Government of **Western Australia**
Department of **Water and Environmental Regulation**

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Perfluoroalkyl and polyfluoroalkyl substances (PFAS) in the Perth metropolitan area

Ambient concentrations in surface water and groundwater

November 2022

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Executive summary

Ambient concentrations of per- and poly-fluoroalkyl substances (PFAS) in surface water and groundwater were measured in autumn and spring sampling events across the Perth metropolitan area. Surface water was sampled in urban lakes at 38 locations on the Swan Coastal Plain and in four recreational reservoirs on the Darling Scarp. Groundwater was sampled at 35 locations on the Swan Coastal Plain, with sampling locations selected to cover a range of land use categories including residential, industrial and commercial land, urban bushland and semi-rural land.

The suite of analytes for this project included 28 PFAS compounds in the autumn sampling event, extended to 30 compounds in the spring event. Throughout the sampling program, nine different PFAS compounds were detected in surface water sampling, and 13 were detected in groundwater. The three most-commonly detected PFAS compounds were perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA) and perfluorohexane sulfonate (PFHxS). These three PFAS were detected above the limit of reporting at every surface water sampling location on the Swan Coastal Plain in the autumn sampling event, and at 36 out of 38 locations in the spring sampling event. Short-chain perfluoroalkyl carboxylic acids and perfluorobutanesulfonic acid were also detected at most locations.

PFOS was detected above the limit of reporting at every surface water sampling location, including those on the Darling Scarp, with a maximum concentration of 0.044 micrograms per litre (μg/L). The median PFOS concentration for sampling sites located on the Swan Coastal Plain was 0.005 μg/L. Surface water bodies with the highest PFAS concentrations appear to be those with a significant amount of commercial/industrial land in their catchment. There is also a trend towards higher PFAS concentrations in lakes located closer to the city centre. PFAS concentrations in reservoirs on the Darling Scarp were very low, with only minor detections of PFOS and PFHxS, just above laboratory limits of reporting (LORs), observed in these sampling sites.

Concentrations of PFAS compounds in groundwater were generally lower than the concentrations observed in surface water. PFOS was detected above the limit of reporting at 91 per cent of the groundwater sampling locations, with a maximum concentration of 0.03 μg/L. The median concentration of PFOS across all locations was 0.0027 μg/L in the autumn sampling event and 0.0054 μg/L in the spring event.

Concentrations of PFAS compounds in groundwater were found to be generally higher in areas of more intense land use (that is residential and industrial land) and a greater range of PFAS compounds was detected in the more intensely developed inner-city urban areas. In semi-rural land on the urban fringe and in urban bushland areas the PFAS concentrations in groundwater were approximately an order of magnitude lower than in developed areas, with PFAS compounds being detected just above the laboratory limit of reporting.

The findings of these investigations indicate that there is no unacceptable risk to human health from ambient concentrations of PFAS in surface water or groundwater

in the Perth metropolitan area. Concentrations of PFOS in surface water did not exceed ecological water quality guideline values for 95 per cent species protection at any of the sampling locations. However, the 99 per cent species protection guideline value was exceeded in several lakes, including some that are identified as having high conservation value.

Additionally, there is a potential risk associated with bioaccumulation and biomagnification of PFOS across all sites where PFOS was detected. Further investigation may be required to assess potential risks to higher trophic level fauna such as fish, amphibians, reptiles and birds.

1 Context and objectives

Environmental contamination by per- and poly-fluoroalkyl substances (PFAS) is an emerging challenge worldwide. Since the 1950s, PFAS have been used in various industrial and consumer products, and in aqueous film-forming foams (AFFF) used for fighting flammable, liquid-based fires. Historical use of PFAS has led to their widespread presence in the environment, including significant soil and groundwater contamination in locations where regular firefighting training has been carried out.

In December 2017, Australian federal and state environment ministers endorsed the first PFAS National Environmental Management Plan (PFAS NEMP), developed by the Heads of EPAs Australia and New Zealand (HEPA). The PFAS NEMP was developed to provide nationally consistent guidance on the management of PFAS in the environment, including the assessment of PFAS impacts; prevention of environmental harm from PFAS; and the management and remediation of PFAS contamination. Version 2.0 of the PFAS NEMP was published in May 2020 (HEPA, 2020).

The PFAS NEMP identified a number of knowledge gaps for which further work was recommended to improve our understanding of the risks associated with legacy PFAS in the environment. A key knowledge gap is the need to identify the extent of low-level PFAS impacts, and to determine background concentrations in areas that are not directly impacted by known PFAS point sources. Such knowledge is critical to inform decisions regarding the practicality of adopted guideline values and to inform the development of criteria for soil and waste reuse.

This investigation was undertaken by the Department of Water and Environmental Regulation (the department) in order to characterise background PFAS impacts in surface water and groundwater across the Perth metropolitan area. The investigation has been designed to assess PFAS concentrations in areas that are unlikely to be affected directly by point-sources of PFAS such as airports, landfills, fire stations or wastewater treatment plants.

The Perth urban area contains waterways and wetlands of national significance, including numerous shallow freshwater lakes that are important for recreation, conservation and aesthetic values. The lakes lie within the sandy soils of the Swan Coastal Plain which are underlain by shallow groundwater, and the majority of Perth's urban water bodies are hydraulically connected to the superficial aquifer. Groundwater in the Perth region provides major sources of water for general urban supply as well as being used for irrigation in agriculture, public parks and in private gardens through extensive abstraction from private residential bores.

Urban groundwater is an important resource for the Perth region, but it is also an important pathway for PFAS transport. Due to the coarse, sandy characteristics of the soils on the Swan Coastal Plain, stormwater rapidly infiltrates and percolates through the soil profile, taking any contaminants with it into the superficial groundwater which in turn flows into the streams, estuaries, lakes, and wetlands.

This study aims to characterise the nature and extent of low-level PFAS impacts in surface water and groundwater across the Perth metropolitan area. The information obtained from this investigation will provide an improved understanding of transport pathways and repositories for diffuse legacy PFAS in the urban area, and aims to determine the relative contribution of different land use types to the overall PFAS load in the environment. This may help assess the potential risks to specific urban ecosystems or groundwater resources, and thus inform future management practices around legacy PFAS in the urban environment. Additionally, determining background levels of PFAS across different land use categories and different spatial zones of the Perth metropolitan area will provide valuable data to support regulatory decisions on the management of PFAS contamination originating from major point sources.

2 Background

2.1 What are PFAS?

PFAS are a complex family of manufactured chemicals that have been used for more than 50 years in a range of industrial applications and consumer products. They have been used in water-repellent and stain-resistant treatments for carpets, clothes and paper, and they have also been used in firefighting foams, pesticide formulations, ski waxes and as mist-suppressants in electroplating applications (Smith et al., 2016, Kotthoff et al., 2015)

PFAS are synthetic organofluorine chemicals for which there are no naturally occurring analogues, and their presence in the environment is entirely a result of human activity. PFAS are highly soluble in water, and are surface-active chemicals, which means they can be transported readily in the environment through surface water and groundwater. PFAS are resistant to chemical and biological breakdown, which means that PFAS remain stable in the environment for a very long time (Smith et al., 2016, Lau et al., 2007, Xiao, 2017).

In addition to being persistent, PFAS are known to bioaccumulate and biomagnify in food webs (D'Hollander et al., 2014). Bioaccumulation is process by which, over a period of time, a substance accumulates in the tissue of an organism reaching concentrations that are considerably higher than the concentrations present in its food or surrounding environment. Biomagnification is a process by which the concentration of a substance increases in organisms at higher levels in the food web as that substance is transferred between organisms by predation. This means that where PFAS are present in the environment, concentrations of PFAS compounds are likely to be higher in the tissue of animals that are higher in the food chain. Although the evidence on environmental risks of PFAS is still evolving, studies in animals have shown reproductive, developmental and systemic effects (Lau et al., 2007, Chen et al., 2018, Jantzen et al., 2016, Flynn et al., 2020, Stefani et al., 2014).

The persistence and bioaccumulative properties of PFAS have led to perfluorooctane sulfonate (PFOS) being listed as a persistent organic pollutant under Annex B (restriction of use) of the Stockholm Convention on Persistent Organic Pollutants in 2010 (UNEP, 2017). Perfluorococtanoic acid (PFOA) was added to Annex A (elimination of production and use) in 2019, and the review process has commenced for perfluorohexane sulfonate (PFHxS) (UNEP, 2019). Australia has not yet ratified the 2010 amendment to Annex B of the Stockholm Convention in regard to PFOS. However, the use of long chain (> 6 carbon atoms) PFAS-containing firefighting foams has been phased out in Australia from 2010. The use of long-chain PFAS-based foams is banned in Queensland, and in South Australia a ban on all fluorinated firefighting foams came into effect on 30 January 2018, with a grace period of two years granted to help industry meet the requirements of the ban. The National PFAS Position Statement, released in May 2020 as Appendix D to the revised *Intergovernmental Agreement on a National Framework for Responding to PFAS Contamination* (COAG, 2020), sets out a shared vision of governments to

reduce future releases of PFAS into the environment by phasing out the use of long-chain PFAS and minimising the use of short-chain PFAS by identifying and using alternatives wherever possible.

Table 1: Chemical names, abbreviations and structures of some commonly analysed perfluoroalkyl substances

Abbreviation	Name	Chemical formula
Perfluoroalkyl carboxylic acids (PFCAs)		
PFBA	Perfluorobutanoic acid	$CF_3CF_2CF_2COOH$
PFPeA	Perfluoropentanoic acid	$CF_3CF_2CF_2CF_2COOH$
PFHxA	Perfluorohexanoic acid	$CF_3CF_2CF_2CF_2CF_2COOH$
PFHpA	Perfluoroheptanoic acid	$CF_3CF_2CF_2CF_2CF_2CF_2COOH$
PFOA	Perfluorooctanoic acid	$CF_3CF_2CF_2CF_2CF_2CF_2CF_2COOH$
PFNA	Perfluorononanoic acid	$CF_3CF_2CF_2CF_2CF_2CF_2CF_2CF_2COOH$
PFDA	Perfluorodecanoic acid	$CF_3CF_2CF_2CF_2CF_2CF_2CF_2CF_2CF_2COOH$
Perfluoroalkyl sulfonic acids (PFSAs)		
PFBS	Perfluorobutanesulfonic acid	$CF_3CF_2CF_2CF_2SO_3H$
PFPeS	Perfluoropentanesulfonic acid	$CF_3CF_2CF_2CF_2CF_2SO_3H$
PFHxS	Perfluorohexanesulfonic acid	$CF_3CF_2CF_2CF_2CF_2CF_2SO_3H$
PFHpS	Perfluoroheptanesulfonic acid	$CF_3CF_2CF_2CF_2CF_2CF_2CF_2SO_3H$
PFOS	Perfluorooctanesulfonic acid	$CF_3CF_2CF_2CF_2CF_2CF_2CF_2CF_2SO_3H$
Fluorotelomer sulfonic acids (FTSAs)		
4:2 FTSA	1H.1H.2H.2H-perfluorohexanesulfonic acid	$CF_3CF_2CF_2CF_2CH_2CH_2SO_3H$
6:2 FTSA	1H.1H.2H.2H-perfluorooctanesulfonic acid	$CF_3CF_2CF_2CF_2CF_2CF_2CH_2CH_2SO_3H$
8:2 FTSA	1H.1H.2H.2H-perfluorodecanesulfonic acid	$CF_3CF_2CF_2CF_2CF_2CF_2CF_2CF_2CH_2CH_2SO_3H$
10:2 FTSA	1H.1H.2H.2H-perfluorododecanesulfonic acid	$CF_3CF_2CF_2CF_2CF_2CF_2CF_2CF_2CF_2CF_2CH_2CH_2SO_3H$

PFOS, PFOA and PFHxS are the three most commonly detected PFAS compounds, and environmental toxicity data is more extensive and reliable for these three species than for the many other PFAS, so they are often the focus of environmental assessments related to PFAS. There are over 4,000 discrete PFAS chemicals

known, but current standard analytical suites using liquid chromatography/tandem mass spectrometry only include about 33 PFAS (HEPA, 2020). In Australia, most commercial laboratories offer analytical suites of up to 30 compounds. Various methodologies have been developed to detect and quantify a broader range of PFAS, but standard analytical suites are applied for most analysis of environmental samples. The chemical names, abbreviations and structures of some of the commonly analysed PFAS compounds are listed in Table 1.

2.2 Sources, fate and transport of PFAS in the urban environment

Sources of environmental release of chemicals may be categorised as either point sources, or diffuse sources. Point sources have a single identifiable origin, and generally impact a readily defined area. In the case of PFAS, firefighting training facilities, landfills, manufacturing sites and wastewater treatment plants are examples of typical point sources (Smith et al., 2016, UNEP, 2017).

