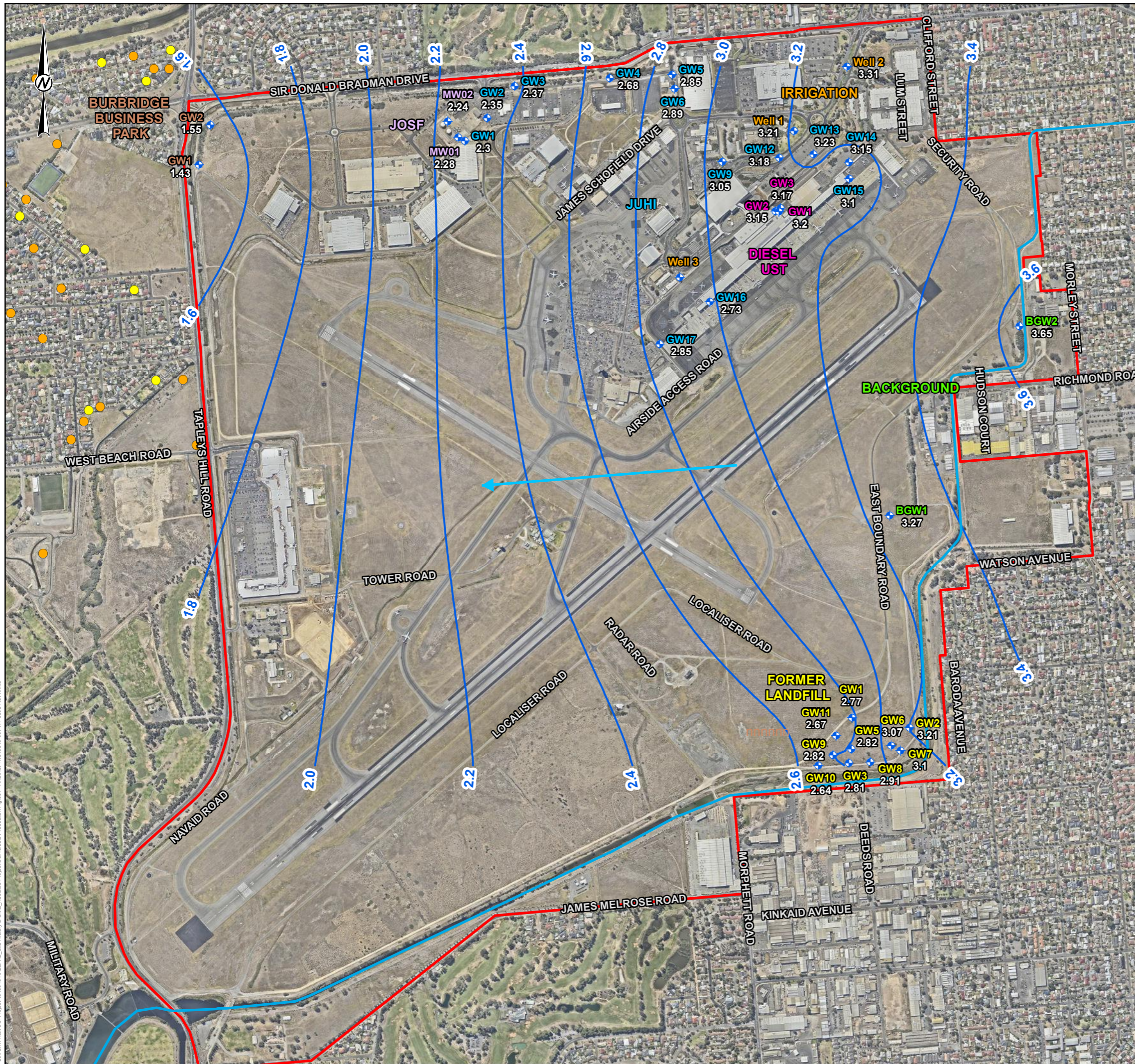
**PROJECT**  
SITE HISTORY AND QUALITATIVE RISK ASSESSMENT OF PERFLUORINATED CHEMICAL SOURCES - ADELAIDE AIRPORT

**TITLE**  
SITE LAYOUT AND FEATURES OF INTEREST

CONSULTANT	YYYY-MM-DD	2016-04-19
	PREPARED	KB
	DESIGN	-
	REVIEW	MP
	APPROVED	JC

Path: S:\11\_Aerials3\_Project\1546945\_AAL\BPL\_Site\_History\_GME\_Adelaid\Project\Deliverables\Production\Fig001\_AAL\Rev1\1546945\_001-R\_Fig002\_Rev1.mxd

© THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN ON THE SHEET. THIS SIZE HAS BEEN ADJUSTED FROM 25mm



- LEGEND**
- Groundwater Monitoring Well and Groundwater Elevation (m AHD)
  - Domestic
  - General / Unknown
  - Inferred Groundwater Contour (m AHD)
  - Inferred Groundwater Flow Direction
  - Brownhill / Keswick Creek
  - Approximate Site Boundary

- NOTES**
1. Groundwater Monitoring Well location georeference from BF (Groundwaterwells) AAL Wells.dwg, or from field staff location or from Golder requested survey.
  2. Roads data sourced from DPTI, Department for Transport Energy and Infrastructure, South Australian Government, sourced <http://www.dptiapps.com.au/dataportal/Roads.zip>, sourced 19.06.2014.
  3. Suburb data sourced from MapInfo StreetPro.
  4. Watercourse and groundwater monitoring well data sourced from WaterConnect, South Australian Government.

0 200 400 600 800 1,000 METRES

REFERENCE SCALE: 1:12,250 (at A3)

PROJECTION: GDA 1994 MGA Zone 54

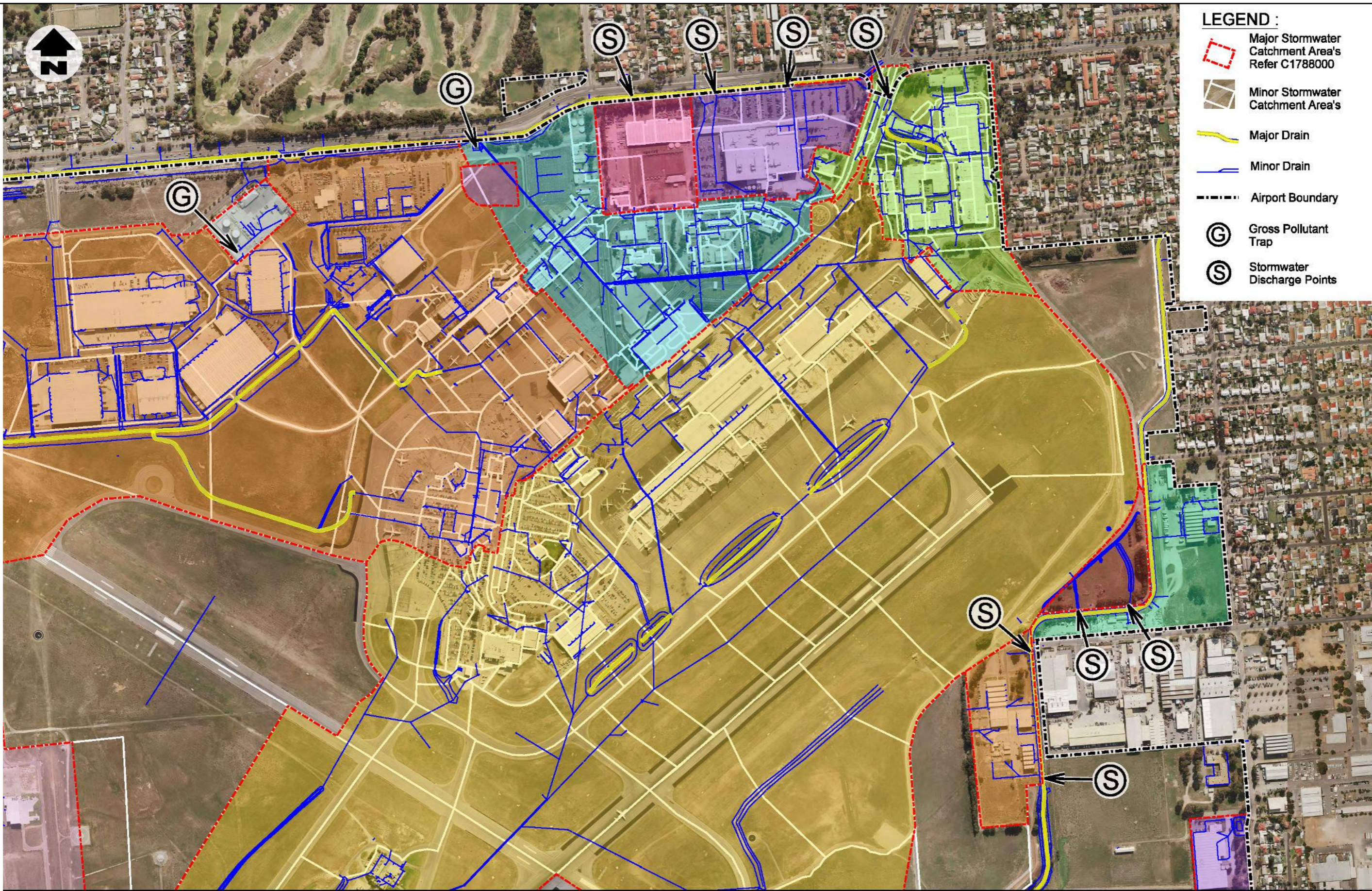
CLIENT  
ADELAIDE AIRPORT LIMITED

PROJECT  
SITE HISTORY AND QUALITATIVE RISK ASSESSMENT OF PERFLUORINATED CHEMICAL SOURCES - ADELAIDE AIRPORT

TITLE  
**MONITORING WELL LOCATIONS AND INFERRED GROUNDWATER CONTOURS**

CONSULTANT	DATE	REVISION
	YYYY-MM-DD	2016-04-15
	PREPARED	KB
	DESIGN	-
	REVIEW	MP
	APPROVED	JC

Path: S:\11\_Activity3\_Project1546945\_AAL\BPA\_L\_Site\_History\_Golder\_Adelade\ProjectDrawables\Production\Fig001 - AAL Rev111546945-001-R-F0003\F001.mxd



- LEGEND :**
- Major Stormwater Catchment Area's Refer C1788000
  - Minor Stormwater Catchment Area's
  - Major Drain
  - Minor Drain
  - Airport Boundary
  - G Gross Pollutant Trap
  - S Stormwater Discharge Points

**COPYRIGHT**  
1. Base image sourced from Adelaide Airport Limited

**CLIENT**  
ADELAIDE AIRPORT LIMITED

**PROJECT**  
SITE HISTORY AND QUALITATIVE RISK ASSESSMENT OF PERFLUORINATED CHEMICAL SOURCES - ADELAIDE

**TITLE**  
STORMWATER CATCHMENT TERMINAL PRECINCT DRAINAGE & CATCHMENT AREAS

CONSULTANT	
YYYY-MM-DD	2016-05-06
PREPARED	KB
DESIGN	-
REVIEW	VJ
APPROVED	JC

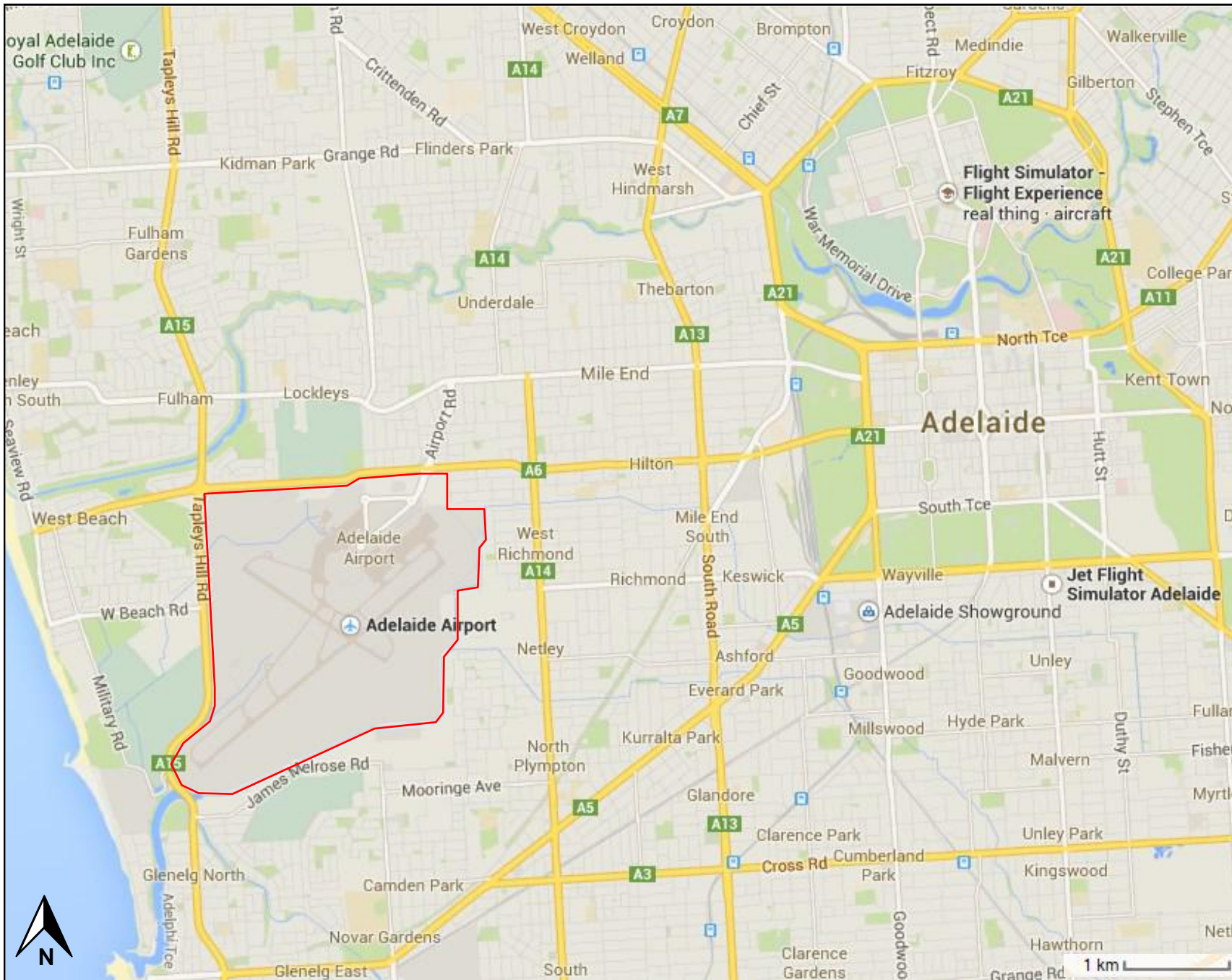


REFERENCE SCALE: Not to Scale

PROJECT No. 1546945 CONTROL 001-R Rev. 2 FIGURE 4


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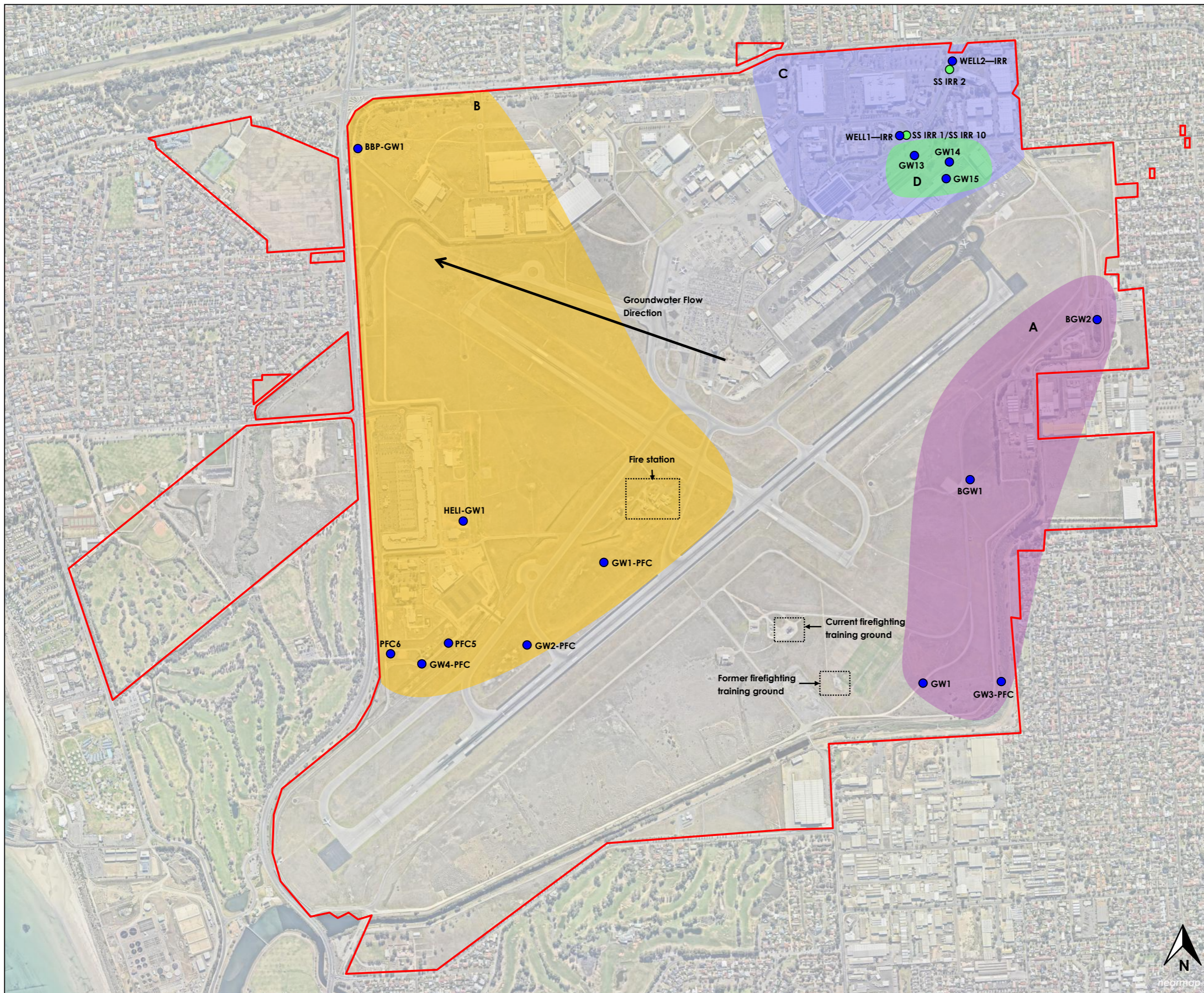
THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN. THE SHEET SIZE HAS BEEN MODIFIED FROM 29mm



**FIGURE 1A**  
**Site Location**  
**Map—Adelaide**  
**Airport**

**Adelaide Airport**  
**Detailed PFAS Assessment**  
 For  
**Adelaide Airport Limited**

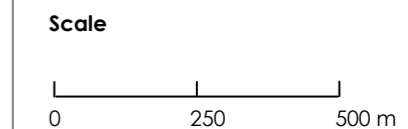
Job No: 160786  
 Drawn: K Bradey  
 Checked: 



**Figure 2A**  
**Sample Location**  
**Plan —Adelaide**  
**Airport**

**Adelaide and Parafield**  
**Airports**  
**Detailed PFAS Assessment**  
 For  
**Adelaide Airport Limited**

- Legend**
- Approximate Site Boundary
  - Groundwater Well Location
  - Soil Sample Location
  - A—up gradient groundwater zone
  - B—down gradient groundwater zone
  - C—irrigation area groundwater zone
  - D—TEN area groundwater zone

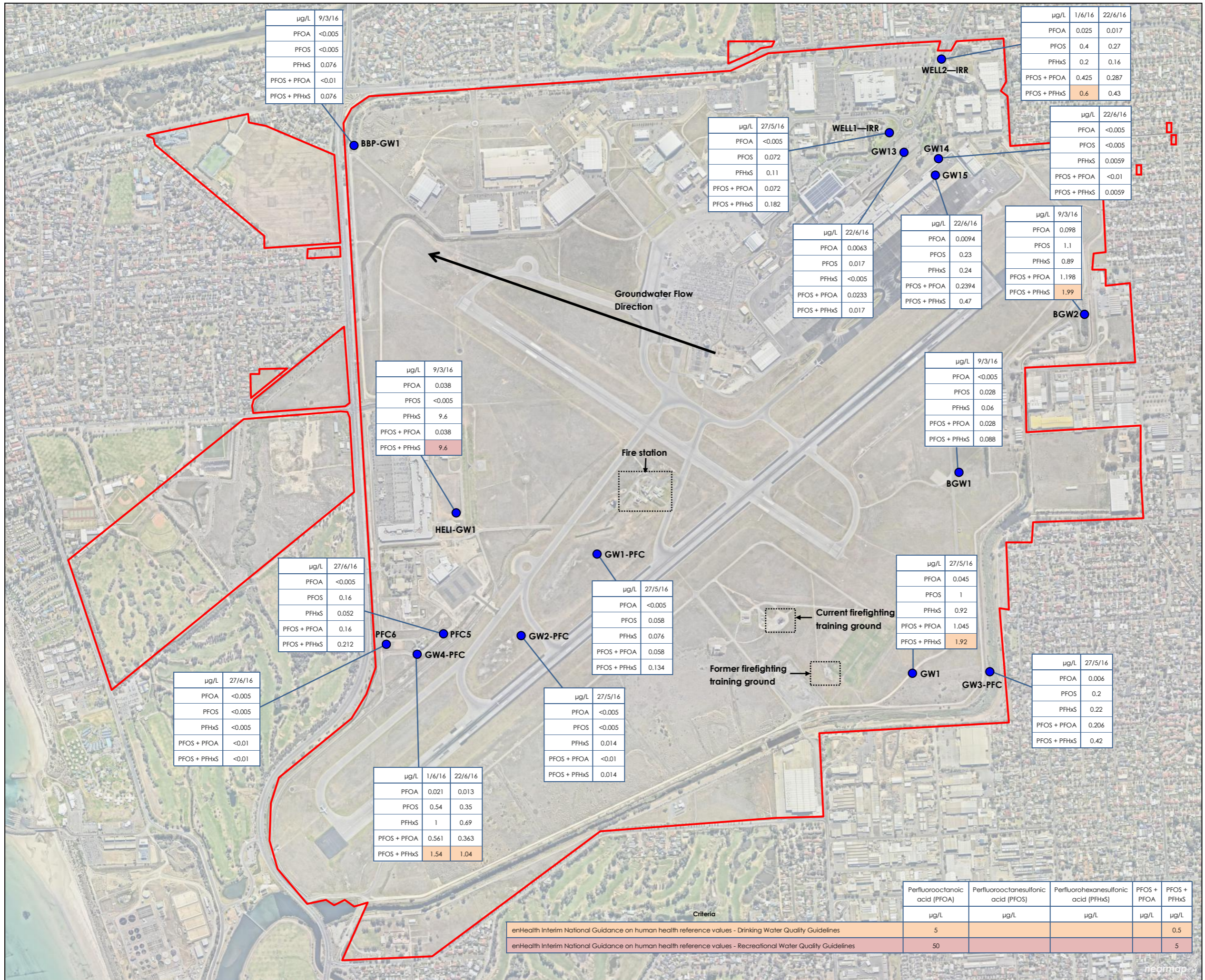


Job No: 160786

Drawn: H Custance

Checked:

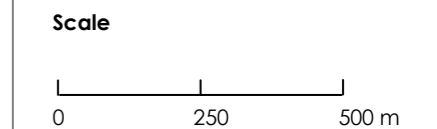




**Figure 3A**  
**Groundwater Concentrations—**  
**Adelaide Airport**

**Adelaide and Parafield Airports**  
**Detailed PFAS Assessment**  
 For  
**Adelaide Airport Limited**

- Legend**
- Approximate Site Boundary
  - Groundwater Well Location



**Job No:** 160786  
**Drawn:** H Custance  
**Checked:**

	PFAS in water				
	PFOA: Perfluorooctanoic acid	PFOS: Perfluorooctanesulfonic acid	PFHxS: Perfluorohexanesulfonic acid	PFOS + PFOA	PFOS + PFHxS
	µg/L	µg/L	µg/L	µg/L	µg/L
PQL	0.005	0.005	0.005	-	-
enHealth Interim National Guidance on human health reference values - Drinking Water Quality Guidelines	5				0.5
enHealth Interim National Guidance on human health reference values - Recreational Water Quality Guidelines	50				5

Sample ID	Sample Date					
<b>Groundwater</b>						
BBP-GW1	9/03/2016	<0.005	<0.005	0.076	<0.01	0.076
BGW 2	9/03/2016	0.098	1.1	0.89	1.198	1.99
HELIGW1	9/03/2016	0.038	<0.005	9.6	0.038	9.6
BGW 1	9/03/2016	<0.005	0.028	0.06	0.028	0.088
GW1-PFC	27/05/2016	<0.005	0.058	0.076	0.058	0.134
GW2-PFC	27/05/2016	<0.005	<0.005	0.014	<0.01	0.014
GW3-PFC	27/05/2016	0.006	0.2	0.22	0.206	0.42
GW4-PFC	1/06/2016	0.021	0.54	1	0.561	1.54
	22/06/2016	0.013	0.35	0.69	0.363	1.04
GW1	27/05/2016	0.045	1	0.92	1.045	1.92
WELL1-IRR	27/05/2016	<0.005	0.072	0.11	0.072	0.182
GW13	22/06/2016	0.0063	0.017	<0.005	0.0233	0.017
GW14	22/06/2016	<0.005	<0.005	0.0059	<0.01	0.0059
GW15	22/06/2016	0.0094	0.23	0.24	0.2394	0.47
PFC5	27/06/2016	<0.005	0.16	0.052	0.16	0.212
PFC6	27/06/2016	<0.005	<0.005	<0.005	<0.01	<0.01
WELL2-IRR	1/06/2016	0.025	0.4	0.2	0.425	0.6
	22/06/2016	0.017	0.27	0.16	0.287	0.43

	PFAS in water				
	PFOA: Perfluorooctanoic acid	PFOS: Perfluorooctanesulfonic acid	PFHxS: Perfluorohexanesulfonic acid	PFOS + PFOA	PFOS + PFHxS
	µg/L	µg/L	µg/L	µg/L	µg/L
PQL	0.005	0.005	0.005	-	-
enHealth Interim National Guidance on human health reference values - Drinking Water Quality Guidelines	5				0.5
enHealth Interim National Guidance on human health reference values - Recreational Water Quality Guidelines	50				5

QA / QC Samples: Duplicates (Intra-Laboratory)						
BGW 1	9/03/2016	<0.005	0.028	0.06	0.028	0.088
BGW 10	9/03/2016	<0.005	0.024	0.06	0.024	0.084
RPD%		^	-15%	0%	-15%	-5%

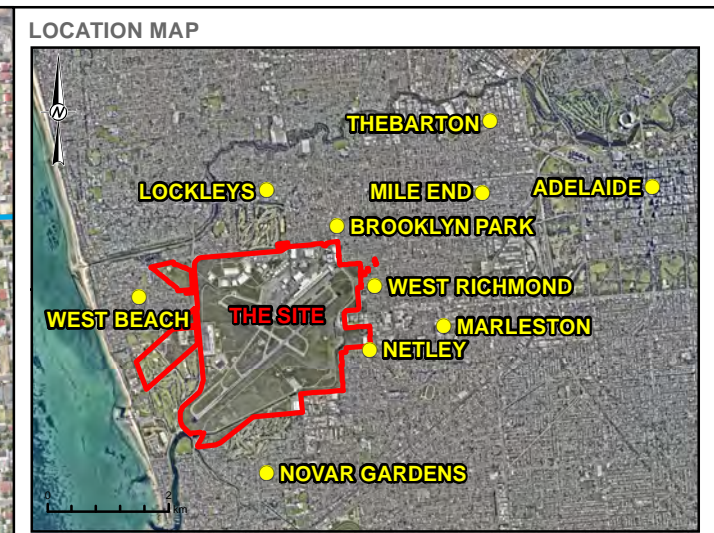
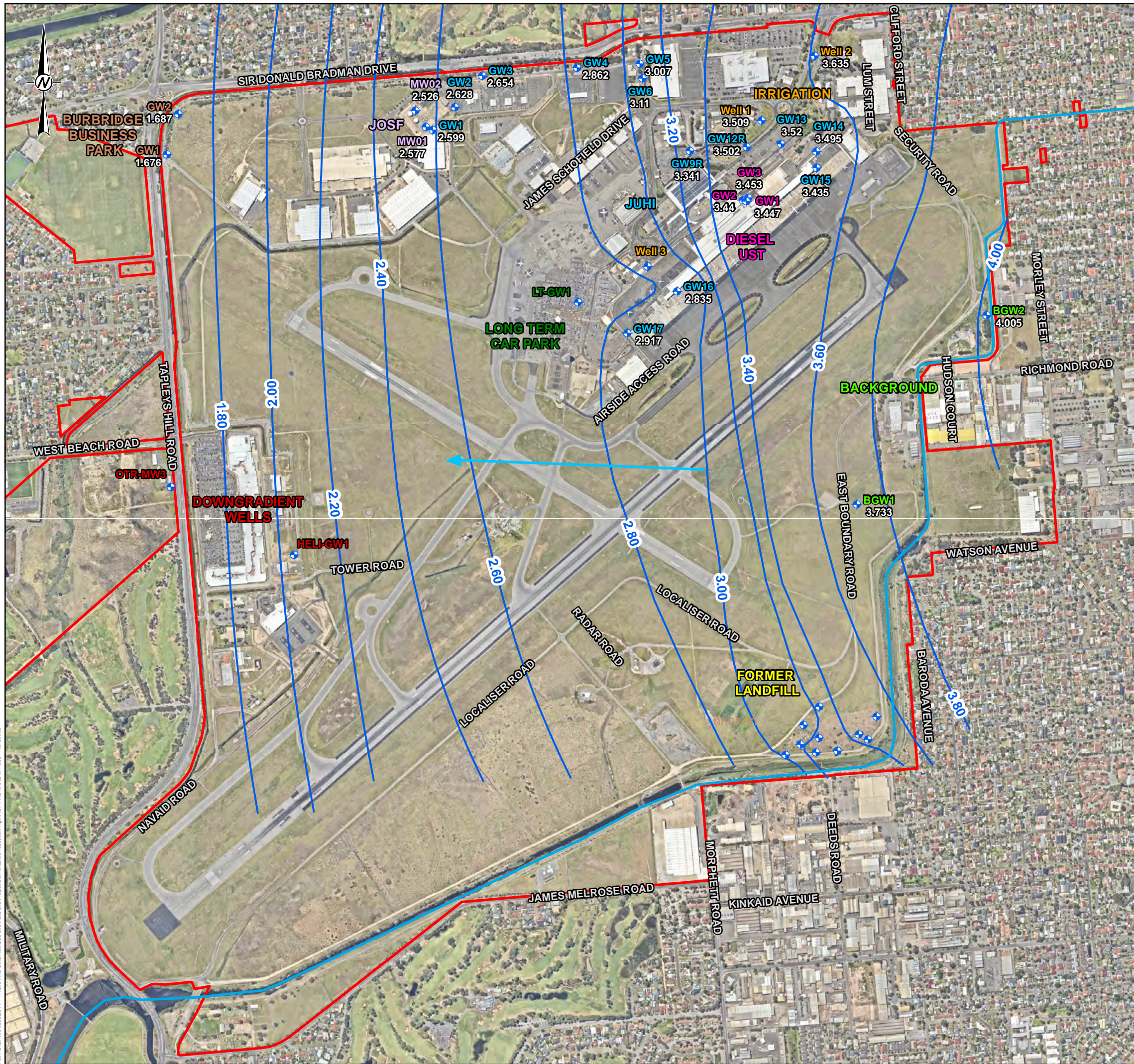
PFC4	22/07/2016	0.013	0.35	0.69	0.363	1.04
PFC99	22/07/2016	0.017	0.31	0.66	0.327	0.97
RPD%		27%	-12%	-4%	-10%	-7%

PFC6	27/06/2016	<0.005	<0.005	<0.005	<0.01	<0.01
PFC98	27/06/2016	<0.005	<0.005	<0.005	<0.01	<0.01
RPD%		^	^	^	^	^

GW1-PFC	27/05/2016	<0.005	0.058	0.076	0.058	0.134
GW100-PFC	27/05/2016	<0.005	0.052	0.067	0.052	0.119
RPD%		^	-11%	-13%	-11%	-12%

RPD value exceeds 20%

$$\%RPD = \frac{(\text{Concentration 1} - \text{Concentration 2}) \times 100}{\text{Mean Concentration}}$$



- LEGEND**
- ◆ Groundwater Monitoring Well and Groundwater Elevation (m AHD)
  - Inferred Groundwater Contour (m AHD)
  - Inferred Groundwater Flow Direction
  - Brownhill / Keswick Creek
  - Approximate Site Boundary

**NOTES**

1. Groundwater Monitoring Well location georeference from BF (Groundwaterwells) AAL Wells.dwg, or from field staff location or from Golder requested survey.

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1. Aerial image sourced from Nearmap Pty. Ltd, aerial dated 21.01.2017.
2. Roads data sourced from Data SA, <https://data.sa.gov.au/data/dataset/roads>.
3. Watercourse data sourced from WaterConnect, South Australian Government.



REFERENCE SCALE: 1:12,250 (at A3)  
 PROJECTION: GDA 1994 MGA Zone 54

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PROJECT  
 ANNUAL GROUNDWATER MONITORING REPORT 2015 - ADELAIDE AIRPORT

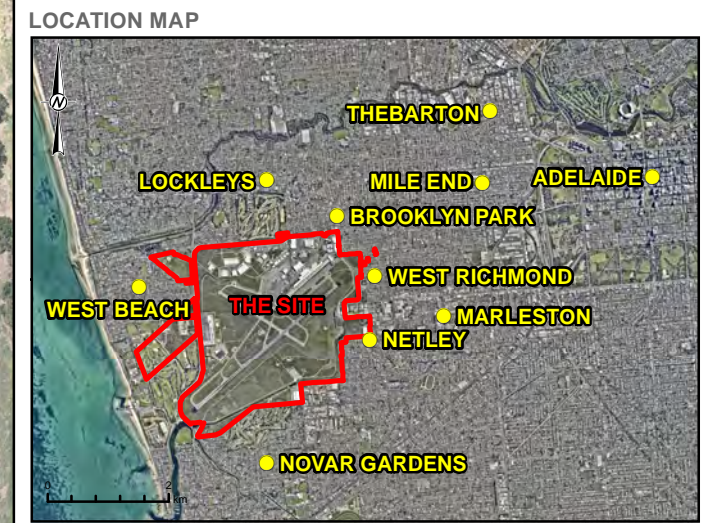
TITLE  
 MONITORING WELL LOCATIONS AND INFERRED GROUNDWATER CONTOURS

CONSULTANT	DATE	REVISION
	YYYY-MM-DD	2017-02-15
	PREPARED	GB
	DESIGN	-
	REVIEW	SM
	APPROVED	JC

PROJECT No. 1414240 CONTROL 003-R Rev. 0 FIGURE 1

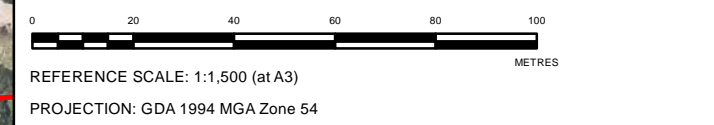
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THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN. THE SHEET SIZE HAS BEEN MODIFIED FROM 25mm



- LEGEND**
- Groundwater Monitoring Well and Groundwater Elevation (m AHD)
  - Inferred Groundwater Contour (m AHD)
  - Inferred Groundwater Flow Direction
  - Brownhill / Keswick Creek
  - Approximate Site Boundary

- NOTES**
1. Groundwater Monitoring Well location georeference from BF (Groundwaterwells) AAL Wells.dwg, or from field staff location or from Golder requested survey.
- COPYRIGHT**
1. Aerial image sourced from Nearmap Pty. Ltd, aerial dated 21.01.2017.
  2. Roads data sourced from Data SA, <https://data.sa.gov.au/data/dataset/roads>.
  3. Watercourse data sourced from WaterConnect, South Australian Government.



CLIENT		ADELAIDE AIRPORT LIMITED	
PROJECT		ANNUAL GROUNDWATER MONITORING REPORT 2015 - ADELAIDE AIRPORT	
TITLE		MONITORING WELL LOCATIONS AND INFERRED GROUNDWATER CONTOURS	
CONSULTANT	YYYY-MM-DD	2017-02-15	
	PREPARED	GB	
	DESIGN	-	
	REVIEW	SM	
	APPROVED	JC	
PROJECT No.	CONTROL	Rev.	FIGURE
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THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN. THE SHEET SIZE HAS BEEN REDUCED FROM 25mm

EQL	PFAS/PFOA																	
	8:2 FTS (39108-34-4)	6:2 FTS (27619-97-2)	PFOA (335-67-1)	PFOS (1763-23-1)	PFOSA (754-91-6)	PFPeA (2706-90-3)	PFTeDA (376-06-7)	PFTTrDA (72629-94-8)	PFUdA (2058-94-8)	PFBS (375-73-5)	PFBuA (375-22-4)	PFDA (335-76-2)	PFDoA (307-55-1)	PFDS (67906-42-7)	PFHpA (375-85-9)	PFHxA (307-24-4)	PFHxS (432-50-7)	PFNA (375-95-1)
ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
GHD Aircservices Australia (June 2015) - Interim Screening Levels (EISLs), Groundwater (Drinking Water)	0.4	5	0.4	0.2														0.2

Field ID	Sampled Date	Monitoring Round	Sample Code	Laboratory Report Number	8:2 FTS (39108-34-4)	6:2 FTS (27619-97-2)	PFOA (335-67-1)	PFOS (1763-23-1)	PFOSA (754-91-6)	PFPeA (2706-90-3)	PFTeDA (376-06-7)	PFTTrDA (72629-94-8)	PFUdA (2058-94-8)	PFBS (375-73-5)	PFBuA (375-22-4)	PFDA (335-76-2)	PFDoA (307-55-1)	PFDS (67906-42-7)	PFHpA (375-85-9)	PFHxA (307-24-4)	PFHxS (432-50-7)	PFNA (375-95-1)
GW12R-A066	21/09/2016	Sept-2016-AAL (PFAS)	N16/026642	RN1132362	<0.05	<0.05	<0.02	0.026	<0.02	0.025	<0.05	<0.05	<0.02	0.025	<0.05	<0.02	<0.02	<0.02	0.023	0.034	0.056	<0.01
GW9R-A066	21/09/2016	Sept-2016-AAL (PFAS)	N16/026641	RN1132362	<0.05	<0.05	<0.02	0.027	<0.02	0.035	<0.05	<0.05	<0.02	0.017	<0.05	<0.02	<0.02	<0.02	0.022	0.046	0.031	<0.01
Heli-GW1-A059	20/09/2016	Sept-2016-AAL (PFAS)	N16/026639	RN1132362	<0.05	<0.05	<0.02	0.033	<0.02	0.027	<0.05	<0.05	<0.02	0.095	0.073	<0.02	<0.02	<0.02	<0.01	0.074	0.24	<0.01
OTR-MW3-A059	23/09/2016	Sept-2016-AAL (PFAS)	N16/026640	RN1132362	<0.05	<0.05	<0.02	0.051	<0.02	<0.02	<0.05	<0.05	<0.02	<0.01	<0.05	<0.02	<0.02	<0.02	<0.01	<0.01	<0.02	<0.01
WELL3-A049	22/09/2016	Sept-2016-AAL (PFAS)	N16/026643	RN1132362	<0.05	<0.05	<0.02	0.037	<0.02	<0.02	<0.05	<0.05	<0.02	0.07	<0.05	<0.02	<0.02	<0.02	<0.01	0.014	0.087	<0.01

ug/L - micrograms per litre

< - less than laboratory limit of reporting

Abbreviations:

EQL - Effective Quantitative Limit

PFAS - perfluoroalkyl substances

PFOA - perfluorooctanoic acid

Prepared by:	OH	Date:	28/11/2016
Checked by:	MP	Date:	28/11/2016



Adelaide Airport Limited Annual Groundwater Monitoring Report 2016

Project Number: 1414240

Table A5- Chemical Results- RPDs

<b>Lab Report Number</b>	RN1132362			RN1132362
<b>Field ID</b>	GW12R-A066	DUP4A	<b>RPD</b>	RP1
<b>Sampled Date/Time</b>	21/09/2016	21/09/2016		23/09/2016

Chemical Name	Units	EQL				
8:2 FTS (39108-34-4)	ug/L	0.05	<0.05	<0.05	0	<0.05
6:2 FTS (27619-97-2)	ug/L	0.05	<0.05	<0.05	0	<0.05
PFOA (335-67-1)	ug/L	0.02	<0.02	<0.02	0	<0.02
PFOS (1763-23-1)	ug/L	0.02	0.026	0.023	12	<0.01
PFOSA (754-91-6)	ug/L	0.02	<0.02	<0.02	0	<0.02
PFPeA (2706-90-3)	ug/L	0.02	0.025	0.025	0	<0.02
PFTeDA (376-06-7)	ug/L	0.02	<0.05	<0.05	0	<0.05
PFTrDA (72629-94-8)	ug/L	0.02	<0.05	<0.05	0	<0.05
PFUdA (2058-94-8)	ug/L	0.02	<0.02	<0.02	0	<0.02
PFBS (375-73-5)	ug/L	0.02	0.025	0.023	8	<0.01
PFBuA (375-22-4)	ug/L	0.05	<0.05	<0.05	0	<0.05
PFDA (335-76-2)	ug/L	0.02	<0.02	<0.02	0	<0.02
PFDoA (307-55-1)	ug/L	0.02	<0.02	<0.02	0	<0.02
PFDS (67906-42-7)	ug/L	0.02	<0.02	<0.02	0	<0.02
PFHpA (375-85-9)	ug/L	0.02	0.023	0.028	20	<0.01
PFHxA (307-24-4)	ug/L	0.02	0.034	0.032	6	<0.01
PFHxS (432-50-7)	ug/L	0.02	0.056	0.044	<b>24</b>	<0.02
PFNA (375-95-1)	ug/L	0.02	<0.01	<0.01	0	<0.01

\*RPDs have only been considered where a concentration is greater than 1 times the EQL.