PFAS have been used as components of AFFF which are used for the suppression of flammable liquid fires. Consequently, firefighting training activities at airports or defence bases are the most common cause of major point-source PFAS contamination in Australia. Large fuel storage facilities can also be major point sources due to their use of AFFF deluge systems for fire control (UNEP, 2017).

However, PFAS are also found in a wide range of consumer products that people use daily, including food wrappers, water-resistant paper, and stain-repellant fabrics. Consequently, PFAS enter domestic waste streams and are present in landfill leachate, wastewater and biosolids. Waste recovery products can therefore contain low concentrations of PFAS, and the re-use of such products – spreading of compost or irrigation of parks with recycled waste water, for example – can lead to dispersal of low-level PFAS impacts over a wide area (Szabo et al., 2018).

In urban landscapes numerous small sources may be present, and their impacts may co-mingle in the environment to contribute to widespread ambient concentrations. There are many ways in which minor releases of PFAS could have historically occurred, and may continue to occur, in urban areas. These include testing and washing of firefighting equipment; discharges from fire extinguishers; discharges from light industrial premises such as upholsterers or chrome plating facilities; and leaching from septic tanks.

2.3 Ambient PFAS in urban areas

The term *ambient background concentration* is used to describe conditions in areas that are not impacted by point sources of contamination. The ambient background concentration of a contaminant is defined as the concentration in a specified locality that is the sum of the naturally occurring background and the contaminant levels that have been introduced from diffuse or non-point sources by general anthropogenic activity not attributable to industrial, commercial or agricultural activities.

However, there is a lack of consistency in the scientific literature on what constitutes diffuse contamination or a point source. Because PFAS are synthetic chemicals, there is no natural background, but PFAS can be detected in soil and water in areas far removed from any point sources as a result of long-range transport of airborne droplets or dust particles (Xie et al., 2015, Ahrens and Bundschuh, 2014). Numerous studies have investigated ambient concentrations of PFAS in areas far removed for any point sources, and these have identified detectable concentrations of PFAS in soils (Vedagiri et al., 2018), freshwater (Zushi et al., 2008), marine water (Yamashita et al., 2005) and even arctic snow (Xie et al., 2015).

In urban areas, ambient concentrations may be due in part to long-range airborne transport of PFAS but also, given the high solubility and mobility of PFAS, to the merged effects of numerous minor point sources. In this report, the term 'ambient concentration' is used to refer to the concentration of PFAS identified in locations where the impacts are understood to be reasonably uniform over a wide area, and cannot be attributed to a single point source.

Stormwater runoff has been identified as a major non-point source of PFAS inputs to urban water bodies (Zushi et al., 2008, Chen et al., 2017). PFAS has been detected in urban stormwater in the US and Japan at concentrations similar to those identified in treated wastewater (Houtz and Sedlak, 2012, Murakami et al., 2009). A study of relative contributions of different potential transport pathways for PFAS inputs into urban lakes in Albany, New York found that stormwater run-off was the main contributor to PFAS in urban lakes (Kim and Kannan, 2007). Some of the PFAS present in stormwater has been shown to originate from atmospheric sources and deposited in rainwater, but contributions from street run-off and drainage from industrial areas are likely to be more significant (Xiao et al., 2012).

A small number of number of studies has been published on the assessment of background PFAS concentrations in an Australian context. A study of perfluorinated alkyl acids in the waters and biota of Sydney Harbour found PFOS and PFOA concentrations in water ranged from 0.0075 to 0.021 μg/L and 0.0042 to 0.0064 μg/L, respectively (Thompson et al., 2011). An investigation into PFAS concentrations in the Brisbane River system following a major flood event in 2011 returned similar findings, with mean PFOS concentrations in the range 0.00018 to 0.015 μg/L and mean PFOA concentrations ranging from 0.00013 to 0.0061 μg/L (Gallen et al., 2014).

More recently, ambient concentrations of PFAS compounds and various other contaminants of emerging concern were measured in soil, surface water and sediments within five urban regions of Victoria, including the Melbourne urban area (Sardiña et al., 2019). The study found that PFAS (especially PFOS) were detected most frequently in sediment samples, with more variable results between regions and across land use gradients for soil and surface water samples. Concentrations of PFAS in surface water were also temporally variable due to changes in rainfall and streamflow inputs, and the study concluded that seasonal monitoring was important to fully understand the risks to aquatic ecosystems from legacy environmental PFAS.

In 2016, a report by the South Australian Environmental Protection Authority (Gaylard, 2016) found relatively high concentrations of PFAS in the livers of deceased bottlenose dolphins from the Swan-Canning estuary when compared with levels in dolphins from other regions in Australia. Subsequently, the Department of Biodiversity, Conservation and Attractions (DBCA) conducted an investigation into PFAS concentrations throughout the Swan-Canning estuary and its urban tributaries. The investigation found that concentrations of PFAS compounds varied between different sections of the estuary system, with significant catchment inputs from major point sources contributing to elevated concentrations within the Middle Swan Estuary and Canning Estuary.

The findings of the DBCA study indicate that, in addition to inputs from major point sources such as Perth Airport, RAAF Base Pearce and landfills, surface water bodies in the metropolitan area may be impacted by widespread low-level PFAS inputs from multiple minor historical sources. The PFAS concentrations observed in many urban waterways in which summer flow is dominated by groundwater inputs suggest that superficial groundwater is also impacted with low-level ambient concentrations of PFAS. The current investigation of ambient PFAS in urban lakes and groundwater aims to better characterise the extent and magnitude of PFAS impacts across the Perth metropolitan area, and to understand how the level of ambient PFAS varies across different land use categories.

3 Investigation program

3.1 Site selection

Sampling locations were selected to provide a broad coverage of the Perth metropolitan area, and to encompass a range of land uses to allow for comparison between land use types. For each site, the dominant surrounding land use was determined and classified using the Australia Land Use and Management (ALUM) Classification scheme.

Table 2: Australian land use and management (ALUM) classifications used to categorise sampling locations.

Land use code		Land use class	Description
1		Conservation and natural environments	Bushland reserves/remnant urban bushland
3		Production from dryland agriculture and plantations	Urban fringe small rural holdings. Semi-rural residential properties and 'hobby farms'.
5	5a	Intensive uses	General industrial and commercial use
	5b	Intensive uses	Urban residential use

The land use categories relevant to this investigation are presented in Table 2. Maps showing the locations and distribution of sampling sites across the Perth metropolitan area are shown in Figures 1 and 2.

Surface water sites

Surface water sampling locations in this investigation were predominantly permanent lakes within the Perth metropolitan area, and sampling locations are listed in Table 3. The water bodies sampled were all fresh, and included large natural lakes, as well as a number of small, highly modified lakes within urban parks.

The conservation value of the lakes varies widely. Although all of the sampled lakes on the Swan Coastal Plain are surrounded by urban development, many of the large lakes retain extensive areas of natural riparian vegetation and adjacent bushland and have significant conservation importance. One lake (S37) is a wetland of international importance designated under the Ramsar Convention, and another (S38) supports a critically endangered ecological community of thrombolites. At the other end of the spectrum, many of the small lakes are within urban parks, and in addition to their ornamental role, these serve as stormwater infiltration basins for the surrounding urban land.

A common feature of most (but not all) of the lakes on the Swan Coastal Plain is that they are in connection with superficial groundwater, and PFAS inputs to the lakes may therefore arise from a combination of stormwater runoff and groundwater inflow.

Four reservoirs located on the Darling Scarp east of Perth were included in the surface water sampling program to provide reference points outside the urban area. The reservoir catchments are only slightly impacted by human development, containing small areas of low-density residential land and rural holdings, but dominated by natural bushland. Water in the reservoirs is not expected to be connected to groundwater.

Groundwater sites

A preliminary list of 50 potential groundwater sampling sites was selected from the department's database of monitoring bores to achieve broad coverage of the metropolitan area and covering a range of land use categories. All of the groundwater monitoring bores were located on State Government land, typically within parks and reserves or on road reserves. The initial list was refined by eliminating any bores with screened intervals unsuitable for sampling just below the water table. A further selection process was developed in order to remove any sites that had the potential to be impacted by likely point sources such as landfills or wastewater treatment plants. This included a desktop assessment that involved using aerial imagery to review the setting and historical land uses in the vicinity of each sampling location and reference to the department's contaminated sites register to identify any known and/or potential sources nearby. Groundwater sampling locations are listed in Table 4.

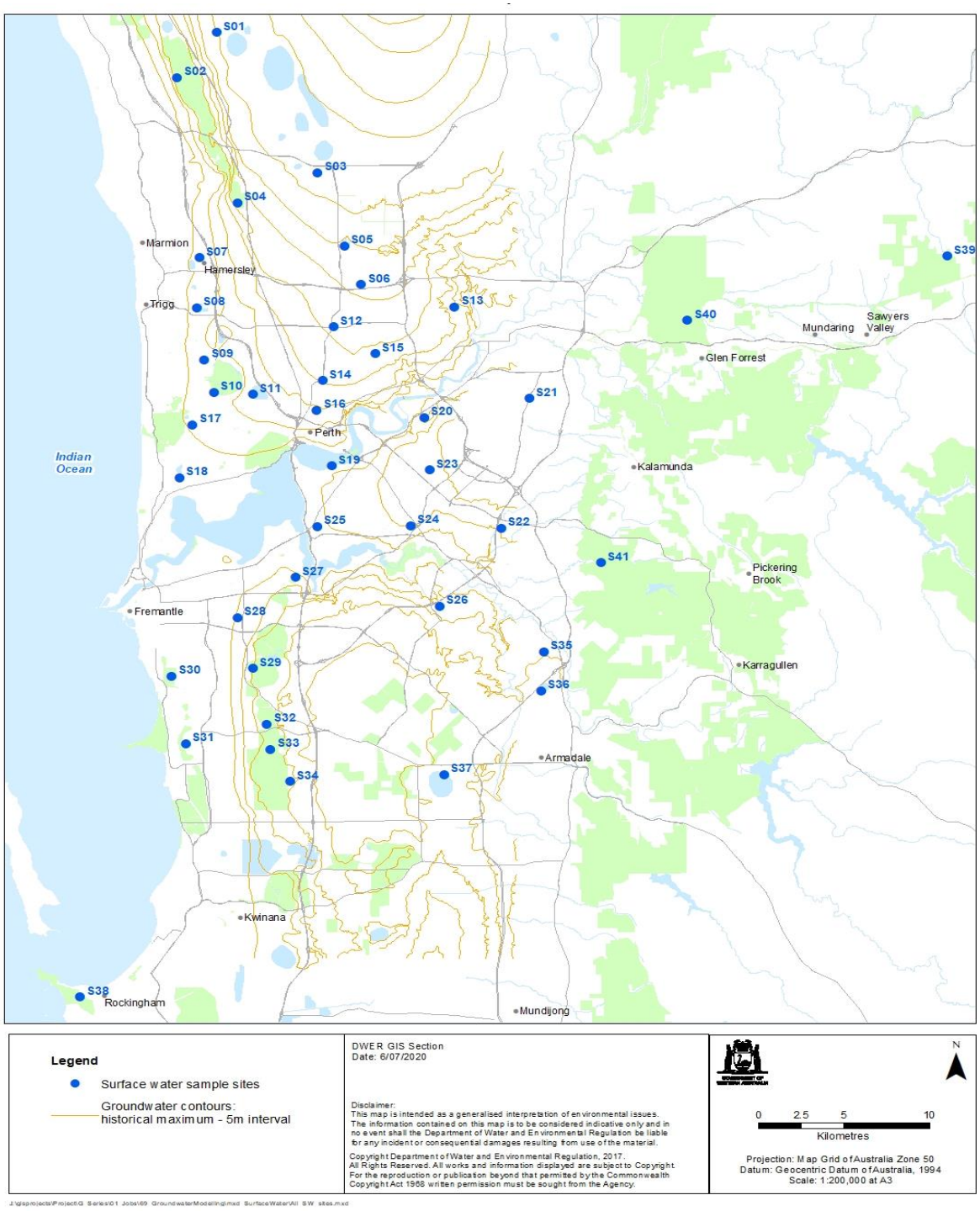

Figure 1: Surface water sampling locations in the Perth metropolitan area

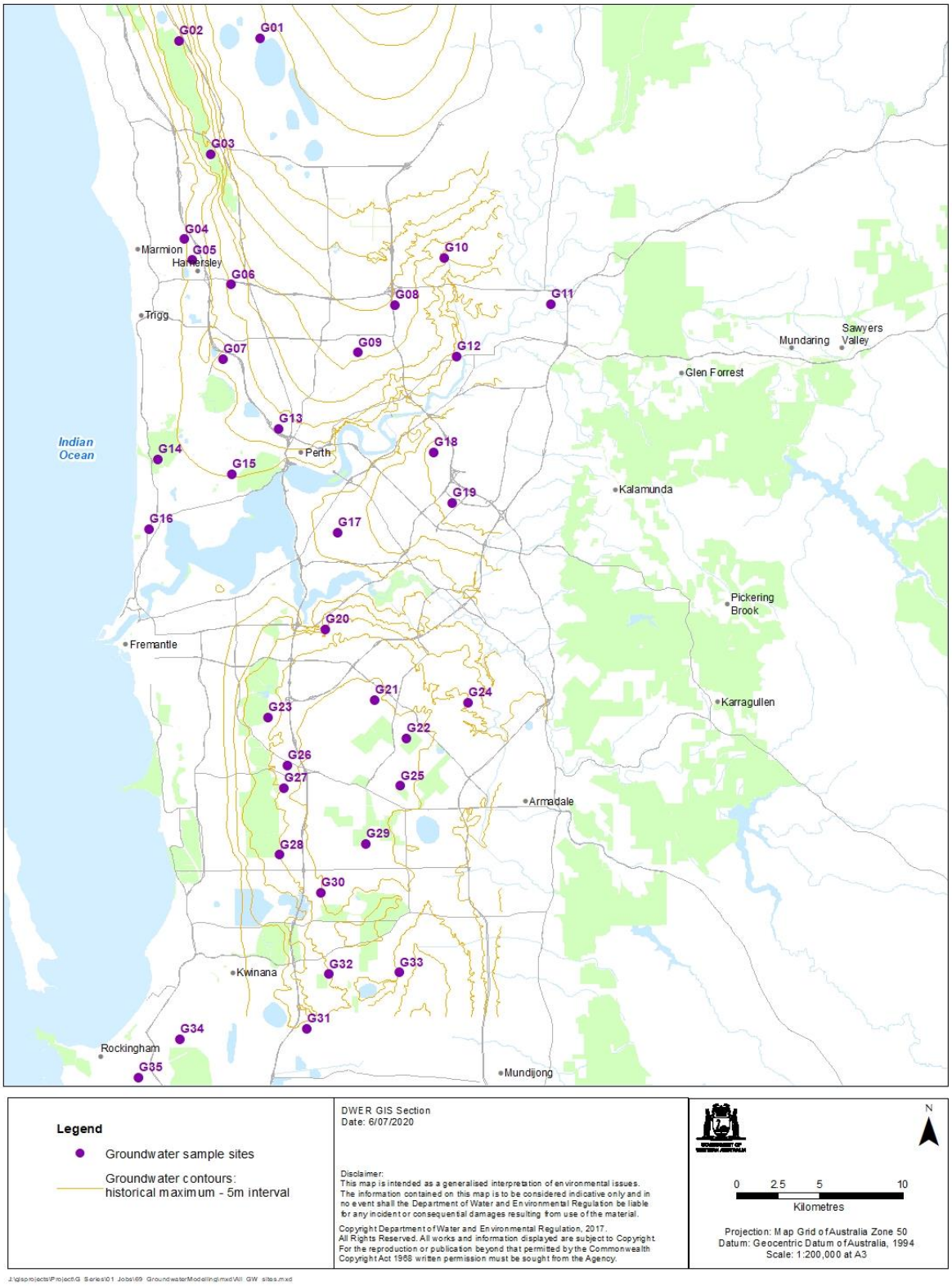

Figure 2: Groundwater sampling locations in the Perth metropolitan area

Table 3: List of surface water sampling locations

Site ID	Site name	Catchment – Dominant land use class
S01	Da Vinci Park	Intensive uses – residential
S02	Lake Joondalup	Intensive uses – residential
S03	Warradale Park	Intensive uses – residential
S04	Lake Goollelal	Intensive uses – residential
S05	Emu Lake	Intensive uses – residential
S06	Native Animal Rescue	Intensive uses – industrial
S07	Little Carine Swamp	Intensive uses – residential
S08	Lake Gwelup	Intensive uses – industrial and residential
S09	Jackadder Lake	Intensive uses – residential
S10	Herdsman Lake	Intensive uses – industrial and residential
S11	Lake Monger	Intensive uses – residential
S12	Dianella Open Space	Intensive uses – residential
S13	Woolgar Park	Intensive uses – residential
S14	Ron Stone Park	Intensive uses – residential
S15	Nora Hughes Park	Intensive uses – residential
S16	Hyde Park (East)	Intensive uses – residential
S17	Perry Lakes (East)	Intensive uses – residential
S18	Lake Claremont	Intensive uses – residential
S19	South Perth Foreshore	Intensive uses – residential
S20	Centenary Park	Intensive uses – residential
S21	Ollie Worrell Reserve	Intensive uses – residential
S22	Woodlupine Brook Reserve	Intensive uses – industrial and residential
S23	Tomato Lake	Intensive uses – industrial and residential
S24	Mitchell Park	Intensive uses – residential
S25	McDougall Park	Intensive uses – residential
S26	Tom Bateman Reserve	Intensive uses – industrial and residential
S27	Blue Gum Lake	Intensive uses – residential
S28	Fred Baldwin Park	Intensive uses – residential
S29	Bibra Lake	Intensive uses – residential
S30	Manning Lake	Intensive uses – residential
S31	Lake Coogee	Intensive uses – residential
S32	Yangebup Lake	Intensive uses – residential
S33	Kogalup Lake	Intensive uses – residential
S34	Copulup Lake	Intensive uses – residential
S35	Mary Carroll Park	Intensive uses – residential
S36	Champion Lakes	Intensive uses – residential
S37	Forrestdale Lake	Urban fringe small rural holdings
S38	Lake Richmond	Intensive uses – residential
S39	Lake Leschenaultia	Conservation and natural environments
S40	Glen Brook Dam	Conservation and natural environments
S41	Bickley Brook Dam	Conservation and natural environments
S42	Serpentine Falls	Conservation and natural environments

Table 4: List of groundwater sampling locations

Site ID	Locality	Dominant land use class
G01	Mariginiup	Urban fringe small rural holdings.
G02	Tapping	Intensive uses – residential
G03	Woodvale	Intensive uses – residential
G04	Duncraig	Intensive uses – residential
G05	Carine	Intensive uses – residential
G06	Balcatta	Intensive uses – industrial
G07	Osborne Park	Intensive uses – industrial
G08	Beechboro	Intensive uses – residential
G09	Morley	Intensive uses – commercial
G10	Whiteman Park	Conservation and natural environments
G11	Middle Swan	Intensive uses – residential
G12	Bassendean	Intensive uses – residential
G13	Leederville	Intensive uses – commercial
G14	City Beach	Conservation and natural environments
G15	Shenton Park	Intensive uses – residential
G16	Cottesloe	Intensive uses – residential
G17	Como	Intensive uses – residential
G18	Cloverdale	Intensive uses – residential
G19	Kewdale	Intensive uses – industrial
G20	Willetton	Intensive uses – residential
G21	Canning Vale	Intensive uses – residential
G22	Canning Vale	Conservation and natural environments
G23	Bibra Lake	Intensive uses – residential
G24	Huntingdale	Intensive uses – residential
G25	Piara Waters	Conservation and natural environments
G26	Cockburn Central	Intensive uses – industrial
G27	Success	Intensive uses – residential
G28	Hammond Park	Intensive uses – residential
G29	Banjup	Conservation and natural environments
G30	Wandi	Urban fringe small rural holdings
G31	Wellard	Urban fringe small rural holdings
G32	Casuarina	Conservation and natural environments
G33	Oakford	Urban fringe small rural holdings
G34	East Rockingham	Urban fringe small rural holdings
G35	Rockingham	Intensive uses – residential

3.2 Sample collection

Sampling personnel collected water samples by entering the water body to a suitable depth using waders. Grab samples were taken by inserting a capped sample container (volume 500 ml) beneath the water surface with the opening pointing down to avoid the collection of surface films. The container was then opened while ensuring, wherever possible, a distance of 10 cm below the water level and more than 10 cm from the sediment bed. Immediately after sample collection, water

temperature, pH, specific conductivity and dissolved oxygen were measured at the sampling point using a YSI Pro-DSS multiprobe water quality meter.

Groundwater samples were collected using a low-flow sampling technique. Sampling wells were gauged to determine the standing water level, and a low-flow bladder pump was lowered into the well to a depth approximately one metre below the water table. Each well was pumped until at least three casing volumes of water had been displaced and field readings of pH, temperature, electrical conductivity, oxidation-reduction potential and dissolved oxygen had stabilised, before samples were collected in 500 ml bottles.

The low-flow pump was fitted with fluorine-free hoses, o-rings and bladders and the hoses and bladder were replaced at each well to minimise potential for cross-contamination of groundwater samples. O-rings were rinsed along with the steel components of the pump after the collection of each sample and replaced after every 10 sampling events.

3.3 Laboratory analysis

Samples were analysed by a commercial laboratory using a solid phase liquid extraction and liquid chromatography/tandem mass spectrometry (LC/MS/MS) methodology in accordance with USEPA Method 537. A suite of 28 PFAS compounds was analysed in the autumn surface water and groundwater monitoring events, extended to 30 compounds for the spring monitoring events due to methodological improvements introduced by the analytical laboratory. The concentration of each analyte was determined using the isotope dilution technique. Quantification of linear and branched isomers was conducted as a single total response using the relative response factor for the corresponding linear standard. A branched PFOS standard and branched PFHxS standards were used for quantification of PFOS and PFHxS respectively. The full suite of PFAS compounds analysed, and the laboratory limits of reporting for each analyte are listed in Appendix A.

3.4 Quality assurance and quality control (QA/QC)

Quality control procedures were adopted during the fieldwork in accordance with guidance provide in the PFAS NEMP. The purpose of QA/QC procedures is to provide evidence that the data obtained is fit for interpretative use.

Field blanks were collected at a rate of one per sampling day using PFAS-free water supplied by the analytical laboratory. During groundwater sampling, rinsate blanks (collected by rinsing the groundwater pump with PFAS-free water) were collected at a rate of at least one per six primary samples collected. Field blank, rinsate and trip blank results confirmed the absence of any extraneous field or laboratory sources of PFAS, with the exception of two minor detections of PFOS in field blanks during groundwater sampling on 14, 15 and 17 May 2019. Minor contamination of the PFAS-free water from an external (field) source is the likely explanation for this and

the analytical results of associated samples collected on those days do not appear to be affected.

Blind intra-laboratory duplicates were submitted to the primary analytical laboratory at a rate of approximately one in every 15 samples, and excellent agreement between duplicate samples was observed in all instances.

Field (inter-laboratory) duplicates were collected at a rate of at least one per 10 primary samples collected. Relative percentage differences (RPDs) for the PFOS, PFHxS and PFOA were consistently below the target value of 50 per cent. Instances where the acceptable RPD was exceeded appear to be limited to instances where less-commonly detected PFAS compounds are present at concentrations very close to the detection limit, under which circumstance small variations in the measured concentration lead to a large RPD. Because concentrations of the relevant contaminants are very low in all samples, and concentrations of most analytes are close to (or below) the limits of detection for the analytical technique, relative percentage differences RPDs of up to 50 per cent have been deemed acceptable for the purposes of this study. Exceedances of the acceptable RPD appear to reflect the sensitivity limits of the analytical method and are not considered to impact the validity of the data in this instance. For full details of the results of inter-laboratory duplicate analyses, see tabulated results in Appendix F.

Although some minor QA/QC non-conformances are evident within the analytical results, it is considered unlikely that the quality of the data is adversely impacted. Overall, the data presented within this investigation is considered to be of adequate quality and completeness to meet the project objective, which is to provide a characterisation of ambient concentrations of PFAS compounds surface water and groundwater.

4 Results and discussion

4.1 Nature and magnitude of PFAS impacts

Of the 30 PFAS included in the analytical suite, nine PFAS were detected in surface water, and 14 PFAS were detected in groundwater. Sixteen PFAS in the analytical suite were not detected above the limit of reporting in any samples.

As expected, the three PFAS most commonly detected were PFOS, PFOA and PFHxS. However, the alkyl carboxylic acids perfluoropentanoic acid (PFPeA), perfluorohexanoic acid (PFHxA) and perfluoroheptanoic acid (PFHpA), and perfluorobutane sulfonic acid (PFBS) were also detected at a majority of sampling locations.

It is notable that the only fluorotelomer sulfonic acid detected in any samples was 6:2FTSA, which was detected only at two groundwater sampling locations. Firefighting foams based on fluorotelomer sulfonic acids have been the predominant type of AFFF used since 2000 (Smith et al., 2016), but fluorotelomers can oxidise in

the environment to form linear perfluoralkyl carboxylic acids, such as PFHxA, PFPeA and PFBA.