\*\*High RPDs are in bold (Acceptable RPDs for each EQL multiplier range are: 20 (1-10 x EQL); 20 (10-30 x EQL); 20 (> 30 x EQL) )

\*\*\*Interlab Duplicates are matched on a per compound basis as methods vary between laboratories. Any methods in the row header relate to those used in the primary laboratory

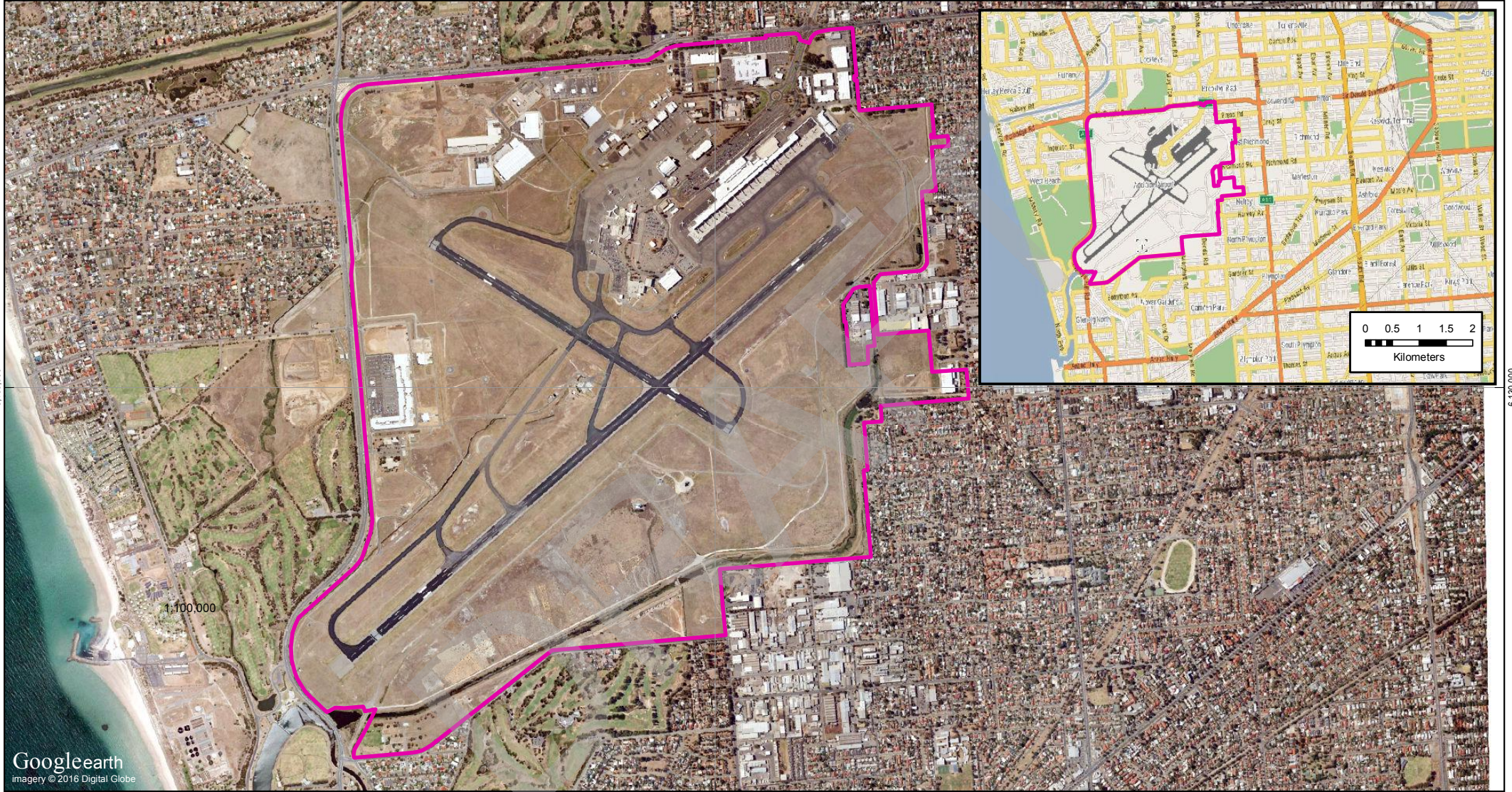
NA denotes Not Available as RPD can only be calculated when both concentrations are above the limit of reporting

< - less than laboratory limit of reporting

ug/L -micrograms per litre

Prepared by:	OH	Date:	28/11/2016
Checked by:	MP	Date:	9/12/2016

275,000



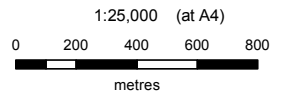
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6,130,000

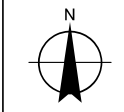
1:100,000

Googleearth  
imagery © 2016 Digital Globe


275,000



Map Projection: Universal Transverse Mercator  
 Horizontal Datum: GDA 1994  
 Grid: GDA 1994 MGA Zone 54



**Legend**

 Site Boundary (Adelaide Airport)



Airservices Australia Pty Ltd  
 Adelaide Airport  
 Preliminary Site Investigation

Job Number	31-34071
Revision	A
Date	15 Jun 2016

**Site Locality**

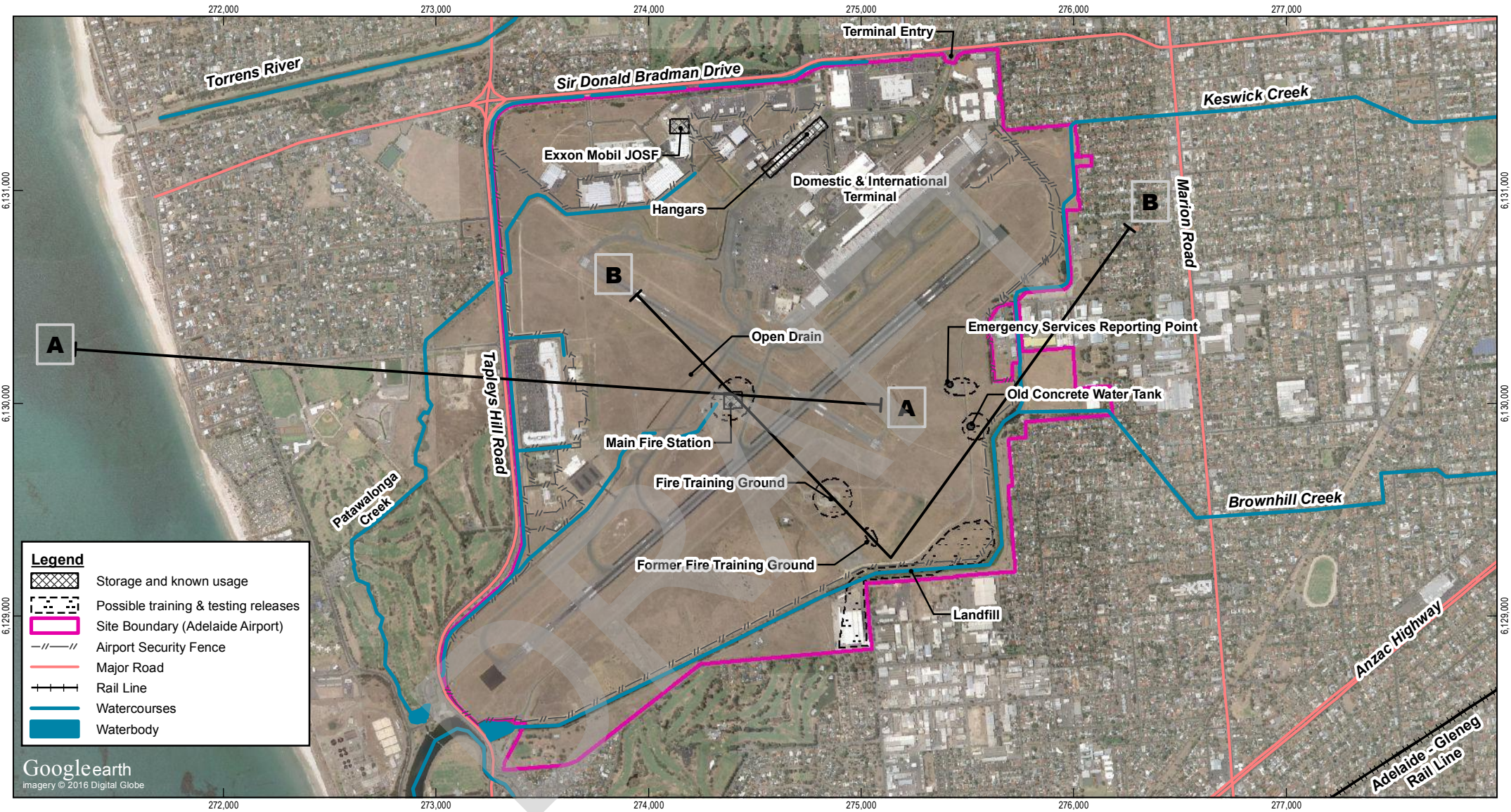
**Figure 1**

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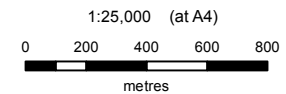
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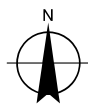
Data source: Google Earth: imagery (May 2015, extracted March 2016); PSMA: street map (2016). Created : jvc



Googleearth  
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Map Projection: Universal Transverse Mercator  
 Horizontal Datum: GDA 1994  
 Grid: GDA 1994 MGA Zone 54



Airservices Australia Pty Ltd  
 Adelaide Airport  
 Preliminary Site Investigation

Job Number	31-34071
Revision	C
Date	07 Nov 2016

## Site Layout and Details

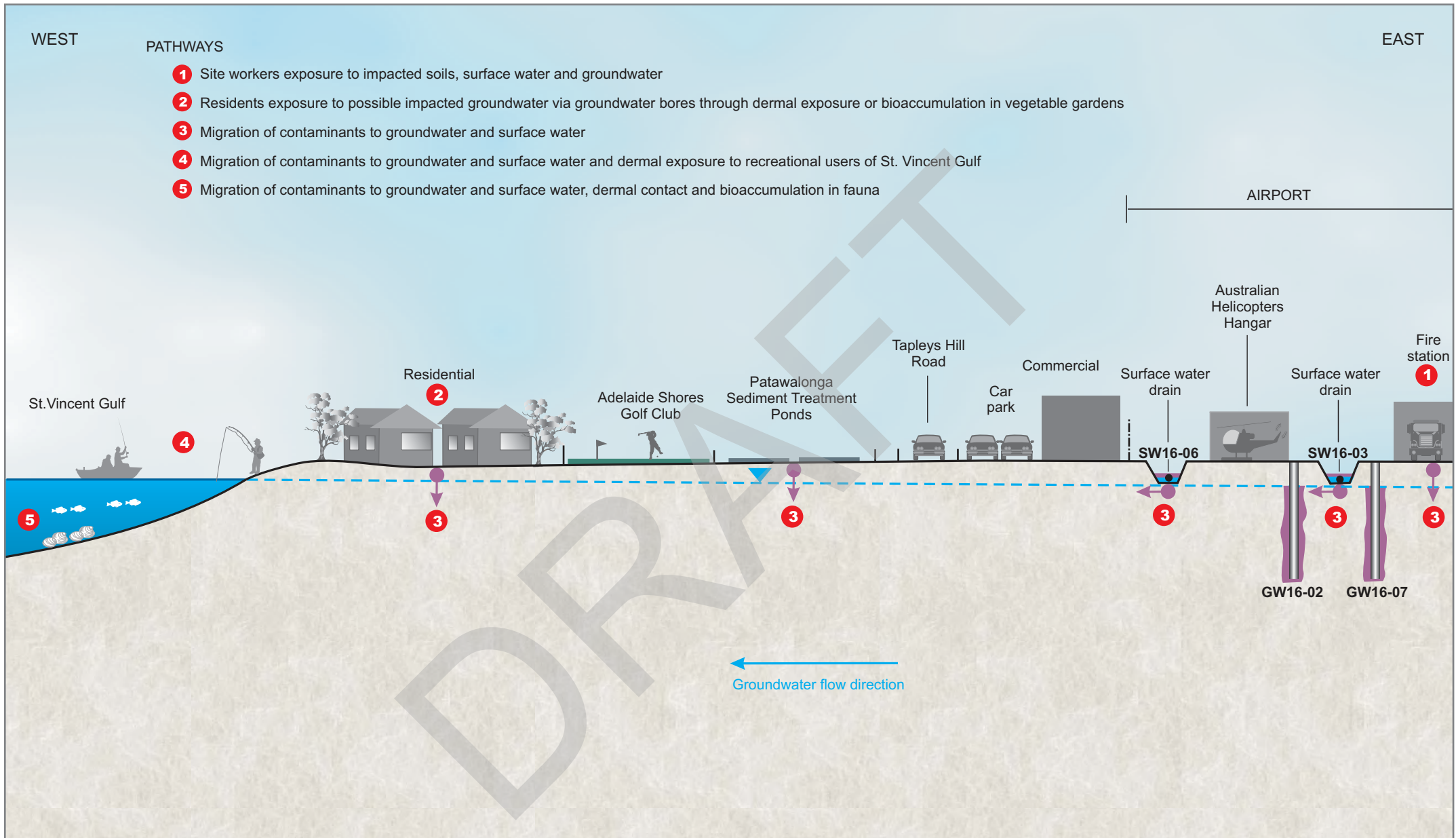
Figure 2

S:\GIS\Projects\31-34071\import\34071\GIS Brisbane by jvc\maps\31-34071-103\_AdiSiteDetails\_revC.mxd

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Data source: Google Earth: aerial imagery (Mar 2016, extracted Jun 2016). Created : jvc



**LEGEND**

- Sands
- PFAS impact
- Migration of contaminants
- Standing water level (approximate)

**NOTE**

Conceptual diagram only - not to scale



Adelaide Airport  
Preliminary Sampling Report

Cross Section A

Job Number	31-34071
Revision	A
Date	25 AUG 2016

Figure 3a

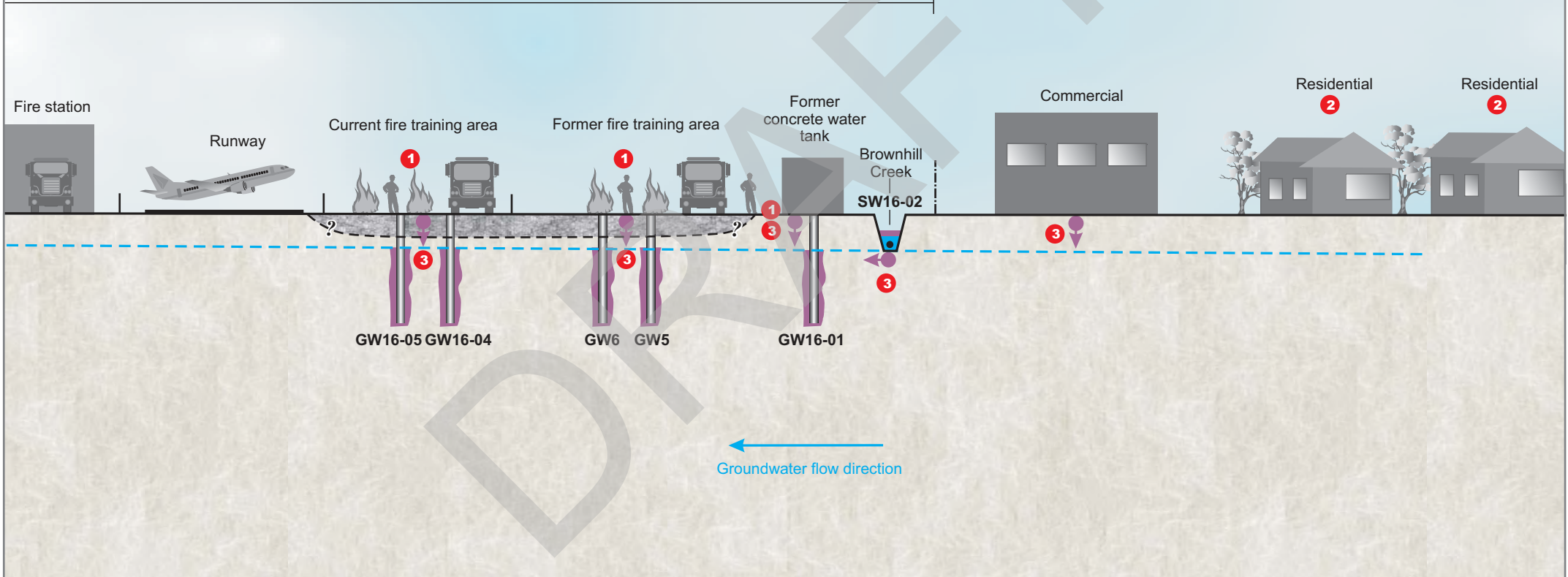
WEST

EAST

PATHWAYS

- 1 Site workers exposure to impacted soils, surface water and groundwater
- 2 Residents exposure to possible impacted groundwater via groundwater bores through dermal exposure or bioaccumulation in vegetable gardens
- 3 Migration of contaminants to groundwater and surface water

AIRPORT



LEGEND

- Fill (sand, gravelly sand, sandy clay)
- Sands
- PFAS impact
- Migration of contaminants
- Standing water level (approximate)

NOTE

Conceptual diagram only - not to scale



Adelaide Airport  
 Preliminary Sampling Report  
 Cross Section A

Job Number	31-34071
Revision	A
Date	25 AUG 2016

Figure 3b



Paper Size A4

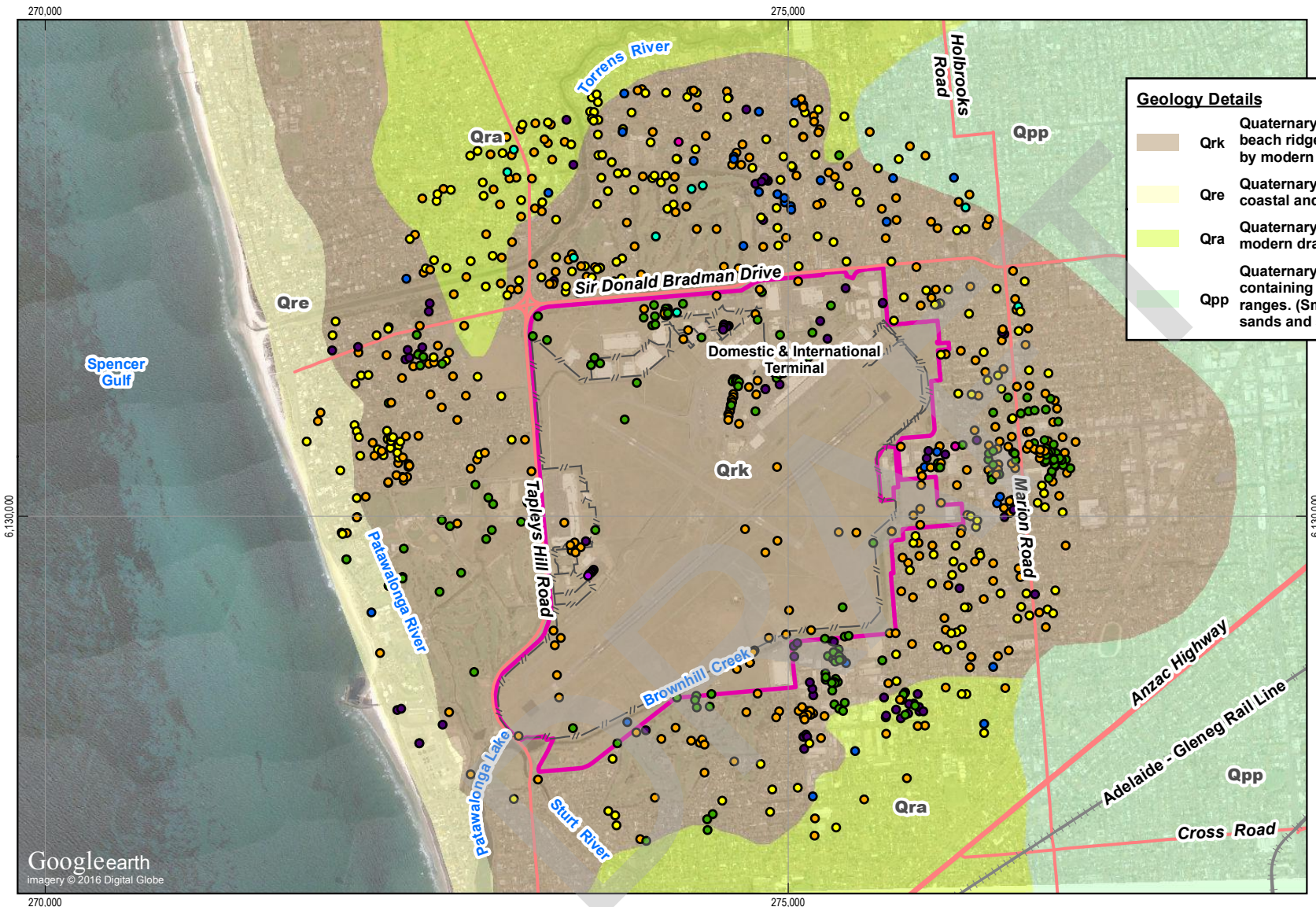


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Adelaide Airport  
Preliminary Site Investigation

Job Number | 31-34071  
Revision | A  
Date | 01 Jul 2016

Conceptual Site Model Pathways

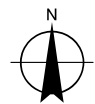
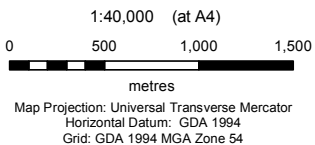
Figure: 4



Geology Details	
	Qrk Quaternary aged: St Kilda Formation: Light-grey shelly stranded beach ridge deposits and shelly silts and sands overlain in places by modern intertidal and swamp deposits.
	Qre Quaternary aged: Semaphore Sand; White quartz sand of the coastal and modern dunes.
	Qra Quaternary aged: Grey fluvial silts, sands and gravels of modern drainage channels.
	Qpp Quaternary aged: Pooraka Formation; Pale red-brown sandy clay containing carbonate of the Loveday Soil. Gravel lenses near ranges. (Small outcrops of older calcrete and veneers of younger sands and soils are not differentiated).

Legend	
	Site Boundary (Adelaide Airport)
Bore (Purpose)	
	Domestic
	Drainage / Industrial
	General / Investigation / Unknown
	Geothermal
	Investigation
	Irrigation
	Monitoring / Observation
	Recharge
	Airport Security Fence
	Major Road
	Rail Line

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Preliminary Site Investigation

Job Number | 31-34071  
Revision | A  
Date | 15 Jun 2016

## Geology and Bores

Figure 2

H:\Projects\31\34071\GIS\maps\31-34071-102\_AdiGeology\_revA.mxd

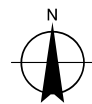
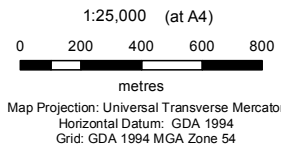
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Data source: Google Earth: aerial imagery (Mar 2016, extracted Jun 2016); WaterConnect, SA Gov: bores (May2016); GA: scanned 100K Geological Mapping (2010); PSMA: road / rail (2016). Created : jvc



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Airservices Australia Pty Ltd  
Adelaide Airport  
Preliminary Sampling Report

Job Number	31-34071
Revision	A
Date	25 Aug 2016

## Surface Water and Groundwater Monitoring Locations

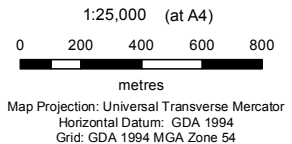
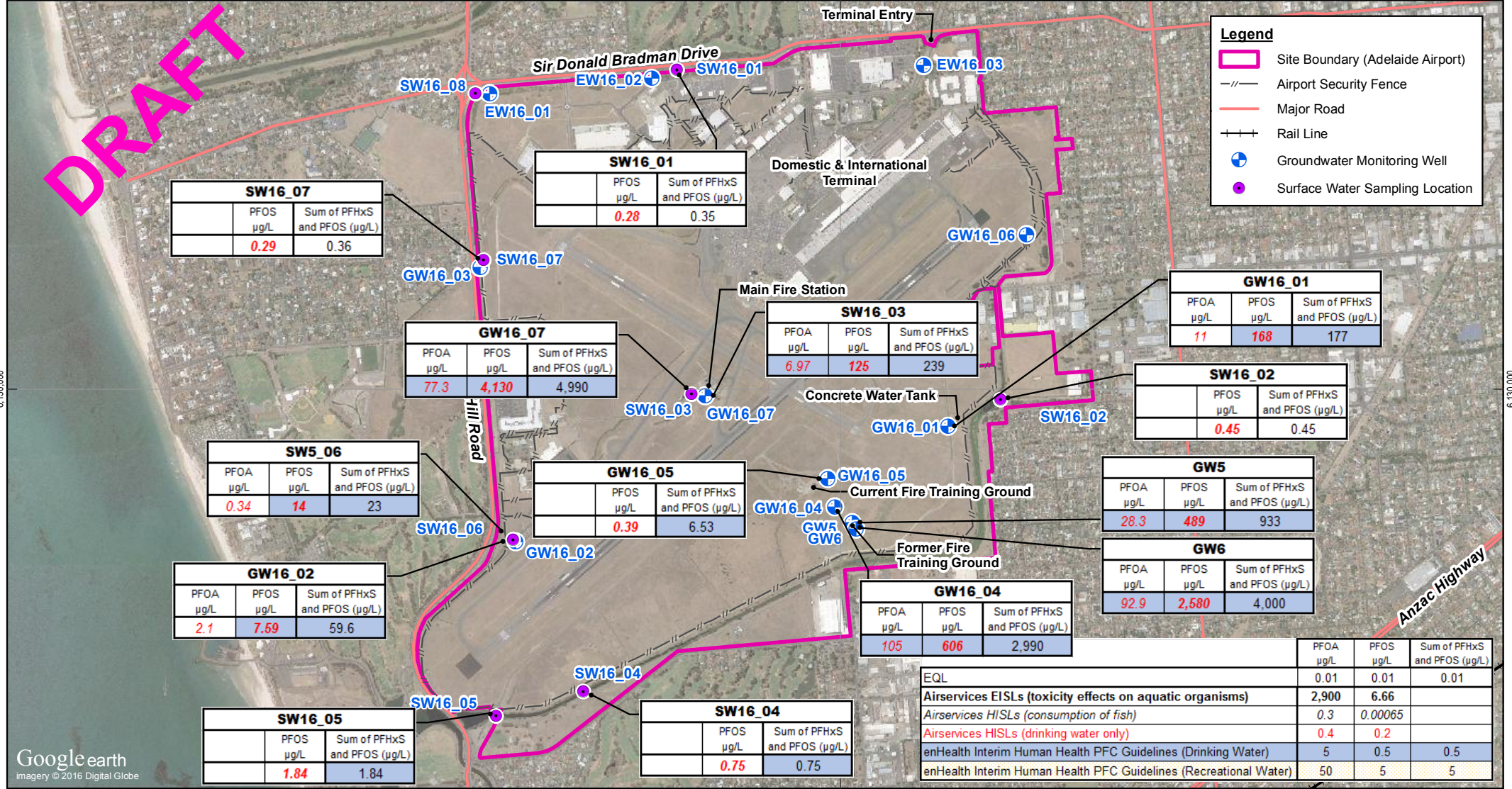
Figure 2

N:\AU\Melbourne\Projects\31\34071\GIS\Maps\Working\3134071\_AdelaideSAQP\_002\_MonitoringLocs\_refA.mxd

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Data source: Google Earth: aerial imagery (Mar 2016, extracted Jun 2016). Created : jvc



**NOTE**  
The laboratory results that were greater than adopted guidelines (refer tabulation) are the only ones shown.

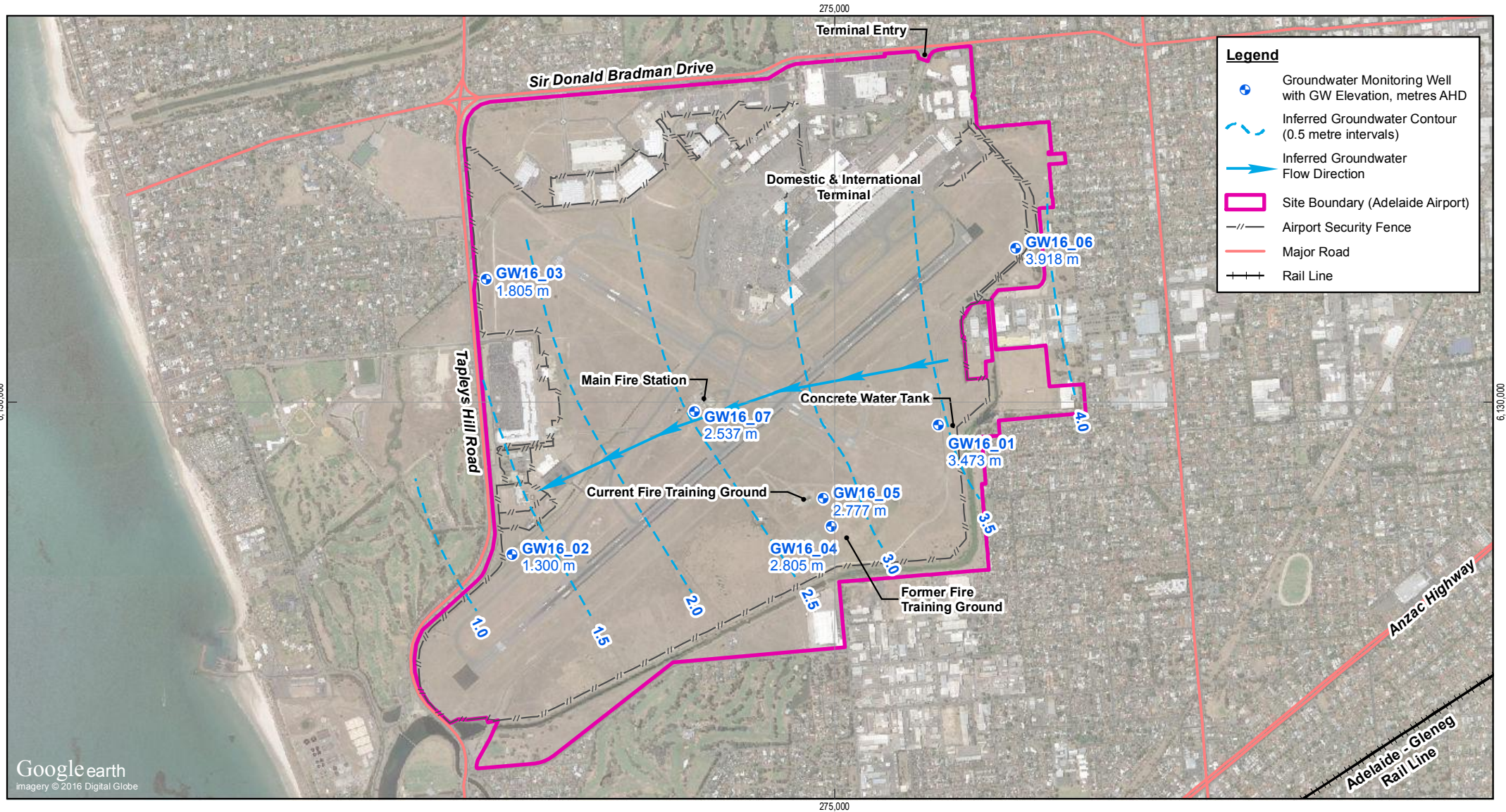


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Adelaide Airport  
Preliminary Sampling Report

Job Number | 31-34071  
Revision | A  
Date | 25 Aug 2016

**Surface Water and Groundwater Monitoring Results**

Figure 3



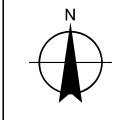
**Legend**

- Groundwater Monitoring Well with GW Elevation, metres AHD
- Inferred Groundwater Contour (0.5 metre intervals)
- Inferred Groundwater Flow Direction
- Site Boundary (Adelaide Airport)
- Airport Security Fence
- Major Road
- Rail Line

1:25,000 (at A4)

0 200 400 600 800 metres

Map Projection: Universal Transverse Mercator  
Horizontal Datum: GDA 1994  
Grid: GDA 1994 MGA Zone 54



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Adelaide Airport  
Preliminary Sampling Report

Job Number	31-34071
Revision	A
Date	30 Aug 2016

### Inferred Groundwater Contouring August 2016

Figure 4

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 Data source: Google Earth: aerial imagery (Mar 2016, extracted Jun 2016). Created : jvc  
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Appendix E  
Table 1  
Soil Analytical Results Ecological ISLs

	Cations				Per- and Polyfluoroalkyl Subst	TOC	Particle Size Analysis by Hydr				Inorganics				Metals			PFCs						
	Exchangeable Calcium	Exchangeable Magnesium	Exchangeable Potassium	Exchangeable Sodium			Sum of PFHxS and PFOS	Total Organic Carbon	Clay (<2 µm)	CEC	DENSITY	Moisture	pH (CaCl2)	Aluminium	Iron	Silicon	10:2 Fluorotelomer sulfonic acid (10:2 FTS)	1H,1H,2H,2H-perfluorohexanesulfonic acid (4:2 FTS)	N-Ethyl perfluorooctane sulfonamidoacetic acid (Et)	N-Methyl perfluorooctane sulfonamidoacetic acid (M)	Perfluorobutane Sulfonate	Perfluoroheptane sulfonic acid (PFHpS)		
	meq/100g	meq/100g	meq/100g	meq/100g	µg/L	%	%	meq/100g	g/cm3	%	pH Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg			
EQL	0.1	0.1	0.1	0.1	0.2	0.02	1	0.1	0.01	1	0.1	50	50	1	0.0005	0.0005	0.0002	0.0002	0.0002	0.0002	0.0002			
Airservices EISLs (terrestrial) – 95% protection																								
Airservices EISLs (terrestrial) – com./ind., 60% protection, low reliability																								
Airservices EISLs (terrestrial) – residential, 80% protection, low reliability																								
Location_Code	Sample_Depth	Sampled_Date																						
GW16_01	0.2	28/07/2016	20.9	7	0.4	0.7	864	0.61	-	-	-	29	-	15.6	8.1	12,900	24,200	2620	<0.0005	<0.0005	<0.0002	<0.0002	0.0032	0.0259
	1	28/07/2016	18.4	12.7	0.7	2.6	726	0.46	-	-	-	34.5	-	20.7	8.3	25,300	26,500	30	<0.0005	<0.0005	<0.0002	<0.0002	0.0493	0.0193
	2	28/07/2016	-	-	-	-	-	-	40	-	-	2.7	-	-	-	-	-	-	-	-	-	-	-	
GW16_02	0.5	29/07/2016	22.2	4.1	0.6	0.6	29.6	0.31	-	-	-	27.5	-	17.5	8.3	5610	7760	20	<0.0005	<0.0005	<0.0002	<0.0002	0.0023	0.001
	1.5	29/07/2016	-	-	-	-	-	-	27	-	-	2.68	-	-	-	-	-	-	-	-	-	-	-	
	2	29/07/2016	22	7.5	1.3	1.4	3.5	0.29	-	-	-	32.3	-	27.3	7.8	12,100	24,100	10	<0.0005	<0.0005	<0.0002	<0.0002	0.0014	<0.0002
GW16_03	0.2	29/07/2016	18.3	5.1	0.6	0.5	0.8	1.28	-	-	-	24.6	-	16.8	7.6	6120	11,000	211	<0.0005	<0.0005	<0.0002	<0.0002	<0.0002	<0.0002
	1	29/07/2016	10.9	5	0.7	1.9	<0.2	0.47	-	-	-	18.6	-	26.2	8	21,600	25,700	52	<0.0005	<0.0005	<0.0002	<0.0002	<0.0002	<0.0002
	1.5	29/07/2016	-	-	-	-	-	-	16	-	-	2.66	-	-	-	-	-	-	-	-	-	-	-	
GW16_04	0.2	28/07/2016	20.7	3.7	0.6	1.4	320	0.57	-	-	-	26.4	-	15.6	7.7	11,000	20,600	9320	<0.0005	<0.0005	<0.0002	<0.0002	0.0002	0.0008
	0.75	28/07/2016	9.5	3.3	1	2.5	813	0.16	24	-	-	16.3	2.56	26	8.4	22,100	27,500	20	<0.0005	<0.0005	<0.0002	<0.0002	0.122	0.0221
GW16_05	0.5	28/07/2016	21.6	4.4	0.4	2.6	2	0.73	-	-	-	29.1	-	22.6	8.5	18,800	22,200	4760	<0.0005	<0.0005	<0.0002	<0.0002	<0.0002	<0.0002
	1.5	28/07/2016	21.6	4.8	1	1.8	1.2	0.12	-	-	-	29.2	-	20.4	8.2	19,500	25,600	430	<0.0005	<0.0005	<0.0002	<0.0002	<0.0002	<0.0002
	3	28/07/2016	-	-	-	-	-	-	47	-	-	2.73	-	-	-	-	-	-	-	-	-	-	-	
GW16_06	0.5	28/07/2016	4.3	3.1	0.3	0.7	<0.2	0.36	-	-	-	8.5	-	15.5	7.1	11,300	16,500	13,100	<0.0005	<0.0005	<0.0002	<0.0002	<0.0002	<0.0002
	2	28/07/2016	3.3	3.8	0.3	0.7	<0.2	0.08	33	-	-	8.3	2.69	15.7	7.7	17,200	22,600	13	<0.0005	<0.0005	<0.0002	<0.0002	<0.0002	<0.0002
GW16_07	0.2	29/07/2016	7.6	2.4	0.5	1.7	31,800	0.7	-	-	-	12.3	-	20.3	8.1	13,700	24,100	7640	<0.0005	<0.0005	<0.0002	<0.0002	0.0187	0.153
	0.5	29/07/2016	-	-	-	-	-	-	12	-	-	2.65	-	-	-	-	-	-	-	-	-	-	-	
	1	29/07/2016	1.6	0.8	0.2	0.7	3020	0.05	-	-	-	3.4	-	16.9	7.8	2040	2390	41	<0.0005	<0.0005	<0.0002	<0.0002	0.0159	0.0177
<b>Duplicate Samples</b>																								
GW16_05	0.5	28/07/2016	21.6	4.4	0.4	2.6	2	0.73	-	-	-	29.1	-	22.6	8.5	18,800	22,200	4760	<0.0005	<0.0005	<0.0002	<0.0002	<0.0002	<0.0002
QC01 (BFD)	0.5	28/07/2016	-	-	-	-	2.3	0.67	-	-	-	-	-	23.5	8.4	19,000	22,400	6000	<0.0005	<0.0005	<0.0002	<0.0002	0.0003	<0.0002
RPD (%)			-	-	-	-	14.0	8.57	-	-	-	-	-	3.9	1.2	1	1	23.0	NC	NC	NC	NC	40	NC
GW16_02	0.5	29/07/2016	22.2	4.1	0.6	0.6	29.6	0.31	-	-	-	27.5	-	17.5	8.3	5610	7760	20	<0.0005	<0.0005	<0.0002	<0.0002	0.0023	0.001
QC03 (ILD)	0.5	29/07/2016	-	-	-	-	-	0.5	-	-	-	-	-	18	-	6800	8200	-	-	<0.0005	-	-	<0.0005	-
RPD (%)			-	-	-	-	-	46.9	-	-	-	-	-	2.8	-	19.2	5.5	-	-	NC	-	-	74.0	-

**BOLD** RPD exceeds nominal threshold of 50%  
**NC** RPD not calculated as both primary and duplicate samples were below EQL  
 Where one of either the primary or duplicate sample was recorded below the laboratory EQL, the EQL was adopted to calculate the RPD