Table 5: PFAS detections above LOR* in surface water and groundwater

PFAS	Surface water (42 sites)		Groundwater (35 sites)	
	Number of sites with detection	Maximum concentration (µg/L)	Number of sites with detection	Maximum concentration (µg/L)
Perfluoroalkyl carboxylic acids (PFCAs)				
PFBA	24	0.24	8	0.16
PFPeA	38	0.19	23	0.017
PFHxA	38	0.16	23	0.022
PFHpA	37	0.038	19	0.01
PFOA	39	0.038	20	0.034
PFNA	0	-	2	0.015
PFDA	0	-	2	0.006
Perfluoroalkyl sulfonic acids (PFSAs)				
PFPrS	0	-	13	0.005
PFBS	38	0.16	22	0.019
PFPeS	31	0.19	13	0.005
PFHxS	39	0.08	25	0.033
PFHpS	0	-	5	0.003
PFOS	42	0.044	32	0.03
Fluorotelomer sulfonic acids (FTSAs)				
6:2 FTSA	0	-	2	0.015

** See Appendix A for LORs.*

The fact that these perfluorocarboxylic acids were observed in many of the water samples, coupled with the low number of detections of fluorotelomer sulfonates, indicates that the selected sampling locations have largely avoided recent sources of PFAS, and that the observed PFAS detections are most likely the result of diffuse historical legacy releases of AFFF and/or older industrial/domestic sources of PFAS. However, it is understood that long-chain PFAS (containing chains of six carbon atoms or more) are generally more environmentally toxic and bioaccumulative than short-chain PFAS (Lau et al., 2007, Conder et al., 2008).

PFAS concentrations in surface water

As mentioned above, the three PFAS most commonly detected in surface water were PFOS, PFOA and PFHxS. These three PFAS were detected above the limit of reporting at every sampling location on the Swan Coastal Plain in the autumn sampling event, and at 36 out of 38 locations in the spring sampling event. The concentrations of these three PFAS were generally more consistent across the range of sampling locations, in contrast to some of the short-chain alkyl acids, the

concentrations of which varied widely at different locations. PFOS was detected above the limit of reporting at every sampling location, with a maximum concentration of 0.044 μg/L at site S24. The median PFOS concentration for sampling sites located on the Swan Coastal Plain was 0.0065 μg/L, and this value was consistent across the autumn and spring sampling events.

Concentrations of PFOA and PFHxS display more variation between the autumn and spring sampling, with generally higher concentrations being observed in the autumn event (see bar graphs in Appendix B). The maximum concentration of PFOA was 0.038 μg/L (at S19 in autumn) and the maximum concentration of PFHxS was 0.08 μg/L (at S23 in autumn). Median concentrations[1] of PFOA and PFHxS at sites on the Swan Coastal Plain in autumn and spring respectively were 0.01 μg/L and 0.006 μg/L for PFOA and 0.013 μg/L and 0.0085 μg/L for PFHxS.

PFAS concentrations in groundwater

Concentrations of PFAS compounds in groundwater were generally lower than the concentrations observed in surface water. PFOS was detected above the limit of reporting at 91 per cent of the sampling locations, with a maximum concentration of 0.03 μg/L at site G09. The median concentration of PFOS across all locations was 0.0020 μg/L in the autumn sampling event and 0.0033 μg/L in the spring event. PFHxS was detected at 71 per cent of sampling locations and at most locations the concentrations of PFOS and PFHxS were of similar magnitude. The median concentration of PFHxS was 0.004 μg/L in the autumn sampling event and 0.003 μg/L in the spring event.

PFOA was detected at above the limit of reporting at only 57 per cent of the groundwater sampling locations, and concentrations of PFOA were, in most cases, much lower than the concentrations of PFOS or PFHxS. The median concentration of PFOA in groundwater was 0.002 μg/L in both the autumn and spring sampling events.

The relatively low concentrations of PFOA at most groundwater sampling locations points towards legacy firefighting foams being the most significant source of ambient PFAS in groundwater. At most sites in this investigation the ratio of the concentration of PFOA to the sum of the concentrations of all perfluoroalkyl acids (PFOA:ΣPFAAs) was in the range 0.1 to 0.2. Previous studies have shown that PFOA:ΣPFAAs is typically in the range 0.3 to 0.5 in groundwater impacted by landfill leachate (Hepburn et al., 2019), and similarly PFOA represents a significant portion of PFAS in groundwater impacted by wastewater treatment plant effluent (Szabo et al., 2018).

[1] For all statistical calculations described in this report, data points with a value below the LOR were assigned a value equal to half the LOR. This simple approach may provide an overestimate of ambient concentrations in data sets with a large proportion of values below the LOR, but this slightly conservative outcome is considered acceptable for the purposes of this study. Further discussion regarding methods of dealing with values below LORs is provided in USEPA. 2000. *Guidance for Data Quality Assessment, Practical Methods for Data Analysis, EPA QA/G-9, QA00 UPDATE* [Online]. Available: www.epa.gov/quality/guidance-data-quality-assessment (accessed 2020).

4.2 Seasonal and spatial trends

Surface water

Surface water results across the 42 sampling locations display clear trends that provide some indication of the potential sources and transport mechanisms for PFAS in the urban environment. Bar graphs showing the sum of PFOS and PFHxS concentrations; PFOA concentrations; and 'sum of PFAS' concentrations at each of the 42 surface water sampling locations are presented in Appendix B.

Some locations were dry and could not be sampled in April 2019 (S12, S14, S37), while others (S18, S24, S35) had very low water levels, and at these locations the entrainment of some sediment in the sample could not be avoided.

At most sampling locations, the concentrations of PFOS + PFHxS observed in October were lower than those observed in April. This suggests that in most water bodies, winter stormwater inflow to the lakes dilutes the legacy PFAS load. Evaporation may then lead to an increase in PFAS concentrations over the drier summer months. In a small number of locations, a higher PFOS + PFHxS concentration was observed in the spring sampling event. This appears to have occurred at lakes that receive a significant portion of their inflow from industrial land, and winter stormflow may be contributing inputs of some PFAS compounds from fresher contamination sources in these instances (S06, S21). It is also possible that some urban lakes, particularly ornamental lakes in public parks, are topped up with groundwater by local authorities during the summer months to maintain water levels (S16, S36). This could result in lower PFAS levels being observed at the end of the summer period if the volume of supplemented water was greater than the winter stormwater inflow.

Maps displaying spatial trends for selected PFAS analytes in surface water are shown in Appendix D. In general, higher concentrations of PFAS have been observed at locations within the older developed areas of Perth – areas approximately represented by sampling locations S9 to S29. Water bodies located further north or south on the fringe of the metropolitan area have lower concentrations of the major PFAS compounds.

The trend towards higher concentrations in lakes located closer to the city centre can be seen in the graph presented in Figure 3, which shows concentrations of PFOS plotted against the predicted travel time by car from the Perth city centre. It can be seen that most of the higher values are observed at locations less than 30 minutes from the city, a travel time that generally corresponds to the extent of older inner-suburban areas developed prior to about 1980. Many of these locations include those lakes that receive a substantial portion of their stormwater inflow from areas with industrial and commercial land uses. Such sites are represented by yellow circles in Figure 3.

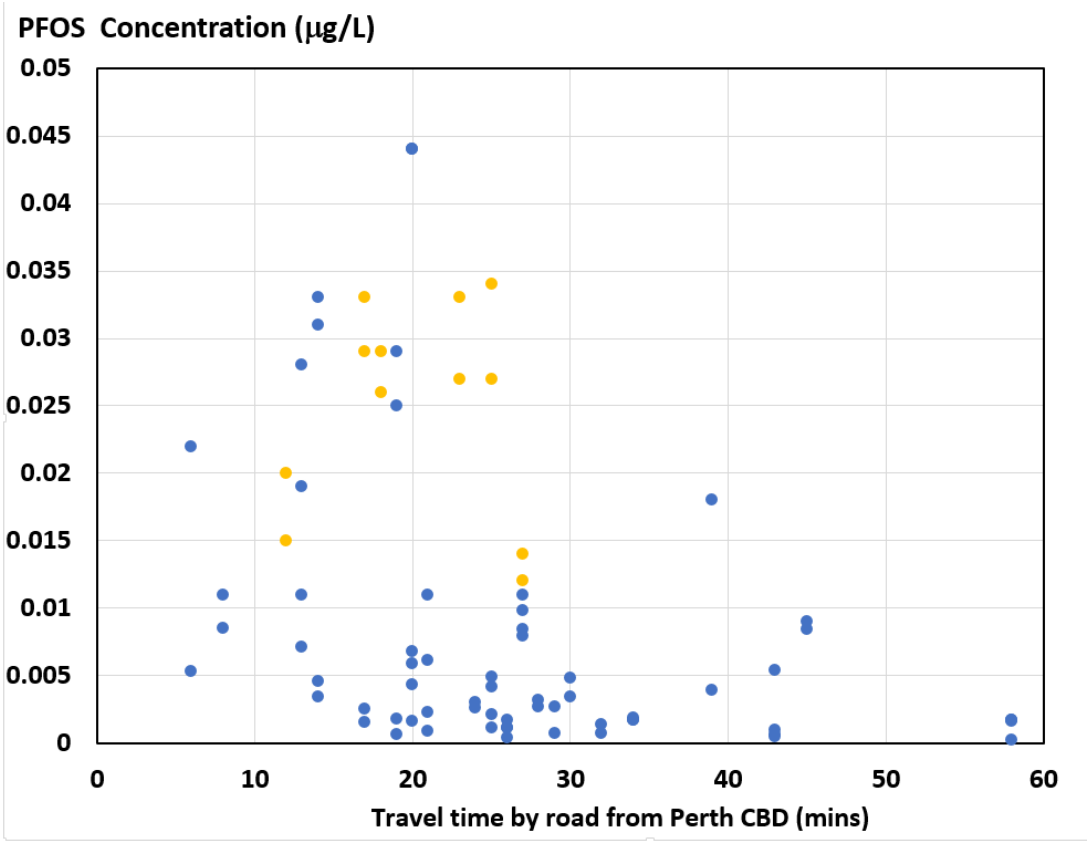

Figure 3: *PFOS concentrations in surface water, measured in both the autumn and spring sampling events, plotted against the estimated travel time by car from the Perth city centre. Travel time was estimated using Google Earth. Data points shown in yellow are lakes that have a substantial amount of industrial land in their catchment.*

Groundwater

Concentrations of PFAS compounds in groundwater were, in most locations, lower than the concentrations observed in surface water, and the concentrations of PFAS compounds in groundwater displayed less seasonal variation than those in surface water. Bar graphs showing the sum of PFOS and PFHxS concentrations; PFOA concentrations; and 'sum of PFAS' concentrations at each of the 35 groundwater sampling locations are presented in Appendix C.

At the majority of sampling locations, only minor differences were observed between the autumn and spring concentrations of PFAS compounds. At some locations (for example, G07, G12 and G17) spring concentrations were significantly higher than those observed in autumn, while at a few others (for example, G04, G18, G24, G28) the reverse was apparent. Because the sample locations have been chosen to be well removed from any point sources, it is to be expected that groundwater concentrations would be less susceptible to seasonal variation than those in surface water. The differences seen at a small number of sample locations may be due to the influence of localised zones of enhanced infiltration such as compensation basins or surface drains, for example.

Spatial trends in concentrations of PFAS compounds in groundwater appear to be similar to those observed for surface water, with higher concentrations generally being observed in older established suburbs. Contour maps showing spatial trends for selected PFAS analytes in groundwater are shown in Appendix E. For some PFAS compounds, notably PFOA and PFOS, it appears that the most significant impacts are evident in the inner north and north-eastern parts of the urban area, with significantly lower impacts observed south of the Swan River. However, the effects of surrounding land use may also be important here since the majority of sampling locations located in industrial and commercial areas were also in the inner north and north-eastern parts of the city. The significance of land use categories is discussed further below.

4.3 Comparison between land use categories

Surface water

The surface water bodies sampled in this study have catchments that vary widely in area, and in the range of land uses present. A further consideration is that most of the water bodies are hydraulically connected with groundwater, so their inputs and outputs will be comprised of a combination of groundwater through-flow and surface water influx, which will vary on a seasonal basis. All of the lakes sampled on the Swan Coastal Plain receive inputs through stormwater drainage networks from surrounding land, and some small lakes in urban parkland may receive managed top-ups from groundwater to maintain water levels during summer.

In spite of the varied catchments and diverse characteristics of the water bodies sampled, some trends associated with land use are evident in the data. Most notably, the four small reservoirs located on the Darling Scarp (S39–S42) have very low concentrations of PFAS in comparison to the sites sampled on the Swan Coastal Plain. This is shown in the box and whisker plots presented in Figure 4. Although nine PFAS compounds were detected in surface water bodies on the Swan Coastal Plain, only PFOS and PFHxS were detected in the reservoirs, and at concentrations very close to the limits of reporting. The dominant land use category in the catchments of these reservoirs is ‘conservation and natural environments’ and it is therefore expected that there would be very few sources of historical PFAS release in these areas. However, the reservoirs are not entirely free of direct human influence, as they are open to recreational use by the general public including in some cases, swimming, and/or boating activities. Nonetheless, the very low concentrations detected in these water bodies confirms that they might be considered as suitable reference sites to assess ambient concentrations arising mostly from long-range airborne transport of PFAS.

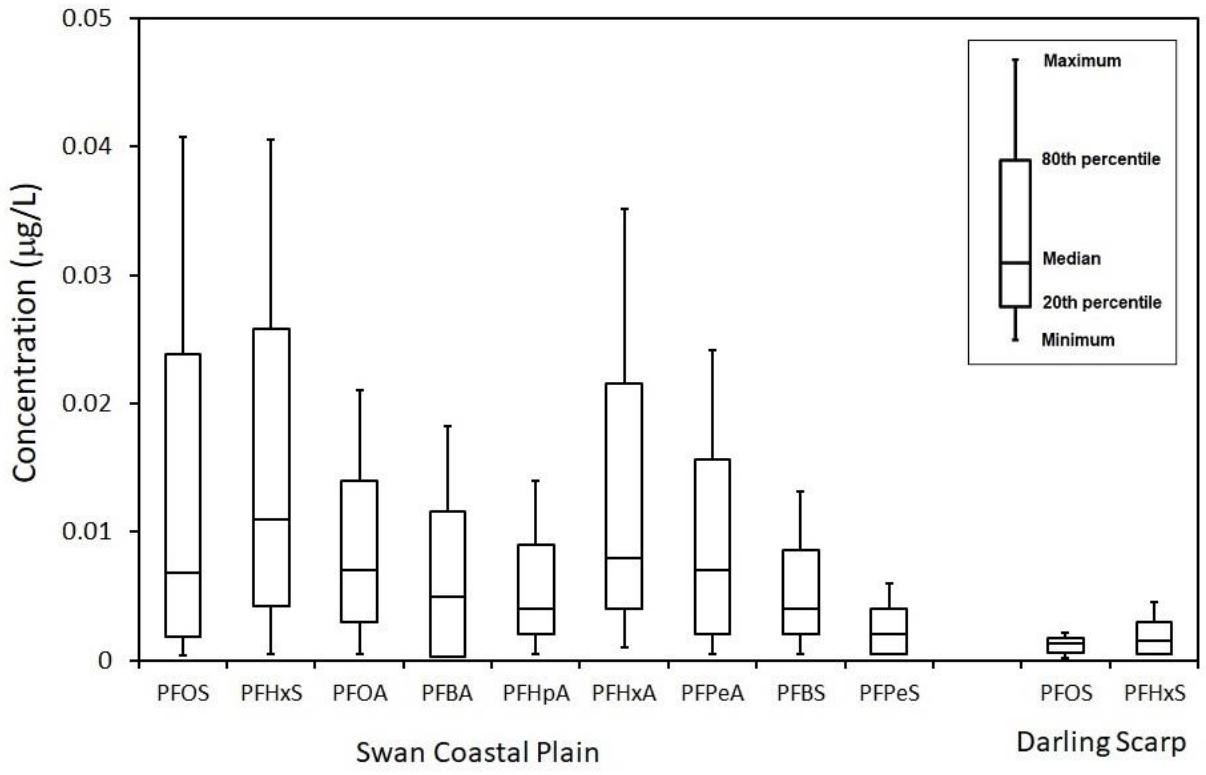

Figure 4: *Box and whisker plots for the nine PFAS compounds detected in surface water on the Swan Coastal Plain, and the two compounds detected in water bodies on the Darling Scarp.*

Groundwater

When the results of groundwater analysis are compared across the different land use categories considered in this investigation, it is evident that PFAS compounds were detected at higher concentrations in areas of more intense land use (residential and industrial land) and a greater range of PFAS compounds were detected in the more intensely developed urban areas.

Table 6 shows the detection frequency within each land use category for each of the 13 PFAS compounds that were detected above the laboratory limit of reporting in this study. The largest number of PFAS compounds was detected in residential and industrial land with 12 compounds being detected in each of these categories. The C5 to C8 perfluoroalkyl carboxylic acids, along with PFOS and PFHxS, were detected at all sampling locations in industrial land, and with the exception of PFHxS, these compounds were also detected in at least 70 per cent of sampling locations in residential land. In contrast, at most locations in semi-rural land or conservation reserves, only a small number of PFAS compounds were detected. PFOS was the most frequently detected compound in these land use categories, detected at 83 per cent of semi-rural sites and 67 per cent of conservation reserves.

The observed detection frequencies seem to indicate that PFAS impacts in groundwater in residential and industrial areas may originate from a wider range of sources than that observed in less intensely developed areas. However, it should be

noted that laboratory limits of detection may not be low enough to detect the full range of PFAS compounds present in areas where the overall PFAS impacts are very low.

Table 6: Detection frequencies (per cent of sites where a particular compound was detected) for 13 PFAS compounds in groundwater, according to land use category.

PFAS compound	Detection frequencies (%) Land use category			
	Bushland	**Semi-rural**	**Residential**	**Industrial**
Perfluoroalkyl carboxylic acids (PFCAs)				
PFBA	16.67	0	29.41	33. 33
PFPeA	33.33	33.33	70.59	100
PFHxA	33.33	33.33	76.47	100
PFHpA	16.67	16.67	70.59	100
PFOA	16.67	16.67	70.59	100
PFNA	0	0	5.88	16. 67
PFDA	0	0	0	33.33
Perfluoroalkyl sulfonic acids (PFSAs)				
PFPrS	0	0	35.29	33.33
PFBS	16.67	16.67	88.24	83.33
PFPeS	0	0	58.82	50
PFHxS	16.67	33.33	94.12	100
PFHpS	0	0	17.65	33.33
PFOS	66.67	83.33	100	100
Fluorotelomer sulfonic acids (FTSAs)				
6:2 FTSA	16.67	0	5.88	0

Box and whisker plots for the six most commonly detected PFAS compounds are presented in Figure 5, showing a comparison between the concentrations of PFAS compounds detected in each of the four land use categories. The plots clearly show that the concentrations detected in residential and industrial land are typically about an order of magnitude higher than those detected in semi-rural areas or urban bushland reserves.

Superficially, the plots appear to show that that background PFAS concentrations groundwater in industrial land are much higher than in residential land. However, it is important to consider that the data comprises a much larger number of sites located in residential land (21) than in industrial land (6). Although it is certainly true that maximum concentrations detected in industrial land are considerably higher than maximum concentrations detected in residential land, a two-sample T-test of the data sets indicates that the differences between the mean values of the concentrations of

PFAS compounds is not statistically significant.[2] Therefore, the impacts in residential and industrial land should be considered to be of similar magnitude until a larger data set from industrial land can be obtained to refine the characterisation of any potential differences between these land use categories.

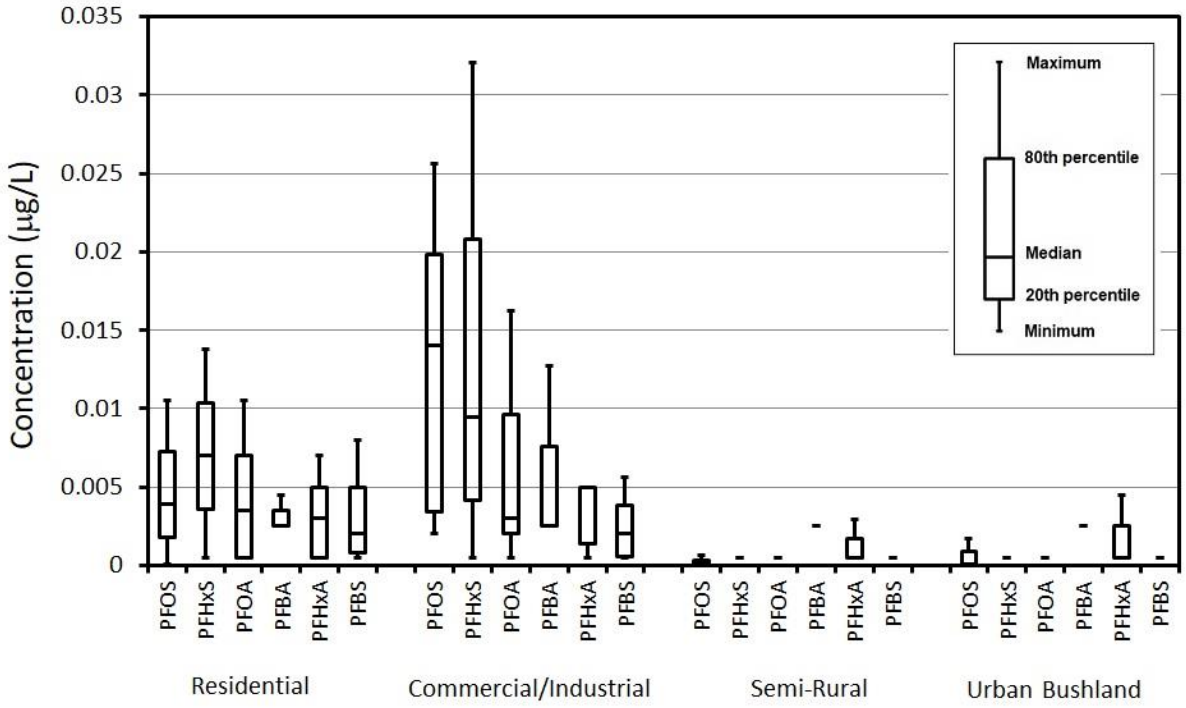

Figure 5: *Box and whisker plots for six of the most common PFAS compounds detected in groundwater, showing comparisons between four land use categories.*

4.4 Comparison with health and ecological guideline values

The Australian Government Department of Health has derived health-based guidance values for PFAS site investigations in Australia (Department of Health, 2017). Health-based guidance values have been published for PFOA and for the sum of PFOS and PFHxS, and these values can be used to assess potential human exposure through food, drinking water and non-potable uses such as garden irrigation. Health-based guidelines for recreational water bodies have been published in a guidance document prepared by the National Health and Medical Research Council (NHMRC), based on potential exposure scenarios for particular activities that may occur in such settings (NHMRC, 2019). Table 7 lists the relevant health-based guidance values for water.

[2] For example, a two-sample T-test, assuming unequal variances, comparing PFOS concentrations for residential and industrial sampling sites, gave P(two-tail) = 0.093; t-Stat = -2.068; t-Crit = 2.570; df = 5, alpha = 0.05. Null hypothesis (that the means are equal) is not rejected.

Table 7: Human health guideline values developed by Australian health regulators

Description	PFOS + PFHxS	PFOA
Drinking water quality guideline value	0.07 μg/L	0.56 μg/L
Non-potable use guideline value*	0.7 μg/L	5.6 μg/L
Recreational water quality guideline value	2 μg/L	10 μg/L

* *The Western Australian Department of Health advises that values equivalent to 10 times the drinking water guideline value may be applied as screening levels for the assessment of non-potable uses (such as garden irrigation). However, in some circumstances, an exposure assessment may need to be undertaken to adjust the tolerable daily intake based on likely exposure under the particular scenario being assessed.*

Concentrations of PFOA did not exceed any health-based guidance values in either surface water or groundwater at any of the locations sampled in this study. PFOS + PFHxS concentrations exceeded drinking water guideline values in surface water at five locations in April 2019 and at one location in October 2019. As none of the surface water bodies sampled in this investigation are used as drinking water sources, the observed concentrations of PFOS + PFHxS are not considered to pose a risk to human health. Additionally, none of the surface water bodies sampled in this study are used for recreational fishing, and swimming is unlikely except at three of the four reservoirs sampled on the Darling Scarp. No exceedances of recreational water quality guideline values were observed at any of the sampling locations in this study.

Concentrations of PFOS + PFHxS in groundwater did not exceed any health-based guideline values at any of the locations sampled in this investigation. Superficial groundwater is used extensively in the Perth metropolitan area for domestic garden irrigation, and the findings of this investigation confirm that ambient PFAS concentrations in superficial groundwater do not pose a risk to human health when groundwater is abstracted for irrigation use at locations well removed from point sources of PFAS contamination.

Health-based guideline values are available for only three of the 13 PFAS compounds detected in surface water and groundwater. However, in all samples PFOS, PFOA and PFHxS were the dominant species present. Other PFAS were generally detected at concentrations close to their LOR, with the occasional exception of short-chain carboxylic acids such as PFBA and PFHxA. While studies of the health effects of the short-chain carboxylic acids are limited, available information indicates that these compounds are likely to be less toxic, and less bioaccumulative than PFOS, PFOA and PFHxS. (Barmentlo et al., 2015, Gomis et al., 2018)

Draft ecological water quality guideline values (shown in Table 8) have been developed by the Australian Government's former Department of Agriculture, Water and the Environment through the Water Quality Guideline (WQG) framework (Water Quality Australia, 2019) and adopted in the PFAS NEMP (HEPA, 2020). The water quality guideline values are presented as species protection levels representing the

maximum concentrations considered to be protective of a given proportion of aquatic species, ranging from 80 per cent to 99 per cent of species. These default guideline values (DGVs) are intended to be applied according to the current or desired aquatic ecosystem condition and associated level of protection.