Appendix E  
Table 1  
Soil Analytical Results Ecological ISLs

		PFCs Cont																							Major Ions	
		Perfluorohexane sulfonic acid (PFHxS)	Perfluoropentanoic acid (PFPeA)	8:2 Fluorotelomer sulfonate	N-Et-FOSA	N-Et-FOSE	N-Me-FOSA	N-Me-FOSE	6:2 Fluorotelomer Sulfonate (6:2 FTS)	PFOA	PFPeA	PFBA	PFDoA	PFDoS	PFDoA	PFHpA	PFHxA	PFNA	PFOS	PFOSA	PFTeA	PFTrIA	PFUnA	Sum of PFAS	Potassium	
		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/kg	mg/kg	
EQL		0.0002	0.0002		0.0005	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.001	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0002	0.2	50	
Airservices EISLs (terrestrial) – 95% protection				3.73						3.73										0.373						
Airservices EISLs (terrestrial) – com./ind., 60% protection, low reliability				3.73						3.73										4.71						
Airservices EISLs (terrestrial) – residential, 80% protection, low reliability				3.73						3.73										0.91						
Location_Code	Sample_Depth	Sampled_Date																								
GW16_01	0.2	28/07/2016	0.124	0.0008	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0128	0.0056	<0.001	<0.0002	<0.0002	<0.0002	0.0008	0.0057	<0.0002	0.74	<0.0002	<0.0005	<0.0002	<0.0002	919	2490	
	1	28/07/2016	0.534	0.0136	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0368	0.0436	<0.001	<0.0002	<0.0002	<0.0002	0.014	0.123	<0.0002	0.192	<0.0002	<0.0005	<0.0002	<0.0002	1020	5180	
	2	28/07/2016	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
GW16_02	0.5	29/07/2016	0.0173	0.0002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0016	0.0012	<0.001	<0.0002	<0.0002	<0.0002	0.0005	0.0023	<0.0002	0.0123	<0.0002	<0.0005	<0.0002	<0.0002	38.7	2300	
	1.5	29/07/2016	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	2	29/07/2016	0.0029	0.0002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0002	0.0008	<0.001	<0.0002	<0.0002	<0.0002	<0.0002	0.0016	<0.0002	0.0006	<0.0002	<0.0005	<0.0002	<0.0002	7.5	4270	
GW16_03	0.2	29/07/2016	<0.0002	<0.0002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0002	<0.0002	<0.001	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0008	<0.0002	<0.0005	<0.0002	<0.0002	0.8	1430	
	1	29/07/2016	<0.0002	<0.0002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0002	<0.0002	<0.001	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0005	<0.0002	<0.0002	<0.2	7650	
	1.5	29/07/2016	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
GW16_04	0.2	28/07/2016	0.008	0.0003	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0018	0.0003	<0.001	<0.0002	0.0031	<0.0002	<0.0002	0.0006	<0.0002	0.312	0.0005	<0.0005	<0.0002	<0.0002	328	2440	
	0.75	28/07/2016	0.57	0.0461	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.044	0.0873	0.013	<0.0002	<0.0002	<0.0002	0.0244	0.275	<0.0002	0.243	<0.0002	<0.0005	<0.0002	<0.0002	1450	8830	
GW16_05	0.5	28/07/2016	0.0008	<0.0002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0002	<0.0002	<0.001	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0012	<0.0002	<0.0005	<0.0002	<0.0002	2	4360	
	1.5	28/07/2016	0.0006	<0.0002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0002	<0.0002	<0.001	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0006	<0.0002	<0.0005	<0.0002	<0.0002	1.2	7200	
	3	28/07/2016	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
GW16_06	0.5	28/07/2016	<0.0002	<0.0002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0002	<0.0002	<0.001	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0005	<0.0002	<0.0002	<0.2	2600	
	2	28/07/2016	<0.0002	<0.0002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0002	<0.0002	<0.001	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0005	<0.0002	<0.0002	<0.2	3710	
GW16_07	0.2	29/07/2016	0.393	0.0098	0.002	<0.0005	<0.0005	<0.0005	<0.0005	0.0011	0.0321	0.0161	0.003	0.0009	<0.0002	0.0065	0.0593	0.0017	31.4	0.0072	<0.0005	<0.0002	<0.0002	0.0002	32,100	5540
	0.5	29/07/2016	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	1	29/07/2016	0.16	0.0072	0.0016	<0.0005	<0.0005	<0.0005	<0.0005	0.0015	0.0253	0.0116	0.001	0.0004	0.0004	<0.0002	0.0087	0.0408	<0.0002	2.86	0.0012	<0.0005	<0.0002	<0.0002	3150	350
Duplicate Samples																										
GW16_05	0.5	28/07/2016	0.0008	<0.0002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0002	<0.0002	<0.001	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0012	<0.0002	<0.0005	<0.0002	<0.0002	2	4360	
QC01 (BFD)	0.5	28/07/2016	0.0019	<0.0002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0002	0.0003	<0.001	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0004	<0.0002	<0.0005	<0.0002	<0.0002	2.9	4340	
RPD (%)			81.5	NC	NC	NC	NC	NC	NC	NC	40	NC	NC	NC	NC	NC	NC	NC	100	NC	NC	NC	NC	36.7	0.5	
GW16_02	0.5	29/07/2016	0.0173	0.0002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0016	0.0012	<0.001	<0.0002	<0.0002	<0.0002	0.0005	0.0023	<0.0002	0.0123	<0.0002	<0.0005	<0.0002	<0.0002	38.7	2300	
QC03 (ILD)	0.5	29/07/2016	0.015	<0.005	<0.005	<0.01	<0.01	<0.01	-	<0.01	<0.005	-	-	<0.005	-	<0.005	<0.005	<0.005	0.013	0.01	<0.005	<0.005	<0.005	-	2000	
RPD (%)			14.2	184.6	NC	NC	NC	NC	-	103.0	-	-	-	-	NC	163.6	74.0	NC	5.5	192.2	NC	NC	NC	-	14.0	

**BOLD** RPD exceeds nominal threshold of 50%  
**NC** RPD not calculated as both primary and duplicate samples were below EQL  
 Where one of either the primary or duplicate sample was recorded below the laboratory EQL, the EQL was adopted to calculate the RPD



Appendix E  
Table 2  
Soil Analytical Results Human Health ISLs

	Cations				Per- and Polyfluoroalkyl Subst	TOC	Particle Size Analysis by Hydr			Inorganics				Metals			PFCs						
	Exchangeable Calcium	Exchangeable Magnesium	Exchangeable Potassium	Exchangeable Sodium			Sum of PFHxS and PFOS	Total Organic Carbon	Clay (<2 µm)	CEC	DENSITY	Moisture	pH (CaCl2)	Aluminium	Iron	Silicon	10:2 Fluorotelomer sulfonic acid (10:2 FTS)	1H,1H,2H,2H-perfluorohexanesulfonic acid (4:2 FTS)	N-Ethyl perfluorooctane sulfonamidoacetic acid (Et)	N-Methyl perfluorooctane sulfonamidoacetic acid (M)	Perfluorobutane Sulfonate	Perfluoroheptane sulfonic acid (PFHps)	
	meq/100g	meq/100g	meq/100g	meq/100g	µg/L	%	%	meq/100g	g/cm3	%	pH Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg		
EQL	0.1	0.1	0.1	0.1	0.2	0.02	1	0.1	0.01	1	0.1	50	50	1	0.0005	0.0005	0.0002	0.0002	0.0002	0.0002			
Airservices HISLs – industrial (direct contact only)																							
Airservices HISLs – residential (direct contact only)																							
Location_Code	Sample_Depth	Sampled_Date																					
GW16_01	0.2	28/07/2016	20.9	7	0.4	0.7	864	0.61	-	-	29	-	15.6	8.1	12,900	24,200	2620	<0.0005	<0.0005	<0.0002	<0.0002	0.0032	0.0259
	1	28/07/2016	18.4	12.7	0.7	2.6	726	0.46	-	-	34.5	-	20.7	8.3	25,300	26,500	30	<0.0005	<0.0005	<0.0002	<0.0002	0.0493	0.0193
	2	28/07/2016	-	-	-	-	-	-	-	40	-	2.7	-	-	-	-	-	-	-	-	-	-	-
GW16_02	0.5	29/07/2016	22.2	4.1	0.6	0.6	29.6	0.31	-	-	27.5	-	17.5	8.3	5610	7760	20	<0.0005	<0.0005	<0.0002	<0.0002	0.0023	0.001
	1.5	29/07/2016	-	-	-	-	-	-	27	-	2.68	-	-	-	-	-	-	-	-	-	-	-	
GW16_03	2	29/07/2016	22	7.5	1.3	1.4	3.5	0.29	-	-	32.3	-	27.3	7.8	12,100	24,100	10	<0.0005	<0.0005	<0.0002	<0.0002	0.0014	<0.0002
	0.2	29/07/2016	18.3	5.1	0.6	0.5	0.8	1.28	-	-	24.6	-	16.8	7.6	6120	11,000	211	<0.0005	<0.0005	<0.0002	<0.0002	<0.0002	<0.0002
	1	29/07/2016	10.9	5	0.7	1.9	<0.2	0.47	-	-	18.6	-	26.2	8	21,600	25,700	52	<0.0005	<0.0005	<0.0002	<0.0002	<0.0002	<0.0002
GW16_04	1.5	29/07/2016	-	-	-	-	-	-	16	-	2.66	-	-	-	-	-	-	-	-	-	-	-	
	0.2	28/07/2016	20.7	3.7	0.6	1.4	320	0.57	-	-	26.4	-	15.6	7.7	11,000	20,600	9320	<0.0005	<0.0005	<0.0002	<0.0002	0.0002	0.0008
GW16_05	0.75	28/07/2016	9.5	3.3	1	2.5	813	0.16	24	-	16.3	2.56	26	8.4	22,100	27,500	20	<0.0005	<0.0005	<0.0002	<0.0002	0.122	0.0221
	0.5	28/07/2016	21.6	4.4	0.4	2.6	2	0.73	-	-	29.1	-	22.6	8.5	18,800	22,200	4760	<0.0005	<0.0005	<0.0002	<0.0002	<0.0002	<0.0002
	1.5	28/07/2016	21.6	4.8	1	1.8	1.2	0.12	-	-	29.2	-	20.4	8.2	19,500	25,600	430	<0.0005	<0.0005	<0.0002	<0.0002	<0.0002	<0.0002
GW16_06	3	28/07/2016	-	-	-	-	-	-	47	-	2.73	-	-	-	-	-	-	-	-	-	-	-	
	0.5	28/07/2016	4.3	3.1	0.3	0.7	<0.2	0.36	-	-	8.5	-	15.5	7.1	11,300	16,500	13,100	<0.0005	<0.0005	<0.0002	<0.0002	<0.0002	<0.0002
GW16_07	2	28/07/2016	3.3	3.8	0.3	0.7	<0.2	0.08	33	-	8.3	2.69	15.7	7.7	17,200	22,600	13	<0.0005	<0.0005	<0.0002	<0.0002	<0.0002	<0.0002
	0.2	29/07/2016	7.6	2.4	0.5	1.7	31,800	0.7	-	-	12.3	-	20.3	8.1	13,700	24,100	7640	<0.0005	<0.0005	<0.0002	<0.0002	0.0187	0.153
	0.5	29/07/2016	-	-	-	-	-	-	12	-	2.65	-	-	-	-	-	-	-	-	-	-	-	
1	29/07/2016	1.6	0.8	0.2	0.7	3020	0.05	-	-	3.4	-	16.9	7.8	2040	2390	41	<0.0005	<0.0005	<0.0002	<0.0002	0.0159	0.0177	
Duplicate Samples																							
GW16_05	0.5	28/07/2016	21.6	4.4	0.4	2.6	2	0.73	-	-	29.1	-	22.6	8.5	18,800	22,200	4760	<0.0005	<0.0005	<0.0002	<0.0002	<0.0002	<0.0002
QC01 (BFD)	0.5	28/07/2016	-	-	-	-	2.3	0.67	-	-	-	-	23.5	8.4	19,000	22,400	6000	<0.0005	<0.0005	<0.0002	<0.0002	0.0003	<0.0002
RPD (%)			-	-	-	-	14.0	8.571	-	-	-	-	3.9	1.2	1	1	23.0	NC	NC	NC	NC	40	NC
GW16_02	0.5	29/07/2016	22.2	4.1	0.6	0.6	29.6	0.31	-	-	27.5	-	17.5	8.3	5610	7760	20	<0.0005	<0.0005	<0.0002	<0.0002	0.0023	0.001
QC03 (ILD)	0.5	29/07/2016	-	-	-	-	-	0.5	-	-	-	-	18	-	6800	8200	-	<0.005	-	-	-	<0.005	-
RPD (%)			-	-	-	-	-	46.91	-	-	-	-	2.8	-	19.2	5.5	-	-	NC	-	-	74.0	-

**BOLD** RPD exceeds nominal threshold of 50%  
**NC** RPD not calculated as both primary and duplicate samples below EQL  
 Where one of either the primary or duplicate sample was recorded below the laboratory EQL,  
 the EQL was adopted to calculate the RPD



Appendix E  
Table 2  
Soil Analytical Results Human Health ISLs

	PFCs cont																				Major Ions			
	Perfluorohexane sulfonic acid (PFHxS)	Perfluoropentanoic acid (PFPeA)	8:2 Fluorotelomer sulfonate	N-Et-FOSA	N-Et-FOSE	N-Me-FOSA	N-Me-FOSE	6:2 Fluorotelomer Sulfonate (6:2 FTS)	PFOA	PFPeA	PFBA	PFDA	PFDS	PFDA	PFHpA	PFHxA	PFNA	PFOS	PFOSA	PFTEA	PFTrIA	PFUnA	Sum of PFAS	Potassium
	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/kg	mg/kg
EQL	0.0002	0.0002	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0002	0.0002	0.001	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0005	0.0002	0.0002	0.2	50
Airservices HISLs – industrial (direct contact only)			240					900	240									90						
Airservices HISLs – residential (direct contact only)			16					60	16									6						

Location_Code	Sample_Depth	Sampled_Date	Perfluorohexane sulfonic acid (PFHxS)	Perfluoropentanoic acid (PFPeA)	8:2 Fluorotelomer sulfonate	N-Et-FOSA	N-Et-FOSE	N-Me-FOSA	N-Me-FOSE	6:2 Fluorotelomer Sulfonate (6:2 FTS)	PFOA	PFPeA	PFBA	PFDA	PFDS	PFDA	PFHpA	PFHxA	PFNA	PFOS	PFOSA	PFTEA	PFTrIA	PFUnA	Sum of PFAS	Potassium
GW16_01	0.2	28/07/2016	0.124	0.0008	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0128	0.0056	<0.001	<0.0002	<0.0002	<0.0002	0.0008	0.0057	<0.0002	0.74	<0.0002	<0.0005	<0.0002	<0.0002	919	2490
	1	28/07/2016	0.534	0.0136	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0368	0.0436	<0.001	<0.0002	<0.0002	<0.0002	0.014	0.123	<0.0002	0.192	<0.0002	<0.0005	<0.0002	<0.0002	1020	5180
	2	28/07/2016	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GW16_02	0.5	29/07/2016	0.0173	0.0002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0016	0.0012	<0.001	<0.0002	<0.0002	<0.0002	0.0005	0.0023	<0.0002	0.0123	<0.0002	<0.0005	<0.0002	<0.0002	38.7	2300
	1.5	29/07/2016	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2	29/07/2016	0.0029	0.0002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0002	0.0008	<0.001	<0.0002	<0.0002	<0.0002	<0.0002	0.0016	<0.0002	0.0006	<0.0002	<0.0005	<0.0002	<0.0002	7.5	4270
GW16_03	0.2	29/07/2016	<0.0002	<0.0002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0002	<0.0002	<0.001	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0008	<0.0002	<0.0005	<0.0002	<0.0002	0.8	1430
	1	29/07/2016	<0.0002	<0.0002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0002	<0.0002	<0.001	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0005	<0.0002	<0.0002	<0.2	7650
	1.5	29/07/2016	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GW16_04	0.2	28/07/2016	0.008	0.0003	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0018	0.0003	<0.001	<0.0002	0.0031	<0.0002	<0.0002	0.0006	<0.0002	0.312	0.0005	<0.0005	<0.0002	<0.0002	328	2440
	0.75	28/07/2016	0.57	0.0461	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.044	0.0873	0.013	<0.0002	<0.0002	<0.0002	0.0244	0.275	<0.0002	0.243	<0.0002	<0.0005	<0.0002	<0.0002	1450	8830
GW16_05	0.5	28/07/2016	0.0008	<0.0002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0002	<0.0002	<0.001	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0012	<0.0002	<0.0005	<0.0002	<0.0002	2	4360
	1.5	28/07/2016	0.0006	<0.0002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0002	<0.0002	<0.001	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0006	<0.0002	<0.0005	<0.0002	<0.0002	1.2	7200
	3	28/07/2016	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GW16_06	0.5	28/07/2016	<0.0002	<0.0002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0002	<0.0002	<0.001	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0005	<0.0002	<0.0002	<0.2	2600
	2	28/07/2016	<0.0002	<0.0002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0002	<0.0002	<0.001	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0005	<0.0002	<0.0002	<0.2	3710
GW16_07	0.2	29/07/2016	0.393	0.0098	0.002	<0.0005	<0.0005	<0.0005	<0.0005	0.0011	0.0321	0.0161	0.003	0.003	0.0009	<0.0002	0.0065	0.0593	0.0017	31.4	0.0072	<0.0005	<0.0002	0.0002	32,100	5540
	0.5	29/07/2016	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1	29/07/2016	0.16	0.0072	0.0016	<0.0005	<0.0005	<0.0005	<0.0005	0.0015	0.0253	0.0116	0.001	0.0004	0.0004	<0.0002	0.0087	0.0408	<0.0002	2.86	0.0012	<0.0005	<0.0002	<0.0002	3150	350

Duplicate Samples			Perfluorohexane sulfonic acid (PFHxS)	Perfluoropentanoic acid (PFPeA)	8:2 Fluorotelomer sulfonate	N-Et-FOSA	N-Et-FOSE	N-Me-FOSA	N-Me-FOSE	6:2 Fluorotelomer Sulfonate (6:2 FTS)	PFOA	PFPeA	PFBA	PFDA	PFDS	PFDA	PFHpA	PFHxA	PFNA	PFOS	PFOSA	PFTEA	PFTrIA	PFUnA	Sum of PFAS	Potassium
GW16_05	0.5	28/07/2016	0.0008	<0.0002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0002	<0.0002	<0.001	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0012	<0.0002	<0.0005	<0.0002	<0.0002	2	4360
QC01 (BFD)	0.5	28/07/2016	0.0019	<0.0002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0002	0.0003	<0.001	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0004	<0.0002	<0.0005	<0.0002	<0.0002	2.9	4340
RPD (%)			81.5	NC	NC	NC	NC	NC	NC	NC	NC	40	NC	NC	NC	NC	NC	NC	NC	100	NC	NC	NC	NC	36.7	0.5
GW16_02	0.5	29/07/2016	0.0173	0.0002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0016	0.0012	<0.001	<0.0002	<0.0002	<0.0002	0.0005	0.0023	<0.0002	0.0123	<0.0002	<0.0005	<0.0002	<0.0002	38.7	2300
QC03 (ILD)	0.5	29/07/2016	0.015	<0.0005	<0.0005	<0.01	<0.01	<0.01	<0.01	<0.01	<0.005	-	-	<0.005	-	<0.005	<0.005	<0.005	<0.005	0.013	0.01	<0.005	<0.005	<0.005	-	2000
RPD (%)			14.2	184.6	NC	NC	NC	NC	-	NC	103.0	-	-	NC	-	NC	163.6	74.0	NC	5.5	192.2	NC	NC	NC	-	14.0

**BOLD** RPD exceeds nominal threshold of 50%  
**NC** RPD not calculated as both primary and duplicate samples below EQL  
 Where one of either the primary or duplicate sample was recorded below the laboratory EQL, the EQL was adopted to calculate the RPD



Appendix E  
Table 3  
Water Analytical Results

	Field								Alkalinity by PC Titrator				Chloride by Discrete Analyser		Ionic Balance by PCT DA and Turbi SO4 DA			Major Cations - Dissolved			
	Standing Water Level	Electrical Conductivity (field)	Redox Potential (field)	Temperature (field)	Dissolved Oxygen (field)	pH (field)	Purge Volume	Alkalinity (Carbonate as CaCO3)	Alkalinity (Hydroxide as CaCO3)	Alkalinity (total as CaCO3)	Bicarbonate Alkalinity as CaCO3	Chloride	Anions Total	Cations Total	Ionic Balance	Calcium (Filtered)	Magnesium (Filtered)	Potassium (Filtered)	Sodium (Filtered)		
	mbgl	µs/cm	mV	°C	%	pH units	L	mg/L	mg/L	mg/L	mg/L	mg/L	meq/L	meq/L	%	mg/L	mg/L	mg/L	mg/L		
EQL								1	1	1	1		0.01	0.01	0.01	1	1	1	1		
Airservices EISLs (toxicity effects on aquatic organisms)																					
Airservices HISLs (consumption of fish)																					
Airservices HISLs (drinking water only)																					
enHealth Interim Human Health PFC Guidelines (Drinking Water)																					
enHealth Interim Human Health PFC Guidelines (Recreational Water)																					

Site_ID	Field_ID	Location_Code	Sampled_Date																			
<b>Groundwater</b>																						
Adelaide Airport	EW16_01	EW16	4/08/2016	3.042	4827	-141.6	17.5	0.21	7.15	14.0	<1	<1	483	483	1240	53.2	52.7	0.48	114	182	37	714
Adelaide Airport	EW16_02	EW16	4/08/2016	1.282	16791	-216.6	17.9	0.15	7.00	14.0	<1	<1	1960	1960	5280	206	206	0.06	59	315	51	4050
Adelaide Airport	EW16_03	EW16	4/08/2016	2.068	2698	-221.1	18.6	0.40	7.03	4.0	<1	<1	642	642	615	33.3	32.8	0.85	55	81	13	529
Adelaide Airport	GW16_01	GW16	4/08/2016	1.778	1867	93.8	18.1	1.10	7.24	14.0	<1	<1	732	732	212	22.6	22.6	0.18	41	61	13	349
Adelaide Airport	GW16_02	GW16	3/08/2016	0.692	39210	-34.7	15.9	0.23	6.78	15.0	<1	<1	756	756	12,400	505	512	0.74	742	1050	213	8820
Adelaide Airport	GW16_03	GW16	4/08/2016	0.672	15731	14.4	15.7	3.39	7.53	19.0	<1	<1	526	526	5270	184	183	0.3	95	275	53	3540
Adelaide Airport	GW16_04	GW16	3/08/2016	0.180	4349	129.0	15.7	7.51	7.09	16.0	<1	<1	1440	1440	13,500	488	524	3.48	38	361	196	11,200
Adelaide Airport	GW16_05	GW16	3/08/2016	0.265	32668	59.5	14.2	2.08	7.64	15.0	<1	<1	1350	1350	10,100	384	403	2.31	71	262	115	8620
Adelaide Airport	GW16_06	GW16	4/08/2016	1.762	14134	128.1	17.9	3.70	6.98	16.0	<1	<1	507	507	5080	164	157	2.4	343	370	17	2500
Adelaide Airport	GW16_07	GW16	3/08/2016	0.155	13729	-65.9	14.8	0.30	7.27	19.0	<1	<1	719	719	5290	208	222	3.14	117	310	64	4350
Adelaide Airport	GW5	GW5	3/08/2016	1.378	1926	-135.1	16.1	3.67	7.50	21.0	<1	<1	951	951	650	43.2	41.2	2.48	17	45	20	830
Adelaide Airport	GW6	GW6	3/08/2016	1.170	550		15.8	7.12	7.62	18.0	<1	<1	1270	1270	1330	75.6	80.8	3.32	15	62	41	1700
<b>Surface Water</b>																						
Adelaide Airport	SW16_01	SW16	4/08/2016	-	-	-	-	-	-	-	163	<1	543	380	2510	91.2	88.3	1.62	51	163	23	1650
Adelaide Airport	SW16_02	SW16	3/08/2016	-	-	-	-	-	-	-	<1	<1	103	103	78	5.07	4.34	7.79	19	17	3	44
Adelaide Airport	SW16_03	SW16	3/08/2016	-	-	-	-	-	-	-	<1	<1	421	421	1310	53.8	54.1	0.28	66	64	11	1040
Adelaide Airport	SW16_04	SW16	3/08/2016	-	-	-	-	-	-	-	<1	<1	108	108	143	7.21	6.36	6.28	20	19	4	85
Adelaide Airport	SW16_05	SW16	3/08/2016	-	-	-	-	-	-	-	<1	<1	112	112	159	7.8	6.69	7.71	19	18	5	95
Adelaide Airport	SW16_06	SW16	3/08/2016	-	-	-	-	-	-	-	<1	<1	297	297	824	36.3	35.8	0.72	56	85	10	592
Adelaide Airport	SW16_07	SW16	4/08/2016	-	-	-	-	-	-	-	<1	<1	190	190	540	21.7	20.8	2.05	23	42	6	370
Adelaide Airport	SW16_08	SW16	4/08/2016	-	-	-	-	-	-	-	<1	<1	194	194	481	19.6	18.7	2.45	34	38	6	315
<b>Duplicate Samples</b>																						
Adelaide Airport	GW16_04	GW16	3/08/2016	-	-	-	-	-	-	-	<1	<1	1440	1440	13,500	488	524	3.48	38	361	196	11,200
Adelaide Airport	QC01(BFD)	GW16_04	3/08/2016	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RPD(%)				-	-	-	-	-	-	-	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Adelaide Airport	QC02(ILD)	GW16_04	3/08/2016	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RPD(%)				-	-	-	-	-	-	-	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Adelaide Airport	SW16_07	SW16	4/08/2016	-	-	-	-	-	-	-	<1	<1	190	190	540	21.7	20.8	2.05	23	42	6	370
Adelaide Airport	QC03(BFD)	SW16_07	4/08/2016	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RPD(%)				-	-	-	-	-	-	-	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Adelaide Airport	QC04(ILD)	SW16_07	4/08/2016	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RPD(%)				-	-	-	-	-	-	-	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
<b>Rinsate Samples</b>																						
Adelaide Airport	RIN01		3/08/2016	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

**BOLD** RPD exceeds nominal threshold of 50%  
**NC** RPD not calculated as both primary and duplicate samples below EQL  
 Where one of either the primary or duplicate sample was recorded below the laboratory EQL, the EQL was adopted to calculate the RPD



Appendix E  
Table 3  
Water Analytical Results

		Per- and Polyfluoroalkyl Substances (PFAS) by LCMS																			
	10:2 Fluorotelomer sulfonic acid (10:2 FTS)	1H,1H,2H,2H-perfluorohexanesulfonic acid (6:2 FTS)	N-Ethyl perfluorooctane sulfonamidoacetic acid (Et)	N-Methyl perfluorooctane sulfonamidoacetic acid (M)	Perfluorobutane Sulfonate	Perfluoroheptane sulfonic acid (PFHxS)	Perfluorohexane sulfonic acid (PFHxS)	Perfluoropentanoic acid (PFPeA)	8:2 Fluorotelomer sulfonate	N-E-FOSA	N-Et-FOSE	N-Me-FOSA	N-Me-FOSE	6:2 Fluorotelomer Sulfonate (6:2 FTS)	PFOA	PFPeA	PFBA	PFDA	PFDS	PFDoA	
EQL	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	mg/L	µg/L	mg/L	mg/L	mg/L	
Airservices EISLs (toxicity effects on aquatic organisms)	0.05	0.05	0.02	0.02	0.02	0.02	0.02	0.02	0.05	0.00005	0.00005	0.00005	0.00005	0.05	0.01	0.00002	0.1	0.00002	0.00002	0.00002	
Airservices HISLs (consumption of fish)									2900					0.0065	2900						
Airservices HISLs (drinking water only)									0.3					5	0.4						
enHealth Interim Human Health PFC Guidelines (Drinking Water)							0.5		0.4					5	0.4						
enHealth Interim Human Health PFC Guidelines (Recreational Water)							5							50							
Site_ID	Field_ID	Location_Code	Sampled_Date																		
<b>Groundwater</b>																					
Adelaide Airport	EW16_01	EW16	4/08/2016	<0.05	<0.05	<0.02	<0.02	<0.02	<0.02	<0.05	<0.00005	<0.00005	<0.00005	<0.00005	<0.05	<0.01	<0.00002	<0.1	<0.00002	<0.00002	<0.00002
Adelaide Airport	EW16_02	EW16	4/08/2016	<0.05	<0.05	<0.02	<0.02	<0.02	<0.02	<0.05	<0.00005	<0.00005	<0.00005	<0.00005	<0.05	<0.01	<0.00002	<0.1	<0.00002	<0.00002	<0.00002
Adelaide Airport	EW16_03	EW16	4/08/2016	<0.05	<0.05	<0.02	<0.02	0.05	0.12	<0.05	<0.00005	<0.00005	<0.00005	<0.00005	<0.05	<0.01	<0.00002	<0.1	<0.00002	<0.00002	<0.00002
Adelaide Airport	GW16_01	GW16	4/08/2016	<0.05	<0.05	<0.02	<0.02	42.3	10.2	209	6.7	<0.05	<0.00005	<0.00005	<0.05	11	0.023	<0.1	<0.00002	<0.00002	<0.00002
Adelaide Airport	GW16_02	GW16	3/08/2016	<0.05	<0.05	<0.05	<0.05	21.6	1.38	52	2.36	<0.05	<0.00012	<0.00012	<0.00012	<0.05	2.1	0.0115	<0.1	<0.00005	<0.00005
Adelaide Airport	GW16_03	GW16	4/08/2016	<0.05	<0.05	<0.02	<0.02	<0.02	<0.02	<0.05	<0.00005	<0.00005	<0.00005	<0.00005	<0.05	<0.01	<0.00002	<0.1	<0.00002	<0.00002	<0.00002
Adelaide Airport	GW16_04	GW16	3/08/2016	<0.1	<0.1	<0.1	<0.1	822	66.7	2380	293	<0.1	<0.00025	<0.00025	<0.00025	<0.1	105	0.374	38.9	<0.0001	<0.0001
Adelaide Airport	GW16_05	GW16	3/08/2016	<0.05	<0.05	<0.05	<0.05	3.3	<0.05	6.14	1.14	<0.05	<0.00012	<0.00012	<0.00012	<0.05	0.19	0.00162	<0.1	<0.00005	<0.00005
Adelaide Airport	GW16_06	GW16	4/08/2016	<0.05	<0.05	<0.02	<0.02	0.06	<0.02	0.24	<0.05	<0.00005	<0.00005	<0.00005	<0.05	<0.01	0.00003	<0.1	<0.00002	<0.00002	<0.00002
Adelaide Airport	GW16_07	GW16	3/08/2016	<0.1	<0.1	<0.1	<0.1	150	47.4	861	16	0.47	<0.00025	<0.00025	<0.00025	1.84	77.3	0.0865	<0.1	<0.0001	<0.0001
Adelaide Airport	GW5	GW5	3/08/2016	<0.05	<0.05	<0.02	<0.02	67.1	21.8	444	27.7	<0.05	<0.00005	<0.00005	<0.00005	<0.05	28.3	0.0382	0.9	<0.00002	<0.00002
Adelaide Airport	GW6	GW6	3/08/2016	<0.1	<0.1	0.16	<0.1	396	58.7	1420	142	<0.1	<0.00025	<0.00025	<0.00025	<0.1	92.9	0.194	24.8	<0.0001	<0.0001
<b>Surface Water</b>																					
Adelaide Airport	SW16_01	SW16	4/08/2016	<0.05	<0.05	<0.02	<0.02	<0.02	<0.02	0.07	<0.02	<0.05	<0.00005	<0.00005	<0.00005	<0.00005	<0.05	<0.01	<0.00002	<0.1	<0.00002
Adelaide Airport	SW16_02	SW16	3/08/2016	<0.05	<0.05	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.05	<0.00005	<0.00005	<0.00005	<0.00005	<0.05	<0.01	<0.00002	<0.1	<0.00002
Adelaide Airport	SW16_03	SW16	3/08/2016	<0.05	<0.05	<0.02	<0.02	22.2	6.59	114	16.3	0.44	<0.00005	<0.00005	<0.00005	<0.00005	0.2	6.97	0.0125	<0.1	0.00005
Adelaide Airport	SW16_04	SW16	3/08/2016	<0.05	<0.05	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.05	<0.00005	<0.00005	<0.00005	<0.00005	<0.05	<0.01	<0.00002	<0.1	<0.00002
Adelaide Airport	SW16_05	SW16	3/08/2016	<0.05	<0.05	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.05	<0.00005	<0.00005	<0.00005	<0.00005	<0.05	<0.01	<0.00002	<0.1	<0.00002
Adelaide Airport	SW16_06	SW16	3/08/2016	<0.05	<0.05	<0.02	<0.02	1.55	0.54	9.05	0.39	<0.05	<0.00005	<0.00005	<0.00005	<0.00005	<0.05	0.34	0.00087	<0.1	<0.00002
Adelaide Airport	SW16_07	SW16	4/08/2016	<0.05	<0.05	<0.02	<0.02	<0.02	<0.02	0.07	<0.02	<0.05	<0.00005	<0.00005	<0.00005	<0.00005	<0.05	<0.01	<0.00002	<0.1	<0.00002
Adelaide Airport	SW16_08	SW16	4/08/2016	<0.05	<0.05	<0.02	<0.02	<0.02	<0.02	0.07	<0.02	<0.05	<0.00005	<0.00005	<0.00005	<0.00005	<0.05	<0.01	<0.00002	<0.1	<0.00002
<b>Duplicate Samples</b>																					
Adelaide Airport	GW16_04	GW16	3/08/2016	<0.1	<0.1	<0.1	<0.1	822	66.7	2380	293	<0.1	<0.00025	<0.00025	<0.00025	<0.1	105	0.374	38.9	<0.0001	<0.0001
Adelaide Airport	QC01(BFD)	GW16_04	3/08/2016	<0.1	<0.1	<0.1	<0.1	816	66.8	2420	298	<0.1	<0.00025	<0.00025	<0.00025	<0.1	110	0.373	37.6	0.0001	<0.0001
RPD(%)	NC	NC	NC	NC	NC	NC	NC	0.7	0.1	1.7	1.7	NC	NC	NC	NC	NC	4.65	0.27	3.399	NC	NC
Adelaide Airport	QC02(ILD)	GW16_04	3/08/2016	-	-	-	-	3.1	0.63	11	1.2	<0.01	<0.00005	-	<0.05	0.55	1.20	0.63	-	-	<0.00001
RPD(%)	NC	NC	NC	NC	NC	NC	NC	198.497	196.257	198.16	198.368	NC	NC	NC	NC	NC	197.92	104.96	193.6	NC	NC
Adelaide Airport	SW16_07	SW16	4/08/2016	<0.05	<0.05	<0.02	<0.02	<0.02	<0.02	0.07	<0.02	<0.05	<0.00005	<0.00005	<0.00005	<0.00005	<0.05	<0.01	<0.00002	<0.1	<0.00002
Adelaide Airport	QC03(BFD)	SW16_07	4/08/2016	<0.05	<0.05	<0.02	<0.02	<0.02	<0.02	0.04	<0.02	<0.05	<0.00005	<0.00005	<0.00005	<0.00005	<0.05	<0.01	<0.00002	<0.1	<0.00002
RPD(%)	NC	NC	NC	NC	NC	NC	NC	54.55	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	
Adelaide Airport	QC04(ILD)	SW16_07	4/08/2016	-	-	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.00005	-	<0.05	<0.01	<0.00001	<0.005	-	-	<0.00001
RPD(%)	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
<b>Rinsate Samples</b>																					
Adelaide Airport	RIN01		3/08/2016	<0.05	<0.05	<0.02	<0.02	<0.02	<0.02	<0.05	<0.00005	<0.00005	<0.00005	<0.00005	<0.05	<0.01	<0.00002	<0.1	<0.00002	<0.00002	<0.00002

**BOLD** RPD exceeds nominal threshold of 50%  
**NC** RPD not calculated as both primary and duplicate samples below EQL  
 Where one of either the primary or duplicate sample was recorded below the laboratory EQL, the EQL was adopted to calculate the RPD



Appendix E  
Table 3  
Water Analytical Results

Per- and Polyfluoroalkyl Substances (PFAS) by LCMS cont													pH by PC Titrator	Sulfate (Turbidimetric) as SO4 2- by DA	Total Dissolved Solids (High Level)		
	PFHpA	PFHxA	PFNA	PFOS	PFOSA	PFTeA	PFTrA	PFUnA	Sum of PFAS	Sum of PFAS (Swedish Water Quality Guideline plus	Sum of PFAS and PFOS	pH (Lab)	pH Units	Sulfate as SO4 - Turbidimetric (Filtered)	Total Dissolved Solids		
	mg/L	mg/L	mg/L	µg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	µg/L			mg/L	mg/L		
EQL	0.00002	0.00002	0.00002	0.01	0.00002	0.00005	0.00002	0.00002	0.01	0.01	0.01		0.01	1	10		
Airservices EISLs (toxicity effects on aquatic organisms)				6.66													
Airservices HSLs (consumption of fish)				0.00065													
Airservices HSLs (drinking water only)				0.2													
enHealth Interim Human Health PFC Guidelines (Drinking Water)				0.5								0.5					
enHealth Interim Human Health PFC Guidelines (Recreational Water)				5								5					
Site_ID	Field_ID	Location_Code	Sampled_Date														
<b>Groundwater</b>																	
Adelaide Airport	EW16_01	EW16	4/08/2016	<0.00002	<0.00002	<0.00002	<0.01	<0.00002	<0.00005	<0.00002	<0.00002	<0.01	<0.01	<0.01	7.97	410	2840
Adelaide Airport	EW16_02	EW16	4/08/2016	<0.00002	<0.00002	<0.00002	<0.01	<0.00002	<0.00005	<0.00002	<0.00002	<0.01	<0.01	<0.01	7.89	858	10,100
Adelaide Airport	EW16_03	EW16	4/08/2016	<0.00002	<0.00002	<0.00002	0.18	<0.00002	<0.00005	<0.00002	<0.00002	0.35	0.35	0.3	7.83	150	1680
Adelaide Airport	GW16_01	GW16	4/08/2016	0.00436	0.0402	<0.00002	168	0.00009	<0.00005	<0.00002	<0.00002	515	482	377	7.98	98	1190
Adelaide Airport	GW16_02	GW16	3/08/2016	0.00078	0.0132	<0.00005	7.59	<0.00005	<0.00012	<0.00005	<0.00005	112	99.6	59.6	7.57	6720	28,800
Adelaide Airport	GW16_03	GW16	4/08/2016	<0.00002	<0.00002	<0.00002	0.02	<0.00002	<0.00005	<0.00002	<0.00002	0.02	0.02	0.02	8.11	1180	9120
Adelaide Airport	GW16_04	GW16	3/08/2016	0.0749	0.875	<0.0001	606	<0.0001	<0.00025	<0.0001	<0.0001	5640	5190	2990	7.9	3780	30,600
Adelaide Airport	GW16_05	GW16	3/08/2016	0.00034	0.00209	<0.00005	0.39	<0.00005	<0.00012	<0.00005	<0.00005	15.2	13.6	6.53	8.17	3490	23,100
Adelaide Airport	GW16_06	GW16	4/08/2016	<0.00002	<0.00002	<0.00002	0.02	<0.00002	<0.00005	<0.00002	<0.00002	0.35	0.32	0.26	7.76	529	8580
Adelaide Airport	GW16_07	GW16	3/08/2016	0.0071	0.216	<0.0001	4130	0.00024	<0.00025	<0.0001	<0.0001	5590	5460	4990	8	2160	10,100
Adelaide Airport	GW5	GW5	3/08/2016	0.00866	0.0849	0.00004	489	0.00006	<0.00005	<0.00002	<0.00002	1210	1150	933	8.17	283	2100
Adelaide Airport	GW6	GW6	3/08/2016	0.0256	0.458	<0.0001	2580	<0.0001	<0.00025	<0.0001	<0.0001	5390	5140	4000	8.14	610	3830
<b>Surface Water</b>																	
Adelaide Airport	SW16_01	SW16	4/08/2016	<0.00002	<0.00002	<0.00002	0.28	<0.00002	<0.00005	<0.00002	<0.00002	0.35	0.35	0.35	8.88	458	4580
Adelaide Airport	SW16_02	SW16	3/08/2016	<0.00002	<0.00002	<0.00002	0.45	<0.00002	<0.00005	<0.00002	<0.00002	0.45	0.45	0.45	8.14	39	322
Adelaide Airport	SW16_03	SW16	3/08/2016	0.00351	0.0319	0.00016	125	0.00013	<0.00005	<0.00002	<0.00002	340	321	239	8.22	403	3040
Adelaide Airport	SW16_04	SW16	3/08/2016	<0.00002	<0.00002	<0.00002	0.75	<0.00002	<0.00005	<0.00002	<0.00002	0.75	0.75	0.75	7.76	49	413
Adelaide Airport	SW16_05	SW16	3/08/2016	<0.00002	<0.00002	<0.00002	1.84	<0.00002	<0.00005	<0.00002	<0.00002	1.84	1.84	1.84	7.86	52	475
Adelaide Airport	SW16_06	SW16	3/08/2016	0.0002	0.00231	<0.00002	14	<0.00002	<0.00005	<0.00002	<0.00002	29.2	27.8	23	8.06	342	1920
Adelaide Airport	SW16_07	SW16	4/08/2016	<0.00002	<0.00002	<0.00002	0.29	<0.00002	<0.00005	<0.00002	<0.00002	0.36	0.36	0.36	8.18	129	1170
Adelaide Airport	SW16_08	SW16	4/08/2016	<0.00002	<0.00002	<0.00002	0.05	<0.00002	<0.00005	<0.00002	<0.00002	0.05	0.05	0.05	8.07	104	1070
<b>Duplicate Samples</b>																	
Adelaide Airport	GW16_04	GW16	3/08/2016	0.0749	0.875	<0.0001	606	<0.0001	<0.00025	<0.0001	<0.0001	5640	5190	2990	7.9	3780	30,600
Adelaide Airport	QC01(BFD)	GW16_04	3/08/2016	0.0784	0.892	<0.0001	607	<0.0001	<0.00025	<0.0001	<0.0001	5700	5260	3030	8.04	-	29,700
RPD(%)	4.57	1.92	NC	0.16	NC	NC	NC	NC	NC	1.06	1.34	1.33	1.76	NC	NC	2.99	
Adelaide Airport	QC02(ILD)	GW16_04	3/08/2016	0.0005	0.01	<0.00001	5.00	<0.00005	-	-	-	-	-	-	7.80	-	30,000
RPD(%)	197.35	196.38	NC	196.73	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	1.27	NC	1.98
Adelaide Airport	SW16_07	SW16	4/08/2016	<0.00002	<0.00002	<0.00002	0.29	<0.00002	<0.00005	<0.00002	<0.00002	0.36	0.36	0.36	8.18	129	1170
Adelaide Airport	QC03(BFD)	SW16_07	4/08/2016	<0.00002	<0.00002	<0.00002	0.25	<0.00002	<0.00005	<0.00002	<0.00002	0.29	0.29	0.29	8.12	-	1100
RPD(%)	NC	NC	NC	14.81	NC	NC	NC	NC	NC	21.54	21.54	21.54	21.54	NC	NC	6.17	
Adelaide Airport	QC04(ILD)	SW16_07	4/08/2016	<0.00001	<0.00001	<0.00001	<0.01	<0.00001	-	-	-	-	-	-	8.1	-	1,100
RPD(%)	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	0.98	NC	6.17
<b>Rinsate Samples</b>																	
Adelaide Airport	RIN01		3/08/2016	<0.00002	<0.00002	<0.00002	0.02	<0.00002	<0.00005	<0.00002	<0.00002	0.02	0.02	0.02	-	-	-

**BOLD** RPD exceeds nominal threshold of 50%  
**NC** RPD not calculated as both primary and duplicate samples below EQL  
 Where one of either the primary or duplicate sample was recorded below the laboratory EQL, the EQL was adopted to calculate the RPD



Googleearth  
Imagery © 2017 Digital Globe

1:25,000 (at A4)  
0 200 400 600 800  
metres  
Map Projection: Universal Transverse Mercator  
Horizontal Datum: GDA 1994  
Grid: GDA 1994 MGA Zone 54



Airservices Australia Pty Ltd  
Adelaide Airport  
Groundwater and Surface Water Monitoring

Job Number	31-35615-01
Revision	A
Date	07 Dec 2017

### Sampling Locations

Figure 1

G:\31\3561501\GIS\Maps\Working\313561501\_Adelaide\_Airport\_002\_SamplingLocations\_RevA\_MM.mxd

145 Ann Street Brisbane QLD 4000 T 61 7 3316 3000 F 61 7 3316 3333 E bnemail@ghd.com W www.ghd.com

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Data source: Google Earth: aerial imagery (Mar 2016, extracted Jun 2016). Created : jvc



Appendix D  
Table 1  
Groundwater PFAS results

	PFAS																															
	N-Ethyl perfluorooctane sulfonamidoacetic acid	Perfluoroheptane sulfonic acid	Perfluorodecane sulfonic acid (PFDS)	10:2 Fluorotelomer sulfonic acid	4:2 Fluorotelomer sulfonic acid	Perfluorobutane sulfonic acid	N-Methyl perfluorooctane sulfonamidoacetic acid	Perfluorohexane sulfonic acid (PFHxS)	Perfluoropentanoic acid	PFHxS and PFOS (Sum of Total) - Lab Calc	8:2 Fluorotelomer sulfonic acid	N-Ethyl perfluorooctane sulfonamide	N-Ethyl perfluorooctane sulfonamidoethanol	N-Methyl perfluorooctane sulfonamide	N-Methyl perfluorooctane sulfonamidoethanol	6:2 Fluorotelomer Sulfonate (6:2 FTS)	Perfluorooctanoic acid (PFOA)	Perfluoropentane sulfonic acid	Perfluorobutanoic acid	Perfluorodecanoic acid	Perfluorododecanoic acid	Perfluoroheptanoic acid	Perfluorohexanoic acid (PFHxA)	Perfluorononanoic acid	Perfluorooctane sulfonic acid (PFOS)	Perfluorooctane sulfonamide (FOSA)	Perfluorotetradecanoic acid	Perfluorotridecanoic acid	Perfluoroundecanoic acid	PFAS (Sum of Total)	PFAS (Sum of Total)(WA DER List)	
	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	
EQL	0.02	0.02	0.02	0.05	0.05	0.02	0.02	0.02	0.02	0.01	0.05	0.05	0.05	0.05	0.05	0.05	0.01	0.02	0.1	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.05	0.02	0.05	0.02	0.01	0.01
Airservices HISLs (drinking water only)											0.4					5	0.4									0.2						
DoH (2017) - PFAS Drinking water quality guideline										0.07						0.56																
DoH (2017) - PFAS Recreational water quality guideline										0.7						5.6																

Site_ID	Location	Sampled_Date																																
Adelaide Airport	GW01	05/10/2017	<0.02	0.24	<0.02	<0.05	<0.05	2.11	<0.02	7.09	7.14	17.1	1.81	<0.05	<0.05	<0.05	<0.05	<0.05	1.12	4.1	2.26	2.9	0.44	0.04	8.12	10.6	1.03	9.98	<0.02	<0.05	<0.02	0.06	58.1	54
Adelaide Airport	GW02	05/10/2017	<0.02	2.9	<0.02	<0.05	<0.05	26.2	<0.02	140	155	181	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	1.12	51.7	29.5	49.1	<0.02	<0.02	164	256	0.61	41.2	<0.02	<0.05	<0.02	<0.02	917	884
Adelaide Airport	GW16_04	05/10/2017	<0.05 <sup>#1</sup>	110	<0.05 <sup>#1</sup>	<0.05	<0.05	739	<0.05 <sup>#1</sup>	4790	350	5720	<0.05	<0.12 <sup>#1</sup>	<0.12 <sup>#1</sup>	<0.12 <sup>#1</sup>	<0.12 <sup>#1</sup>	<0.05	174	813	150	<0.05 <sup>#1</sup>	<0.05 <sup>#1</sup>	174	2470	0.94	931	<0.05 <sup>#1</sup>	<0.12 <sup>#1</sup>	<0.05 <sup>#1</sup>	<0.05 <sup>#1</sup>	10,700	9780	
Adelaide Airport	GW16_05	05/10/2017	<0.05 <sup>#1</sup>	<0.05 <sup>#1</sup>	<0.05 <sup>#1</sup>	<0.05	<0.05	0.98	<0.05 <sup>#1</sup>	2.86	<0.05 <sup>#1</sup>	3.34	<0.05	<0.12 <sup>#1</sup>	<0.12 <sup>#1</sup>	<0.12 <sup>#1</sup>	<0.05	0.11	0.82	<0.2 <sup>#1</sup>	<0.05 <sup>#1</sup>	<0.05 <sup>#1</sup>	0.35	0.94	<0.05 <sup>#1</sup>	0.48	<0.05 <sup>#1</sup>	<0.12 <sup>#1</sup>	<0.05 <sup>#1</sup>	<0.05 <sup>#1</sup>	6.54	5.72		
Adelaide Airport	GW16_07	05/10/2017	<0.02	26	<0.02	<0.05	<0.05	45.7	<0.02	417	20.6	1600	0.39	<0.05	<0.05	<0.05	<0.05	2.14	34.6	54.9	10.8	0.1	<0.02	16.4	109	0.96	1180	<0.02	<0.05	<0.02	<0.02	1920	1840	

Statistical Summary																																
Number of Results		5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Minimum Concentration		<0.02	<0.05	<0.02	<0.05	<0.05	0.98	<0.02	2.86	<0.05	3.34	<0.05	<0.05	<0.05	<0.05	<0.05	0.11	0.82	<0.2	<0.02	<0.02	0.35	0.94	<0.05	0.48	<0.02	<0.05	<0.02	<0.02	<0.02	6.54	5.72
Maximum Concentration		<0.05	110	<0.05	<0.05	<0.05	739	<0.05	4790	350	5720	1.81	<0.12	<0.12	<0.12	<0.12	2.14	174	813	150	0.44	<0.05	174	2470	1.03	1180	<0.05	<0.12	<0.05	0.06	10700	9780

Data Comments  
#1 Reported Analyte LOR is higher than Requested Analyte LOR



Appendix D  
Table 3  
Surface water PFAS results

		PFAS																															
		N-Ethyl perfluorooctane sulfonamidoacetic acid	Perfluoroheptane sulfonic acid	Perfluorodecanesulfonic acid (PFDS)	10:2 Fluorotelomer sulfonic acid	4:2 Fluorotelomer sulfonic acid	Perfluorobutane sulfonic acid	N-Methyl perfluorooctane sulfonamidoacetic acid	Perfluorohexane sulfonic acid (PFHxS)	Perfluoropentanoic acid	PFHxS and PFOs (Sum of Total) - Lab Calc	8:2 Fluorotelomer sulfonic acid	N-Ethyl perfluorooctane sulfonamide	N-Ethyl perfluorooctane sulfonamidoethanol	N-Methyl perfluorooctane sulfonamide	N-Methyl perfluorooctane sulfonamidoethanol	6:2 Fluorotelomer Sulfonate (6:2 FTS)	Perfluorooctanoic acid (PFOA)	Perfluoropentane sulfonic acid	Perfluorobutanoic acid	Perfluorodecanoic acid	Perfluorododecanoic acid	Perfluoroheptanoic acid	Perfluorohexanoic acid (PFHxA)	Perfluorononanoic acid	Perfluorooctane sulfonic acid (PFOS)	Perfluorooctane sulfonamide (FOSA)	Perfluorotetradecanoic acid	Perfluorotridecanoic acid	Perfluoroundecanoic acid	PFAS (Sum of Total)	PFAS (Sum of Total)(WA DER List)	
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	
EQL		0.02	0.02	0.02	0.05	0.05	0.02	0.02	0.02	0.02	0.01	0.05	0.05	0.05	0.05	0.05	0.05	0.01	0.02	0.1	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.05	0.02	0.02	0.01	0.01
Airservices EISLs (toxicity effects on aquatic organisms)												2900						2900									6.66						
Airservices HISLs (consumption of fish)												0.3						0.0065	0.3								0.00065						
DOH (2017) - PFAS Recreational water quality guideline										0.7								5.6															
CRC Care 2017 Tech Report 38 PFAS ESL Freshwater 95% Species Protection																		220									0.13						
CRC Care 2017 Tech Report 38 PFAS ESL Marine 95% Species Protection																		8500									7.8						
CRC Care 2017 Tech Report 38 PFAS ESL Marine 99% Species Protection																		3000									0.29						
<b>Site ID</b>	<b>Location</b>	<b>Sampled Date</b>																															
Adelaide Airport	CFTG_SW	05/10/2017	<0.02	<0.02	<0.02	<0.05	<0.05	<0.02	<0.02	0.09	<0.02	0.27	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.03	<0.02	<0.1	<0.02	<0.02	0.15	0.12	<0.02	0.18	<0.02	<0.05	<0.02	<0.02	0.57	0.57
Adelaide Airport	MFS_SW	05/10/2017	<0.02	5.31	<0.02	<0.05	<0.05	4.23	<0.02	45.2	3.41	267	1.64	<0.05	<0.05	<0.05	<0.05	0.24	5.82	6.84	1.2	0.48	0.07	3.94	10.7	0.95	222	0.2	<0.05	<0.02	0.12	312	298
<b>Statistical Summary</b>																																	
Number of Results		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Minimum Concentration		<0.02	<0.02	<0.02	<0.05	<0.05	<0.02	<0.02	0.09	<0.02	0.27	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.03	<0.02	<0.1	<0.02	<0.02	0.15	0.12	<0.02	0.18	<0.02	<0.05	<0.02	<0.02	<0.02	0.57	0.57
Maximum Concentration		<0.02	5.31	<0.02	<0.05	<0.05	4.23	<0.02	45.2	3.41	267	1.64	<0.05	<0.05	<0.05	<0.05	0.24	5.82	6.84	1.2	0.48	0.07	3.94	10.7	0.95	222	0.2	<0.05	<0.02	0.12	312	298	



**Appendix D**  
**Table 5**  
**Summary of available historical results**

		PFAS																																		
		N-Ethyl perfluorooctane sulfonamidoacetic acid	Perfluoroheptane sulfonic acid	Perfluorodecanesulfonic acid (PFDS)	10:2 Fluorotelomer sulfonic acid	4:2 Fluorotelomer sulfonic acid	Perfluorobutane sulfonic acid	N-Methyl perfluorooctane sulfonamidoacetic acid	Perfluorohexane sulfonic acid (PFHxS)	Perfluoropentanoic acid	PFHxS and PFOs (Sum of Total) - Lab Calc	8:2 Fluorotelomer sulfonic acid	N-Ethyl perfluorooctane sulfonamide	N-Ethyl perfluorooctane sulfonamidoethanol	N-Methyl perfluorooctane sulfonamide	N-Methyl perfluorooctane sulfonamidoethanol	6:2 Fluorotelomer Sulfonate (6:2 FTS)	Perfluorooctanoic acid (PFOA)	Perfluoropentane sulfonic acid	Perfluorobutanoic acid	Perfluorodecanoic acid	Perfluorododecanoic acid	Perfluoroheptanoic acid	Perfluorohexanoic acid (PFHxA)	Perfluorononanoic acid	Perfluorooctane sulfonic acid (PFOS)	Perfluorooctane sulfonamide (FOSA)	Perfluorotetradecanoic acid	Perfluorotridecanoic acid	Perfluoroundecanoic acid	PFAS (Sum of Total)	PFAS (Sum of Total)(WA DER List)				
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L			
EQL		0.02	0.02	0.02	0.05	0.05	0.02	0.02	0.02	0.02	0.01	0.05	0.05	0.05	0.05	0.05	0.05	0.01	0.02	0.1	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.05	0.02	0.05	0.02	0.02	0.01	0.01	
Site_ID	Location	Sampled_Date																																		
Adelaide Airport	GW01	27/08/2003																																		
Adelaide Airport	GW01	6/08/2004																																		
Adelaide Airport	GW01	18/07/2005																																		
Adelaide Airport	GW01	9/10/2006																																		
Adelaide Airport	GW01	14/06/2007																																		
Adelaide Airport	GW01	19/10/2009																																		
Adelaide Airport	GW01	17/01/2011																																		
Adelaide Airport	GW01	26/04/2012																																		
Adelaide Airport	GW01	11/04/2013						64100		87700	52700						800	24700		32200				19600	136000	1000	9900					700				
Adelaide Airport	GW01	24/10/2016	<0.02	1.18		<0.05	<0.05	10.3	<0.02	31	15.1	67.8	9.45	<0.05	<0.05	<0.05	<0.05	0.52	5.21	4.99	8.4	0.71	<0.02	4.54	17.4	1.57	36.8	0.14	<0.05	<0.02	0.08	147	139			
Adelaide Airport	GW01	05/10/2017	<0.02	0.24	<0.02	<0.05	<0.05	2.11	<0.02	7.09	7.14	17.1	1.81	<0.05	<0.05	<0.05	<0.05	0.18	4.1	2.26	2.9	0.44	0.04	8.12	10.6	1.03	9.98	<0.02	<0.05	<0.02	0.06	58.1	54			
Adelaide Airport	GW02	18/07/2005																																		
Adelaide Airport	GW02	9/10/2006																																		
Adelaide Airport	GW02	14/06/2007																																		
Adelaide Airport	GW02	19/10/2009																																		
Adelaide Airport	GW02	17/01/2011																																		
Adelaide Airport	GW02	26/04/2012																																		
Adelaide Airport	GW02	11/04/2013						2700		3700	2600						<5.5	600		1700				900	6200	<5	20					<5				
Adelaide Airport	GW02	24/10/2016	<0.02	16.8		<0.05	<0.05	232	<0.02	769	233	848	<0.05	<0.05	0.53	<0.05	<0.05	0.32	74.6	144	102	<0.02	<0.02	179	300	0.3	79.1	<0.02	<0.05	<0.02	<0.02	<0.02	2130	1970		
Adelaide Airport	GW02	05/10/2017	<0.02	2.9	<0.02	<0.05	<0.05	26.2	<0.02	140	155	181	<0.05	<0.05	<0.05	<0.05	<0.05	1.12	51.7	29.5	49.1	<0.02	<0.02	164	256	0.61	41.2	<0.02	<0.05	<0.02	<0.02	<0.02	917	884		
Adelaide Airport	GW16_04	03/08/2016	<0.1	66.7	<0.1	<0.1	822	<0.1	2380	293	2990	<0.1	<0.25	<0.25	<0.25	<0.25	<0.1	105	374	38.9	<0.1	<0.1	<0.1	74.9	875	<0.1	606	<0.1	<0.25	<0.1	<0.1	<0.1	5640	5190		
Adelaide Airport	GW16_04	05/10/2017	<0.05 <sup>#1</sup>	110	<0.05 <sup>#1</sup>	<0.05	<0.05	739	<0.05 <sup>#1</sup>	4790	350	5720	<0.05	<0.12 <sup>#1</sup>	<0.12 <sup>#1</sup>	<0.12 <sup>#1</sup>	<0.12 <sup>#1</sup>	<0.05	174	813	150	<0.05 <sup>#1</sup>	<0.05 <sup>#1</sup>	174	2470	0.94	931	<0.05 <sup>#1</sup>	<0.12 <sup>#1</sup>	<0.05 <sup>#1</sup>	<0.05 <sup>#1</sup>	<0.05 <sup>#1</sup>	10,700	9780		
Adelaide Airport	GW16_05	03/08/2016	<0.05	<0.05	<0.05	<0.05	3.3	<0.05	6.14	1.14	6.53	<0.05	<0.12	<0.12	<0.12	<0.12	<0.05	0.19	1.62	<0.1	<0.05	<0.05	<0.05	0.34	2.09	<0.05	0.39	<0.05	<0.12	<0.05	<0.05	15.2	13.6			
Adelaide Airport	GW16_05	05/10/2017	<0.05 <sup>#1</sup>	<0.05 <sup>#1</sup>	<0.05 <sup>#1</sup>	<0.05	<0.05	0.98	<0.05 <sup>#1</sup>	2.86	<0.05 <sup>#1</sup>	3.34	<0.05	<0.12 <sup>#1</sup>	<0.12 <sup>#1</sup>	<0.12 <sup>#1</sup>	<0.12 <sup>#1</sup>	<0.05	0.11	0.82	<0.2 <sup>#1</sup>	<0.05 <sup>#1</sup>	<0.05 <sup>#1</sup>	0.35	0.94	<0.05 <sup>#1</sup>	0.48	<0.05 <sup>#1</sup>	<0.12 <sup>#1</sup>	<0.05 <sup>#1</sup>	<0.05 <sup>#1</sup>	6.54	5.72			
Adelaide Airport	GW16_07	03/08/2016	<0.1	47.4	<0.1	<0.1	150	<0.1	861	16	4990	0.47	<0.25	<0.25	<0.25	<0.25	1.84	77.3	86.5	<0.1	<0.1	<0.1	<0.1	7.1	216	<0.1	4130	0.24	<0.25	<0.1	<0.1	5590	5460			
Adelaide Airport	GW16_07	05/10/2017	<0.02	26	<0.02	<0.05	<0.05	45.7	<0.02	417	20.6	1600	0.39	<0.05	<0.05	<0.05	<0.05	2.14	34.6	54.9	10.8	0.1	<0.02	16.4	109	0.96	1180	<0.02	<0.05	<0.02	<0.02	1920	1840			
Adelaide Airport	LFTG_SW	05/10/2017	<0.02	<0.02	<0.02	<0.05	<0.05	<0.02	<0.02	0.09	<0.02	0.27	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.03	<0.02	<0.1	<0.02	<0.02	0.15	0.12	<0.02	0.18	<0.02	<0.05	<0.02	<0.02	0.57	0.57			
Adelaide Airport	MFS_SW	05/10/2017	<0.02	5.31	<0.02	<0.05	<0.05	4.23	<0.02	45.2	3.41	267	1.64	<0.05	<0.05	<0.05	<0.05	0.24	5.82	6.84	1.2	0.48	0.07	3.94	10.7	0.95	222	0.2	<0.05	<0.02	0.12	312	298			

**Data Comments**  
#1 Reported Analyte LOR is higher than Requested Analyte LOR



**Appendix D**  
**Table 6**  
**QAQC - Assessment of field duplicates**

Airservices Australia  
Adelaide Airport  
Groundwater and surface water monitoring

Field Duplicates (water)  
Filter: SDG in(ALSE-Melbourne 09-Oct-17)






SDG Field ID Sampled Date/Tir	ALSE-Melbourne 09-Oct-17 GW16_04 5/10/2017 14:30	ALSE-Melbourne 09-Oct-17 QC01 5/10/2017 14:30	RPD	ALSE-Melbourne 09-Oct-17 GW16_04 5/10/2017 14:30	9-Oct-17 QC02 5/10/2017 14:30	RPD
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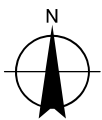
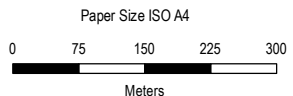
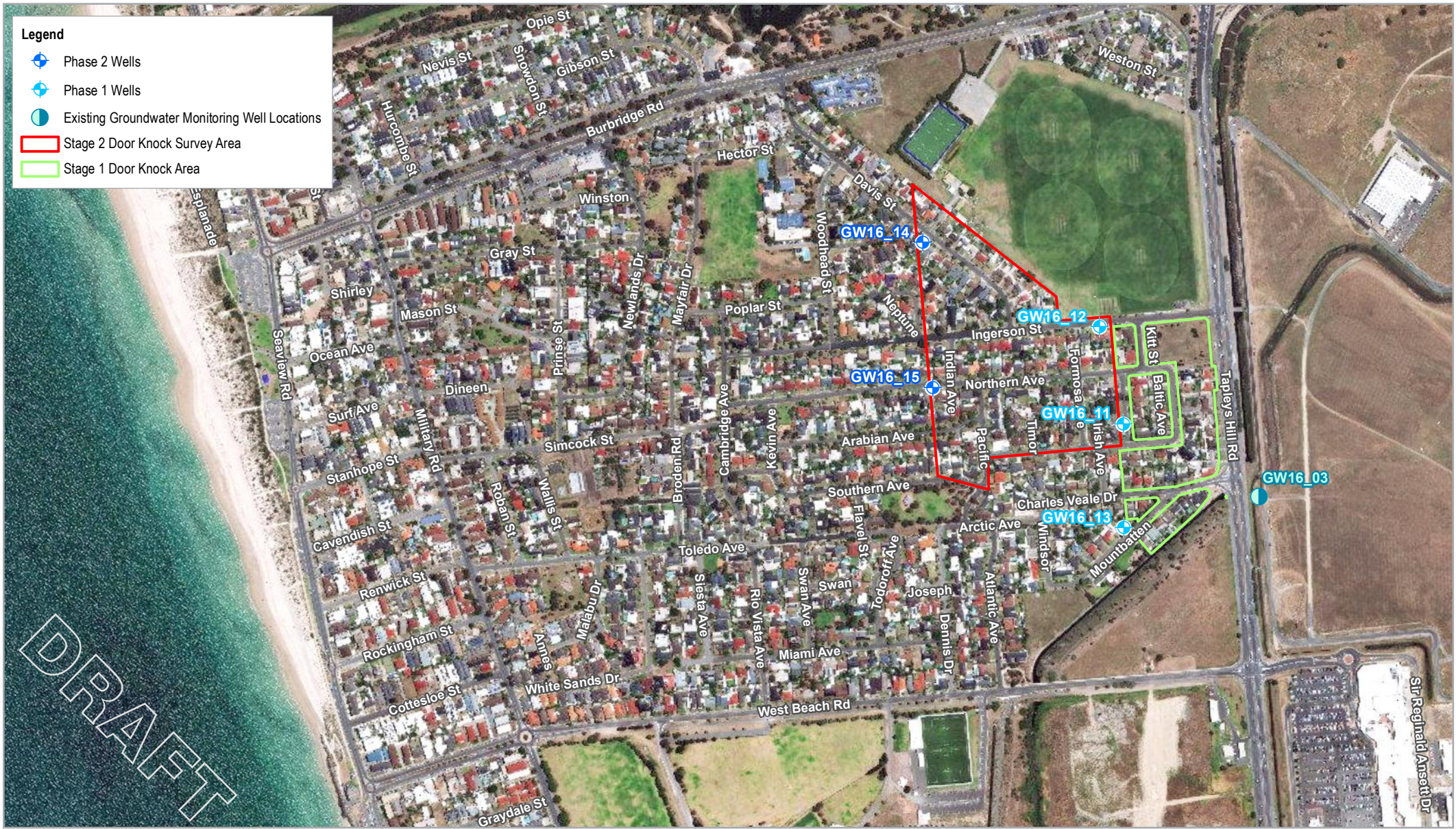
Chem_Grd	ChemName	Units	EQL					
Surfactants	Anionic Surfactants as MBAS	µg/l	100	7300	7400	1	7300	
PAHs	Pyrene	µg/L	1	<1	<1	0	<1	<1
	Acenaphthene	µg/L	1	<1	<1	0	<1	<1
	Acenaphthylene	µg/L	1	<1	<1	0	<1	<1
	Anthracene	µg/L	1	<1	<1	0	<1	<1
	Benz(a)anthracene	µg/L	1	<1	<1	0	<1	<1
	Benzo(a)pyrene	µg/L	0.5 : 1 (Interlab)	<0.5	<0.5	0	<0.5	<1
	Benzo(b+j)fluoranthene	µg/L	1	<1	<1	0	<1	<1
	Benzo(k)fluoranthene	µg/L	1	<1	<1	0	<1	<1
	Benzo(g,h,i)perylene	µg/L	1	<1	<1	0	<1	<1
	Chrysene	µg/L	1	<1	<1	0	<1	<1
	Dibenz(a,h)anthracene	µg/L	1	<1	<1	0	<1	<1
	Fluoranthene	µg/L	1	<1	<1	0	<1	<1
	Fluorene	µg/L	1	<1	<1	0	<1	<1
	Indeno(1,2,3-c,d)pyrene	µg/L	1	<1	<1	0	<1	<1
	Naphthalene	µg/L	5 : 10 (Interlab)	<5	<5	0	<5	<1
	Naphthalene	µg/L	1 : 10 (Interlab)	<1	<1	0	<1	<1
	Phenanthrene	µg/L	1	<1	<1	0	<1	<1
	PAHs (Sum of total) - Lab calc	µg/L	0.5 : 1 (Interlab)	<0.5	<0.5	0	<0.5	<1
	Benzo(a)pyrene TEQ (zero) - Lab Calc	µg/L	0.5	<0.5	<0.5	0	<0.5	
TRH - NEP	C6-C10 minus BTEX (F1)	µg/L	20	<20	<20	0	<20	<20
	C6 - C10 Fraction	µg/L	20	<20	<20	0	<20	<20
	>C10-C16 minus Naphthalene (F2)	µg/L	100 : 50 (Interlab)	<100	<100	0	<100	<50
	>C10 - C16 Fraction	µg/L	100 : 50 (Interlab)	<100	<100	0	<100	<50
	>C16 - C34 Fraction (F3)	µg/L	100	<100	<100	0	<100	<100
	>C34 - C40 Fraction (F4)	µg/L	100	<100	<100	0	<100	<100
	>C10 - C40 (Sum of Total)	µg/L	100	<100	<100	0	<100	
M 2013								
TRH - NEP	C6 - C 9 Fraction	µg/L	20	<20	<20	0	<20	<20
	C10 - C14 Fraction	µg/L	50	<50	<50	0	<50	<50
	C15 - C28 Fraction	µg/L	100	<100	<100	0	<100	<100
	C29 - C36 Fraction	µg/L	50 : 100 (Interlab)	<50	<50	0	<50	<100
	C10 - C36 (Sum of Total)	µg/L	50 : 100 (Interlab)	<50	<50	0	<50	<100
M 1999								
BTEXN	Benzene	µg/L	1	<1	<1	0	<1	<1
	Toluene	µg/L	2 : 1 (Interlab)	<2	<2	0	<2	<1
	Ethylbenzene	µg/L	2 : 1 (Interlab)	<2	<2	0	<2	<1
	Xylene (o)	µg/L	2 : 1 (Interlab)	<2	<2	0	<2	<1
	Xylene (m & p)	µg/L	2	<2	<2	0	<2	<2
	Xylene Total	µg/L	2 : 3 (Interlab)	<2	<2	0	<2	<3
	BTEX (Sum of Total) - Lab Calc	µg/L	1	<1	<1	0	<1	
PFAS	N-Ethyl perfluorooctane sulfonamidoacetic	µg/L	0.02 : 0.05 (Interlab)	<0.05	<0.05	0	<0.05	<0.05
	Perfluoroheptane sulfonic acid	µg/L	0.02 : 0.01 (Interlab)	110	114	4	110	140
	Perfluorodecanesulfonic acid (PFDS)	µg/L	0.02 : 0.01 (Interlab)	<0.05	<0.05	0	<0.05	<0.01
	10:2 Fluorotelomer sulfonic acid	µg/L	0.05 : 0.01 (Interlab)	<0.05	<0.05	0	<0.05	<0.01
	4:2 Fluorotelomer sulfonic acid	µg/L	0.05 : 0.01 (Interlab)	<0.05	<0.05	0	<0.05	0.02
	Perfluorobutane sulfonic acid	µg/L	0.02 : 0.01 (Interlab)	739	750	1	739	1000
	N-Methyl perfluorooctane sulfonamidoacetic	µg/L	0.02 : 0.05 (Interlab)	<0.05	<0.05	0	<0.05	<0.05
	Perfluorohexane sulfonic acid (PFHxS)	µg/L	0.02 : 0.01 (Interlab)	4790	4910	2	4790	5800
	Perfluoropentanoic acid	µg/L	0.02 : 0.01 (Interlab)	350	355	1	350	450
	PFHxS and PFOS (Sum of Total) - Lab Calc	µg/L	0.01	5720	5810	2	5720	6740
	8:2 Fluorotelomer sulfonic acid	µg/L	0.05 : 0.01 (Interlab)	<0.05	<0.05	0	<0.05	<0.01
	N-Ethyl perfluorooctane sulfonamide	µg/L	0.05	<0.12	<0.12	0	<0.12	<0.05
	N-Ethyl perfluorooctane sulfonamidoethane	µg/L	0.05	<0.12	<0.12	0	<0.12	<0.05
	N-Methyl perfluorooctane sulfonamide	µg/L	0.05	<0.12	<0.12	0	<0.12	<0.05
	N-Methyl perfluorooctane sulfonamidoethane	µg/L	0.05	<0.12	<0.12	0	<0.12	<0.05
	6:2 Fluorotelomer Sulfonate (6:2 FTS)	µg/L	0.05	<0.05	<0.05	0	<0.05	0.07
	Perfluorooctanoic acid (PFOA)	µg/L	0.01	174	171	2	174	230
	Perfluoropentane sulfonic acid	µg/L	0.02 : 0.01 (Interlab)	813	840	3	813	930
	Perfluorobutanoic acid	µg/L	0.1 : 0.05 (Interlab)	150	158	5	150	260
	Perfluorodecanoic acid	µg/L	0.02 : 0.01 (Interlab)	<0.05	<0.05	0	<0.05	0.02
	Perfluorododecanoic acid	µg/L	0.02 : 0.01 (Interlab)	<0.05	<0.05	0	<0.05	<0.01
	Perfluoroheptanoic acid	µg/L	0.02 : 0.01 (Interlab)	174	190	9	174	180
	Perfluorohexanoic acid (PFHxA)	µg/L	0.02 : 0.01 (Interlab)	2470	2560	4	2470	2000
	Perfluorononanoic acid	µg/L	0.02 : 0.01 (Interlab)	0.94	1.03	9	0.94	1.1
	Perfluorooctane sulfonic acid (PFOS)	µg/L	0.01	931	902	3	931	940
	Perfluorooctane sulfonamide (FOSA)	µg/L	0.02 : 0.05 (Interlab)	<0.05	<0.05	0	<0.05	0.09
	Perfluorotetradecanoic acid	µg/L	0.05 : 0.01 (Interlab)	<0.12	<0.12	0	<0.12	<0.01
	Perfluorotridecanoic acid	µg/L	0.02 : 0.01 (Interlab)	<0.05	<0.05	0	<0.05	<0.01
	Perfluoroundecanoic acid	µg/L	0.02 : 0.01 (Interlab)	<0.05	<0.05	0	<0.05	0.04
	PFAS (Sum of Total)	µg/L	0.01 : 0.1 (Interlab)	10700	11000	3	10700	11931.34
	PFAS (Sum of Total)(WA DER List)	µg/L	0.01 : 0.05 (Interlab)	9780	10000	2	9780	10860.07

\*RPDs have only been considered where a concentration is greater than 1 times the EQL.

\*\*High RPDs are in bold (Acceptable RPDs for each EQL multiplier range are: 200 (1-10 x EQL); 50 (10-30 x EQL); 50 (> 30 x EQL) )

\*\*\*Interlab Duplicates are matched on a per compound basis as methods vary between laboratories. Any methods in the row header relate to those used in the primary laboratory

- Legend**
-  Phase 2 Wells
  -  Phase 1 Wells
  -  Existing Groundwater Monitoring Well Locations
  -  Stage 2 Door Knock Survey Area
  -  Stage 1 Door Knock Area



Map Projection: Transverse Mercator  
 Horizontal Datum: GDA 1994  
 Grid: GDA 1994 MGA Zone 54



**Airservices Australia**  
**Airservices Bore Survey and**  
**Surface Water Sampling**

**Groundwater Use Survey Areas**  
**and Well Locations**

Project No. 33-18931  
 Revision No. A  
 Date 22 Feb 2019

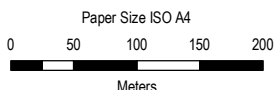
**FIGURE 1**

Data source: Streets - SA DPTI 2015, Cadastre - SA DPTI 2014, Satellite Imagery - ESRI Imagery Basemap (Extracted 16 Oct 2018), Created by: kqvvelasco

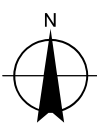


**Legend**

- Surface Water and Sediment Sampling Locations
- Airport Boundary



Map Projection: Transverse Mercator  
 Horizontal Datum: GDA 1994  
 Grid: GDA 1994 MGA Zone 54









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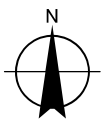
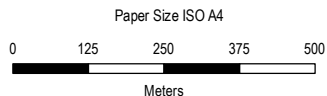
Project No. 33-18931  
 Revision No. A  
 Date 22 Feb 2019

**Surface Water and  
 Sediment Sampling Locations**

**FIGURE 2**

Data source: Streets - SA DPTI 2015, Cadastre - SA DPTI 2014, Satellite Imagery (Extracted 16 Oct 2018) - Created by: kqvelasco

- Legend**
-  Phase 1 Monitoring Wells
  -  Phase 2 Monitoring Wells
  -  2016 Groundwater Monitoring Locations
  -  Existing Groundwater Monitoring Well Locations
  -  Groundwater Contours (mAH)
  -  Main Roads



Map Projection: Transverse Mercator  
 Horizontal Datum: GDA 1994  
 Grid: GDA 1994 MGA Zone 54

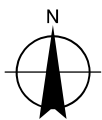
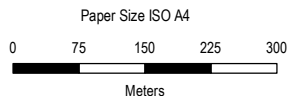
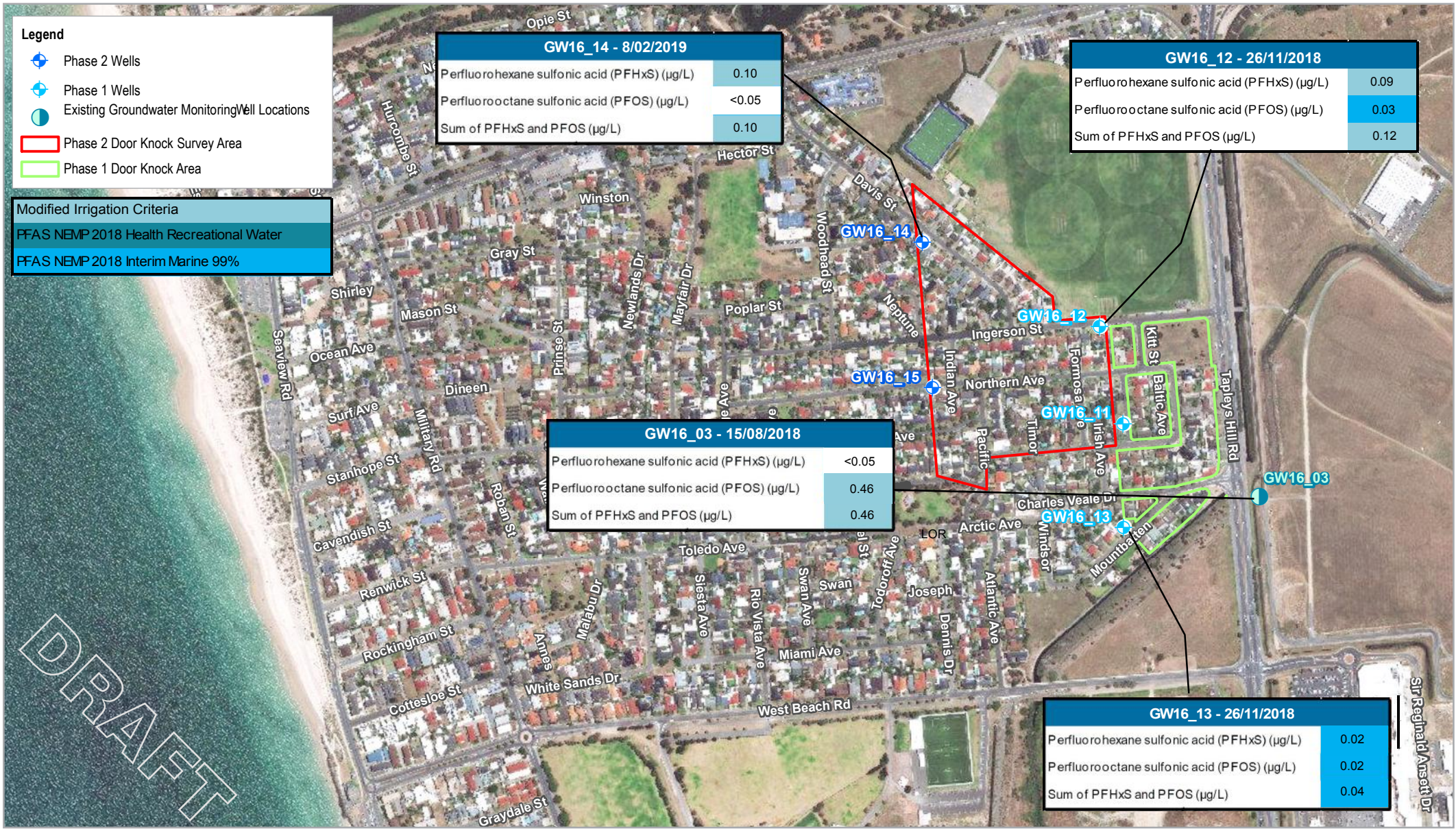
**Airservices Australia**  
**Airservices Bore Survey and**  
**Surface Water Sampling**

Project No. 33-18931  
 Revision No. A  
 Date 21 Feb 2019

**Groundwater Contour Map**

**FIGURE 3**

Data source: Streets - SA DPTI 2015, Cadastre - SA DPTI 2014, Satellite Imagery - ESRI Imagery Basemap (Extracted 16 Oct 2018), Created by: kvvelasco



Map Projection: Transverse Mercator  
 Horizontal Datum: GDA 1994  
 Grid: GDA 1994 MGA Zone 54



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### Groundwater PFAS Concentration Map

Project No. 33-18931  
 Revision No. A  
 Date 22 Feb 2019

**FIGURE 4**

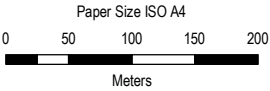
Data source: Streets - SA DPTI 2015, Cadastre - SA DPTI 2014, Satellite Imagery - ESRI Imagery Basemap (Extracted 16 Oct 2018), Created by: kqvelasco



**DRAFT**

**Legend**

- Surface Water and Sediment Sampling Locations
- Airport Boundary



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Project No. 33-18931  
 Revision No. A  
 Date 22 Feb 2019

**Surface Water and Sediment  
 PFAS Concentration Map**

**FIGURE 5**

Data source: Streets - SA DPTI 2015, Cadastre - SA DPTI 2014, Satellite Imagery (Extracted 16 Oct 2018) - . Created by: kqvelesco



Analytical Results Tables  
Table 1 - Groundwater Results

	Inorganics	PFAS												
	Total Dissolved Solids	Perfluorobutane sulfonic acid (PFBS)	Perfluoropentane sulfonic acid (PFPeS)	Perfluorohexane sulfonic acid (PFHxS)	Perfluoroheptane sulfonic acid (PFHpS)	Perfluorooctane sulfonic acid (PFOS)	Perfluorodecane sulfonic acid (PFDS)	Perfluorobutanoic acid (PFBA)	Perfluoropentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)		
	mg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
EQL	10	0.01	0.01	0.01	0.01	0.01	0.01	0.05	0.01	0.01	0.01	0.01	0.01	0.01
Modified Irrigation Criteria <sup>^</sup>														0.56
PFAS NEMP 2018 Health Recreational Water														5.6
PFAS NEMP 2018 Interim Marine 99%														19

Date/Time	Field ID	Sample Type	Matrix Type	Total Dissolved Solids	Perfluorobutane sulfonic acid (PFBS)	Perfluoropentane sulfonic acid (PFPeS)	Perfluorohexane sulfonic acid (PFHxS)	Perfluoroheptane sulfonic acid (PFHpS)	Perfluorooctane sulfonic acid (PFOS)	Perfluorodecane sulfonic acid (PFDS)	Perfluorobutanoic acid (PFBA)	Perfluoropentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)
26/11/2018	GW16_11	Normal	water	19,000	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.01	<0.01	<0.01	<0.01
26/11/2018	GW16_12	Normal	water	8,200	0.04	0.02	0.09	<0.01	0.03	<0.01	<0.05	0.02	0.03	<0.01	0.03
26/11/2018	GW16_13	Normal	water	8,300	<0.01	<0.01	0.02	<0.01	0.02	<0.01	<0.05	0.03	0.04	0.06	0.06
8/02/2019	GW16-14	Normal	water	-	-	-	0.10	-	<0.01	-	-	-	-	-	0.02
8/02/2019	GW16-15	Normal	water	-	-	-	<0.01	-	<0.01	-	-	-	-	-	<0.01

Note:

<sup>^</sup> Modified PFAS NEMP 2018 Health Drinking Water criteria adopted for irrigation purposes.