Table 8: Draft ecological water quality guideline values applicable to freshwater aquatic ecosystems*

Level of Protection	PFOS	PFOA
99% species protection **- high conservation value systems**	0.00023 μg/L	19 μg/L
95% species protection **- slightly to moderately disturbed systems**	0.13 μg/L	220 μg/L
90% species protection – highly disturbed systems	2 μg/L	632 μg/L
80% species protection – highly disturbed systems	31 μg/L	1,824μg/L

* *At the time of writing, the draft DGVs for PFOS and PFOA are under review through the WQG framework and may be revised.*

Concentrations of PFOA did not exceed the 99 per cent species protection guideline value in either surface water or groundwater at any of the locations sampled in this study. Although PFOS concentrations in all surface water samples were below the 95 per cent species protection guideline value, the 99 per cent species protection guideline value for PFOS was exceeded in all surface water sampling locations.

Most of the water bodies sampled in this investigation are modified urban lakes that are not considered to be of high conservation value and, in regard to direct toxicity, the PFAS concentrations detected here would not be considered to pose an unacceptable risk to aquatic biota. However, the WQG framework recommends that for toxicants that are bioaccumulative, the 99 per cent species protection guideline value should be used as a screening value for moderately disturbed ecosystems.

The extensive exceedance of the PFOS 99 per cent species protection DGV throughout surface water bodies in the metropolitan area may indicate a potential risk of bioaccumulation and biomagnification in higher trophic order organisms, such as water birds, that feed on aquatic biota in the lakes and wetlands. However, it should be noted that the 99 per cent species protection DGV for PFOS is extremely low and just above the laboratory limit of detection for this investigation, meaning that almost any detection of PFOS represents an exceedance of the DGV.

Exceedance of the 99 per cent species protection DGV is not in itself an indicator of unacceptable risk to biota. However, it does indicate that further assessments, such as investigating ecological community structure, food web analysis and sampling of

mid-trophic level biota, may be warranted to better characterise the potential impacts of ambient PFAS on urban wetland fauna.

5 Conclusions

Across the Perth metropolitan area, PFAS are present in surface water bodies and groundwater at low concentrations due to widespread legacy effects from multiple minor point sources. PFOS, PFOA and PFHxS are the major compounds present and these three PFAS were detected at most locations, but other perfluoroalkyl acids and short-chain perfluorosulfonic acids such as PFBA were also frequently detected.

The median concentration of PFOS in urban lakes on the Swan Coastal Plain was 0.005 μg/L, although considerable spatial variation in concentrations was observed across the urban area. Concentrations of PFAS in surface water bodies were typically higher in the autumn sampling event than in spring, and the highest concentrations were measured in lakes that had extremely low water levels in the autumn monitoring event. Higher PFAS concentrations were generally observed in lakes located within the older inner-suburban areas, and also in lakes that have a significant contribution from industrial or commercial land in their catchment. Lakes within the Beeliar wetland system through the city's south-western corridor had relatively low levels of ambient PFAS, and the four reservoirs on the Darling Scarp were found to have the lowest concentrations of any of the sampling sites. PFOS and PFHxS were the only compounds detected in the reservoirs and detections were very close to the limit of reporting in all instances.

PFAS concentrations in groundwater were lower than those observed in surface water, although a greater number of PFAS compounds were detected in groundwater. Nonetheless, PFOS, PFHxS and PFOA remained the most significant contributors to the ambient PFAS at most groundwater locations. The ratio of the PFOA concentration to the sum of the concentrations of all polyfluoroalkyl acids was generally low, which indicates that legacy firefighting foam releases are likely to be the main contributor to ambient PFAS in groundwater, rather than domestic waste sources such as landfills or septic systems.

A clear spatial trend was observed in both the surface water and groundwater results indicating that the nature and magnitude of PFAS impacts may be related to the intensity and the age of land development. With regard to the groundwater results, this is evident in the contour mapping, which shows that the highest concentrations are generally seen in the inner (and older) suburbs close to the city centre. Clear concentration differences were also evident across different land use types, with industrial and residential land having higher background PFAS levels than semi-rural or urban bushland area. In general, ambient PFAS levels in groundwater outside the developed areas on the Swan Coastal Plain appear to be very low and any detections of PFAS compounds in semi-rural or bushland areas were barely above the laboratory limits of reporting.

The findings of this investigation support the hypothesis that ambient PFAS in urban lakes and groundwater in Perth has resulted from long-term cumulative inputs from numerous minor point sources within residential and commercial/industrial areas of the city. Firefighting foams appear likely to be the main contributor to the ambient concentrations, and likely scenarios for release would include emergency response

events, small-scale training events in parks or public open space, washing of fire-response vehicles, and accidental releases. Other known uses of PFAS may also have played a role, including use as mist-suppressants in electroplating, use for stain-resistant and water-repellent fabric treatments, and use as adjuvants in pesticide formulations. Dispersal of PFAS from these multiple minor discharges is likely to have occurred through surface flow and transport in stormwater run-off, as well as through infiltration to groundwater and further short-range transport through groundwater migration. Further dispersal and merging of multiple minor sources could occur through abstraction and use of superficial groundwater for irrigation. It should be noted, however, that this investigation has avoided known major point sources, and the conditions in the vicinity of significant point sources such as airports, landfills and fire-training facilities are likely be very different.

In addition to the minor point sources described above, a small portion of the ambient PFAS detected in the urban environment will have resulted from long-range and local atmospheric transport through airborne dust and aerosols. It is likely that this source accounts for the low concentrations observed in undeveloped areas sampled in this study, such as semi-rural properties on the urban fringe and reservoirs on the Darling Scarp.

None of the surface water or groundwater results have indicated any unacceptable risk to human health from ambient concentrations of PFAS. The draft default guideline value for 99 per cent ecosystem protection level was exceeded in all surface water locations on the Swan Coastal Plain. As the majority of urban lakes sampled in this study are modified ecosystems the risks posed by ambient PFAS to aquatic biota in the lakes and wetlands are generally considered to be low. However, lakes identified as high conservation value ecosystems may be considered priority sites for further investigations to assess potentials risks to ecosystem function and health. The findings of the investigation highlight a potential for bioaccumulation and biomagnification of PFAS in higher trophic order biota that feed in urban lakes, and further assessment of the risks to such biota may be indicated.

A positive finding of this investigation is that ambient PFAS impacts appear to be at very low levels outside of the older developed urban areas of Perth. This may be attributed to the phasing out of firefighting foams containing long-chain PFAS, and improved practices around the management and use of firefighting foams in training exercises. Newer urban areas are also likely to have improved stormwater collection and management, and newer industrial areas are likely to have better infrastructure for the management of incidental spills, discharges and off-site surface run-off.

While the current investigation has focused on PFAS, it should be acknowledged that urban water bodies are subject to multiple chemical stressors, including a wide range of contaminants originating from anthropogenic activity under residential and industrial land uses. Any measures considered for the mitigation or reduction of ongoing PFAS inputs into urban surface water bodies and groundwater should therefore be considered in the context of managing the total contaminant load, and not focus on PFAS alone.

The findings of this investigation have indicated that important areas for future study include assessment of food chains to better characterise the risks posed by ambient PFAS to higher trophic level organisms such as water birds or reptiles. Detailed analysis of catchment inputs may be carried out to identify source areas and to inform options for the improved management of stormwater inputs so as to minimise further contributions to the PFAS load in lakes and wetlands. A further data gap exists around the PFAS load present in lake sediments, and the potential for seasonal cycling of PFAS concentrations in sediment and water. These issues could be addressed by further detailed investigations of specific lake systems, encompassing seasonal sediment and water analysis over a period of years.

Shortened forms

AFFF	Aqueous film-forming foam
ALUM	Australian Land Use and Management (classification system)
LOR	Limit of reporting
DGV	Default guideline value
DBCA	Department of Biodiversity, Conservation and Attractions
DWER	Department of Water and Environmental Regulation
HEPA	Heads of EPAs Australia and New Zealand
NHMRC	National Health and Medical Research Council
PFAS	Per- and polyfluorinated alkyl substances
PFAS NEMP	PFAS National Environmental Management Plan
PFHxS	Perfluorohexane sulfonic acid
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctane sulfonic acid
QA/QC	Quality analysis and quality control
RPD	Relative percentage difference
SAQP	Sampling and analysis quality plan
US EPA	United States Environmental Protection Agency
WQG	Water quality guidelines

Glossary

ambient background concentration	the sum of the naturally occurring background and the contaminant levels that have been introduced from diffuse or non-point sources by general anthropogenic activity
ambient concentration	contaminant concentration arising from diffuse or non-point sources by general anthropogenic activity
analyte	the chemical being measured in a sample
aquifer	rock or sediment in a geological formation, group of formations or part of a formation which is saturated and sufficiently permeable to store and transmit quantities of water
bioaccumulation	accumulation of a substance in organisms from water, soil/sediment and/or food so that the concentration of the substance in or on the organism is increased relative to the concentration in the surrounding medium
bioavailability	proportion of a chemical substance that is available to an organism for uptake through, or adsorption onto, its cellular membrane
biomagnification	increase in concentration of a substance in organisms with each trophic level of a food chain
biota	living organisms in a given area
contaminant	substance which causes contamination
contamination	condition of land or water in which chemical substance is present at above background levels and presents, or has the potential to present, a risk to human health, the environment or any environmental value.
diffuse	widespread without a single identifiable point source
ecological	referring to ecology
ecosystem	a community of organisms and their environment with all the interactions that transfer energy and recycle resources
exposure	amount of a chemical released to the environment, the route by which it is released and the consequent contact of organisms with the chemical
guideline values	concentrations that indicate a potential risk to the environment or human health
infiltration	the passing of water into the soil or into a drainage system
landfill	a facility for the disposal of waste by burial
leaching	the release of contaminants from solid materials, such as soil or waste, into liquids

pathway	the route by which a contaminant can reach a receptor
per- and poly-fluoroalkyl substances	group of manufactured chemicals, containing a component with multiple fluorine atoms, with many specialty applications – examples are perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA)
persistent	a chemical substance that has a half-life in water greater than two months, or a half-life in soil greater than six months, or a half-life in sediment greater than six months, or a half-life in air greater than two days, taking into account environmentally relevant considerations
point source	contamination coming from a single identifiable point and therefore not diffuse
receptor	living organisms including humans, the habitat which supports such organisms, or natural resources that could be adversely affected by environmental contamination resulting from a release at, or migration from, a site.
risk	the probability of adverse effects caused under specified circumstances by an agent, in an organism, a population, or an ecological system, based on the hazard of a chemical and its level of exposure for a specific use and location
toxicity	the degree to which a substance is toxic (that is, has an adverse biochemical effect)

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Appendices

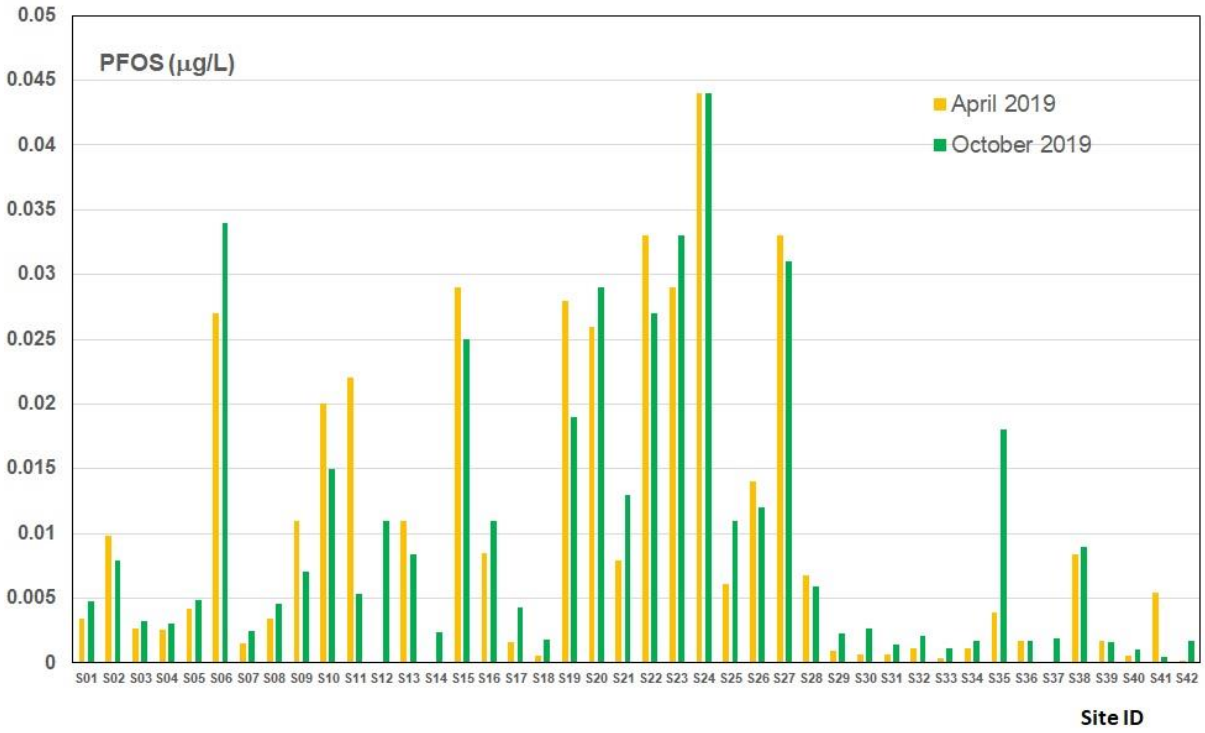
Appendix A — Per- and poly-fluoroalkyl substances and laboratory limits of reporting