Analytical Results Tables  
Table 1 - Groundwater Results

PFAS													
	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnDA)	Perfluorododecanoic acid (PFDoDA)	Perfluorotridecanoic acid (PFTrDA)	Perfluorotetradecanoic acid (PFTeDA)	Perfluorooctane sulfonamide (FOSA)	N-Methyl perfluorooctane sulfonamide (MeFOSA)	N-Ethyl perfluorooctane sulfonamide (EtFOSA)	N-Methyl perfluorooctane sulfonamidoethanol (MEFOSE)	N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	
	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
EQL	0.01	0.01	0.01	0.01	0.01	0.01	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Modified Irrigation Criteria^													
PFAS NEMP 2018 Health Recreational Water													
PFAS NEMP 2018 Interim Marine 99%													

Date/Time	Field ID	Sample Type	Matrix Type	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnDA)	Perfluorododecanoic acid (PFDoDA)	Perfluorotridecanoic acid (PFTrDA)	Perfluorotetradecanoic acid (PFTeDA)	Perfluorooctane sulfonamide (FOSA)	N-Methyl perfluorooctane sulfonamide (MeFOSA)	N-Ethyl perfluorooctane sulfonamide (EtFOSA)	N-Methyl perfluorooctane sulfonamidoethanol (MEFOSE)	N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)
26/11/2018	GW16_11	Normal	water	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
26/11/2018	GW16_12	Normal	water	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
26/11/2018	GW16_13	Normal	water	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
8/02/2019	GW16-14	Normal	water	-	-	-	-	-	-	-	-	-	-	-	-
8/02/2019	GW16-15	Normal	water	-	-	-	-	-	-	-	-	-	-	-	-

Note:

^ Modified PFAS NEMP 2018 Health Drinking Water criteria adopted



**Analytical Results Tables**  
**Table 1 - Groundwater Results**

	PFAS									
	N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	4:2 Fluorotelomer sulfonic acid (4:2 FTS)	6:2 Fluorotelomer Sulfonate (6:2 FTS)	8:2 Fluorotelomer sulfonic acid (8:2 FTS)	10:2 Fluorotelomer sulfonic acid (10:2 FTS)	PFAS (Sum of Total)	Sum of PFHxS and PFOS	PFAS (Sum of Total)(WA DER List)	Sum of US EPA PFAS (PFOS + PFOA)*	Sum of enHealth PFAS (PFHxS + PFOS + PFOA)*
	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
EQL	0.05	0.01	0.05	0.01	0.01	0.1	0.01	0.05	0.01	0.01
Modified Irrigation Criteria^							0.07			
PFAS NEMP 2018 Health Recreational Water							0.7			
PFAS NEMP 2018 Interim Marine 99%							0.00023			

Date/Time	Field ID	Sample Type	Matrix Type	N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	4:2 Fluorotelomer sulfonic acid (4:2 FTS)	6:2 Fluorotelomer Sulfonate (6:2 FTS)	8:2 Fluorotelomer sulfonic acid (8:2 FTS)	10:2 Fluorotelomer sulfonic acid (10:2 FTS)	PFAS (Sum of Total)	Sum of PFHxS and PFOS	PFAS (Sum of Total)(WA DER List)	Sum of US EPA PFAS (PFOS + PFOA)*	Sum of enHealth PFAS (PFHxS + PFOS + PFOA)*
26/11/2018	GW16_11	Normal	water	<0.05	<0.01	0.06	<0.01	<0.01	<0.1	<0.01	0.06	<0.01	<0.01
26/11/2018	GW16_12	Normal	water	<0.05	<0.01	0.68	<0.01	<0.01	0.94	0.12	0.92	0.06	0.15
26/11/2018	GW16_13	Normal	water	<0.05	<0.01	0.07	<0.01	<0.01	0.3	0.04	0.3	0.08	0.1
8/02/2019	GW16-14	Normal	water	-	-	<0.05	-	-	-	0.1	-	0.02	0.12
8/02/2019	GW16-15	Normal	water	-	-	<0.05	-	-	-	<0.01	-	<0.01	<0.01

Note:  
^ Modified PFAS NEMP 2018 Health Drinking Water criteria adopted



Analytical Results Tables  
Table 2 - Sediment Results (Phase 1)

	Inorganics	Leachate	PFAS									
	Moisture (%)	pH (Final)	Perfluorobutane sulfonic acid (PFBS)		Perfluoropentane sulfonic acid (PFPeS)		Perfluorohexane sulfonic acid (PFHxS)		Perfluoroheptane sulfonic acid (PFHpS)		Perfluorooctane sulfonic acid (PFOS)	
	%	pH Units	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	
EQL	0.1	0.1	0.0002	0.02	0.0002	0.02	0.0002	0.02	0.0002	0.02	0.0002	
Adopted Sediment Criteria												
PFAS NEMP 2018 Health Recreational Water												
PFAS NEMP 2018 Interim Marine 99%												

Date/Time	Field ID	Sample Type	Matrix Type	Moisture (%)	pH (Final)	Perfluorobutane sulfonic acid (PFBS) mg/kg	Perfluorobutane sulfonic acid (PFBS) µg/L	Perfluoropentane sulfonic acid (PFPeS) mg/kg	Perfluoropentane sulfonic acid (PFPeS) µg/L	Perfluorohexane sulfonic acid (PFHxS) mg/kg	Perfluorohexane sulfonic acid (PFHxS) µg/L	Perfluoroheptane sulfonic acid (PFHpS) mg/kg	Perfluoroheptane sulfonic acid (PFHpS) µg/L	Perfluorooctane sulfonic acid (PFOS) mg/kg
22/11/2018 15:00	soil_1	Normal	soil	25.7	9	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02	0.0024
22/11/2018 15:00	soil_2	Normal	soil	58.9	8.7	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02	0.0011
22/11/2018 15:00	soil_3	Normal	soil	69.7	8.3	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02	0.0024
22/11/2018 15:00	soil_4	Normal	soil	26	9.1	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02	0.0002
22/11/2018 15:00	soil_5	Normal	soil	21.3	9	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02	<0.0002
22/11/2018 15:00	soil_6	Normal	soil	14.2	9.4	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02	0.0003
22/11/2018 15:00	soil_7	Normal	soil	75.2	7.8	0.0003	<0.02	0.0006	<0.02	0.0126	0.18	0.0026	0.04	0.244
22/11/2018 15:00	soil_8	Normal	soil	54.2	8.1	<0.0002	<0.02	<0.0002	<0.02	0.0023	0.13	0.0003	<0.02	0.0172



Analytical Results Tables  
Table 2 - Sediment Results (Phase 1)

	PFAS												
	Perfluorooctane sulfonic acid (PFOS)	Perfluorodecanesulfonic acid (PFDS)		Perfluorobutanoic acid (PFBA)		Perfluoropentanoic acid (PFPeA)		Perfluorohexanoic acid (PFHxA)		Perfluoroheptanoic acid (PFHpA)			
	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L
EQL	0.01	0.0002	0.02	0.001	0.1	0.0002	0.02	0.0002	0.02	0.0002	0.02	0.0002	0.02
Adopted Sediment Criteria													
PFAS NEMP 2018 Health Recreational Water													
PFAS NEMP 2018 Interim Marine 99%													

Date/Time	Field ID	Sample Type	Matrix Type	Perfluorooctane sulfonic acid (PFOS)	Perfluorodecanesulfonic acid (PFDS)	Perfluorobutanoic acid (PFBA)	Perfluoropentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)	Perfluorodecanoic acid (PFDA)	Perfluorododecanoic acid (PFDDA)	Perfluorotridecanoic acid (PFTDA)
22/11/2018 15:00	soil_1	Normal	soil	0.06	<0.0002	<0.02	<0.001	<0.1	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02
22/11/2018 15:00	soil_2	Normal	soil	0.02	<0.0002	<0.02	<0.001	<0.1	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02
22/11/2018 15:00	soil_3	Normal	soil	0.03	<0.0002	<0.02	<0.001	<0.1	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02
22/11/2018 15:00	soil_4	Normal	soil	<0.01	<0.0002	<0.02	<0.001	<0.1	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02
22/11/2018 15:00	soil_5	Normal	soil	<0.01	<0.0002	<0.02	<0.001	<0.1	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02
22/11/2018 15:00	soil_6	Normal	soil	<0.01	<0.0002	<0.02	<0.001	<0.1	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02
22/11/2018 15:00	soil_7	Normal	soil	2.2	<0.0002	<0.02	<0.001	<0.1	0.0005	<0.02	0.0012	0.03	0.0004	<0.02
22/11/2018 15:00	soil_8	Normal	soil	0.58	<0.0002	<0.02	<0.002	<0.1	<0.0002	<0.02	0.0002	<0.02	<0.0002	<0.02



**Analytical Results Tables**  
**Table 2 - Sediment Results (Phase 1)**

	PFAS												
	Perfluorooctanoic acid (PFOA)		Perfluorononanoic acid (PFNA)		Perfluorodecanoic acid (PFDA)		Perfluoroundecanoic acid (PFUnDA)		Perfluorododecanoic acid (PFDoDA)		Perfluorotridecanoic acid (PFTrDA)		
	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	
EQL	0.0002	0.01	0.0002	0.02	0.0002	0.02	0.0002	0.02	0.0002	0.02	0.0002	0.02	0.0002
Adopted Sediment Criteria	0.22												
PFAS NEMP 2018 Health Recreational Water		5.6											
PFAS NEMP 2018 Interim Marine 99%		19											

Date/Time	Field ID	Sample Type	Matrix Type	Perfluorooctanoic acid (PFOA) mg/kg	Perfluorooctanoic acid (PFOA) µg/L	Perfluorononanoic acid (PFNA) mg/kg	Perfluorononanoic acid (PFNA) µg/L	Perfluorodecanoic acid (PFDA) mg/kg	Perfluorodecanoic acid (PFDA) µg/L	Perfluoroundecanoic acid (PFUnDA) mg/kg	Perfluoroundecanoic acid (PFUnDA) µg/L	Perfluorododecanoic acid (PFDoDA) mg/kg	Perfluorododecanoic acid (PFDoDA) µg/L	Perfluorotridecanoic acid (PFTrDA) mg/kg	Perfluorotridecanoic acid (PFTrDA) µg/L
22/11/2018 15:00	soil_1	Normal	soil	<0.0002	<0.01	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02
22/11/2018 15:00	soil_2	Normal	soil	<0.0002	<0.01	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02
22/11/2018 15:00	soil_3	Normal	soil	<0.0002	<0.01	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02
22/11/2018 15:00	soil_4	Normal	soil	<0.0002	<0.01	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02	0.0003	<0.02	<0.0002	<0.02
22/11/2018 15:00	soil_5	Normal	soil	<0.0002	<0.01	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02
22/11/2018 15:00	soil_6	Normal	soil	<0.0002	<0.01	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02	0.0002	<0.02	<0.0002	<0.02
22/11/2018 15:00	soil_7	Normal	soil	0.0022	0.03	0.0003	<0.02	0.0014	<0.02	0.0003	<0.02	0.004	<0.02	0.0005	<0.02
22/11/2018 15:00	soil_8	Normal	soil	0.0004	0.02	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02	0.0007	<0.02	<0.0002	<0.02



Analytical Results Tables  
Table 2 - Sediment Results (Phase 1)

	PFAS												
	Perfluorotridecanoic acid (PFTTrDA)	Perfluorotetradecanoic acid (PFTTeDA)	Perfluorooctane sulfonamide (FOSA)	N-Methyl perfluorooctane sulfonamide (MeFOSA)	N-Ethyl perfluorooctane sulfonamide (EtFOSA)	N-Methyl perfluorooctane sulfonamidoethanol (MEFOSE)							
	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L
EQL	0.02	0.0005	0.05	0.0002	0.02	0.0005	0.05	0.0005	0.05	0.0005	0.05	0.0005	0.05
Adopted Sediment Criteria													
PFAS NEMP 2018 Health Recreational Water													
PFAS NEMP 2018 Interim Marine 99%													

Date/Time	Field ID	Sample Type	Matrix Type	Perfluorotridecanoic acid (PFTTrDA)	Perfluorotetradecanoic acid (PFTTeDA)	Perfluorooctane sulfonamide (FOSA)	N-Methyl perfluorooctane sulfonamide (MeFOSA)	N-Ethyl perfluorooctane sulfonamide (EtFOSA)	N-Methyl perfluorooctane sulfonamidoethanol (MEFOSE)					
22/11/2018 15:00	soil_1	Normal	soil	<0.02	<0.0005	<0.05	<0.0002	<0.02	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.05
22/11/2018 15:00	soil_2	Normal	soil	<0.02	<0.0005	<0.05	<0.0002	<0.02	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.05
22/11/2018 15:00	soil_3	Normal	soil	<0.02	<0.0005	<0.05	<0.0002	<0.02	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.05
22/11/2018 15:00	soil_4	Normal	soil	<0.02	<0.0005	<0.05	<0.0002	<0.02	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.05
22/11/2018 15:00	soil_5	Normal	soil	<0.02	<0.0005	<0.05	<0.0002	<0.02	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.05
22/11/2018 15:00	soil_6	Normal	soil	<0.02	<0.0005	<0.05	<0.0002	<0.02	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.05
22/11/2018 15:00	soil_7	Normal	soil	<0.02	<0.0005	<0.05	<0.0002	<0.02	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.05
22/11/2018 15:00	soil_8	Normal	soil	<0.02	<0.0005	<0.05	<0.0002	<0.02	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.05



Analytical Results Tables  
Table 2 - Sediment Results (Phase 1)

	PFAS											
	N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)		N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)		N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)		4:2 Fluorotelomer sulfonic acid (4:2 FTS)		6:2 Fluorotelomer Sulfonate (6:2 FTS)		8:2 Fluorotelomer sulfonic acid (8:2 FTS)	
	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L
EQL	0.0005	0.05	0.0002	0.02	0.0002	0.02	0.0005	0.05	0.0005	0.05	0.0005	0.05
Adopted Sediment Criteria												
PFAS NEMP 2018 Health Recreational Water												
PFAS NEMP 2018 Interim Marine 99%												

Date/Time	Field ID	Sample Type	Matrix Type	EtFOSE		MeFOSAA		EtFOSAA		4:2 FTS		6:2 FTS		8:2 FTS	
22/11/2018 15:00	soil_1	Normal	soil	<0.0005	<0.05	<0.0002	<0.02	<0.0002	<0.02	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.0005
22/11/2018 15:00	soil_2	Normal	soil	<0.0005	<0.05	<0.0002	<0.02	<0.0002	<0.02	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.0005
22/11/2018 15:00	soil_3	Normal	soil	<0.0005	<0.05	<0.0002	<0.02	<0.0002	<0.02	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.0005
22/11/2018 15:00	soil_4	Normal	soil	<0.0005	<0.05	<0.0002	<0.02	<0.0002	<0.02	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.0005
22/11/2018 15:00	soil_5	Normal	soil	<0.0005	<0.05	<0.0002	<0.02	<0.0002	<0.02	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.0005
22/11/2018 15:00	soil_6	Normal	soil	<0.0005	<0.05	<0.0002	<0.02	<0.0002	<0.02	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.0005
22/11/2018 15:00	soil_7	Normal	soil	<0.0005	<0.05	<0.0002	<0.02	<0.0002	<0.02	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.0005
22/11/2018 15:00	soil_8	Normal	soil	<0.0005	<0.05	<0.0002	<0.02	<0.0002	<0.02	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.0005



Analytical Results Tables  
Table 2 - Sediment Results (Phase 1)

	PFAS								
	8:2 Fluorotelomer sulfonic acid (8:2 FTS)	10:2 Fluorotelomer sulfonic acid (10:2 FTS)		PFAS (Sum of Total)		Sum of PFHxS and PFOS		PFAS (Sum of Total)(WA DER List)	
	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L
EQL	0.05	0.0005	0.05	0.0002	0.01	0.0002	0.01	0.0002	0.01
Adopted Sediment Criteria						0.22			
PFAS NEMP 2018 Health Recreational Water							0.7		
PFAS NEMP 2018 Interim Marine 99%							0.00023		

Date/Time	Field ID	Sample Type	Matrix Type	8:2 FTS (µg/L)	10:2 FTS (mg/kg)	10:2 FTS (µg/L)	PFAS (mg/kg)	PFAS (µg/L)	Sum of PFHxS and PFOS (mg/kg)	Sum of PFHxS and PFOS (µg/L)	PFAS (mg/kg)	PFAS (µg/L)
22/11/2018 15:00	soil_1	Normal	soil	<0.05	<0.0005	<0.05	0.0024	0.06	0.0024	0.06	0.0024	0.06
22/11/2018 15:00	soil_2	Normal	soil	<0.05	<0.0005	<0.05	0.0011	0.02	0.0011	0.02	0.0011	0.02
22/11/2018 15:00	soil_3	Normal	soil	<0.05	<0.0005	<0.05	0.0024	0.03	0.0024	0.03	0.0024	0.03
22/11/2018 15:00	soil_4	Normal	soil	<0.05	<0.0005	<0.05	0.0005	<0.01	0.0002	<0.01	0.0002	<0.01
22/11/2018 15:00	soil_5	Normal	soil	<0.05	<0.0005	<0.05	<0.0002	<0.01	<0.0002	<0.01	<0.0002	<0.01
22/11/2018 15:00	soil_6	Normal	soil	<0.05	<0.0005	<0.05	0.0005	<0.01	0.0003	<0.01	0.0003	<0.01
22/11/2018 15:00	soil_7	Normal	soil	<0.05	<0.0005	<0.05	0.271	2.48	0.257	2.38	0.261	2.44
22/11/2018 15:00	soil_8	Normal	soil	<0.05	<0.0005	<0.05	0.0211	0.73	0.0195	0.71	0.0201	0.73



Analytical Results Tables  
Table 3- Sediment Results (Phase 2)

	Inorganics	Leachate	PFAS								
	Moisture (%)	pH (Final)	Perfluorobutane sulfonic acid (PFBS)		Perfluoropentane sulfonic acid (PFPeS)		Perfluorohexane sulfonic acid (PFHxS)		Perfluoroheptane sulfonic acid (PFHpS)		Perfluorooctane sulfonic acid (PFOS)
	%	pH Units	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg
EQL	0.1	0.1	0.0002	0.02	0.0002	0.02	0.0002	0.02	0.0002	0.02	0.0002
Adopted Sediment Criteria											
PFAS NEMP 2018 Health Recreational Water											
PFAS NEMP 2018 Interim Marine 99%											

Date/Time	Field ID	Sample Type	Matrix Type	Moisture (%)	pH (Final)	Perfluorobutane sulfonic acid (PFBS) mg/kg	Perfluorobutane sulfonic acid (PFBS) µg/L	Perfluoropentane sulfonic acid (PFPeS) mg/kg	Perfluoropentane sulfonic acid (PFPeS) µg/L	Perfluorohexane sulfonic acid (PFHxS) mg/kg	Perfluorohexane sulfonic acid (PFHxS) µg/L	Perfluoroheptane sulfonic acid (PFHpS) mg/kg	Perfluoroheptane sulfonic acid (PFHpS) µg/L	Perfluorooctane sulfonic acid (PFOS) mg/kg
9/01/2019 14:30	SD01	Normal	soil	25.5	8.8	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02	0.0030
9/01/2019 14:30	SD02	Normal	soil	51.4	8.4	<0.0002	<0.02	0.0009	<0.02	0.0003	<0.02	<0.0002	<0.02	0.0010
9/01/2019 14:30	SD03	Normal	soil	73.1	7.5	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02	0.0023
9/01/2019 14:30	SD04	Normal	soil	18.6	8.7	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02	<0.0002
9/01/2019 14:30	SD05	Normal	soil	14.4	9.0	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02	<0.0002
9/01/2019 14:30	SD06	Normal	soil	19.5	9.4	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02	<0.0002
9/01/2019 14:30	SD07	Normal	soil	70.4	8.0	<0.0002	<0.02	0.0004	<0.02	0.0082	0.15	0.0024	0.03	0.252
9/01/2019 14:30	SD08	Normal	soil	64.2	8.2	<0.0002	<0.02	<0.0002	<0.02	0.0022	0.06	<0.0002	<0.02	0.0159



Analytical Results Tables  
Table 3- Sediment Results (Phase 2)

	Inorganics	Leachate	PFAS								
	Moisture (%)	pH (Final)	Perfluorooctane sulfonic acid (PFOS)	Perfluorodecanesulfonic acid (PFDS)	Perfluorobutanoic acid (PFBA)	Perfluoropentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)				
	%	pH Units	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L
EQL	0.1	0.1	0.01	0.0002	0.02	0.001	0.1	0.0002	0.02	0.0002	0.02
Adopted Sediment Criteria											
PFAS NEMP 2018 Health Recreational Water											
PFAS NEMP 2018 Interim Marine 99%											

Date/Time	Field ID	Sample Type	Matrix Type											
9/01/2019 14:30	SD01	Normal	soil	25.5	8.8	0.07	<0.0002	<0.02	<0.001	<0.1	<0.0002	<0.02	<0.0002	<0.02
9/01/2019 14:30	SD02	Normal	soil	51.4	8.4	0.03	<0.0002	<0.02	<0.001	<0.1	<0.0002	<0.02	<0.0002	<0.02
9/01/2019 14:30	SD03	Normal	soil	73.1	7.5	0.02	<0.0002	<0.02	<0.001	<0.1	<0.0002	<0.02	<0.0002	<0.02
9/01/2019 14:30	SD04	Normal	soil	18.6	8.7	<0.01	<0.0002	<0.02	<0.001	<0.1	<0.0002	<0.02	<0.0002	<0.02
9/01/2019 14:30	SD05	Normal	soil	14.4	9.0	<0.01	<0.0002	<0.02	<0.001	<0.1	<0.0002	<0.02	<0.0002	<0.02
9/01/2019 14:30	SD06	Normal	soil	19.5	9.4	<0.01	<0.0002	<0.02	<0.001	<0.1	<0.0002	<0.02	<0.0002	<0.02
9/01/2019 14:30	SD07	Normal	soil	70.4	8.0	1.64	<0.0002	<0.02	<0.001	<0.1	0.0002	<0.02	0.0012	<0.02
9/01/2019 14:30	SD08	Normal	soil	64.2	8.2	0.17	<0.0002	<0.02	<0.001	<0.1	<0.0002	<0.02	0.0002	<0.02



Analytical Results Tables  
Table 3- Sediment Results (Phase 2)

	Inorganics	Leachate	PFAS										
	Moisture (%)	pH (Final)	Perfluoroheptanoic acid (PFHpA)		Perfluorooctanoic acid (PFOA)		Perfluorononanoic acid (PFNA)		Perfluorodecanoic acid (PFDA)		Perfluoroundecanoic acid (PFUnDA)		
	%	pH Units	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg		
EQL	0.1	0.1	0.0002	0.02	0.0002	0.01	0.0002	0.02	0.0002	0.02	0.0002	0.02	0.0002
Adopted Sediment Criteria					0.22								
PFAS NEMP 2018 Health Recreational Water						5.6							
PFAS NEMP 2018 Interim Marine 99%						19							

Date/Time	Field ID	Sample Type	Matrix Type											
9/01/2019 14:30	SD01	Normal	soil	25.5	8.8	<0.0002	<0.02	<0.0002	<0.01	<0.0002	<0.02	0.0002	<0.02	<0.0002
9/01/2019 14:30	SD02	Normal	soil	51.4	8.4	<0.0002	<0.02	<0.0002	<0.01	<0.0002	<0.02	0.0003	<0.02	<0.0002
9/01/2019 14:30	SD03	Normal	soil	73.1	7.5	<0.0002	<0.02	<0.0002	<0.01	<0.0002	<0.02	0.0004	<0.02	<0.0002
9/01/2019 14:30	SD04	Normal	soil	18.6	8.7	<0.0002	<0.02	<0.0002	<0.01	<0.0002	<0.02	<0.0002	<0.02	<0.0002
9/01/2019 14:30	SD05	Normal	soil	14.4	9.0	<0.0002	<0.02	<0.0002	<0.01	<0.0002	<0.02	<0.0002	<0.02	<0.0002
9/01/2019 14:30	SD06	Normal	soil	19.5	9.4	<0.0002	<0.02	<0.0002	<0.01	<0.0002	<0.02	<0.0002	<0.02	<0.0002
9/01/2019 14:30	SD07	Normal	soil	70.4	8.0	0.0003	<0.02	0.0016	0.02	0.0004	<0.02	0.0024	<0.02	0.0023
9/01/2019 14:30	SD08	Normal	soil	64.2	8.2	<0.0002	<0.02	0.0004	<0.01	<0.0002	<0.02	0.0003	<0.02	0.0004



Analytical Results Tables  
Table 3- Sediment Results (Phase 2)

	Inorganics	Leachate	PFAS								
	Moisture (%)	pH (Final)	Perfluoroundecanoic acid (PFUnDA)	Perfluorododecanoic acid (PFDoDA)	Perfluorotridecanoic acid (PFTrDA)	Perfluorotetradecanoic acid (PFTeDA)	Perfluorooctane sulfonamide (FOSA)				
	%	pH Units	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L
EQL	0.1	0.1	0.02	0.0002	0.02	0.0002	0.02	0.0005	0.05	0.0002	0.02
Adopted Sediment Criteria											
PFAS NEMP 2018 Health Recreational Water											
PFAS NEMP 2018 Interim Marine 99%											

Date/Time	Field ID	Sample Type	Matrix Type											
9/01/2019 14:30	SD01	Normal	soil	25.5	8.8	<0.02	<0.0002	<0.02	<0.0002	<0.02	<0.0005	<0.05	<0.0002	<0.02
9/01/2019 14:30	SD02	Normal	soil	51.4	8.4	<0.02	0.0011	<0.02	<0.0002	<0.02	<0.0005	<0.05	<0.0002	<0.02
9/01/2019 14:30	SD03	Normal	soil	73.1	7.5	<0.02	<0.0002	<0.02	<0.0002	<0.02	<0.0005	<0.05	<0.0002	<0.02
9/01/2019 14:30	SD04	Normal	soil	18.6	8.7	<0.02	0.0004	<0.02	<0.0002	<0.02	<0.0005	<0.05	<0.0002	<0.02
9/01/2019 14:30	SD05	Normal	soil	14.4	9.0	<0.02	<0.0002	<0.02	<0.0002	<0.02	<0.0005	<0.05	<0.0002	<0.02
9/01/2019 14:30	SD06	Normal	soil	19.5	9.4	<0.02	<0.0002	<0.02	<0.0002	<0.02	<0.0005	<0.05	<0.0002	<0.02
9/01/2019 14:30	SD07	Normal	soil	70.4	8.0	<0.02	0.0070	<0.02	<0.0002	<0.02	<0.0005	<0.05	0.0005	<0.02
9/01/2019 14:30	SD08	Normal	soil	64.2	8.2	<0.02	0.0017	<0.02	0.0004	<0.02	<0.0005	<0.05	<0.0002	<0.02



Analytical Results Tables  
Table 3- Sediment Results (Phase 2)

	Inorganics	Leachate	PFAS								
	Moisture (%)	pH (Final)	N-Methyl perfluorooctane sulfonamide (MeFOSA)		N-Ethyl perfluorooctane sulfonamide (EtFOSA)		N-Methyl perfluorooctane sulfonamidoethanol (MEFOSE)		N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)		N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOsAA)
	%	pH Units	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg
EQL	0.1	0.1	0.0005	0.05	0.0005	0.05	0.0005	0.05	0.0005	0.05	0.0002
Adopted Sediment Criteria											
PFAS NEMP 2018 Health Recreational Water											
PFAS NEMP 2018 Interim Marine 99%											

Date/Time	Field ID	Sample Type	Matrix Type	Moisture (%)	pH (Final)	MeFOSA (mg/kg)	MeFOSA (µg/L)	EtFOSA (mg/kg)	EtFOSA (µg/L)	MEFOSE (mg/kg)	MEFOSE (µg/L)	EtFOSE (mg/kg)	EtFOSE (µg/L)	MeFOsAA (mg/kg)
9/01/2019 14:30	SD01	Normal	soil	25.5	8.8	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.05	<0.0002
9/01/2019 14:30	SD02	Normal	soil	51.4	8.4	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.05	<0.0002
9/01/2019 14:30	SD03	Normal	soil	73.1	7.5	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.05	<0.0002
9/01/2019 14:30	SD04	Normal	soil	18.6	8.7	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.05	<0.0002
9/01/2019 14:30	SD05	Normal	soil	14.4	9.0	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.05	<0.0002
9/01/2019 14:30	SD06	Normal	soil	19.5	9.4	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.05	<0.0002
9/01/2019 14:30	SD07	Normal	soil	70.4	8.0	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.05	<0.0002
9/01/2019 14:30	SD08	Normal	soil	64.2	8.2	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.05	<0.0002



Analytical Results Tables  
Table 3- Sediment Results (Phase 2)

	Inorganics	Leachate	PFAS								
	Moisture (%)	pH (Final)	N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	4:2 Fluorotelomer sulfonic acid (4:2 FTS)	6:2 Fluorotelomer Sulfonate (6:2 FTS)	8:2 Fluorotelomer sulfonic acid (8:2 FTS)				
	%	pH Units	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L
EQL	0.1	0.1	0.02	0.0002	0.02	0.0005	0.05	0.0005	0.05	0.0005	0.05
Adopted Sediment Criteria											
PFAS NEMP 2018 Health Recreational Water											
PFAS NEMP 2018 Interim Marine 99%											

Date/Time	Field ID	Sample Type	Matrix Type											
9/01/2019 14:30	SD01	Normal	soil	25.5	8.8	<0.02	<0.0002	<0.02	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.05
9/01/2019 14:30	SD02	Normal	soil	51.4	8.4	<0.02	<0.0002	<0.02	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.05
9/01/2019 14:30	SD03	Normal	soil	73.1	7.5	<0.02	<0.0002	<0.02	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.05
9/01/2019 14:30	SD04	Normal	soil	18.6	8.7	<0.02	<0.0002	<0.02	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.05
9/01/2019 14:30	SD05	Normal	soil	14.4	9.0	<0.02	<0.0002	<0.02	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.05
9/01/2019 14:30	SD06	Normal	soil	19.5	9.4	<0.02	<0.0002	<0.02	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.05
9/01/2019 14:30	SD07	Normal	soil	70.4	8.0	<0.02	<0.0002	<0.02	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.05
9/01/2019 14:30	SD08	Normal	soil	64.2	8.2	<0.02	<0.0002	<0.02	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.05



Analytical Results Tables  
Table 3- Sediment Results (Phase 2)

	Inorganics	Leachate	PFAS							
	Moisture (%)	pH (Final)	10:2 Fluorotelomer sulfonic acid (10:2 FTS)		PFAS (Sum of Total)		Sum of PFHxS and PFOS		PFAS (Sum of Total)(WA DER List)	
			mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L
EQL	0.1	0.1	0.0005	0.05	0.0002	0.01	0.0002	0.01	0.0002	0.01
Adopted Sediment Criteria							0.22			
PFAS NEMP 2018 Health Recreational Water								0.7		
PFAS NEMP 2018 Interim Marine 99%								0.00023		

Date/Time	Field ID	Sample Type	Matrix Type	Moisture (%)	pH (Final)	10:2 FTS (mg/kg)	10:2 FTS (µg/L)	PFAS (mg/kg)	PFAS (µg/L)	Sum of PFHxS and PFOS (mg/kg)	Sum of PFHxS and PFOS (µg/L)	PFAS (mg/kg)	PFAS (µg/L)
9/01/2019 14:30	SD01	Normal	soil	25.5	8.8	<0.0005	<0.05	0.0032	0.07	0.0030	0.07	0.0030	0.07
9/01/2019 14:30	SD02	Normal	soil	51.4	8.4	<0.0005	<0.05	0.0049	0.03	0.0013	0.03	0.0013	0.03
9/01/2019 14:30	SD03	Normal	soil	73.1	7.5	<0.0005	<0.05	0.0027	0.02	0.0023	0.02	0.0023	0.02
9/01/2019 14:30	SD04	Normal	soil	18.6	8.7	<0.0005	<0.05	0.0003	<0.01	<0.0002	<0.01	<0.0002	<0.01
9/01/2019 14:30	SD05	Normal	soil	14.4	9.0	<0.0005	<0.05	<0.0002	<0.01	<0.0002	<0.01	<0.0002	<0.01
9/01/2019 14:30	SD06	Normal	soil	19.5	9.4	<0.0005	<0.05	<0.0002	<0.01	<0.0002	<0.01	<0.0002	<0.01
9/01/2019 14:30	SD07	Normal	soil	70.4	8.0	<0.0005	<0.05	0.279	1.84	0.260	1.79	0.264	1.81
9/01/2019 14:30	SD08	Normal	soil	64.2	8.2	<0.0005	<0.05	0.0215	0.23	0.0181	0.23	0.0187	0.23



**Analytical Results Tables**  
**Table 4 - Surface Water Results (Phase 1)**

PFAS												
	Perfluorobutane sulfonic acid (PFBS)	Perfluoropentane sulfonic acid (PFPeS)	Perfluorohexane sulfonic acid (PFHxS)	Perfluoroheptane sulfonic acid (PFHpS)	Perfluorooctane sulfonic acid (PFOS)	Perfluorodecanesulfonic acid (PFDS)	Perfluorobutanoic acid (PFBA)	Perfluoropentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)
	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
EQL	0.02	0.02	0.02	0.02	0.01	0.02	0.1	0.02	0.02	0.02	0.01	0.02
PFAS NEMP 2018 Health Recreational Water											5.6	
PFAS NEMP 2018 Interim Marine 99%											19	

Date/Time	Field ID	Sample Type	Matrix Type	Perfluorobutane sulfonic acid (PFBS)	Perfluoropentane sulfonic acid (PFPeS)	Perfluorohexane sulfonic acid (PFHxS)	Perfluoroheptane sulfonic acid (PFHpS)	Perfluorooctane sulfonic acid (PFOS)	Perfluorodecanesulfonic acid (PFDS)	Perfluorobutanoic acid (PFBA)	Perfluoropentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)
22/11/2018 15:00	SW01	Normal	water	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.05	<0.05	<0.05	<0.05	<0.05
22/11/2018 15:00	SW02	Normal	water	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.1	<0.02	<0.02	<0.02	<0.01	<0.02
22/11/2018 15:00	SW03	Normal	water	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.1	<0.02	<0.02	<0.02	<0.01	<0.02
22/11/2018 15:00	SW04	Normal	water	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.05	<0.05	<0.05	<0.05	<0.05
22/11/2018 15:00	SW05	Normal	water	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.05	<0.05	<0.05	<0.05	<0.05
22/11/2018 15:00	SW06	Normal	water	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.05	<0.05	<0.05	<0.05	<0.05
22/11/2018 15:00	SW07	Normal	water	0.12	0.08	0.58	0.04	0.89	<0.02	<0.1	0.05	0.25	0.02	0.06	<0.02
22/11/2018 15:00	SW08	Normal	water	<0.02	<0.02	0.08	<0.02	0.29	<0.02	<0.1	<0.02	0.05	<0.02	0.02	<0.02



**Analytical Results Tables**  
**Table 4 - Surface Water Results (Phase 1)**

	PFAS											
	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnDA)	Perfluorododecanoic acid (PFDoDA)	Perfluorotridecanoic acid (PFTrDA)	Perfluorotetradecanoic acid (PFTeDA)	Perfluorooctane sulfonamide (FOSA)	N-Methyl perfluorooctane sulfonamide (MeFOSA)	N-Ethyl perfluorooctane sulfonamide (EtFOSA)	N-Methyl perfluorooctane sulfonamidoethanol (MEFOSE)	N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)
	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
EQL	0.02	0.02	0.02	0.02	0.05	0.02	0.05	0.05	0.05	0.05	0.02	0.02
PFAS NEMP 2018 Health Recreational Water												
PFAS NEMP 2018 Interim Marine 99%												

Date/Time	Field ID	Sample Type	Matrix Type	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnDA)	Perfluorododecanoic acid (PFDoDA)	Perfluorotridecanoic acid (PFTrDA)	Perfluorotetradecanoic acid (PFTeDA)	Perfluorooctane sulfonamide (FOSA)	N-Methyl perfluorooctane sulfonamide (MeFOSA)	N-Ethyl perfluorooctane sulfonamide (EtFOSA)	N-Methyl perfluorooctane sulfonamidoethanol (MEFOSE)	N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)
22/11/2018 15:00	SW01	Normal	water	<0.05	<0.05	<0.05	<0.05	<0.12	<0.05	<0.12	<0.12	<0.12	<0.12	<0.05	<0.05
22/11/2018 15:00	SW02	Normal	water	<0.02	<0.02	<0.02	<0.02	<0.05	<0.02	<0.05	<0.05	<0.05	<0.05	<0.02	<0.02
22/11/2018 15:00	SW03	Normal	water	<0.02	<0.02	<0.02	<0.02	<0.05	<0.02	<0.05	<0.05	<0.05	<0.05	<0.02	<0.02
22/11/2018 15:00	SW04	Normal	water	<0.05	<0.05	<0.05	<0.05	<0.12	<0.05	<0.12	<0.12	<0.12	<0.12	<0.05	<0.05
22/11/2018 15:00	SW05	Normal	water	<0.05	<0.05	<0.05	<0.05	<0.12	<0.05	<0.12	<0.12	<0.12	<0.12	<0.05	<0.05
22/11/2018 15:00	SW06	Normal	water	<0.05	<0.05	<0.05	<0.05	<0.12	<0.05	<0.12	<0.12	<0.12	<0.12	<0.05	<0.05
22/11/2018 15:00	SW07	Normal	water	<0.02	<0.02	<0.02	<0.02	<0.05	<0.02	<0.05	<0.05	<0.05	<0.05	<0.02	<0.02
22/11/2018 15:00	SW08	Normal	water	<0.02	<0.02	<0.02	<0.02	<0.05	<0.02	<0.05	<0.05	<0.05	<0.05	<0.02	<0.02



**Analytical Results Tables**  
**Table 4 - Surface Water Results (Phase 1)**

	PFAS						
	4:2 Fluorotelomer sulfonic acid (4:2 FTS)	6:2 Fluorotelomer Sulfonate (6:2 FTS)	8:2 Fluorotelomer sulfonic acid (8:2 FTS)	10:2 Fluorotelomer sulfonic acid (10:2 FTS)	PFAS (Sum of Total)	Sum of PFHxS and PFOS	PFAS (Sum of Total)(WA DER List)
	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
EQL	0.05	0.05	0.05	0.05	0.01	0.01	0.01
PFAS NEMP 2018 Health Recreational Water						0.7	
PFAS NEMP 2018 Interim Marine 99%						0.00023	

Date/Time	Field ID	Sample Type	Matrix Type	4:2 FTS	6:2 FTS	8:2 FTS	10:2 FTS	PFAS (Sum of Total)	Sum of PFHxS and PFOS	PFAS (Sum of Total)(WA DER List)
22/11/2018 15:00	SW01	Normal	water	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
22/11/2018 15:00	SW02	Normal	water	<0.05	<0.05	<0.05	<0.05	0.02	0.02	0.02
22/11/2018 15:00	SW03	Normal	water	<0.05	<0.05	<0.05	<0.05	0.02	0.02	0.02
22/11/2018 15:00	SW04	Normal	water	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
22/11/2018 15:00	SW05	Normal	water	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
22/11/2018 15:00	SW06	Normal	water	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
22/11/2018 15:00	SW07	Normal	water	<0.05	<0.05	<0.05	<0.05	2.09	1.47	1.97
22/11/2018 15:00	SW08	Normal	water	<0.05	<0.05	<0.05	<0.05	0.44	0.37	0.44



Analytical Results Tables  
Table 5 - Surface Water Results (Phase 2)

	PFAS											
	Perfluorobutane sulfonic acid (PFBS)	Perfluoropentane sulfonic acid (PFPeS)	Perfluorohexane sulfonic acid (PFHxS)	Perfluoroheptane sulfonic acid (PFHpS)	Perfluorooctane sulfonic acid (PFOS)	Perfluorodecanesulfonic acid (PFDS)	Perfluorobutanoic acid (PFBA)	Perfluoropentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)
	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
EQL	0.02	0.02	0.02	0.02	0.01	0.02	0.1	0.02	0.02	0.02	0.01	0.02
PFAS NEMP 2018 Health Recreational Water											5.6	
PFAS NEMP 2018 Interim Marine 99%											19	

Date/Time	Field ID	Sample Type	Matrix Type	Perfluorobutane sulfonic acid (PFBS)	Perfluoropentane sulfonic acid (PFPeS)	Perfluorohexane sulfonic acid (PFHxS)	Perfluoroheptane sulfonic acid (PFHpS)	Perfluorooctane sulfonic acid (PFOS)	Perfluorodecanesulfonic acid (PFDS)	Perfluorobutanoic acid (PFBA)	Perfluoropentanoic acid (PFPeA)	Perfluorohexanoic acid (PFHxA)	Perfluoroheptanoic acid (PFHpA)	Perfluorooctanoic acid (PFOA)	Perfluorononanoic acid (PFNA)
9/01/2019 14:30	SWD01	Normal	water	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.05	<0.05	<0.05	<0.05	<0.05
9/01/2019 14:30	SWD02	Normal	water	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.05	<0.05	<0.05	<0.05	<0.05
9/01/2019 14:30	SWD03	Normal	water	<0.02	<0.02	0.02	<0.02	0.03	<0.02	<0.1	<0.02	<0.02	<0.02	0.01	<0.02
9/01/2019 14:30	SWD04	Normal	water	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.05	<0.05	<0.05	<0.05	<0.05
9/01/2019 14:30	SWD05	Normal	water	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.05	<0.05	<0.05	<0.05	<0.05
9/01/2019 14:30	SWD06	Normal	water	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	<0.05	<0.05	<0.05	<0.05	<0.05
9/01/2019 14:30	SWD07	Normal	water	<0.05	<0.05	0.14	<0.05	0.07	<0.05	<0.2	<0.05	<0.05	<0.05	<0.05	<0.05
9/01/2019 14:30	SWD08	Normal	water	0.14	0.08	0.51	<0.05	0.15	<0.05	<0.2	<0.05	0.21	<0.05	<0.05	<0.05



Analytical Results Tables  
Table 5 - Surface Water Results (Phase 2)

	PFAS											
	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnDA)	Perfluorododecanoic acid (PFDoDA)	Perfluorotridecanoic acid (PFTriDA)	Perfluorotetradecanoic acid (PFTeDA)	Perfluorooctane sulfonamide (FOSA)	N-Methyl perfluorooctane sulfonamide (MeFOSA)	N-Ethyl perfluorooctane sulfonamide (EtFOSA)	N-Methyl perfluorooctane sulfonamidoethanol (MEFOSE)	N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)
	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
EQL	0.02	0.02	0.02	0.02	0.05	0.02	0.05	0.05	0.05	0.05	0.02	0.02
PFAS NEMP 2018 Health Recreational Water												
PFAS NEMP 2018 Interim Marine 99%												

Date/Time	Field ID	Sample Type	Matrix Type	Perfluorodecanoic acid (PFDA)	Perfluoroundecanoic acid (PFUnDA)	Perfluorododecanoic acid (PFDoDA)	Perfluorotridecanoic acid (PFTriDA)	Perfluorotetradecanoic acid (PFTeDA)	Perfluorooctane sulfonamide (FOSA)	N-Methyl perfluorooctane sulfonamide (MeFOSA)	N-Ethyl perfluorooctane sulfonamide (EtFOSA)	N-Methyl perfluorooctane sulfonamidoethanol (MEFOSE)	N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)
9/01/2019 14:30	SWD01	Normal	water	<0.05	<0.05	<0.05	<0.05	<0.12	<0.05	<0.12	<0.12	<0.12	<0.12	<0.05	<0.05
9/01/2019 14:30	SWD02	Normal	water	<0.05	<0.05	<0.05	<0.05	<0.12	<0.05	<0.12	<0.12	<0.12	<0.12	<0.05	<0.05
9/01/2019 14:30	SWD03	Normal	water	<0.02	<0.02	<0.02	<0.02	<0.05	<0.02	<0.05	<0.05	<0.05	<0.05	<0.02	<0.02
9/01/2019 14:30	SWD04	Normal	water	<0.05	<0.05	<0.05	<0.05	<0.12	<0.05	<0.12	<0.12	<0.12	<0.12	<0.05	<0.05
9/01/2019 14:30	SWD05	Normal	water	<0.05	<0.05	<0.05	<0.05	<0.12	<0.05	<0.12	<0.12	<0.12	<0.12	<0.05	<0.05
9/01/2019 14:30	SWD06	Normal	water	<0.05	<0.05	<0.05	<0.05	<0.12	<0.05	<0.12	<0.12	<0.12	<0.12	<0.05	<0.05
9/01/2019 14:30	SWD07	Normal	water	<0.05	<0.05	<0.05	<0.05	<0.12	<0.05	<0.12	<0.12	<0.12	<0.12	<0.05	<0.05
9/01/2019 14:30	SWD08	Normal	water	<0.05	<0.05	<0.05	<0.05	<0.12	<0.05	<0.12	<0.12	<0.12	<0.12	<0.05	<0.05



**Analytical Results Tables**  
**Table 5 - Surface Water Results (Phase 2)**

	PFAS						
	4:2 Fluorotelomer sulfonic acid (4:2 FTS)	6:2 Fluorotelomer Sulfonate (6:2 FTS)	8:2 Fluorotelomer sulfonic acid (8:2 FTS)	10:2 Fluorotelomer sulfonic acid (10:2 FTS)	PFAS (Sum of Total)	Sum of PFHxS and PFOS	PFAS (Sum of Total)(WA DER List)
	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
EQL	0.05	0.05	0.05	0.05	0.01	0.01	0.01
PFAS NEMP 2018 Health Recreational Water						0.7	
PFAS NEMP 2018 Interim Marine 99%						0.00023	

Date/Time	Field ID	Sample Type	Matrix Type	4:2 FTS	6:2 FTS	8:2 FTS	10:2 FTS	PFAS (Sum of Total)	Sum of PFHxS and PFOS	PFAS (Sum of Total)(WA DER List)
9/01/2019 14:30	SWD01	Normal	water	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
9/01/2019 14:30	SWD02	Normal	water	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
9/01/2019 14:30	SWD03	Normal	water	<0.05	<0.05	<0.05	<0.05	0.06	0.05	0.06
9/01/2019 14:30	SWD04	Normal	water	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
9/01/2019 14:30	SWD05	Normal	water	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
9/01/2019 14:30	SWD06	Normal	water	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
9/01/2019 14:30	SWD07	Normal	water	<0.05	<0.05	<0.05	<0.05	0.21	0.21	0.21
9/01/2019 14:30	SWD08	Normal	water	<0.05	<0.05	<0.05	<0.05	1.09	0.66	1.01



Analytical Results Tables  
Table 6 - QA/QC Results

EQL	Inorganics		Leachate	PFAS							
	Moisture (%)	Moisture Content (%)	pH (Final)	Perfluorobutane sulfonic acid (PFBS)		Perfluoropentane sulfonic acid (PFPeS)		Perfluorohexane sulfonic acid (PFHxS)		Perfluoroheptane sulfonic acid (PFHpS)	
	%	%	pH Units	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg
	0.1	1	0.1	0.01	0.0002	0.01	0.0002	0.01	0.0002	0.01	0.0002

Project Phase	Date	Sample ID	Sample Type	Matrix Type										
1	22/11/2018	soil_4	Normal	Sediment			<0.02	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02	<0.0002
		QA01_2	Interlab_D	Sediment				<0.005		<0.005		<0.005		<0.005
		RPD						0		0		0		0
		QA02_2	Interlab_D	Sediment			<0.01		<0.01		<0.01		<0.01	
		RPD						0		0		0		0
		SW04	Normal	Surface Water			<0.05		<0.05		<0.05		<0.05	
		QA01_1	Field_D	Surface Water			<0.05		<0.05		<0.05		<0.05	
		RPD						0		0		0		0
	QA02_1	Interlab_D	Surface Water			<0.01		<0.01		<0.01		<0.01		
	RPD						0		0		0		0	
	GW16_12	Normal	Surface Water			0.04		0.02		0.09		<0.01		
	QA01	Field_D	Surface Water			0.04		0.02		0.09		<0.01		
	RPD						0		0		0		0	
	2	9/01/2019	SD04	Normal	Sediment	18.6	8.7	<0.02	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02
QA01B			Field_D	Sediment	17.9	9.2	<0.02	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02	<0.0002
RPD					4	6	0		0		0		0	
QA02B			Interlab_D	Sediment		16		<0.005		<0.005		<0.005		<0.005
RPD							0		0		0		0	
SWD04			Normal	Surface Water			<0.05		<0.05		<0.05		<0.05	
QA01A			Field_D	Surface Water			<0.05		<0.05		<0.05		<0.05	
RPD							0		0		0		0	
QA02A			Interlab_D	Surface Water			<0.01		<0.01		<0.01		<0.01	
RPD							0		0		0		0	



Analytical Results Tables  
Table 6 - QA/QC Results

Adelaide Airport ESA - Off - Airport Investigations

PFAS																					
Perfluorooctane sulfonic acid (PFOS)		Perfluorodecanesulfonic acid (PFDS)		Perfluorobutanoic acid (PFBA)		Perfluoropentanoic acid (PFPeA)		Perfluorohexanoic acid (PFHxA)		Perfluoroheptanoic acid (PFHpA)		Perfluorooctanoic acid (PFOA)		Perfluorononanoic acid (PFNA)		Perfluorodecanoic acid (PFDA)		Perfluoroundecanoic acid (PFUnDA)			
µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg		
EQL	0.01	0.0002	0.01	0.0002	0.05	0.001	0.01	0.0002	0.01	0.0002	0.01	0.0002	0.01	0.0002	0.01	0.0002	0.01	0.0002	0.01	0.0002	

Project Phase	Date	Sample ID	Sample Type	Matrix Type	Perfluorooctane sulfonic acid (PFOS) µg/L	Perfluorooctane sulfonic acid (PFOS) mg/kg	Perfluorodecanesulfonic acid (PFDS) µg/L	Perfluorodecanesulfonic acid (PFDS) mg/kg	Perfluorobutanoic acid (PFBA) µg/L	Perfluorobutanoic acid (PFBA) mg/kg	Perfluoropentanoic acid (PFPeA) µg/L	Perfluoropentanoic acid (PFPeA) mg/kg	Perfluorohexanoic acid (PFHxA) µg/L	Perfluorohexanoic acid (PFHxA) mg/kg	Perfluoroheptanoic acid (PFHpA) µg/L	Perfluoroheptanoic acid (PFHpA) mg/kg	Perfluorooctanoic acid (PFOA) µg/L	Perfluorooctanoic acid (PFOA) mg/kg	Perfluorononanoic acid (PFNA) µg/L	Perfluorononanoic acid (PFNA) mg/kg	Perfluorodecanoic acid (PFDA) µg/L	Perfluorodecanoic acid (PFDA) mg/kg	Perfluoroundecanoic acid (PFUnDA) µg/L	Perfluoroundecanoic acid (PFUnDA) mg/kg	
1	22/11/2018	soil_4	Normal	Sediment	<0.01	0.0002	<0.02	<0.0002	<0.1	<0.001	<0.02	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.01	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02	<0.0002	
		QA01_2	Interlab_D	Sediment		<0.005		<0.005		<0.005		<0.005		<0.005		<0.005		<0.005		<0.005		<0.005		<0.005	
		RPD					0		0		0		0		0		0		0		0		0		0
		QA02_2	Interlab_D	Sediment		<0.01		<0.01		<0.05		<0.01		<0.01		<0.01		<0.01		<0.01		<0.01		<0.01	
		RPD					0		0		0		0		0		0		0		0		0		0
		SW04	Normal	Surface Water		<0.05		<0.05		<0.2		<0.05		<0.05		<0.05		<0.05		<0.05		<0.05		<0.05	
	26/11/2018	QA01_1	Field_D	Surface Water		<0.05		<0.05		<0.2		<0.05		<0.05		<0.05		<0.05		<0.05		<0.05		<0.05	
		RPD					0		0		0		0		0		0		0		0		0		0
		QA02_1	Interlab_D	Surface Water		<0.01		<0.01		<0.05		<0.01		<0.01		<0.01		<0.01		<0.01		<0.01		<0.01	
		RPD					0		0		0		0		0		0		0		0		0		0
		GW16_12	Normal	Surface Water		0.03		<0.01		<0.05		0.02		0.03		<0.01		0.03		<0.01		<0.01		<0.01	
		QA01	Field_D	Surface Water		0.02		<0.01		<0.05		0.01		0.02		<0.01		0.03		<0.01		<0.01		<0.01	
2	9/01/2019	RPD				40		0		0		67		40		0		0		0		0		0	
		SD04	Normal	Sediment		<0.01	<0.0002	<0.02	<0.0002	<0.1	<0.001	<0.02	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.01	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02	<0.0002
		QA01B	Field_D	Sediment		<0.01	<0.0002	<0.02	<0.0002	<0.1	<0.001	<0.02	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.01	<0.0002	<0.02	<0.0002	<0.02	<0.0002	<0.02	<0.0002
		RPD					0		0		0		0		0		0		0		0		0		0
		QA02B	Interlab_D	Sediment			<0.005		<0.005		<0.005		<0.005		<0.005		<0.005		<0.005		<0.005		<0.005		<0.005
		RPD					0		0		0		0		0		0		0		0		0		0
	9/01/2019	SWD04	Normal	Surface Water		<0.05		<0.05		<0.2		<0.05		<0.05		<0.05		<0.05		<0.05		<0.05		<0.05	
		QA01A	Field_D	Surface Water		<0.05		<0.05		<0.2		<0.05		<0.05		<0.05		<0.05		<0.05		<0.05		<0.05	
		RPD					0		0		0		0		0		0		0		0		0		0
		QA02A	Interlab_D	Surface Water		<0.01		<0.01		<0.05		<0.01		<0.01		<0.01		<0.01		<0.01		<0.01		<0.01	
		RPD					0		0		0		0		0		0		0		0		0		0



Analytical Results Tables  
Table 6 - QA/QC Results

Adelaide Airport ESA - Off - Airport Investigations

PFAS																					
Perfluorododecanoic acid (PFDoDA)		Perfluorotridecanoic acid (PFTriDA)		Perfluorotetradecanoic acid (PFTeDA)		Perfluorooctane sulfonamide (FOSA)		N-Methyl perfluorooctane sulfonamide (MeFOSA)		N-Ethyl perfluorooctane sulfonamide (EtFOSA)		N-Methyl perfluorooctane sulfonamidoethanol (MEFOSE)		N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)		N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOAAA)		N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOAAA)			
µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg
EQL	0.01	0.0002	0.01	0.0002	0.01	0.0005	0.02	0.0002	0.05	0.0005	0.05	0.0005	0.05	0.0005	0.05	0.0005	0.02	0.0002	0.02	0.0002	

Project Phase	Date	Sample ID	Sample Type	Matrix Type	Perfluorododecanoic acid (PFDoDA) µg/L	Perfluorododecanoic acid (PFDoDA) mg/kg	Perfluorotridecanoic acid (PFTriDA) µg/L	Perfluorotridecanoic acid (PFTriDA) mg/kg	Perfluorotetradecanoic acid (PFTeDA) µg/L	Perfluorotetradecanoic acid (PFTeDA) mg/kg	Perfluorooctane sulfonamide (FOSA) µg/L	Perfluorooctane sulfonamide (FOSA) mg/kg	N-Methyl perfluorooctane sulfonamide (MeFOSA) µg/L	N-Methyl perfluorooctane sulfonamide (MeFOSA) mg/kg	N-Ethyl perfluorooctane sulfonamide (EtFOSA) µg/L	N-Ethyl perfluorooctane sulfonamide (EtFOSA) mg/kg	N-Methyl perfluorooctane sulfonamidoethanol (MEFOSE) µg/L	N-Methyl perfluorooctane sulfonamidoethanol (MEFOSE) mg/kg	N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE) µg/L	N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE) mg/kg	N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOAAA) µg/L	N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOAAA) mg/kg	N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOAAA) µg/L	N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOAAA) mg/kg		
1	22/11/2018	soil_4	Normal	Sediment	<0.02	0.0003	<0.02	<0.0002	<0.05	<0.0005	<0.02	<0.0002	<0.05	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.02	<0.0002	<0.02	<0.0002		
		QA01_2	Interlab_D	Sediment		<0.005		<0.005		<0.005		<0.005		<0.005		<0.005		<0.005		<0.005		<0.01		<0.01		
		RPD					0		0		0		0		0		0		0		0		0		0	
		QA02_2	Interlab_D	Sediment		<0.01		<0.01		<0.01		<0.05		<0.05		<0.05		<0.05		<0.05		<0.05		<0.05		
		RPD					0		0		0		0		0		0		0		0		0		0	
		SW04	Normal	Surface Water		<0.05		<0.05		<0.12		<0.05		<0.12		<0.12		<0.12		<0.12		<0.05		<0.05		<0.05
		QA01_1	Field_D	Surface Water		<0.05		<0.05		<0.12		<0.05		<0.12		<0.12		<0.12		<0.12		<0.05		<0.05		<0.05
	RPD					0		0		0		0		0		0		0		0		0		0		
	RPD					0		0		0		0		0		0		0		0		0		0		
	RPD					0		0		0		0		0		0		0		0		0		0		
	RPD					0		0		0		0		0		0		0		0		0		0		
	RPD					0		0		0		0		0		0		0		0		0		0		
	RPD					0		0		0		0		0		0		0		0		0		0		
	RPD					0		0		0		0		0		0		0		0		0		0		
2	9/01/2019	SD04	Normal	Sediment	<0.02	0.0004	<0.02	<0.0002	<0.05	<0.0005	<0.02	<0.0002	<0.05	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.02	<0.0002	<0.02	<0.0002		
		QA01B	Field_D	Sediment	<0.02	<0.0002	<0.02	<0.0002	<0.05	<0.0005	<0.02	<0.0002	<0.05	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.02	<0.0002	<0.02	<0.0002		
		RPD					0		0		0		0		0		0		0		0		0		0	
		QA02B	Interlab_D	Sediment		<0.005		<0.005		<0.005		<0.005		<0.005		<0.005		<0.005		<0.005		<0.01		<0.01		
		RPD					0		0		0		0		0		0		0		0		0		0	
		SWD04	Normal	Surface Water		<0.05		<0.05		<0.12		<0.05		<0.12		<0.12		<0.12		<0.12		<0.05		<0.05		<0.05
		QA01A	Field_D	Surface Water		<0.05		<0.05		<0.12		<0.05		<0.12		<0.12		<0.12		<0.12		<0.05		<0.05		<0.05
	RPD					0		0		0		0		0		0		0		0		0		0		
	RPD					0		0		0		0		0		0		0		0		0		0		
	RPD					0		0		0		0		0		0		0		0		0		0		
	RPD					0		0		0		0		0		0		0		0		0		0		
	RPD					0		0		0		0		0		0		0		0		0		0		
	RPD					0		0		0		0		0		0		0		0		0		0		



Analytical Results Tables  
Table 6 - QA/QC Results

Adelaide Airport ESA - Off - Airport Investigations

PFAS																		
4:2 Fluorotelomer sulfonic acid (4:2 FTS)		6:2 Fluorotelomer Sulfonate (6:2 FTS)		8:2 Fluorotelomer sulfonic acid (8:2 FTS)		10:2 Fluorotelomer sulfonic acid (10:2 FTS)		PFAS (Sum of Total)		Sum of PFHxS and PFOS		PFAS (Sum of Total)(WA DER List)		Sum of US EPA PFAS (PFOS + PFOA)*		Sum of enHealth PFAS (PFHxS + PFOS + PFOA)*		
µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	µg/L	mg/kg	
EQL	0.01	0.0005	0.05	0.0005	0.01	0.0005	0.01	0.0005	0.01	0.0002	0.01	0.0002	0.01	0.0002	0.01	0.005	0.01	0.005

Project Phase	Date	Sample ID	Sample Type	Matrix Type	4:2 FTS (µg/L)	4:2 FTS (mg/kg)	6:2 FTS (µg/L)	6:2 FTS (mg/kg)	8:2 FTS (µg/L)	8:2 FTS (mg/kg)	10:2 FTS (µg/L)	10:2 FTS (mg/kg)	PFAS (µg/L)	PFAS (mg/kg)	Sum PFHxS (µg/L)	Sum PFHxS (mg/kg)	PFAS (WA) (µg/L)	PFAS (WA) (mg/kg)	US EPA PFAS (µg/L)	US EPA PFAS (mg/kg)	enHealth PFAS (µg/L)	enHealth PFAS (mg/kg)			
1	22/11/2018	soil_4	Normal	Sediment	<0.05	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.01	0.0005	<0.01	0.0002	<0.01	0.0002							
		QA01_2	Interlab_D	Sediment		<0.005		<0.01		<0.005		<0.005		<0.05		<0.005		<0.01		<0.005		<0.005			
			RPD			0		0		0		0		0		0		0							
		QA02_2	Interlab_D	Sediment		<0.01		<0.05		<0.01		<0.01		<0.1		<0.01		<0.05		<0.01		<0.01		<0.01	
			RPD			0		0		0		0		0		0		0							
		SW04	Normal	Surface Water		<0.05		<0.05		<0.05		<0.05		<0.05		<0.05		<0.05							
		QA01_1	Field_D	Surface Water		<0.05		<0.05		<0.05		<0.05		<0.05		<0.05		<0.05							
			RPD			0		0		0		0		0		0		0							
		26/11/2018	QA02_1	Interlab_D	Surface Water	<0.01		<0.05		<0.01		<0.01		<0.1		<0.01		<0.05		<0.01		<0.01		<0.01	
			RPD			0		0		0		0		0		0		0							
			GW16_12	Normal	Surface Water	<0.01		0.68		<0.01		<0.01		0.94		0.12		0.92		0.06		0.15		0.15	
			QA01	Field_D	Surface Water	<0.01		0.65		<0.01		<0.01		0.88		0.11		0.86		0.05		0.14		0.14	
				RPD		0		5		0		0		7		9		7		18		7		7	
				SD04	Normal	Sediment	<0.05	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.01	0.0003	<0.01	<0.0002	<0.01	<0.0002					
2	9/01/2019	QA01B	Field_D	Sediment	<0.05	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.05	<0.0005	<0.01	<0.0002	<0.01	<0.0002	<0.01	<0.0002							
			RPD		0		0		0		0		0		0		0								
		QA02B	Interlab_D	Sediment		<0.005		<0.01		<0.005		<0.005		<0.05		<0.005		<0.01		<0.005		<0.005		<0.005	
			RPD			0		0		0		0		0		0		0							
		SWD04	Normal	Surface Water	<0.05		<0.05		<0.05		<0.05		<0.05		<0.05		<0.05		<0.05						
		QA01A	Field_D	Surface Water	<0.05		<0.05		<0.05		<0.05		<0.05		<0.05		<0.05		<0.05						
			RPD			0		0		0		0		0		0		0							
		QA02A	Interlab_D	Surface Water	<0.01		<0.05		<0.01		<0.01		<0.01		<0.1		<0.01		<0.05		<0.01		<0.01		<0.01
			RPD			0		0		0		0		0		0		0							

Goonan, Peter (EPA)

From: Crough, Robert [Robert.Crough@measurement.gov.au]  
 Sent: Friday, 2 November 2012 3:40 PM  
 To: Thomas, Shaun (EPA); Goonan, Peter (EPA)  
 Cc: dioxins  
 Subject: Certificates DAU12\_185, DAU12\_186, DAU12\_195 & DAU12\_196 for the PFC analysis of your fish samples received 31 May 2012 & 28 June 2012. [SEC=DLM-ONLY:For-Official-Use-Only]

Attachments: DAU12\_185.pdf; DAU12\_186.pdf; DAU12\_196.pdf; DAU12\_195.pdf

Use dates from <sup>STU</sup>  
 no includes better < DLE  
 for some low-level results into dioxin not changed  
 = removed PFBA for results as has poor recovery & accept

Dear Peter,  
 I have attached the electronic version of our Certificates DAU12\_185, DAU12\_186, DAU12\_195 & DAU12\_196 for the PFASs analyses of your fish samples received 31 May 2012 & 28 June 2012. If you have any queries or questions on the results contained within these certificates then please do not hesitate to contact me.

We will send the original certificates and an invoice for this work in the next few days.

Thank you for using the services of the National Measurement Institute.

Regards,

**Robert**

Robert Crough

Chemist

Dioxin Analysis Unit

Chemical & Biological Metrology Branch

National Measurement Institute

Department of Industry, Innovation, Science, Research and Tertiary Education

= Urban stormwater  
 with high mobility  
 obtained detection  
 + sample large

	SWETS	FINNES
PAT	13 PFDA 0.8 PFI 0.9	14 PFDA 5.1 PFI 3.7
28	20x 0.9	2 PFDA 4.0
W	X	14 PFDA 1.7 2x X

= All dioxin results < detection levels assigned

PFDA = from prof catip breakdown product

PFOS = original Scotchgard active ingredient

**National Measurement Institute**

105 Delhi Rd, Riverside Corporate Park, North Ryde NSW 2113, Australia

PO Box 138, North Ryde NSW 1760, Australia

Ph: 61-2-9449 0114 Fax: 61-2-9449 1653

Email: [robert.crough@measurement.gov.au](mailto:robert.crough@measurement.gov.au)

Internet: <http://www.measurement.gov.au>

ABN 74 599 608 295

**NMI PYMBLE HAS MOVED!**

Please use the new delivery address, 105 Delhi Rd, North Ryde, NSW 2113

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Coupled	Abundance	Initial detection and peak	Median	Range (max-min)
PFDA	0.8		2 F, 3 W	= 5
PFOS			1 F, 1 W	

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\*\*\*\*\*

Results : Job No. EPA05/120531

Laboratory Reg. No. N12/015834X

Client Sample Ref. PAT1B

Matrix Fish Fillets

Description Patawalonga, ACA BUT (29/05/2012)

Date Extracted 25-Sep-12

DB5 Analysis 17-Oct-12

	Level ng/g
PFBA	<1
PFPeA	<1
PFHxA	<0.5
PFHpA	<0.5
PFOA	<0.5
PFNA	<0.5
PFDA	<0.5
PFUdA	<0.5
PFDoA	0.84
PFOS	0.94

Results : Job No. EPA05/120531

Laboratory Reg. No. N12/015836X

Client Sample Ref. PAT2B

Matrix Fish Fillets

Description Patawalonga, ACA BUT (11/05/2012 +

Date Extracted 25-Sep-12

DB5 Analysis 17-Oct-12

	Level ng/g
PFBA	<1
PFPeA	<1
PFHxA	<0.5
PFHpA	<0.5
PFOA	<0.5
PFNA	<0.5
PFDA	<0.5
PFUdA	<0.5
PFDoA	0.87
PFOS	<0.8

Results : Job No. EPA05/120531

Laboratory Reg. No. N12/015834DUP

Client Sample Ref. Duplicate

Matrix Fish Fillets

Description Duplicate Sample

Date Extracted 25-Sep-12

DB5 Analysis 17-Oct-12

	Level ng/g
PFBA	<1
PFPeA	<1
PFHxA	<0.5
PFHpA	<0.5
PFOA	<0.5
PFNA	<0.5
PFDA	<0.5
PFUdA	<0.5
PFDoA	1.0
PFOS	0.97

Results : Job No. EPA05/120531

Laboratory Reg. No. N12/015834SPK

Client Sample Ref. Spike

Matrix Fish Fillets

Description Spiked Sample - 50 ng/g

Date Extracted 25-Sep-12

DB5 Analysis 17-Oct-12

	Level ng/g
PFBA	18
PFPeA	66
PFHxA	51
PFHpA	75
PFOA	52
PFNA	56
PFDA	50
PFUdA	51
PFDoA	51
PFOS	53

Results : Job No. EPA05/120531

Laboratory Reg. No. BLK L822

Client Sample Ref. Lab Blank

Matrix Blank

Description Lab Blank Batch L822

Date Extracted 25-Sep-12

DB5 Analysis 17-Oct-12

	Level ng/g
PFBA	<0.6
PFPeA	<0.3
PFHxA	<0.2
PFHpA	<0.1
PFOA	<0.1
PFNA	<0.07
PFDA	<0.05
PFUdA	<0.07
PFDoA	<0.06
PFOS	<0.005





**CERTIFICATE OF ANALYSIS # DAU12\_195**

<b>Client</b>	South Australian Environmental Protection Authority GPO Box 2607 Adelaide, SA 5001	<b>Job No.</b>	EPA05/120531
<b>Contact</b>	Peter Goonan	<b>Sampled by</b>	Client
		<b>Date Sampled</b>	various
		<b>Date Received</b>	31-May-12

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

**Method** | AUTL\_07 | **Date Reported** | 1-Nov-12

**Details** | The method is for determination of Perfluoroalkyl substances (PFASs) in biota samples by High Performance Liquid Chromatography tandem Mass Spectrometry (UPLC-MSMS). All results are corrected for labelled surrogates and are reported on a fresh weight basis.

Prior to extraction the sample is spiked with a range of isotopically labelled surrogate standards. Extraction is by organic solvent, with purification using activated silica gel. An aliquot of extract is injected onto the UPLC and detected using mass spectrometry.

**Authorisation**

Gavin Stevenson  
Manager  
Dioxin Analysis Unit

Robert Crough  
Chemist  
Dioxin Analysis Unit

Sample Details : Job No. EPA05/120531			
Laboratory Reg. No.	Client Sample Ref.	Matrix	Description
N12/015825X	WLK1A	Fish Frames	West Lakes, ACA BUT (03/05/2012)
N12/015827X	WLK2A	Fish Frames	West Lakes, ACA BUT (30/04/2012 + 15/05/2012)
N12/015829X	PTR1A	Fish Frames	Port River, ACA BUT (02/05/2012)
N12/015831X	PTR2A	Fish Frames	Port River, ACA BUT (15/05/2012)
N12/015833X	PAT1A	Fish Frames	Patawalonga, ACA BUT (29/05/2012)
N12/015835X	PAT2A	Fish Frames	Patawalonga, ACA BUT (11/05/2012 + 29/05/2012)
N12/015833DUP	Duplicate	Fish Frames	Duplicate Sample
N12/015833SPK	Spike	Fish Frames	Spiked Sample - 50 ng/g
BLK L827	Lab Blank	Blank	Lab Blank Batch L827

Project Details	
Project Name	Not specified
Project Number	Not specified

Key		
Analytes	Isotopically labelled surrogate	
PFHxA	Perfluoro-n-hexanoic acid	Perfluoro-n-[1,2- <sup>13</sup> C <sub>2</sub> ]hexanoic acid Surrogate
PFHpA	Perfluoro-n-heptanoic acid	Perfluoro-n-[1,2,3,4- <sup>13</sup> C <sub>4</sub> ]octanoic acid Surrogate
PFOA	Perfluoro-n-octanoic acid	
PFNA	Perfluoro-n-nonanoic acid	Perfluoro-n-[1,2,3,4,5- <sup>13</sup> C <sub>5</sub> ]nonanoic acid Surrogate
PFDA	Perfluoro-n-decanoic acid	Perfluoro-n-[1,2- <sup>13</sup> C <sub>2</sub> ]decanoic acid Surrogate
PFUdA	Perfluoro-n-undecanoic acid	Perfluoro-n-[1,2- <sup>13</sup> C <sub>2</sub> ]undecanoic acid Surrogate
PFDoA	Perfluoro-n-dodecanoic acid	Perfluoro-n-[1,2- <sup>13</sup> C <sub>2</sub> ]dodecanoic acid Surrogate
PFOS	Perfluoro-n-octanesulfonate	Perfluoro-n-[1,2,3,4- <sup>13</sup> C <sub>4</sub> ]octanesulfonate Surrogate
Units & Abbreviations		
ng/g	nanograms per gram	
<	level less than limit of quantitation (LOQ)	

**Results : Job No. EPA05/120531**

Laboratory Reg. No. N12/015833X

Client Sample Ref. PAT1A

Matrix Fish Frames

Description Patawalonga, ACA BUT (29/05/2012)

Date Extracted 19-Oct-12

DB5 Analysis 29-Oct-12

	Level ng/g
PFHxA	<3
PFHpA	<3
PFOA	<3
PFNA	<1
PFDA	<0.5
PFUdA	<0.5
<del>PFDoA</del>	<del>5.1</del>
<del>PFOS</del>	<del>3.7</del>

**Results : Job No. EPA05/120531**

Laboratory Reg. No. N12/015835X

Client Sample Ref. PAT2A

Matrix Fish Frames

Description Patawalonga, ACA BUT (11/05/2012  
+ 29/05/2012)

Date Extracted 19-Oct-12

DB5 Analysis 29-Oct-12

	Level ng/g
PFHxA	<3
PFHpA	<3
PFOA	<3
PFNA	<1
PFDA	<0.5
PFUdA	<0.5
PFDoA	4.0
PFOS	<2

**Results : Job No. EPA05/120531**

Laboratory Reg. No. N12/015833DUP

Client Sample Ref. Duplicate  
 Matrix Fish Frames  
 Description Duplicate Sample  
 Date Extracted 19-Oct-12  
 DB5 Analysis 29-Oct-12

	Level ng/g
PFHxA	<3
PFHpA	<3
PFOA	<3
PFNA	<1
PFDA	<0.5
PFUdA	<0.5
<del>PFDoA</del>	<del>4.8</del>
<del>PEOS</del>	<del>3.9</del>

**Results : Job No. EPA05/120531**

Laboratory Reg. No. N12/015833SPK

Client Sample Ref. ~~Spike~~

Matrix Fish Frames

Description Spiked Sample - 50 ng/g

Date Extracted 19-Oct-12

DB5 Analysis 29-Oct-12

	Level ng/g
PFHxA	15
PFHpA	36
PFOA	16
PFNA	15
PFDA	13
PFUdA	14
PFDaA	17
PFOS	16

**Results : Job No. EPA05/120531**

**Laboratory Reg. No. BLK L827**

**Client Sample Ref. Lab Blank**

**Matrix Blank**

**Description Lab Blank Batch L827**

**Date Extracted 19-Oct-12**

**DB5 Analysis 29-Oct-12**

	<b>Level ng/g</b>
PFHxA	<0.07
PFHpA	<0.02
PFOA	<0.1
PFNA	<0.02
PFDA	<0.03
PFUdA	<0.08
PFDoA	<0.04
PFOS	<0.02



**Results : Job No. EPA05/120531**

Laboratory Reg. No. N12/015833SPK

Client Sample Ref. Spike

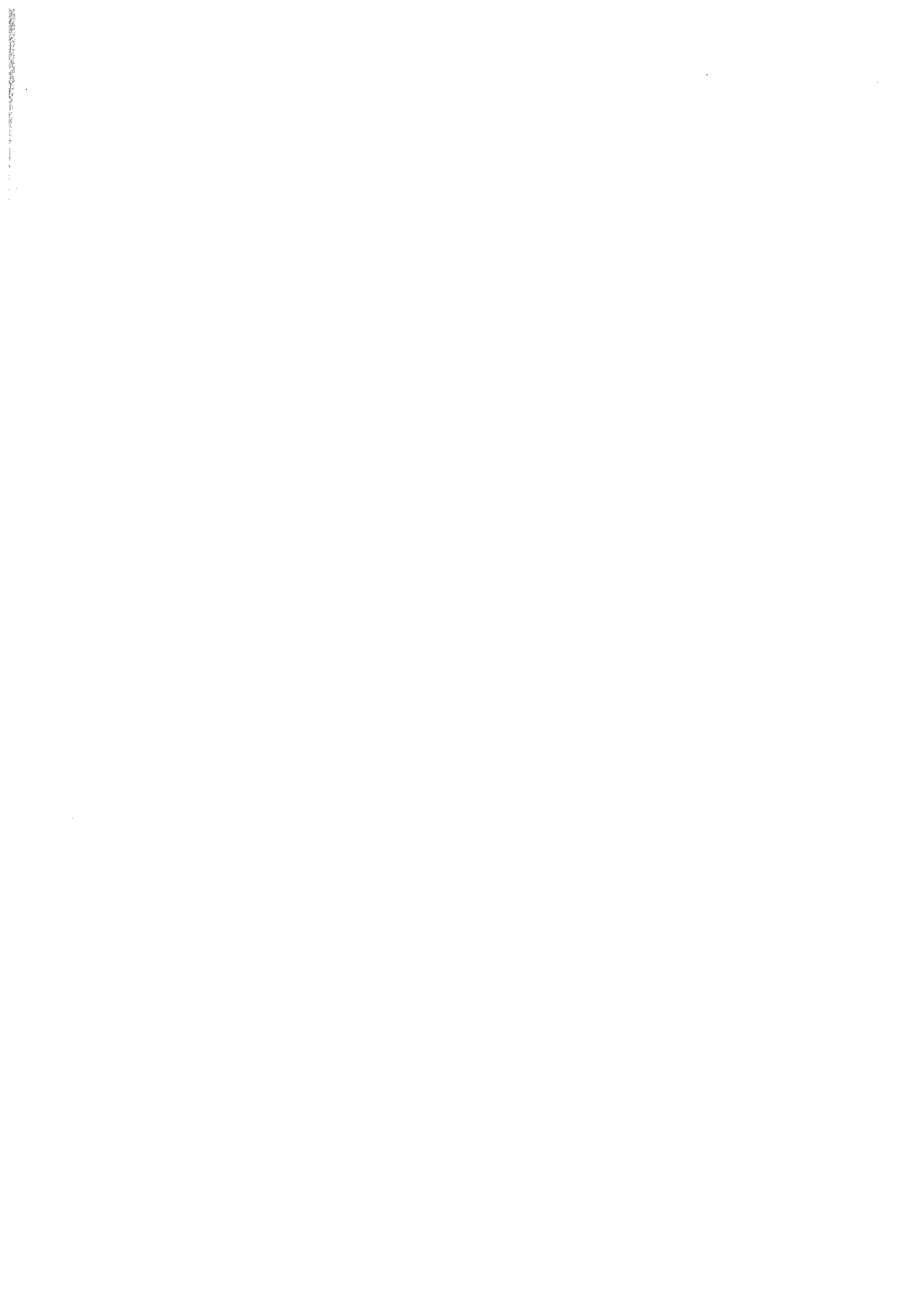
Matrix Fish Frames

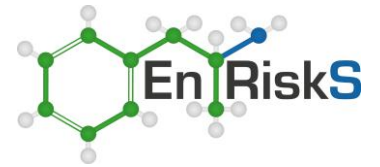
Description Spiked Sample - 16 ng/g

Date Extracted 19-Oct-12

DB5 Analysis 29-Oct-12

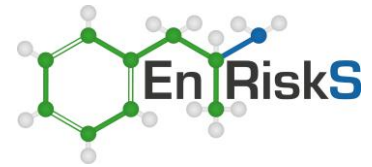
PFHxA	15
PFHpA	36
PFOA	16
PFNA	15
PFDA	13
PFUdA	14
PFDoA	17
PFOS	16





## **Appendix B Derivation of Water RBC**

---



Human health water criteria have been derived on the same basis as presented in the NEPM for workers (NEPC 1999 amended 2013a).

The risk-based criteria (RBC) for water have been derived for PFOS + PFHxS and PFOA on the basis of a threshold approach. Where this is the case the criteria for an exposure pathway (x), can be back-calculated by setting the estimated intake for a chemical (i) to the acceptable intake allowable from soil for that chemical (i), then rearranging the equation as follows:

$$RBC_{x,i} \left( \frac{\text{mg}}{\text{L}} \right) = \frac{\text{Acceptable Intake}}{\text{Intake from Contamination}} = \frac{\text{acceptable intake from water} \times \text{body weight} \times \text{averageing time}}{\text{ingestion rate} \times \text{exposure frequency} \times \text{exposure duration}}$$

**Equation 1**

Similarly, criteria can be derived for other pathways of exposure, with the final RBC calculated by combining the pathway-specific RBC as noted below:

$$RBC(mg/L) = \frac{1}{\left[ \frac{1}{RBC_{ingestion}} \right] + \left[ \frac{1}{RBC_{dermal}} \right]}$$

**Equation 2**

where:

$RBC_{ingestion}$  = derived water guideline associated with incidental ingestion of water by adult workers, refer to **Equation 3**

$RBC_{dermal}$  = derived water guideline associated with dermal absorption of contaminant in water by adult workers, refer to **Equation 4**

This approach assumes that the pathways of exposure are all complete and are additive, and that the toxicological end point considered for all pathways of exposure are the same or additive.