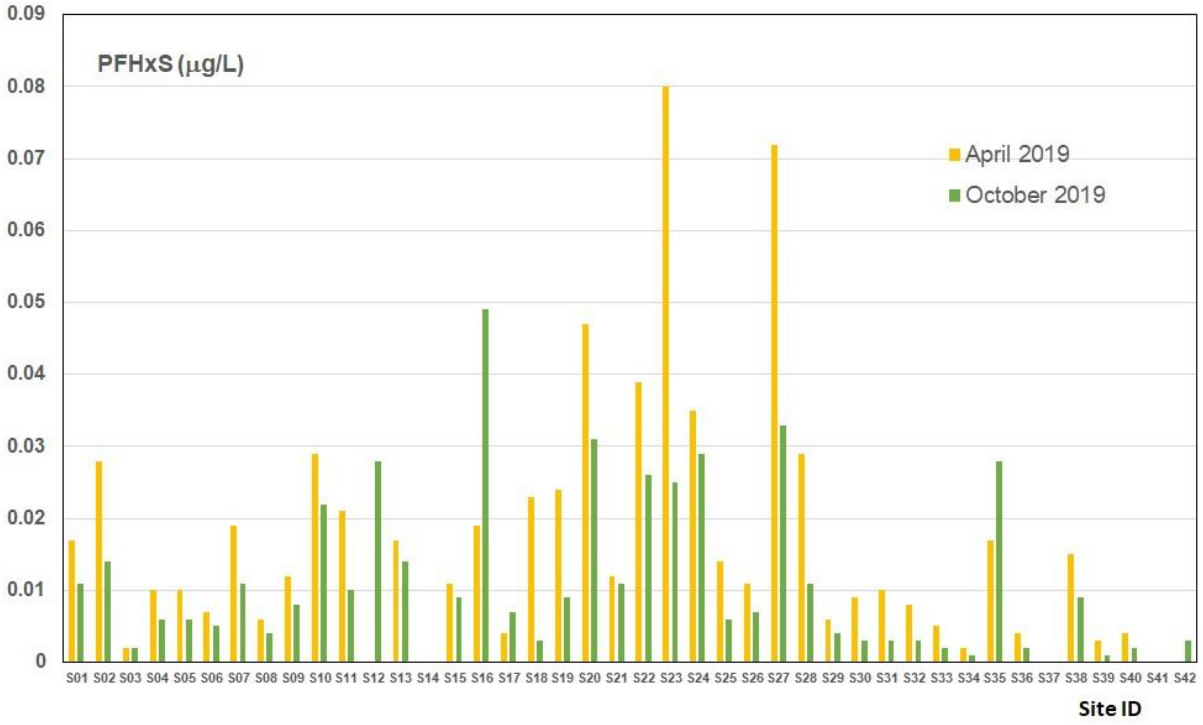
Compound	Limit of reporting (µg/L)	
	Lab 1	Lab 2
n:2 Fluorotelomer sulfonic acids (n:2 FTSAs) – ultra trace		
1H.1H.2H.2H-perfluorodecanesulfonic acid (8:2 FTSA)	0.001	0.001
1H.1H.2H.2H-perfluorododecanesulfonic acid (10:2 FTSA)	0.001	0.001
1H.1H.2H.2H-perfluorohexanesulfonic acid (4:2 FTSA)	0.001	0.001
1H.1H.2H.2H-perfluorooctanesulfonic acid (6:2 FTSA)	0.005	0.001
Perfluoroalkyl carboxylic acids (PFCAs) – ultra trace		
Perfluorobutanoic acid (PFBA)	0.005	0.005
Perfluorodecanoic acid (PFDA)	0.001	0.001
Perfluorododecanoic acid (PFDoDA)	0.001	0.001
Perfluoroheptanoic acid (PFHpA)	0.001	0.001
Perfluorohexanoic acid (PFHxA)	0.001	0.001
Perfluorononanoic acid (PFNA)	0.001	0.001
Perfluorooctanoic acid (PFOA)	0.001	0.0004
Perfluoropentanoic acid (PFPeA)	0.001	0.001
Perfluorotetradecanoic acid (PFTeDA)	0.001	0.001
Perfluorotridecanoic acid (PFTrDA)	0.001	0.001
Perfluoroundecanoic acid (PFUnDA)	0.001	0.001
Perfluoroalkyl sulfonamido substances – ultra trace		
2-(N-ethylperfluoro-1-octane sulfonamido)-ethanol (N-EtFOSE)	0.005	0.001
2-(N-methylperfluoro-1-octane sulfonamido)-ethanol (N-MeFOSE)	0.005	0.001
N-ethylperfluoro-1-octane sulfonamide (N-EtFOSA)	0.005	0.001
N-ethyl-perfluorooctanesulfonamidoacetic acid (N-EtFOSAA)	0.005	0.001
N-methylperfluoro-1-octane sulfonamide (N-MeFOSA)	0.005	0.001
N-methyl-perfluorooctanesulfonamidoacetic acid (N-MeFOSAA)	0.005	0.001
Perfluorooctane sulfonamide (FOSA)	0.005	0.001
Perfluoroalkyl sulfonic acids (PFSAs) – ultra trace		
Perfluorobutanesulfonic acid (PFBS)	0.001	0.001
Perfluorodecanesulfonic acid (PFDS)	0.001	0.001
Perfluoroheptanesulfonic acid (PFHpS)	0.001	0.001
Perfluorohexanesulfonic acid (PFHxS)	0.001	0.0002
Perfluorononanesulfonic acid (PFNS)*	0.001	NR
Perfluorooctanesulfonic acid (PFOS)	0.0001	0.0002

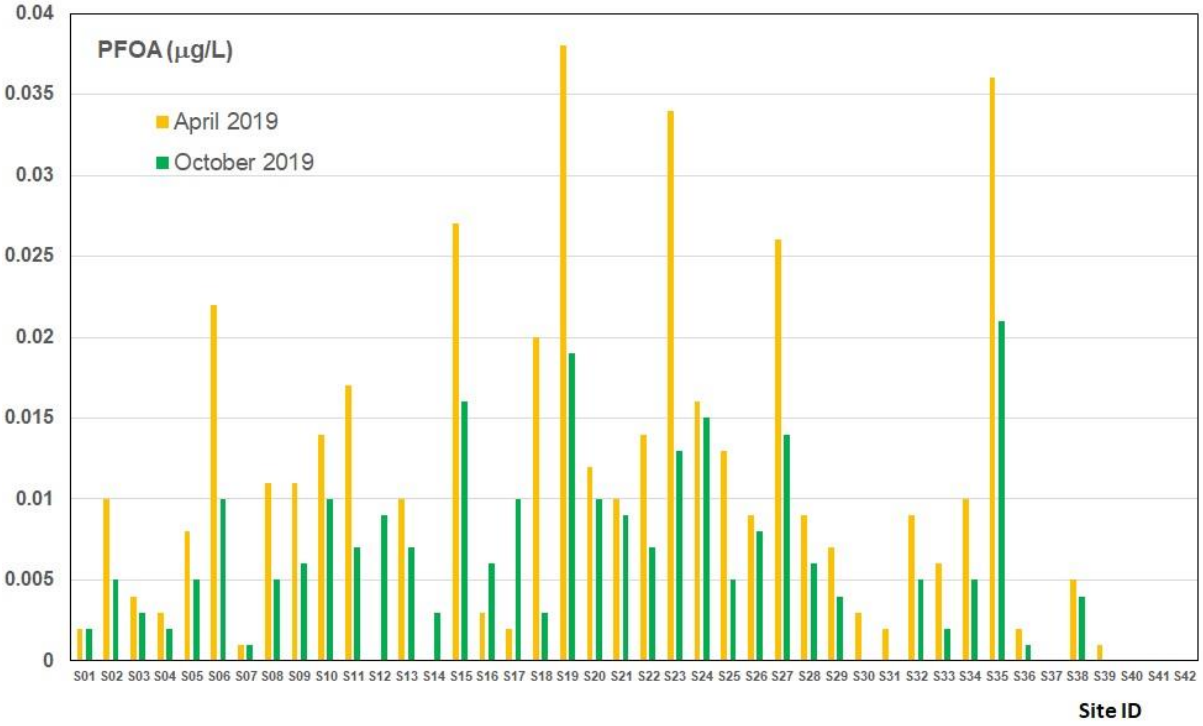
Perfluoropentanesulfonic acid (PFPeS)	0.001	0.001
Perfluoropropanesulfonic acid (PFPrS)*	0.001	NR
PFAS Summations		
Sum (PFHxS + PFOS)	0.001	0.005
Sum of enHealth PFAS (PFHxS + PFOS + PFOA)	0.001	NR
Sum of PFASs (n=30) or (n=28)	0.005	0.005
Sum of US EPA PFAS (PFOS + PFOA)	0.001	NR
Sum of Department of Water and Environmental Regulation PFAS (n=10)	0.005	0.005

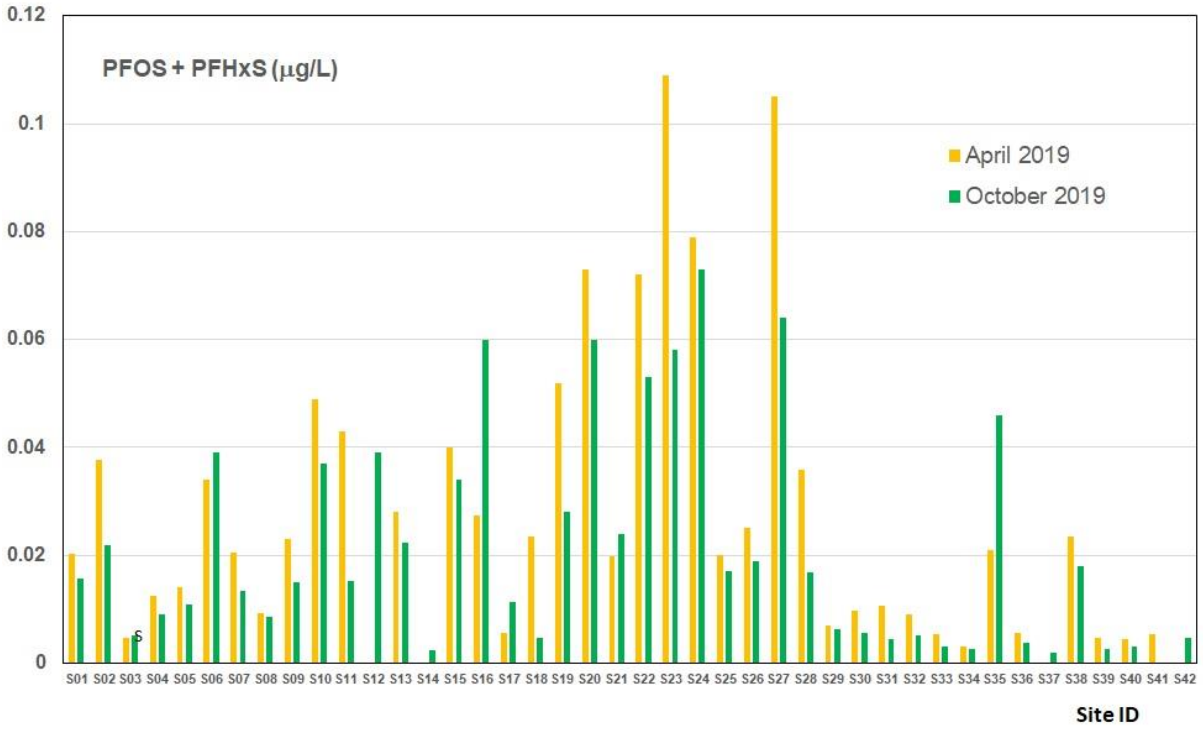
* Compounds not included in the autumn surface water and groundwater monitoring events.