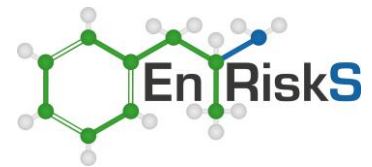
The following outlines the equations used to calculate the pathway specific RBC. **Table E1** presents a summary of the exposure assumptions adopted for the calculations

$$RBC_{ingestion} (mg/L) = \frac{(TDI_o(100\% - BI_o)) \times BW_A \times AT_T}{IR_W \times BA_o \times EF \times ED}$$

**Equation 3**

$$RBC_{dermal} (mg/L) = \frac{(TDI_D(100\% - BI_o)) \times BW_A \times AT_T}{SA_A \times ET \times DP \times CF \times EF \times ED}$$

**Equation 4**



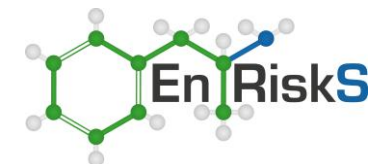
where:

- TDI<sub>o</sub> = TDI relevant for the quantification of oral and dermal intakes, (as mg/kg/day for threshold contaminants) (refer to **Section 5**)
- BI<sub>o</sub> = background intakes relevant to oral/dermal or inhalation exposures (from sources other than soil, which include food, water, air and consumer products where relevant) (as % of the TDI<sub>o</sub>)
- IR<sub>w</sub> = ingestion rate of water by adult workers (mg/day)
- BA<sub>o</sub> = oral bioavailability (unitless, expressed as a fraction of 1)
- SA<sub>A</sub> = exposed skin surface area for adult workers (cm<sup>2</sup>)
- DP = dermal permeability of chemical (cm/hr)
- CF = conversion factor of 1x10<sup>-3</sup> (L/cm<sup>3</sup>)
- EF = exposure frequency (days/year)
- ED = exposure duration for adult workers (years)
- BW<sub>A</sub> = body weight of adult workers (kg)
- AT<sub>T</sub> = averaging time for threshold contaminants (days, = ED x 365 days)

**Table B1: Exposure Parameters Adopted for Calculation of Water RBC**

Exposure	Workers
Exposure Duration	30 years (conservative value). (Note, as PFOS and PFOA act via a threshold mechanism, the assumption of a 1 year or 30-year exposure duration does not affect the risk calculations as this value cancels out).
Exposure Frequency	96 days per year (assumes a worker is in contact with PFAS water 2 days per week – for working weeks on the airport) (conservative assumption based on professional judgement).
Body weight	78 kg (average adult body weight) (enHealth 2012b)
Averaging Time (non-carcinogenic)	Exposure duration x 365 days
Bioavailability	100% (maximum possible)
<b>Incidental Direct Contact with Water</b>	
Gastrointestinal Absorption	100% (maximum possible)
Ingestion Rate	0.005 L/day (industry standard value for contaminated site risk assessments in Australia, assumes 5 mL of water or 1 teaspoon is ingested including water droplets/mist in air)
Time Spent Wet	2 hrs/day (assumed time workers may be wet)
Skin Surface Area	4,750 cm <sup>2</sup> for hands and forearms (enHealth 2012b)
Dermal Permeability to Water	3.25x10 <sup>-5</sup> cm/hour, dermal permeability value for PFOA from ATSDR (2015) for mouse skin (more conservative than human skin), adopted for PFOS + PFHxS and PFOA in the absence of chemical specific data

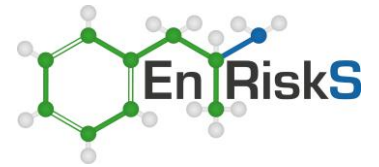
On the basis of the above, the following RBC have been derived for PFAS in water.



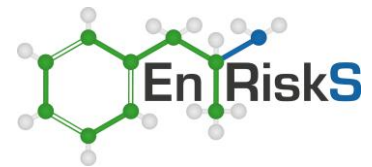
## Derivation of Water Criteria Worker Exposures

Summary of Exposure Parameters	Abbreviation	units	Parameter	References/Notes
Water Ingestion Rate - Adults	IRW	L/day	0.005	Assume incidental ingestion of 5 mL per day (1 teaspoon)
Surface Area of Skin - Adults	SA <sub>A</sub>	cm <sup>2</sup> /day	4750	Hands and forearms (enHealth 2012a)
Time Spent Wet	ET	hours	2	Assumed
Body weight - Adults	BW <sub>C</sub>	kg	78	Average for adults as per enHealth (2012a)
Exposure Frequency	EF	days/year	96	Assumes contact with surface water 2 days per working week
Exposure Duration - Adults	ED <sub>C</sub>	years	30	Schedule B7, Table 5
Averaging Time (noncarcinogenic)	AT <sub>T</sub>	days	ED*365	Calculated based on ED

Threshold Calculations - Adult Worker												
Compound	Toxicity Reference Value Oral (TRV <sub>O</sub> ) (mg/kg/day)	GI Absorption (GAF) (unitless)	Toxicity Reference Value Dermal (TRV <sub>D</sub> ) (mg/kg/day)	Oral Bioavailability BA <sub>O</sub> (%)	Dermal Permeability (DP) (unitless)	Background Intake Oral/Dermal (BI <sub>O</sub> ) (% of TDI)	Toxicity Reference Value Inhalation (TRV <sub>I</sub> ) (mg/m <sup>3</sup> )	Background Intake Inhalation (BI <sub>I</sub> ) (% of TC)	Pathway Specific HILs (mg/L)		Derived Water RBC (not rounded) (mg/L)	Derived Water RBC (to 1 or 2 s.f.) (mg/L)
									Water Ingestion	Dermal		
PFOS + PFHxS	0.00002	1	0.00002	100%	3.25E-05	80%			2.4E-01	3.8E+00	0.22	<b>0.2</b>
PFOA	0.00016	1	0.00016	100%	3.25E-05	80%			1.9E+00	3.1E+01	1.8	<b>1.8</b>



## **Appendix C Toxicity Summary for PFOS and PFHxS**



## C1 PFOS

This toxicity summary has been based on information sourced from the US Department of Health and Human Services Agency for Toxic Substances and Disease Control (ATSDR 2018) and Food Standards Australia New Zealand (FSANZ 2017a) unless otherwise indicated.

### ***Properties and Uses***

PFAS are a family of man-made fluorine-containing chemicals that do not occur naturally in the environment. They have unique properties to make materials stain- and stick-resistant because they repel oil, grease and water. PFAS are often described as being “ubiquitous in the environment”. They have been widely used in man-made products such as surface protection products (e.g. carpet and clothing treatments) and coatings for cardboard and packaging. Some PFAS are, or were also historically used in fire-fighting foams.

There are hundreds of different PFAS; the most common and well-studied compounds are PFOS and PFOA as these PFAS were manufactured at the highest rate. PFOS is a completely fluorinated compound with eight carbons and a sulfonate group. PFOA is a completely fluorinated compound with seven carbons and a carboxyl functional group. Both PFOS and PFOA are metabolically and environmentally stable (i.e. persistent), bioaccumulative and toxic (PBT). Perfluoroalkyl carboxylates and sulfonates are made up of a long perfluorocarbon tail that is both hydrophobic and oleophobic, and a charged end that is hydrophilic.

In addition, many of the PFAS compounds break down to give PFOS or PFOA when released into the environment. Degradation stops at PFOS and PFOA which is why these compounds are commonly found to have accumulated in organisms. These compounds are mobile in soil and leach into groundwater.

### ***Exposure***

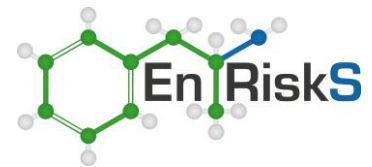
#### Oral

PFOS is readily absorbed via the oral route of exposure. The bioavailability of PFOS is estimated to be >93% within 24 hours (based on studies with rats).

#### Dermal

When an individual (adult or child) comes into direct contact with impacted soil or water, exposure is often assumed to occur via incidental ingestion and dermal contact. However, there is scientific evidence to suggest that the dermal absorption of PFOS is limited in comparison to the ingestion pathway.

The dermal absorption of a chemical depends on the area of skin in contact with the impacted media/chemical, the concentration of chemical in the media, the duration of contact with the media, how tightly the chemical is bound into the media and the ability of the chemical to penetrate the skin. Anionic surfactants (e.g. PFOS), are generally thought to penetrate the whole skin poorly. Experimental values (Scala et. al. 1968) confirm that even at the highest surfactant concentrations studied (0.03 M or 1%), non-detectable concentrations of ionic surfactants passed through the skin



in the first two hours of exposure. Diffusion curves were observed to be non-linear (exponential), with surfactant able to be measured on the underside of the skin four hours following exposure.

Dermal exposures of rats to ammonium PFOA has been shown to produce systemic (e.g., liver, immunotoxicity) effects in animals confirming that the absorption of PFOA by animal skin is possible however estimates of the amount or rates of dermal absorption in humans or animals have not been reported. In addition, experimental studies with rat, mouse and human skin indicate that rat and mouse skin may be more permeable to PFOA than human skin. As would be expected given the physicochemical properties of PFOS and PFOA, dermal permeability was sensitive to pH and was higher when the skin was buffered at pH 2.5 ( $5.5 \times 10^{-2}$  cm/hour) compared to pH 5.5 ( $4.4 \times 10^{-5}$  cm/hour), well above the pKa for the terminal carboxylic acid of PFOA. This suggests that permeability of the unionized acid is greater than that of the dissociated anion (noting that at environmental pH, PFOS, PFOA and PFHxS will be in the ionised form)

Following application of the ammonium salt of PFOA to isolated human or rat epidermis, approximately 0.048% of the dose was absorbed across human epidermis and 1.44% was absorbed across rat epidermis. When applied at the same dose and for the same time frame, 1.44% of the applied dose of PFOA was absorbed across the isolated rat skin however only 0.048% of the dose was absorbed across the isolated human skin. The estimated dermal penetration coefficient was  $9.49 \times 10^{-7}$  cm/hour in the isolated human epidermis and  $3.25 \times 10^{-5}$  cm/hour in the isolated rat epidermis.

Default dermal permeability co-efficients for PFOS are not available (RAIS). This may be because the measurement of the n-octanol / water partition (a critical parameter for estimating the dermal permeability co-efficient) is not practicable via the standard methodology for PFOS as this chemicals form a separate layer when mixed with hydrocarbons and water.

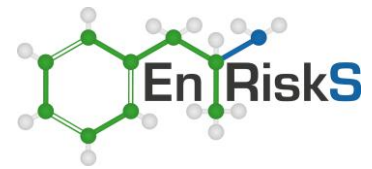
In summary, the existing evidence in the scientific literature indicates that the dermal absorption of PFAS following direct contact is limited in comparison to the ingestion pathway.

### Vapour Inhalation

PFOS is not volatile at environmental pH (it exists as an anion), hence vapour inhalation exposures have not been considered further in this HHERA. The potential health risks associated with the inhalation of dust have however been considered.

### **Distribution**

Unlike other compounds that have PBT characteristics (e.g. organochlorine pesticides, PCBs or dioxins), PFOS is highly water soluble and bioaccumulate by attaching to proteins in the blood rather than accumulating in lipids (USEPA 2014). It has been shown that 99.7% of these chemicals in humans and 97.3% of these chemicals in rats and monkeys is bound to the albumin. Following oral exposure in rats, PFOS is found mainly in the blood, liver, lungs and kidneys. PFOA is found mainly in the blood, liver, testis, spleen, lungs, kidney and brain. In post mortem human studies, most of the PFOS is found in the lungs, kidneys, liver and blood. Most of the PFOA has been found in the lungs, kidneys, liver, blood and bone



PFOS binds to the fatty acid binding protein in the liver and has a medium to high binding affinity for other proteins including the human serum thyroid hormone transport protein, transthyretin, low density lipoproteins and / or alpha-globulins. Transporters, including organic anion transporters, and likely to be involved in the absorption, distribution and excretion of PFOS. PFOS is able to cross the placenta and have been found in breast milk.

### ***Metabolism and Excretion***

There is no evidence (from studies with rats and monkeys) that PFOS is metabolised in the body.

Excretion primarily occurs via the kidneys (in the urine) in rats. Lactation and menstruation are also relevant routes of excretion in women and mice.

The elimination half-life for PFOS is 5.4 years in humans and 121, 48 and 37 days in monkeys, rats and mice respectively. Half-lives are generally consistent between males and females.

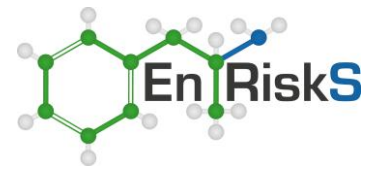
### ***Health Effects***

The database relating to the toxicity of PFOS in animals includes acute and short term studies with mice, rats and monkeys, sub-chronic studies with rats and monkeys, chronic studies with rats and reproductive / developmental studies with mice, rats and rabbits. The critical effects identified from these studies and used by international agencies to develop TRVs include the following:

- Rats: mortality, increased liver weights, decreased body weight, decreased body weight gain, decreased serum cholesterol, increased alanine aminotransferase, hepatocellular hypertrophy and hepatocellular vacuolation, delayed eye-opening, reduced pup viability and weight / weight gain, reduced gestation length;
- Monkeys: mortality, reduced body weight gain, increased liver weight and liver histopathological changes and reduced serum cholesterol;
- Rabbits: lower maternal body weight gain (with no corresponding effect on food ingestion rate), lower foetal weight and abortions; and
- Mice: increased relative liver weight, reduced serum triglycerides, increased foetal liver weight, delayed eye-opening; reduced SBRC plaque forming cell response, impaired learning and memory and increased apoptosis in hippocampal cells.

Data from epidemiological studies with occupationally exposed workers at 3M manufacturing facilities (Alabama, USA and Belgium), communities exposed to contaminated drinking water (USA) and general populations (USA, UK and Scandinavia) are also available. It is noted that concentrations of PFAS in occupationally exposed workers are 100 to 1,000-fold higher than those in the general populations. Despite this, epidemiology studies have generally failed to draw conclusive links between exposure to PFOS and adverse health effects. Associations between exposure to PFOS and the following health effects have been suggested:

- Changes in serum lipid levels e.g. increase total cholesterol levels;
- Changes in serum liver enzymes levels;
- Kidney disease;
- Effects on fertility, pregnancy and birth outcomes; and
- Effects on thyroid and immune function



Overall, the evidence for adverse effects on humans following PFOS exposure from the epidemiological studies is inconsistent. In addition, the biological significance of some of the observed effects has been questioned (i.e. just because an effect is observed it does not mean it is, or will lead to, an adverse effect) and there is the potential that observed effects may be due to confounding factors e.g. exposure to other contaminants or diet.

Due to the above factors, it has been concluded by all regulatory agencies and bodies (including FSANZ) that the available epidemiological data is unsuitable for use in establishing a TRV for PFOS.

### **Classification**

EFSA and the USEPA (2016) have concluded that PFOS is not genotoxic based on negative findings *in vitro* and *in vivo* tests (FSANZ 2017a).

The carcinogenic risk of PFOS has also been recently reviewed (Arrieta-Cortes et al. 2017). The review considered the available animal and human toxicity studies in the context of the process adopted by the International Agency for Research on Cancer (IARC). The review concluded that there was inadequate evidence of carcinogenicity in human and animal studies and PFOS should be classified as *not classifiable as to its carcinogenicity to humans (Group 3)*.

With respect to the overall information available relating to the potential for exposure to PFAS to cause cancer:

- The literature evidence is often contradictory (or vague), even within the same reference;
- Associations with kidney, testicular, liver and bladder cancers have been reported for workers in epidemiological studies, however these studies may include a small number of participants, high occupational exposure and confounding factors (e.g. the study may not be controlled for other cancer causing exposures such as smoking); and
- Some observed effects attributed to causing cancer are reversible, hence are not necessarily adverse. In addition, associations are not causations.

As noted above, there are two general groups of carcinogens (NEPC 1999 amended 2013b):

- Genotoxic carcinogens for which, in theory, any level of exposure could result in a response as the chemical has the ability to interact directly with DNA; and
- Non-genotoxic carcinogens, for which there is a threshold below which exposure is not expected to result in adverse health effects.

PFAS do not possess the chemical / physical properties typically associated with direct genotoxicity and this is supported by an understanding of the mode of action for tumour formation in humans, and differences between humans and animals.

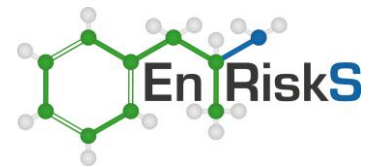
Overall, the weight of evidence is that, if they are carcinogenic, PFOS is a non-genotoxic threshold “carcinogen” (deWitt. J.C. 2015).

## Toxicity Reference Values

On the basis that PFOS and PFOA is not considered to be a genotoxic carcinogen, it has been assessed based on a threshold approach in this HHRA. The following threshold chronic values are available from Level 1 Australian and International sources (**Table C1**):

**Table C1: Summary of Toxicity Information for PFOS**

Source	PFOS	
	TRV ( $\mu\text{g}/\text{kg}/\text{d}$ )	Basis/Comments
<b>Australian</b>		
Food Standards Australia New Zealand (FSANZ), Australian Drinking Water Guidelines (ADWG) (NHMRC 2011 Updated 2016, 2011 updated 2018)	0.02	HBGV based on PBPK modelling for 4 selected pivotal toxicity studies (1 with monkeys and 3 with rats). The final HBGV was derived based on a POD (HED) of 0.6 $\mu\text{g}/\text{kg}/\text{day}$ associated with decreased pup body weight in a two-generation reproductive toxicity study with rats and an UF of 30 (10 for intraspecies variability and 3 for interspecies variability). HBGVs calculated for the other studies were in the range 0.02 to 0.1 $\mu\text{g}/\text{kg}/\text{day}$ .
<b>International</b>		
WHO Drinking Water Guidelines	No guideline value	--
United Kingdom Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment (COT 2006)	0.3	Provisional TDI based on a POD (NOAEL) of 30 $\mu\text{g}/\text{kg}/\text{day}$ associated with decreased serum T3 levels in a 26-week study with cynomolgus monkeys and an UF of 100 for inter- and intra-species variability.
European Food Safety Authority (EFSA 2018)	0.002	Based on an increase in serum cholesterol levels where the median BMDL <sub>5</sub> levels from 3 studies correspond to an estimated chronic daily intake of 1.7-2.0 (median 1.8) ng/kg bw/d, as calculated with a PBPK model for humans. EFSA subsequently established a Tolerable Weekly Intake (TWI) is 13 ng/kg-bw/week. No additional UF applied as the BMD modelling was based on large epidemiological studies from the general population, including sensitive sub-groups.
United States Environmental Protection Agency (USEPA 2016b, 2016a) (Final)	0.02	RfD based on PBPK modelling on for data from 6 subchronic, developmental / neurodevelopmental and reproductive toxicity studies with rats for which measured serum PFOS concentrations were available. Critical effects included increased levels of alanine aminotransferase and blood urea nitrogen, decreased pup body weight and survival rate and increased motor activity / decreased habituation. The adopted UF varied depending on the study and were in the range 30 to 100. Candidate RfDs were in the range 0.02 to 0.05 $\mu\text{g}/\text{kg}/\text{day}$ .
Agency for Toxic Substances and Disease Registry (ATSDR 2018)	0.002	Intermediate MRL based on a POD (HED) of 0.515 $\mu\text{g}/\text{kg}/\text{day}$ associated with delayed eye opening and decreased pup weight in rats. The adopted UF was 300. ATSDR concluded there was insufficient data to derive a chronic MRL.
Danish Ministry for the Environment (Danish Ministry of the Environment 2015)	0.03	TDI based on a POD (BMDL <sub>10</sub> ) of 33 $\mu\text{g}/\text{kg}/\text{day}$ associated with hepatotoxicity (liver toxicity) in a chronic toxicity/carcinogenicity study with rats and an UF of 1,230 (3 for possible differences in pharmacodynamics, 41 for differences in pharmacokinetics and 10 for intraspecies differences).
Minnesota Department of Health (MDH 2009a, 2009b)	0.08	TRV based on a POD (HED) of 2.5 $\mu\text{g}/\text{kg}/\text{day}$ associated with decreased cholesterol and changes in thyroid hormones in rats and a UF of 30.
German Drinking Water Commission (GDWC 2006)	0.1	TRV based on a POD of 25 $\mu\text{g}/\text{kg}/\text{day}$ which was the lowest POD for rats from a range of studies with rats and monkeys. The adopted UF was 300.



### **Notes for Table C1:**

*Grey italics* indicates TRVs that have since been superseded.

BMDL = Benchmark Dose Level, HBGV = Health Based Guideline Value, HED = Human Equivalent Dose, MRL = Minimal Risk Level, NOAEL = No Observed Adverse Effect Level, PBPK = Physiologically Based Pharmacokinetic, POD = Point of Departure, RfD = Reference Dose, TDI = Tolerable Daily Intake, UF = Uncertainty Factor.

**Table C1** indicates that available TRVs for PFOS range from 0.002 to 0.15 µg/kg/day (i.e. a range of 75 times). The differences between the available TRVs are mainly due to the following:

- The selection of the critical study and the point of departure (POD) from the available toxicity studies;
- The application of different uncertainty factors (UFs). The application of significantly different UFs by various agencies is largely due to the toxicokinetics related issues (i.e. clearance), as well as the application of additional UFs because the available studies were less than lifetime for the estimated POD;
- The use (or not) of PBPK modelling; and
- The use of epidemiological data by EFSA (2018) as compared to animal toxicity data by other organisations (including Australia).

In April 2017, FSANZ released TRVs for PFOS, and PFHxS in the form of TDIs (called HBGVs) (FSANZ 2017a). The FSANZ TRVs are the final values for use in Australia and hence the TRVs for PFOS and PFOA have been adopted in this HHRA:

- PFOS: 0.02 µg/kg/day.

It is noted that the FSANZ (2017) assessment predates the ATSDR (2018) and EFSA (2018) assessments, where lower TDIs for PFOS and PFOA were derived (by an order of magnitude). FSANZ has indicated that “*EFSA is reviewing its scientific opinion together with a consideration of the safety of other PFAS chemicals in 2019. Until that time both the conclusions and tolerable weekly intakes are considered provisional and may change*” and “*FSANZ will review the EFSA report to see whether it contains any new information that would warrant a need to reconsider the tolerable daily intakes it published in 2017*”.<sup>9</sup> Until this time, the adoption of the FSANZ (2017) TDIs are appropriate for an Australian HHRA, in line with the recommendations of the ASC NEPM. It is also noted that the ATSDR and EFSA TDIs are equivalent to background intakes of PFAS.

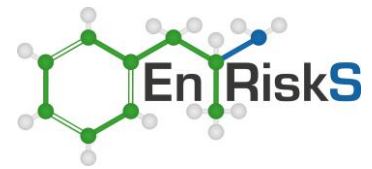
### **Background Intake**

In the HHRA, the background intake of PFOS + PFHxS has been assumed to be 7% of the toxicity value.

The background intakes are based on a literature review of PFOS concentrations in blood serum as undertaken by ToxConsult (ToxConsult 2016a) as part of assessment works at other Defence sites. It is noted that blood levels of PFAS are reflective of all intakes from consumer products, drinking water and the environment in general, including PFOS in food that the general population may be

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<sup>9</sup> <http://www.foodstandards.gov.au/consumer/chemicals/Pages/Perfluorinated-compounds.aspx>



exposed to away from PFAS impacted sites. This is because PFOS accumulates in the blood serum.

For PFOS, the information reviewed by ToxConsult indicated that background intakes in the Australian population were in the order of 0.0008 µg/kg/day (average) and 0.0014 µg/kg/day (upper estimate). This equates to 4% and 7% of the TRV (0.02 µg/kg/day). The upper estimate of 7% has been adopted in this HHRA.

FSANZ (2017b) indicates that there is currently insufficient information to estimate total dietary exposure to PFOS for the general population as the majority of the available information relates to contaminated sites. However, the limited data from the 24<sup>th</sup> Australian Total Diet Survey, alongside information in the scientific literature and further research on PFOS concentrations in fish purchased from Sydney retail outlets by the NSW Food Authority, indicates that dietary exposure from the general food supply is likely to be low. Hence, the adoption of 7% background contribution for PFOS is considered appropriately conservative.

## C2 PFHxS

PFHxS is a completely fluorinated compound with six carbons and a sulfonate group and is the next most well-known PFAS after PFOS and PFOA. In addition, PFHxS is considered to be structurally similar to PFOS (having the same functional group with less carbons) and as a result is often considered of similar potential toxicity as PFOS.

Like PFOS and PFOA, PFHxS is readily absorbed following oral exposure (with a bioavailability of close to 100% within 24 hours in rats) and binds strongly to serum proteins. The highest PFHxS concentrations have generally been reported in the liver and kidney, with elimination occurring primarily in the urine in experimental animals. There is evidence that PFHxS can cross the placenta and PFHxS has been detected in breast milk. The elimination half-life of PFHxS in humans is estimated to be in the range 7.3 to 8.5 years.

There is limited information available relating to the toxicity of PFHxS:

- It has been shown to be a moderate activator of PPAR $\alpha$ ;
- There was no evidence of developmental or reproductive toxicity at the highest dose tested in one study with rats; and
- A number of epidemiological studies have reported associations between PFHxS exposure and health effects including physician diagnosed asthma, cholesterol levels, sperm quality, birth weight and learning difficulties. However, the results of these epidemiological studies are complicated by the factors present in the studies for PFOS and PFOA (as discussed above).

The comparative toxicity of PFHxS (and other PFAS) was recently investigated in a cumulative health risk assessment for 17 PFAS compounds (Borg et.al. 2013). A summary of the POD for hepatotoxicity and reproductive toxicity for the PFAS investigated in the health risk assessment are provided in **Table C2**.

**Table C2: Summary of Toxicity Data for PFAS (Borg et.al. 2013)**

PFAS	POD					
	Hepatotoxicity		Reproductive Toxicity		Other	
	External Dose (mg/kg/day)	Internal Dose (µg/mL serum)	External Dose (mg/kg/day)	Internal Dose (µg/mL serum)	External Dose (mg/kg/day)	Internal Dose (µg/mL serum)
PFBS	<b>100</b>	67 <sup>1</sup>	<b>300</b>	>45 <sup>1</sup>	<b>60<sup>4</sup></b>	--
PFHxS	<b>1</b>	<b>89</b>	<b>&gt;10</b>	<b>&gt;60</b>	<b>0.3<sup>2,4</sup></b>	<b>44<sup>2,4</sup></b>
PFOS <sup>6</sup>	0.025	4.04	0.1	4.9	--	--
PFOSA	0.024 <sup>1</sup>	4.03 <sup>1</sup>	0.1 <sup>1</sup>	4.9 <sup>1</sup>	--	--
PFDS	0.029 <sup>1</sup>	4.85 <sup>1</sup>	0.1 <sup>1</sup>	5.9 <sup>1</sup>	--	--
PFBA	<b>6.0</b>	<b>14</b>	<b>175</b>	<b>4.4</b>	<b>3<sup>5</sup></b>	--
PFPeA	0.04 <sup>1</sup>	4.5 <sup>1</sup>	0.55 <sup>1</sup>	10.0 <sup>1</sup>	--	--
PFHxA	<b>20</b>	5.4 <sup>1</sup>	<b>100</b>	11.9 <sup>1</sup>	--	--
PFHpA	<b>20</b>	6.2 <sup>1</sup>	0.76 <sup>1</sup>	13.8 <sup>1</sup>	--	--
PFOA <sup>6</sup>	0.06	7.1	0.86	15.7	--	--
PFNA	<b>0.83<sup>2</sup></b>	<b>28.5</b>	<b>0.83</b>	<b>8.9</b>	--	--
PFDA	<b>1.2</b>	31.6 <sup>1</sup>	<b>3.0</b>	9.9 <sup>1</sup>	--	--
PFUnA	1.01 <sup>1</sup>	34.6 <sup>1</sup>	1.01 <sup>1</sup>	10.8 <sup>1</sup>	--	--
PFDoA	0.02 <sup>1</sup>	37.7 <sup>1</sup>	1.10 <sup>1</sup>	11.8 <sup>1</sup>	--	--
6:2 FTS	0.020 <sup>1</sup>	3.45 <sup>1</sup>	0.085 <sup>1</sup>	4.2 <sup>1</sup>	<b>15<sup>3</sup></b>	--

**Notes:**

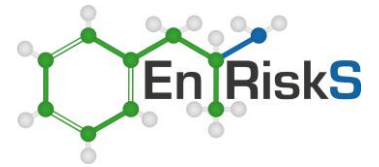
- 1 = Read-across on a molar basis from PFOA, PFOS or PFHxS of PFNA (for PFDA and PFUnA). Borg et. al. (2013) indicates that "for congeners lacking data, read-across extrapolation from the closest most conservative congener on a molar basis has been performed". Read-across is the process where endpoint information for one chemical is used to predict the same endpoint for another chemical which is considered to be similar in some way (e.g. structurally similar). PFTriDA and PFTeDA were also evaluated on this basis
- 2 = Lowest Observed Adverse Effect Level (LOAEL)
- 3 = Critical effect is nephrotoxicity
- 4 = Critical effect is decrease in haemoglobin levels
- 5 = Critical effect decrease in serum cholesterol
- 6 = Based on an independent review of toxicity data by the study authors which may consider different PODs to those selected by other jurisdictions for the development of guideline values and hence, may differ to the information presented above. The information presented by the study authors has been replicated here to ensure a consistent approach is adopted for the review of the toxicity data for PFOS / PFOA as compared to other PFAS compounds.
- = No data available

**Table C2** indicates that where chemical specific information is available and evaluated on a consistent basis (values shown in bold; other values have been estimated via read across from PFOS, PFOA or PFHxS), PODs for other PFAS are 10 to 100 times higher than that for PFOS and PFOA. This means these PFAS compounds are 10 to 100 times less toxic than PFOS and PFOA.

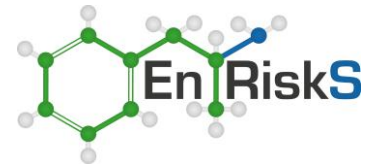
The exceptions are:

- PFNA which has reproductive toxicity and hepatotoxicity PODs (external dose) of 0.83 mg/kg/day; and
- PFHxS which has a haematology toxicity POD (external dose) of 0.3 mg/kg/day which is similar to PFOS and PFOA.

In their recent review (FSANZ 2017b), FSANZ concluded that structure of PFOS and PFHxS are similar, and there is some evidence of similar potency in the activation of PPARα which may at least partially mediate the toxicity of some PFAS.

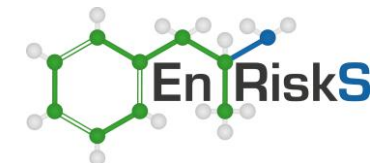


Given this, the TRVs for PFOS of 0.02 µg/kg/day has been adopted for PFHxS in this HHRA. In practical terms, this means that concentrations of PFOS and PFHxS are evaluated together (as a sum) in the HHRA calculations.



## **Appendix D      Risk Calculations – On-Airport**

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## Exposure to Chemicals via Incidental Ingestion of Soil

$$\text{Daily Chemical Intake}_{IS} = C_S \cdot \frac{IR_S \cdot FI \cdot CF \cdot B \cdot EF \cdot ED}{BW \cdot AT} \quad (\text{mg/kg/day})$$

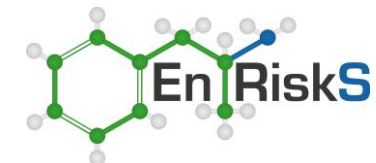
Parameters Relevant to Quantification of Exposure by Adults		
Ingestion Rate - Maximum (IRs, mg/day)	100	Conservative assumption
Fraction Ingested from Source (FI, unitless)	100%	Assumed to be 100%
Bioavailability (Ba, unitless)	100%	Assumed to be 100%
Exposure Frequency (EF, days/year)	60	Assumed maximum
Exposure Duration (ED, years)	30	ASC NEPM
Body Weight (BW, kg)	70	ASC NEPM
Conversion Factor (CF)	1.00E-06	conversion from mg to kg
Averaging Time - NonThreshold (Atc, days)	25550	ASC NEPM
Averaging Time - Threshold (Atn, days)	10950	ASC NEPM

## Current and Former FTG

Maximum Calculations - Key Chemical	Toxicity Data				Soil Concentration (mg/kg)	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day) <sup>-1</sup>	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
PFOS+PFHxS	--	2.0E-05	10%	1.8E-05	140	--	3.3E-05	--		1.8	100%
<b>TOTAL</b>								--		<b>1.8</b>	

## Fire Station

Maximum Calculations - Key Chemical	Toxicity Data				Soil Concentration (mg/kg)	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day) <sup>-1</sup>	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
PFOS+PFHxS	--	2.0E-05	10%	1.8E-05	31.8	--	7.5E-06	--		0.41	100%
<b>TOTAL</b>								--		<b>0.41</b>	



## Exposure to Chemicals via Dermal Contact with Soil

$$\text{Daily Chemical Intake}_{DS} = C_S \cdot \frac{SA_S \cdot AF \cdot FE \cdot ABS \cdot CF \cdot EF \cdot ED}{BW \cdot AT} \quad (\text{mg/kg/day})$$

### Parameters Relevant to Quantification of Exposure by Adults

Surface Area (SAs, cm <sup>2</sup> )	6300	ASC NEPM
Adherence Factor (AF, mg/cm <sup>2</sup> )	0.9	CRC CARE 2011)
Fraction of Day Exposed	0.5	Assumes the worker remains dirty for 12 hours
Conversion Factor (CF)	1.E-06	Conversion of units
Dermal absorption (ABS, unitless)	Chemical-specific (as below)	
Exposure Frequency (EF, days/yr)	60	Assumed maximum
Exposure Duration (ED, years)	30	ASC NEPM
Body Weight (BW, kg)	70	ASC NEPM
Averaging Time - NonThreshold (Atc, days)	25550	ASC NEPM
Averaging Time - Threshold (Atn, days)	10950	ASC NEPM

## Current and Former FTG

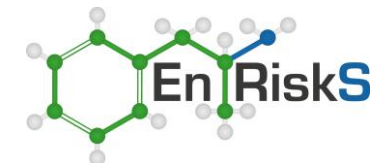
Key Chemical	Toxicity Data					Soil Concentration (mg/kg)	Daily Intake		Calculated Risk		
	Non-Threshold Slope Factor (mg/kg-day) <sup>-1</sup>	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)	Dermal Absorption (ABS)		Non-Threshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)
PFOS+PFHxS	--	2.0E-05	10%	1.8E-05	0.001	140	--	4.7E-07	--	0.026	100%

**TOTAL** -- 0.026

## Fire Station

Key Chemical	Toxicity Data					Soil Concentration (mg/kg)	Daily Intake		Calculated Risk		
	Non-Threshold Slope Factor (mg/kg-day) <sup>-1</sup>	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)	Dermal Absorption (ABS)		Non-Threshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)
PFOS+PFHxS	--	2.0E-05	10%	1.8E-05	0.001	31.8	--	1.1E-07	--	0.0059	100%

**TOTAL** -- 0.0059



## Exposure to Chemicals via Inhalation of Dust

$$\text{Inhalation Exposure Conc}_p = C_a \cdot \frac{ET \cdot FI \cdot DF \cdot CC \cdot EF \cdot ED}{AT} \quad (\text{mg/m}^3)$$

Parameters Relevant to Quantification of Exposure by Adults		
Exposure Time (ET, hr/day)	10	Assumed maximum
Fraction Inhaled from Contaminated Source (FI, unitless)	1	Assume all of dust is from site related soil
Deposition Fraction (DF, unitless)	0.75	ASC NEPM, assume 75% inhaled dust reaches lungs
Ciliary Clearance (CC, unitless)	0.5	ASC NEPM, assume 50% inhaled dust is absorbed
Exposure Frequency (EF, days/yr)	60	Assumed maximum
Exposure Duration (ED, years)	30	ASC NEPM
Averaging Time - NonThreshold (Atc, hours)	613200	ASC NEPM
Averaging Time - Threshold (Atn, hours)	262800	ASC NEPM

## Current and Former FTG

Key Chemical	Toxicity Data				Concentration in Soil		Daily Exposure		Calculated Risk			
	Inhalation Unit Risk ( $\text{mg/m}^3$ ) <sup>-1</sup>	Chronic TC air ( $\text{mg/m}^3$ )	Background Intake (% Chronic TC)	Chronic TC Allowable for Assessment (TC-Background) ( $\text{mg/m}^3$ )	PEF ( $\text{m}^3/\text{kg}$ )	Conc. in Soil (Ca) ( $\text{mg/m}^3$ )	Inhalation Exposure Concentration - NonThreshold ( $\text{mg/m}^3$ )	Inhalation Exposure Concentration - Threshold ( $\text{mg/m}^3$ )	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
PFOS+PFHxS		7.0E-05	10%	6.30E-05	4.40E+08	140	--	8.2E-09	--		0.00013	100%
<b>TOTAL</b>									--		<b>0.00013</b>	

Note:

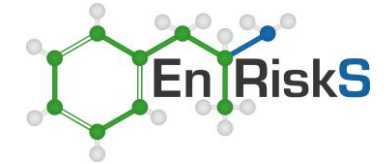
Inhalation TRV derived by the conversion of the EFSA (2008) oral based on an adult body weight of 70 kg and an inhalation volume of 20 m<sup>3</sup>/day.

## Fire Station

Key Chemical	Toxicity Data				Concentration in Soil		Daily Exposure		Calculated Risk			
	Inhalation Unit Risk ( $\text{mg/m}^3$ ) <sup>-1</sup>	Chronic TC air ( $\text{mg/m}^3$ )	Background Intake (% Chronic TC)	Chronic TC Allowable for Assessment (TC-Background) ( $\text{mg/m}^3$ )	PEF ( $\text{m}^3/\text{kg}$ )	Conc. in Soil (Ca) ( $\text{mg/m}^3$ )	Inhalation Exposure Concentration - NonThreshold ( $\text{mg/m}^3$ )	Inhalation Exposure Concentration - Threshold ( $\text{mg/m}^3$ )	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
PFOS+PFHxS		7.0E-05	10%	6.30E-05	4.40E+08	31.8	--	1.9E-09	--		0.000029	100%
<b>TOTAL</b>									--		<b>0.000029</b>	

Note:

Inhalation TRV derived by the conversion of the EFSA (2008) oral based on an adult body weight of 70 kg and an inhalation volume of 20 m<sup>3</sup>/day.



### Exposure to Chemicals via Incidental Ingestion of Groundwater - Current and Former FTG

$$\text{Daily Chemical Intake}_{IW} = C_W \cdot \frac{IR_W \cdot FI \cdot B \cdot EF \cdot ED}{BW \cdot AT} \quad (\text{mg/kg/day})$$

Parameters Relevant to Quantification of Exposure by Ground Crew		
Ingestion Rate (Irw, L/day)	0.005	Incidental ingestion of 5 ml (1 tsp) of water per day
Fraction Ingested from Source	100%	Assumed to be 100%
Exposure Frequency (EF, days/year)	60	Assumed maximum
Exposure Duration (ED, years)	30	As per NEPM (1999 amended 2013)
Body Weight (BW, kg)	70	As per NEPM (1999 amended 2013)
Averaging Time - Threshold (Atn, days)	10950	US EPA 1989 and CSMS 1996

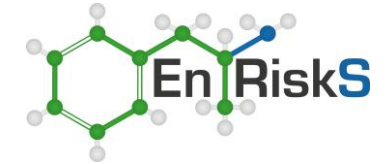
Key Chemical	Toxicity Data				Concentration in Water (Cw)	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day) <sup>-1</sup>	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
PFOS + PFHxS		2.0E-05	10%	1.8E-05	5.72		6.7E-05	--		3.7	100%
<b>TOTAL</b>								--		<b>3.7</b>	

### Dermal Exposure to Chemicals via Contact with Groundwater - Current and Former FTG

$$\text{Daily Chemical Intake}_{DW} = C_W \cdot \frac{SAW \cdot ET \cdot DP \cdot CF \cdot EF \cdot ED}{BW \cdot AT} \quad (\text{mg/kg/day})$$

Parameters Relevant to Quantification of Exposure by Ground Crew		
Surface Area (Saw, cm <sup>2</sup> )	6300	As per NEPM (1999 amended 2013)
Exposure Time (ET, hr/day)	2	Assumed period of time users may be wet each day
Conversion Factor (CF, L/cm <sup>3</sup> )	1.E-03	Conversion of units
Dermal Permeability (cm/hr)	Chemical-specific (as below)	
Exposure Frequency (EF, days/yr)	60	Assumed maximum
Exposure Duration (ED, years)	30	As per NEPM (1999 amended 2013)
Body Weight (BW, kg)	70	As per NEPM (1999 amended 2013)
Averaging Time - Threshold (Atn, days)	10950	US EPA 1989 and CSMS 1996

Key Chemical	Toxicity Data					Concentration in Water (Cw)	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day) <sup>-1</sup>	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)	Dermal Permeability (DP) (cm/hr)		Non-Threshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
PFOS + PFHxS		2.0E-05	10%	1.8E-05	3.20E-5	5.72		5.4E-06	--		0.30	100%
<b>TOTAL</b>									--		<b>0.30</b>	



### Exposure to Chemicals via Incidental Ingestion of Groundwater - Fire Station

$$\text{Daily Chemical Intake}_{IW} = C_W \cdot \frac{IR_W \cdot FI \cdot B \cdot EF \cdot ED}{BW \cdot AT} \quad (\text{mg/kg/day})$$

Parameters Relevant to Quantification of Exposure by Ground Crew		
Ingestion Rate (I <sub>rw</sub> , L/day)	0.005	Incidental ingestion of 5 ml (1 tsp) of water per day
Fraction Ingested from Source	100%	Assumed to be 100%
Exposure Frequency (EF, days/year)	60	Assumed maximum
Exposure Duration (ED, years)	30	As per NEPM (1999 amended 2013)
Body Weight (BW, kg)	70	As per NEPM (1999 amended 2013)
Averaging Time - Threshold (A <sub>tn</sub> , days)	10950	US EPA 1989 and CSMS 1996

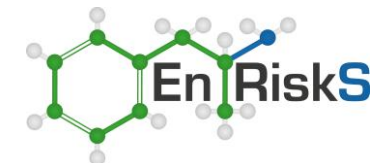
Key Chemical	Toxicity Data				Concentration in Water (C <sub>w</sub> ) (mg/L)	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day) <sup>-1</sup>	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
PFOS + PFHxS		2.0E-05	10%	1.8E-05	4.99		5.9E-05	--		3.3	100%
<b>TOTAL</b>								--		<b>3.3</b>	

### Dermal Exposure to Chemicals via Contact with Groundwater - Fire Station

$$\text{Daily Chemical Intake}_{DW} = C_W \cdot \frac{SAW \cdot ET \cdot DP \cdot CF \cdot EF \cdot ED}{BW \cdot AT} \quad (\text{mg/kg/day})$$

Parameters Relevant to Quantification of Exposure by Ground Crew		
Surface Area (S <sub>aw</sub> , cm <sup>2</sup> )	6300	As per NEPM (1999 amended 2013)
Exposure Time (ET, hr/day)	2	Assumed period of time users may be wet each day
Conversion Factor (CF, L/cm <sup>3</sup> )	1.E-03	Conversion of units
Dermal Permeability (cm/hr)	Chemical-specific (as below)	
Exposure Frequency (EF, days/yr)	60	Assumed maximum
Exposure Duration (ED, years)	30	As per NEPM (1999 amended 2013)
Body Weight (BW, kg)	70	As per NEPM (1999 amended 2013)
Averaging Time - Threshold (A <sub>tn</sub> , days)	10950	US EPA 1989 and CSMS 1996

Key Chemical	Toxicity Data					Concentration in Water (C <sub>w</sub> ) (mg/L)	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day) <sup>-1</sup>	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)	Dermal Permeability (DP) (cm/hr)		Non-Threshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
PFOS + PFHxS		2.0E-05	10%	1.8E-05	3.20E-5	4.99		4.7E-06	--		0.26	100
<b>TOTAL</b>									--		<b>0.26</b>	



### Exposure to Chemicals via Incidental Ingestion of Groundwater - Former Concrete Water Tank Area

$$\text{Daily Chemical Intake}_{IW} = C_W \cdot \frac{IR_W \cdot FI \cdot B \cdot EF \cdot ED}{BW \cdot AT} \quad (\text{mg/kg/day})$$

Parameters Relevant to Quantification of Exposure by Ground Crew		
Ingestion Rate (I <sub>rw</sub> , L/day)	0.005	Incidental ingestion of 5 ml (1 tsp) of water per day
Fraction Ingested from Source	100%	Assumed to be 100%
Exposure Frequency (EF, days/year)	60	Assumed maximum
Exposure Duration (ED, years)	30	As per NEPM (1999 amended 2013)
Body Weight (BW, kg)	70	As per NEPM (1999 amended 2013)
Averaging Time - Threshold (A <sub>tn</sub> , days)	10950	US EPA 1989 and CSMS 1996

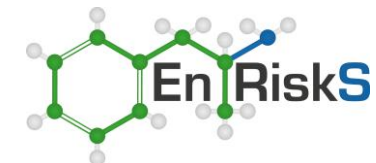
Key Chemical	Toxicity Data				Concentration in Water (C <sub>w</sub> )	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor	Threshold TDI	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background)		NonThreshold	Threshold	Non-Threshold Risk	% Total Risk	Chronic Hazard Quotient	% Total HI
	(mg/kg-day) <sup>-1</sup>	(mg/kg/day)		(mg/kg/day)	(mg/L)	(mg/kg/day)	(mg/kg/day)	(unitless)		(unitless)	
PFOS + PFHxS		2.0E-05	10%	1.8E-05	0.38		4.4E-06	--		0.25	100%
<b>TOTAL</b>								--		<b>0.25</b>	

### Dermal Exposure to Chemicals via Contact with Groundwater - Former Concrete Water Tank Area

$$\text{Daily Chemical Intake}_{DW} = C_W \cdot \frac{SAW \cdot ET \cdot DP \cdot CF \cdot EF \cdot ED}{BW \cdot AT} \quad (\text{mg/kg/day})$$

Parameters Relevant to Quantification of Exposure by Ground Crew		
Surface Area (Saw, cm <sup>2</sup> )	6300	As per NEPM (1999 amended 2013)
Exposure Time (ET, hr/day)	2	Assumed period of time users may be wet each day
Conversion Factor (CF, L/cm <sup>3</sup> )	1.E-03	Conversion of units
Dermal Permeability (cm/hr)	Chemical-specific (as below)	
Exposure Frequency (EF, days/yr)	60	Assumed maximum
Exposure Duration (ED, years)	30	As per NEPM (1999 amended 2013)
Body Weight (BW, kg)	70	As per NEPM (1999 amended 2013)
Averaging Time - Threshold (A <sub>tn</sub> , days)	10950	US EPA 1989 and CSMS 1996

Key Chemical	Toxicity Data					Concentration in Water (C <sub>w</sub> )	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor	Threshold TDI	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background)	Dermal Permeability (DP)		Non-Threshold	Threshold	Non-Threshold Risk	% Total Risk	Chronic Hazard Quotient	% Total HI
	(mg/kg-day) <sup>-1</sup>	(mg/kg/day)		(mg/kg/day)	(cm/hr)	(mg/L)	(mg/kg/day)	(mg/kg/day)	(unitless)		(unitless)	
PFOS + PFHxS		2.0E-05	10%	1.8E-05	3.20E-5	0.38		3.6E-07	--		0.020	100
<b>TOTAL</b>									--		<b>0.020</b>	



### Exposure to Chemicals via Incidental Ingestion of Surface Water - Current and Former FTG

$$\text{Daily Chemical Intake}_{IW} = C_W \cdot \frac{IR_W \cdot FI \cdot B \cdot EF \cdot ED}{BW \cdot AT} \quad (\text{mg/kg/day})$$

Parameters Relevant to Quantification of Exposure by Ground Crew		
Ingestion Rate (I <sub>rw</sub> , L/day)	0.005	Incidental ingestion of 5 ml (1 tsp) of water per day
Fraction Ingested from Source	100%	Assumed to be 100%
Exposure Frequency (EF, days/year)	60	Assumed maximum
Exposure Duration (ED, years)	30	As per NEPM (1999 amended 2013)
Body Weight (BW, kg)	70	As per NEPM (1999 amended 2013)
Averaging Time - Threshold (A <sub>tn</sub> , days)	10950	US EPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Concentration in Water (C <sub>w</sub> )	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day) <sup>-1</sup>	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		Non-Threshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
PFOS + PFHxS		2.0E-05	10%	1.8E-05	0.27		3.2E-06	--		0.18	100%

**TOTAL**      **--**      **0.18**

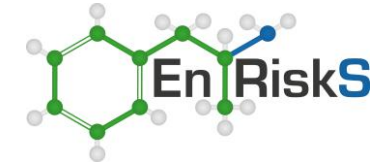
### Dermal Exposure to Chemicals via Contact with Surface Water - Current and Former FTG

$$\text{Daily Chemical Intake}_{DW} = C_W \cdot \frac{SAW \cdot ET \cdot DP \cdot CF \cdot EF \cdot ED}{BW \cdot AT} \quad (\text{mg/kg/day})$$

Parameters Relevant to Quantification of Exposure by Ground Crew		
Surface Area (S <sub>aw</sub> , cm <sup>2</sup> )	6300	As per NEPM (1999 amended 2013)
Exposure Time (ET, hr/day)	2	Assumed period of time users may be wet each day
Conversion Factor (CF, L/cm <sup>3</sup> )	1.E-03	Conversion of units
Dermal Permeability (cm/hr)	Chemical-specific (as below)	
Exposure Frequency (EF, days/yr)	60	Assumed maximum
Exposure Duration (ED, years)	30	As per NEPM (1999 amended 2013)
Body Weight (BW, kg)	70	As per NEPM (1999 amended 2013)
Averaging Time - Threshold (A <sub>tn</sub> , days)	10950	US EPA 1989 and CSMS 1996

Key Chemical	Toxicity Data					Concentration in Water (C <sub>w</sub> )	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day) <sup>-1</sup>	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)	Dermal Permeability (DP) (cm/hr)		Non-Threshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
PFOS + PFHxS		2.0E-05	10%	1.8E-05	3.20E-5	0.27		2.6E-07	--		0.014	100

**--**      **0.014**



### Exposure to Chemicals via Incidental Ingestion of Surface Water - Fire Station

$$\text{Daily Chemical Intake}_{IW} = C_W \cdot \frac{IR_W \cdot FI \cdot B \cdot EF \cdot ED}{BW \cdot AT} \quad (\text{mg/kg/day})$$

Parameters Relevant to Quantification of Exposure by Ground Crew		
Ingestion Rate (I <sub>rw</sub> , L/day)	0.005	Incidental ingestion of 5 ml (1 tsp) of water per day
Fraction Ingested from Source	100%	Assumed to be 100%
Exposure Frequency (EF, days/year)	60	Assumed maximum
Exposure Duration (ED, years)	30	As per NEPM (1999 amended 2013)
Body Weight (BW, kg)	70	As per NEPM (1999 amended 2013)
Averaging Time - Threshold (A <sub>tn</sub> , days)	10950	US EPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Concentration in Water (C <sub>w</sub> )	Daily Intake		Calculated Risk			
	Non-Threshold Slope Factor (mg/kg-day) <sup>-1</sup>	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		NonThreshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
PFOS + PFHxS		2.0E-05	10%	1.8E-05	0.24		2.8E-06	--		0.16	100%
<b>TOTAL</b>								--		<b>0.16</b>	

### Dermal Exposure to Chemicals via Contact with Surface Water - Fire Station

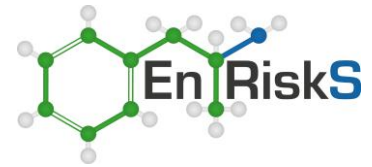
$$\text{Daily Chemical Intake}_{DW} = C_W \cdot \frac{SA_w \cdot ET \cdot DP \cdot CF \cdot EF \cdot ED}{BW \cdot AT} \quad (\text{mg/kg/day})$$

Parameters Relevant to Quantification of Exposure by Ground Crew		
Surface Area (S <sub>aw</sub> , cm <sup>2</sup> )	6300	As per NEPM (1999 amended 2013)
Exposure Time (ET, hr/day)	2	Assumed period of time users may be wet each day
Conversion Factor (CF, L/cm <sup>3</sup> )	1.E-03	Conversion of units
Dermal Permeability (cm/hr)	Chemical-specific (as below)	
Exposure Frequency (EF, days/yr)	60	Assumed maximum
Exposure Duration (ED, years)	30	As per NEPM (1999 amended 2013)
Body Weight (BW, kg)	70	As per NEPM (1999 amended 2013)
Averaging Time - Threshold (A <sub>tn</sub> , days)	10950	US EPA 1989 and CSMS 1996

Key Chemical	Toxicity Data				Concentration in Water (C <sub>w</sub> )	Daily Intake		Calculated Risk				
	Non-Threshold Slope Factor (mg/kg-day) <sup>-1</sup>	Threshold TDI (mg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (mg/kg/day)		Dermal Permeability (DP) (cm/hr)	Non-Threshold (mg/kg/day)	Threshold (mg/kg/day)	Non-Threshold Risk (unitless)	% Total Risk	Chronic Hazard Quotient (unitless)	% Total HI
PFOS + PFHxS		2.0E-05	10%	1.8E-05	3.20E-5	0.24		2.3E-07	--		0.013	100
<b>TOTAL</b>								--		<b>0.013</b>		

## **Appendix E      Risk Calculations – Off-Airport**

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## E1 General

This section outlines the approach used to assess the uptake of PFAS (specifically PFOS and PFHxS) into:

- Eggs where chickens are exposed to soil and/or water containing PFAS; and
- Fruit and vegetables where soil and/or water containing PFAS is used to grow these plants.

There are several steps required to estimate intakes by humans and these steps are outlined below.

## E2 Calculating Intake from Water by Chickens

Estimating the intake of PFAS for chickens uses the same generic equation as is used for people. This approach was originally outlined by the USEPA (USEPA 1989). The basic methodology outlined in the early years of contaminated sites risk assessment (i.e. 1980s) is still relevant today.

The generic equation (or a modified version for a specific type of exposure) is included in the enHealth guidance on risk assessment for Australia. The generic equation is:

$$\text{Intake}_m = \frac{C_m \times IR_m \times FI \times B_o \times EF \times ED}{BW \times AT}$$

Where:

Intake<sub>m</sub> = Daily intake of PFAS i.e. from water consumed by chickens (µg/kg/day)

C<sub>m</sub> = Concentration in PFAS impacted media i.e. in water consumed by chickens (µg/L)

IR<sub>m</sub> = Ingestion rate (kg/day or L/day)

FI = Fraction ingested from contaminated source (unitless)

B<sub>o</sub> = Oral bioavailability (unitless)

EF = Exposure frequency (days/year)

ED = Exposure duration (years)

AT = Averaging time (days)

BW = Body weight (kg)

To assess the risks to health from PFAS, the uptake of the PFAS into the chickens is estimated. The intake of these chemicals can then be converted into an estimate of the concentration that may be in the part of the animal people consume i.e. the eggs. Once the concentrations in eggs are estimated, the potential risks to human health can be estimated based on how many eggs are consumed.

There are a number of ways in which chickens can be exposed to PFAS – ingestion of water that contains PFAS, ingestion of soil (incidental when grazing) that contains PFAS and ingestion of grass or food fodder that may contain PFAS because it has been grown in affected soil or irrigated with affected water. This HHRA considers the situation where groundwater is extracted and provided as a water source for chickens.

The values used for the parameters in this equation are listed in **Table E1**.

**Table E1. Exposure Parameters for Estimating Intake by Chickens**

Parameter	Units	Value for Chickens	Basis / Comment
IR <sub>w</sub>	L/d	0.32	Average daily consumption from Table 9.3.1 Australian and New Zealand Guidelines for Fresh and Marine Water Volume 3 – Primary Industries (ANZECC/ARMCANZ 2000)
FI	unitless	1	Assumed 100% of soil, water and fodder exposure is to affected media
B <sub>o</sub>	unitless	1	Assumed to be 100% bioavailable in all media
EF	d/y	365	Assumed exposed daily
ED	y	8	Personal Communication from NZ agriculture, Agriculture Victoria and owners of backyard chickens
AT	d	2,920	Calculated as the ED x 365 days/year
BW	kg	2.8	Average body weight from Table 9.3.2 Australian and New Zealand Guidelines for Fresh and Marine Water Volume 3 – Primary Industries (ANZECC/ARMCANZ 2000)

### E3 Transfer from Intake by Chickens to Eggs

Only one study was identified that examined the uptake of PFOS, PFHxS or PFOA in eggs, although this report was in German (Kowalczyk 2014). This study was used in the initial assessment that was undertaken as part of the HHRA for RAAF Base Williamtown. The study indicates a percentage of chemical transferred into egg which was were reported as 0.55 (i.e. 55% of what they ingest moves into the eggs)<sup>10</sup>.

A more recent study was conducted as part of the Williamtown HHRA released in December 2017 (AECOM 2017). This study involved the collection of eggs from chickens fed water containing PFAS. The exposure period was 9 weeks followed by an elimination phase, and eggs were collected on a daily basis. Chickens were exposed to water with PFAS concentrations in the order of 0, 0.3, 3, 30 and 300 µg/L (actual concentrations of 0, 0.2, 2.6, 26.7 and 264 µg/L). The study estimated the transfer factors using the more commonly used approach, taking into account the laying rate of the hen (i.e. a hen does not lay eggs every day):

- PFOS: 1.0 µg/edible egg-d/µg/d hen intake; and
- PFHxS: 0.58 to 0.87 (average of 0.69) µg/edible egg-d/µg/d hen intake.

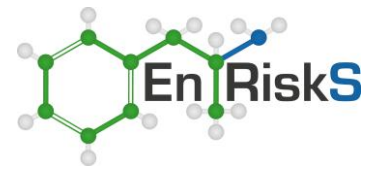
The average weight of a bird in the study was 2.1 kg and the average weight of edible egg per day was 0.056 kg. **Table E2** shows these transfer factors converted into ones that can be used in this assessment.

**Table E2: Intake to Egg Transfer Factors for Chickens**

Chemical	Converted Transfer Factors (µg/kg egg/µg/kg bw-d)
PFOS	37.5
PFHxS	25.9

The above transfer factors have been used in the HHRA.

<sup>10</sup> It is difficult to check the % transfer reported in this study given that the original paper is in German. Given this lack of clarity, the transfer factors determined from the more recent work have been adopted for this assessment.



## E4 Transfer from Water to Fruit and Vegetables

Understanding how fruit and vegetables may accumulate PFAS from water they are grown with is essential for understanding uptake by humans.

Calculating the uptake of PFAS into plants involves the use of a transfer factor, which is a mathematical term that indicates the relationship between PFAS in irrigation water and PFAS in different parts of the fruit or vegetable (e.g. root or leaf), including those parts that may be consumed. Further information on the relevant transfer factors is provided below.

There are 9 studies that investigate the uptake of PFAS into fruit, vegetables and pasture crops from water (AECOM 2017; Blaine et al. 2014; Felizeter, and & de Voogt 2014; Felizeter, S, McLachlan & de Voogt 2012; García-Valcárcel et al. 2014; Wen et al. 2013; Zhang et al. 2019; Zhao et al. 2013; Zhao et al. 2016). **Table E3** lists the transfer factors developed from the above studies.

For the Wen et. al. (2013), Zhao et. al. (2013) and Zhang et. al. (2019) studies, the experimental water concentrations are much higher than would be expected in an environmental situation and/or the data to calculate transfer factors has not been included in the paper. Hence, these results have not been used in this assessment.

The AECOM (2017) study was a 120-day greenhouse trial that investigated the uptake of PFAS into 7 horticultural crops comprising alfalfa, beet, cucumber, radish, lettuce, strawberry and tomatoes. These products are primarily consumed by humans however alfalfa is a common pasture grass for livestock. The crops were housed in 4 different greenhouses and were irrigated with test solutions containing 0 µg/L, 1 µg/L, 10 µg/L and 100 µg/L of PFOS, PFHxS, PFOA and PFHxA, with a further sample of produce irrigated with groundwater sourced from downgradient of the AACO and Williamtown sites (total PFAS concentrations of 37 and 138 µg/L respectively). The aim of the study was to derive transfer factors for the uptake of PFAS into fruit and vegetables.

AECOM (2017) concluded that uptake of PFAS into plants was directly correlated to PFAS concentration in water (with a linear relationship) where irrigation water was artificially modified with PFAS. However, when groundwater from the AACO and Williamtown sites was used to irrigate produce the same relationship was not observed, especially for beet leaf and alfalfa leaf. This was compounded by the saltiness of the groundwater used for irrigation which adds additional uncertainty. There were also some experimental issues with raising the tomatoes, strawberries and cucumbers which means that the transfer factors are not statistically significant for strawberries and cucumbers and no transfer factors were derived for tomatoes. For this reason, transfer factors derived for the AECOM (2017) experiments with groundwater have not been considered in this HHRA.

Data presented in the supplementary material for Blain et. al. (2014) has also been reviewed and used to calculate transfer factors as shown in **Table E4**. Similarly, data presented in the supplementary material for Felizeter, McLachlan and Voogt (2012) has been reviewed and used to calculate transfer factors as shown in **Table E5**. Supplementary data from Felizeter, McLachlan and Voogt (2014) was reviewed by Senversa (2017) as part of the investigation at the Defence RAAF East Sale Base (the report for which is publicly available) and used to calculate transfer factors. The calculated transfer factors have been reviewed by enRiskS and are correct.

**Table E3. Transfer Factors for Water to Fruit and Vegetables Considered in HHRA**

Plant Type	Reference	Transfer Factor <sup>2</sup> (µg/kg plant (ww)/µg/L water)	
		PFOS	PFHxS
<b>Green and Fruiting Vegetables</b>			
Lettuce leaves/foilage	Blain et. al. (2014) <sup>1</sup>	1.3 – 4.2	2.0 – 8.0
	Felizeter et. al. (2012)	0.3 – 2.2	0.45 – 1.1
	AECOM (2017) (spiked water)	0.1 – 2.9 (1.0)	0.1 – 3.9 (1.5)
Cabbage head	Felizeter et. al. (2014)	0.2	0.27
Radish leaf	AECOM (2017) (spiked water)	0.6 – 14.8 (8.1)	1.4 – 9.7 (4.8)
Tomato	Felizeter et. al. (2014)	0.03	0.06
Cucumber	AECOM (2017) (spiked water)	0.03 – 0.2 (0.08)	0.1 – 0.9 (0.4)
Zucchini	Felizeter et. al. (2014)	0.32	0.27
<b>Average of Maximum Values Adopted in HHRA</b>		<b>2.0</b>	<b>2.1</b>
<b>Root Vegetables</b>			
Beet	AECOM (2017) (spiked water)	0.6 – 2.7 (1.2)	2.6 – 7.2 (5.4)
Radish root	AECOM (2017) (spiked water)	0.7- 3.5 (1.5)	0.3 – 2.2 (0.8)
<b>Maximum Value Adopted in HHRA</b>		<b>3.5</b>	<b>7.2</b>
<b>Fruits or Fruiting Vegetables</b>			
Strawberry	Blain et. al. (2014)	Not Detected	Not Detected
	AECOM (2017) (spiked water)	0.03 – 0.8 (0.3)	0.04 – 1.5 (0.3)
<b>Maximum Value Adopted in HHRA</b>		<b>0.8</b>	<b>1.5</b>

**Notes:**

- NA = PFAS not detected in strawberry fruit.
- 1 = Concentration in dw converted to concentration in ww based on a conversion factor of 0.1 (assumes that lettuce is 90% water).
- 2 = Average value provided in parenthesis.
- 3 = Includes data from Felizeter, McLachlan and Voogt (2014).

**Table E4. Calculation of Transfer Factors for Water to Lettuce and Strawberry (Blain et. al. 2014)  
(Used in Table E3)**

Plant Type	Water Concentration (µg/L)		Plant Concentration (µg/kg dw)		Transfer Factor (µg/kg plant (dw)/µg/L water)	
	PFOS	PFHxS	PFOS	PFHxS	PFOS	PFHxS
Lettuce leaves	0.065	0.092	1.44	ND	22	NA
	0.097	0.186	4.05	5.24	42	28
	0.262	0.473	3.28	9.25	13	20
	0.488	0.991	17.3	32.6	35	33
	1.00	1.91	31.1	56.3	31	29
	1.36	4.01	57.4	188	42	47
	3.45	8.48	73.1	417	21	49
	7.94	15.6	279	1,250	35	80
Strawberry fruit	0.065	0.092	ND	ND	NA	NA
	0.097	0.186	ND	ND	NA	NA
	0.262	0.473	ND	ND	NA	NA
	0.488	0.991	ND	ND	NA	NA
	1.00	1.91	ND	ND	NA	NA
	1.36	4.01	ND	ND	NA	NA
	3.45	8.48	ND	ND	NA	NA
	7.94	15.6	ND	ND	NA	NA

**Notes:**

- ND = Not detected.
- NA = Not applicable.

**Table E5: Calculation of Transfer Factors for Water to Lettuce (Felizeter, McLachlan and Voogt 2014)  
(Used in Table E3)**

Plant Type	Water Concentration (µg/L)		Plant Concentration (µg/kg ww)		Transfer Factor (µg/kg plant (ww)/µg/L water)	
	PFOS	PFHxS	PFOS <sup>1</sup>	PFHxS	PFOS	PFHxS
Lettuce foliage	0.055	0.011	0.016	0.014	0.29	1.1
	0.035	0.079	0.05	0.05	1.4	0.45
	0.47	1.06	0.5	0.55	1.1	0.54
	4.4	9.4	9.6	5.8	2.2	0.66

**Notes:**

ND = Not detected.

NA = Not applicable, no analysis for PFAS.

1 = Values are for linear PFOS as concentrations of linear PFOS were higher than branched PFOS

**Table E6. Transfer Factors for Water to Fruit and Vegetables Not Considered in HHRA**

Plant Type	Reference	Transfer Factor <sup>1</sup> (µg/kg plant (ww)/µg/L water)	
		PFOS	PFHxS
Lettuce leaves/foilage	AECOM (2017) (groundwater)	0.1 – 6.1 (1.1)	0.1 – 3.9 (1.4)
Radish leaf	AECOM (2017) (groundwater)	0.6 – 40.4 (11.0)	1.4 – 9.7 (5.3)
Cucumber	AECOM (2017) (groundwater)	0.03 – 0.2 (0.08)	0.1 – 0.9 (0.4)
Beet	AECOM (2017) (groundwater)	0.6 – 7.6 (2.7)	2.6 – 17.6 (6.9)
Radish root	AECOM (2017) (groundwater)	0.7- 8.9 (2.7)	0.3 – 5.1(1.3)
Strawberry	AECOM (2017) (groundwater)	0.03 – 0.8 (0.3)	0.04 – 1.5 (0.3)

**Notes:**

1 = Average value provided in parenthesis.

## E5 Estimating Intake by Humans

As discussed in **Section E1**, the generic equation (or a modified version for a specific type of exposure) is included in the enHealth guidance on risk assessment for Australia. The generic equation is:

$$\text{Intake}_m = \frac{C_m \times IR_m \times FI \times B_o \times EF \times ED}{BW \times AT}$$

Where:

Intake<sub>m</sub> = Daily intake of PFAS i.e. from beef meat for humans (µg/kg/day)

C<sub>m</sub> = Concentration of PFAS in meat (muscle) (µg/kg or µg/L)

IR<sub>m</sub> = Ingestion rate (kg/day or L/day)

FI = Fraction ingested from contaminated source (unitless)

B<sub>o</sub> = Oral bioavailability (unitless)

EF = Exposure frequency (days/year)

ED = Exposure duration (years)

AT = Averaging time (days)

BW = Body weight (kg)

The adopted exposure assumptions are presented in the body of the assessment.

The risk calculation spreadsheets are provided below.

### Intake of Chemicals by Chickens (stock watering with groundwater containing PFAS)

$$\text{Intake}_m = \frac{C_m \times IR_m \times FI \times B_o \times EF \times ED}{BW \times AT} \quad (\mu\text{g}/\text{kg}/\text{day})$$

	PFOS	PFHxS	units
Egg to intake ratio as per study =	1	0.69	mg/edible egg-d/mg/d
Adjusted egg to intake ratio =	37.5	25.9	ug/kg (egg)/ug/kg bw-d

#### Chickens

Exposure Parameters	
Chicken water ingestion rate (L/day)	0.32
Fraction of produce from site in diet (FI)	1
Exposure Frequency (EF, days/year)	365
Exposure Duration (ED, years)	8
Body Weight (BW, kg)	2.8
Bioaccessibility (B)	1
Averaging Time - Threshold (Atn, days)	2920

Well ID	Estimation of Uptake and Intake of PFOS + PFHxS							PFOS + PFHxS in Egg ( $\mu\text{g}/\text{kg}$ )
	Concentration in Soil ( $\mu\text{g}/\text{kg}$ )	Concentration in Water ( $\mu\text{g}/\text{L}$ )	Concentration in Pasture ( $\mu\text{g}/\text{kg ww}$ )	Livestock Intake from Soil ( $\mu\text{g}/\text{kg}/\text{day}$ )	Livestock Intake from Water ( $\mu\text{g}/\text{kg}/\text{day}$ )	Livestock Intake from Pasture ( $\mu\text{g}/\text{kg ww per day}$ )	Total Livestock Intake ( $\mu\text{g}/\text{kg}/\text{day}$ )	
<b>GW16_12</b>								
PFOS	0	0.03	0	0.0E+00	3.4E-03	0.0E+00	3.4E-03	1.3E-01
PFHxS	0	0.09	0	0.0E+00	1.0E-02	0.0E+00	1.0E-02	2.7E-01

## Exposure to Chemicals via Ingestion of Eggs

$$\text{Intake}_m = \frac{C_m \times IR_m \times FI \times B_o \times EF \times ED}{BW \times AT} \quad (\mu\text{g}/\text{kg}/\text{day})$$

### Adults

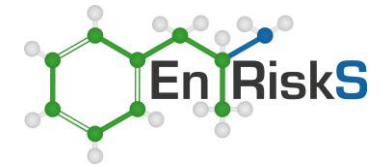
Exposure Parameters	100% Consumption of Eggs
Ingestion Rate of Eggs (IR <sub>p</sub> , kg/day)	0.06
Fraction of produce from site in diet (FI)	100%
Exposure Frequency (EF, days/year)	365
Exposure Duration (ED, years)	35
Body Weight (BW, kg)	70
Bioaccessibility (B)	100%
Averaging Time - Threshold (Atn, days)	12775

Calculations for PFOS+PFHxS	Toxicity Data			PFOS + PFHxS in Egg	Daily Intake	Calculated HQ
	Threshold TDI ( $\mu\text{g}/\text{kg}/\text{day}$ )	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) ( $\mu\text{g}/\text{kg}/\text{day}$ )		( $\mu\text{g}/\text{kg}/\text{day}$ )	(unitless)
<b>GW16_12</b>						
PFOS	2.0E-02	7%	1.9E-02	1.3E-01	1.1E-04	0.0059
PFHxS	2.0E-02	7%	1.9E-02	2.7E-01	2.3E-04	0.012
<b>TOTAL</b>						<b>0.02</b>

### Child

Exposure Parameters	100% Consumption of Eggs
Ingestion Rate of Eggs (IR <sub>p</sub> , kg/day)	0.06
Fraction of produce from site in diet (FI)	100%
Exposure Frequency (EF, days/year)	365
Exposure Duration (ED, years)	5
Body Weight (BW, kg)	15
Bioaccessibility (B)	100%
Averaging Time - Threshold (Atn, days)	1825

Calculations for PFOS+PFHxS	Toxicity Data			PFOS + PFHxS in Eggs	Daily Intake	Calculated HQ
	Threshold TDI ( $\mu\text{g}/\text{kg}/\text{day}$ )	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) ( $\mu\text{g}/\text{kg}/\text{day}$ )		Worst-Case ( $\mu\text{g}/\text{kg}/\text{day}$ )	Worst-Case (unitless)
<b>GW16_12</b>						
PFOS	2.0E-02	7%	1.9E-02	1.3E-01	5.1E-04	0.028
PFHxS	2.0E-02	7%	1.9E-02	2.7E-01	1.1E-03	0.057
<b>TOTAL</b>						<b>0.08</b>



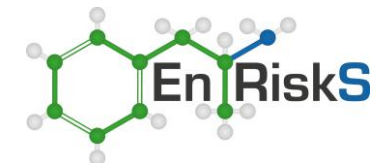
## Exposure to Chemicals via Ingestion of Fruit and Vegetables Following Irrigation with Water Containing PFAS

$$\text{Intake}_m = \frac{C_m \times IR_m \times FI \times B_o \times EF \times ED}{BW \times AT} \quad (\mu\text{g}/\text{kg}/\text{day})$$

### Adults

Exposure Parameters	10% Consumption Home Grown Fruit and Vegetables
Ingestion Rate of Fruit or Vegetables (IR <sub>p</sub> , kg/day)	0.86 Fruit FSANZ (2017g) P90 Consumers
Fraction of produce from site in diet (FI)	10%
Exposure Frequency (EF, days/year)	365
Exposure Duration (ED, years)	35
Body Weight (BW, kg)	70
Bioaccessibility (B)	100%
Averaging Time - Threshold (Atn, days)	12775

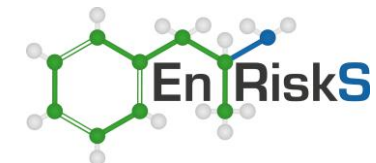
Calculations for PFAS	Toxicity Data			PFAS in Irrigation Water	Water to Produce Transfer Factor	PFAS in Produce	Daily Intake	Calculated HQ
	Threshold TDI	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background)					
	(μg/kg/day)		(μg/kg/day)	(μg/L)	μg/kg plant (ww)/μg/L water	(μg/kg)	(μg/kg/day)	(unitless)
<b>GW16_12</b>								
PFOS	2.0E-02	7%	1.9E-02	0.03	0.8	0.02	2.9E-05	0.0016
PFHxS	2.0E-02	7%	1.9E-02	0.09	1.5	0.14	1.7E-04	0.0089
<b>TOTAL</b>								<b>0.01</b>



## Children

Exposure Parameters	10% Consumption Home Grown Fruit and Vegetables
Ingestion Rate of Fruit or Vegetables (IR <sub>p</sub> , kg/day)	0.59 Fruit FSANZ (2017g) P90 Consumers
Fraction of produce from site in diet (FI)	10%
Exposure Frequency (EF, days/year)	365
Exposure Duration (ED, years)	5
Body Weight (BW, kg)	15
Bioaccessibility (B)	100%
Averaging Time - Threshold (Atn, days)	1825

Calculations for PFAS	Toxicity Data			PFAS in Irrigation Water (µg/L)	Water to Produce Transfer Factor µg/kg plant (ww)/µg/L water	PFAS in Produce (µg/kg)	Daily Intake (µg/kg/day)	Calculated HQ (unitless)
	Threshold TDI (µg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (µg/kg/day)					
<b>GW16_12</b>								
PFOS	2.0E-02	7%	1.9E-02	0.03	0.8	0.02	9.4E-05	0.0051
PFHxS	2.0E-02	7%	1.9E-02	0.09	1.5	0.14	5.3E-04	0.029
<b>TOTAL</b>								<b>0.03</b>



## Exposure to Chemicals via Ingestion of Fruit and Vegetables Following Irrigation with Water Containing PFAS

$$\text{Intake}_m = \frac{C_m \times IR_m \times FI \times B_o \times EF \times ED}{BW \times AT} \quad (\mu\text{g}/\text{kg}/\text{day})$$

### Adults

Exposure Parameters	10% Consumption Home Grown Fruit and Vegetables
Ingestion Rate of Fruit or Vegetables (IR <sub>p</sub> , kg/day)	0.27 Root and Tuber Vegetables FSANZ (2017g) P90 Consumers
Fraction of produce from site in diet (FI)	10%
Exposure Frequency (EF, days/year)	365
Exposure Duration (ED, years)	35
Body Weight (BW, kg)	70
Bioaccessibility (B)	100%
Averaging Time - Threshold (Atn, days)	12775

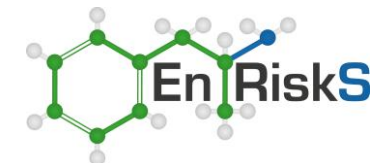
Calculations for PFAS	Toxicity Data			PFAS in Irrigation Water	Water to Produce Transfer Factor	PFAS in Produce	Daily Intake	Calculated HQ
	Threshold TDI	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background)					
	( $\mu\text{g}/\text{kg}/\text{day}$ )		( $\mu\text{g}/\text{kg}/\text{day}$ )	( $\mu\text{g}/\text{L}$ )	$\mu\text{g}/\text{kg}$ plant (ww)/ $\mu\text{g}/\text{L}$ water	( $\mu\text{g}/\text{kg}$ )	( $\mu\text{g}/\text{kg}/\text{day}$ )	(unitless)
<b>GW16_12</b>								
PFOS	2.0E-02	7%	1.9E-02	0.03	3.5	0.11	4.1E-05	0.0022
PFHxS	2.0E-02	7%	1.9E-02	0.09	7.2	0.65	2.5E-04	0.013
<b>TOTAL</b>								<b>0.02</b>



## Children

Exposure Parameters	10% Consumption Home Grown Fruit and Vegetables
Ingestion Rate of Fruit or Vegetables (IR <sub>p</sub> , kg/day)	0.16 Root and Tuber Vegetables FSANZ (2017g) P90 Consumers
Fraction of produce from site in diet (FI)	10%
Exposure Frequency (EF, days/year)	365
Exposure Duration (ED, years)	5
Body Weight (BW, kg)	15
Bioaccessibility (B)	100%
Averaging Time - Threshold (Atn, days)	1825

Calculations for PFAS	Toxicity Data			PFAS in Irrigation Water (µg/L)	Water to Produce Transfer Factor µg/kg plant (ww)/µg/L water	PFAS in Produce (µg/kg)	Daily Intake (µg/kg/day)	Calculated HQ (unitless)
	Threshold TDI (µg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (µg/kg/day)					
<b>GW16_12</b>								
PFOS	2.0E-02	7%	1.9E-02	0.03	3.5	0.11	1.1E-04	0.0060
PFHxS	2.0E-02	7%	1.9E-02	0.09	7.2	0.65	6.9E-04	0.037
<b>TOTAL</b>								<b>0.04</b>



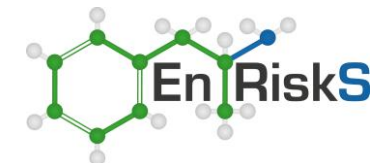
## Exposure to Chemicals via Ingestion of Fruit and Vegetables Following Irrigation with Water Containing PFAS

$$\text{Intake}_m = \frac{C_m \times IR_m \times FI \times B_o \times EF \times ED}{BW \times AT} \quad (\mu\text{g}/\text{kg}/\text{day})$$

### Adults

Exposure Parameters	10% Consumption Home Grown Fruit and Vegetables
Ingestion Rate of Fruit or Vegetables (IR <sub>p</sub> , kg/day)	0.37 Green and Fruiting Vegetables FSANZ (2017g) P90 Consumers
Fraction of produce from site in diet (FI)	10%
Exposure Frequency (EF, days/year)	365
Exposure Duration (ED, years)	35
Body Weight (BW, kg)	70
Bioaccessibility (B)	100%
Averaging Time - Threshold (Atn, days)	12775

Calculations for PFAS	Toxicity Data			PFAS in Irrigation Water (μg/L)	Water to Produce Transfer Factor μg/kg plant (ww)/μg/L water	PFAS in Produce (μg/kg)	Daily Intake	Calculated HQ
	Threshold TDI (μg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (μg/kg/day)				(μg/kg/day)	(unitless)
<b>GW16_12</b>								
PFOS	2.0E-02	7%	1.9E-02	0.03	2.0	0.06	3.2E-05	0.0017
PFHxS	2.0E-02	7%	1.9E-02	0.09	2.1	0.19	1.0E-04	0.0054
<b>TOTAL</b>								<b>0.01</b>



## Children

Exposure Parameters	10% Consumption Home Grown Fruit and Vegetables
Ingestion Rate of Fruit or Vegetables (IR <sub>p</sub> , kg/day)	0.3 Green and Fruiting Vegetables FSANZ (2017g) P90 Consumers
Fraction of produce from site in diet (FI)	10%
Exposure Frequency (EF, days/year)	365
Exposure Duration (ED, years)	5
Body Weight (BW, kg)	15
Bioaccessibility (B)	100%
Averaging Time - Threshold (Atn, days)	1825

Calculations for PFAS	Toxicity Data			PFAS in Irrigation Water (µg/L)	Water to Produce Transfer Factor µg/kg plant (ww)/µg/L water	PFAS in Produce (µg/kg)	Daily Intake (µg/kg/day)	Calculated HQ (unitless)
	Threshold TDI (µg/kg/day)	Background Intake (% TDI)	TDI Allowable for Assessment (TDI-Background) (µg/kg/day)					
<b>GW16_12</b>								
PFOS	2.0E-02	7%	1.9E-02	0.03	2.0	0.06	1.2E-04	0.0065
PFHxS	2.0E-02	7%	1.9E-02	0.09	2.1	0.19	3.8E-04	0.020
<b>TOTAL</b>								<b>0.03</b>