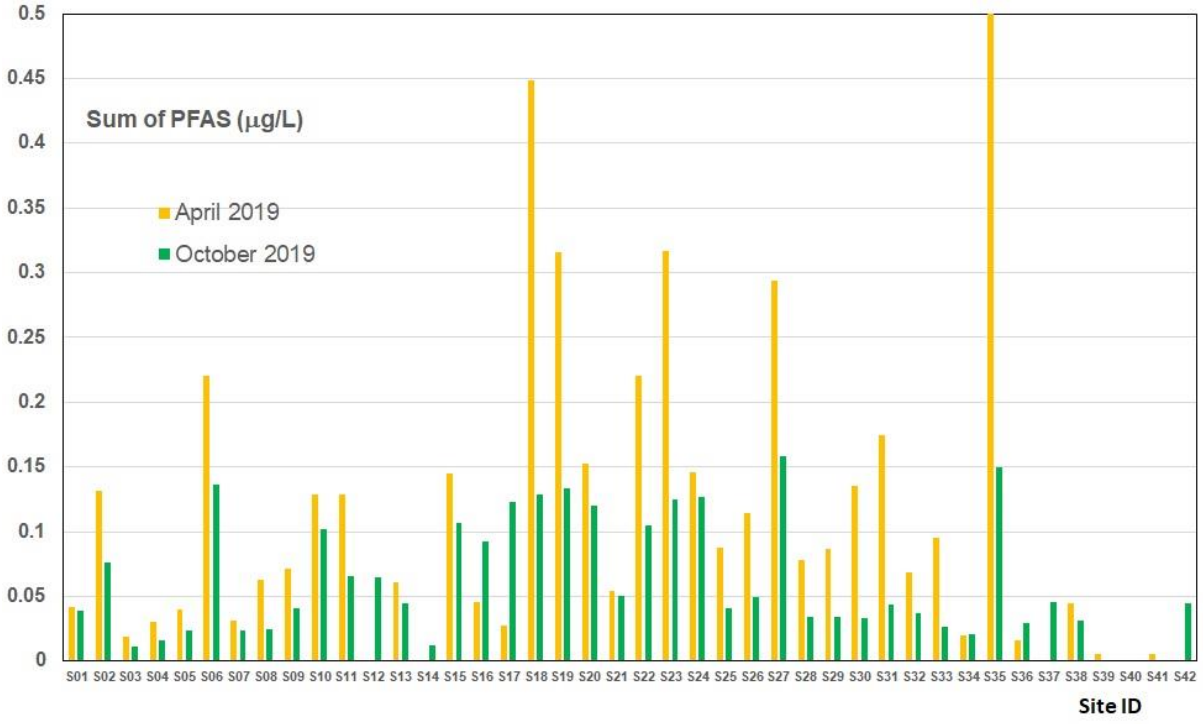
Appendix B – Surface water PFAS concentrations: Bar graphs



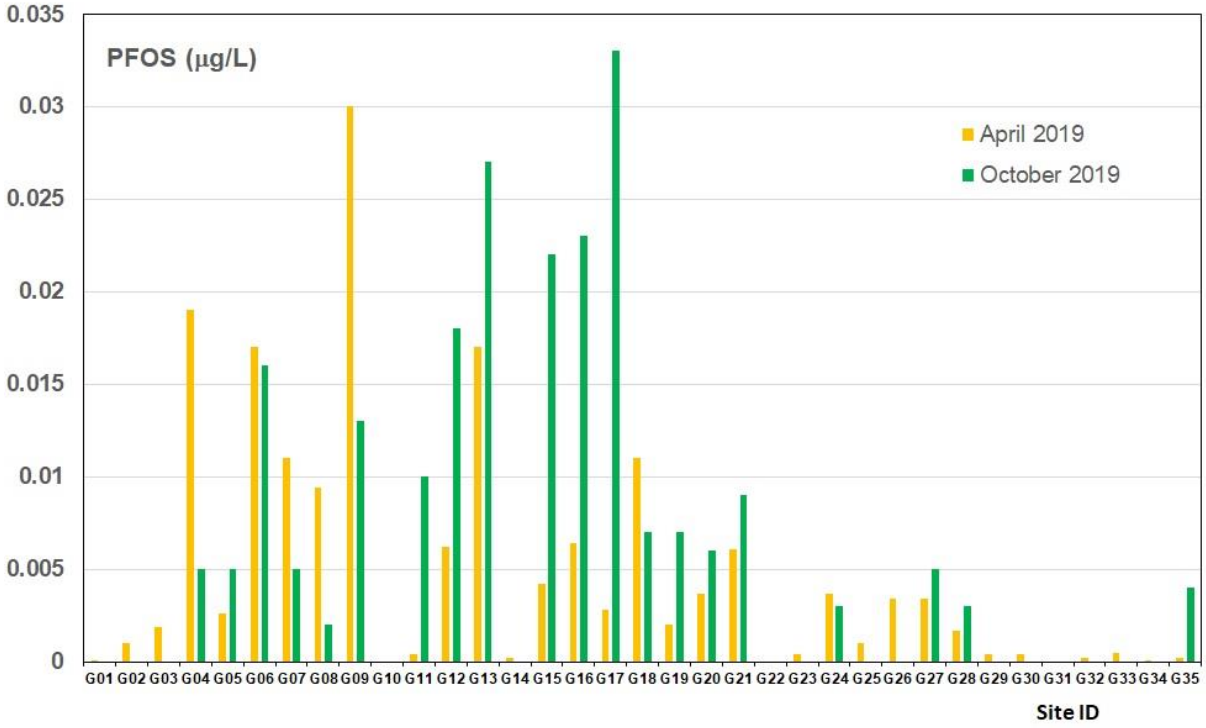

PFHxS (µg/L)
April 2019
October 2019
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
S01 S02 S03 S04 S05 S06 S07 S08 S09 S10 S11 S12 S13 S14 S15 S16 S17 S18 S19 S20 S21 S22 S23 S24 S25 S26 S27 S28 S29 S30 S31 S32 S33 S34 S35 S36 S37 S38 S39 S40 S41 S42
Site ID

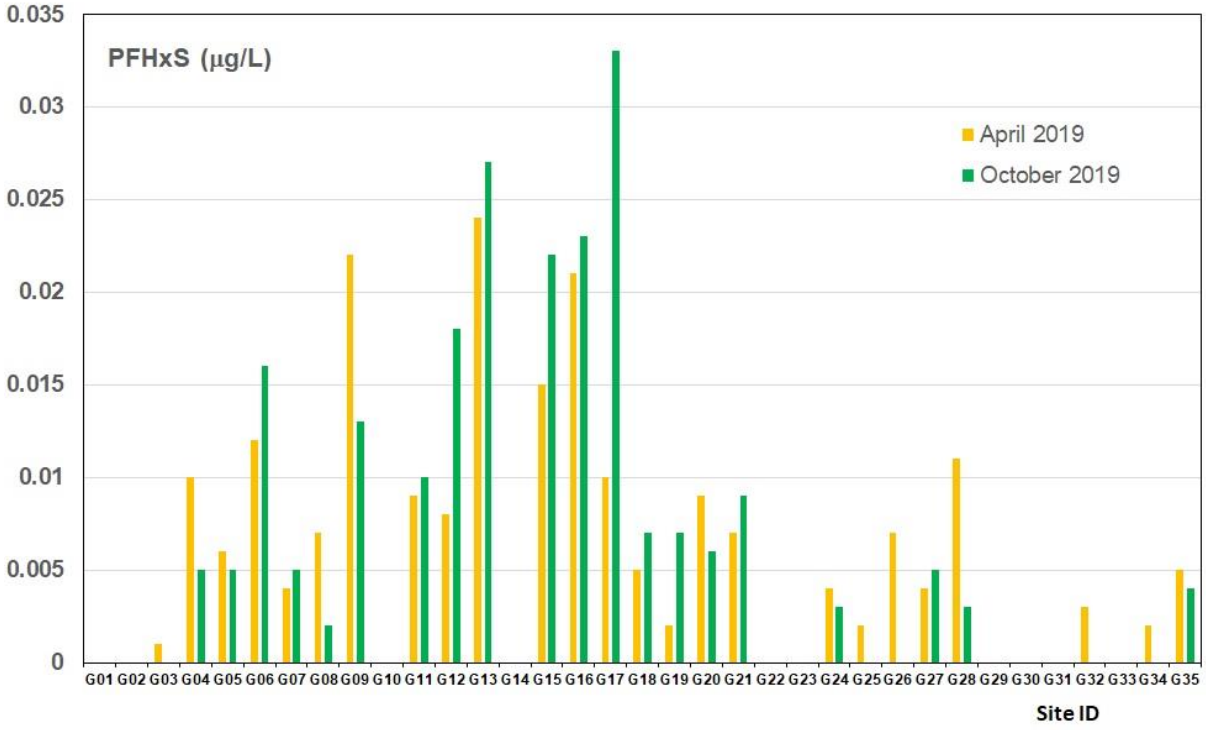

PFOA (µg/L)
April 2019
October 2019
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
S01 S02 S03 S04 S05 S06 S07 S08 S09 S10 S11 S12 S13 S14 S15 S16 S17 S18 S19 S20 S21 S22 S23 S24 S25 S26 S27 S28 S29 S30 S31 S32 S33 S34 S35 S36 S37 S38 S39 S40 S41 S42
Site ID

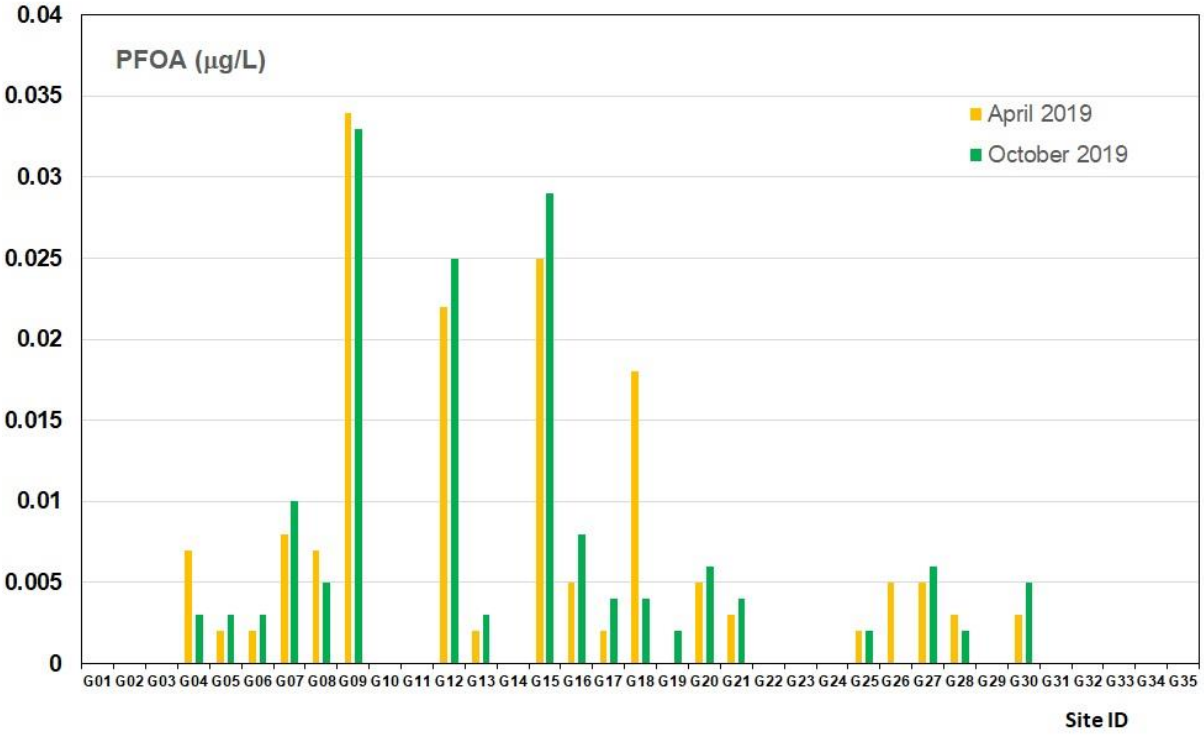

PFOS + PFHxS (µg/L)
April 2019
October 2019
0.12
0.1
0.08
0.06
0.04
0.02
0
S01 S02 S03 S04 S05 S06 S07 S08 S09 S10 S11 S12 S13 S14 S15 S16 S17 S18 S19 S20 S21 S22 S23 S24 S25 S26 S27 S28 S29 S30 S31 S32 S33 S34 S35 S36 S37 S38 S39 S40 S41 S42
Site ID

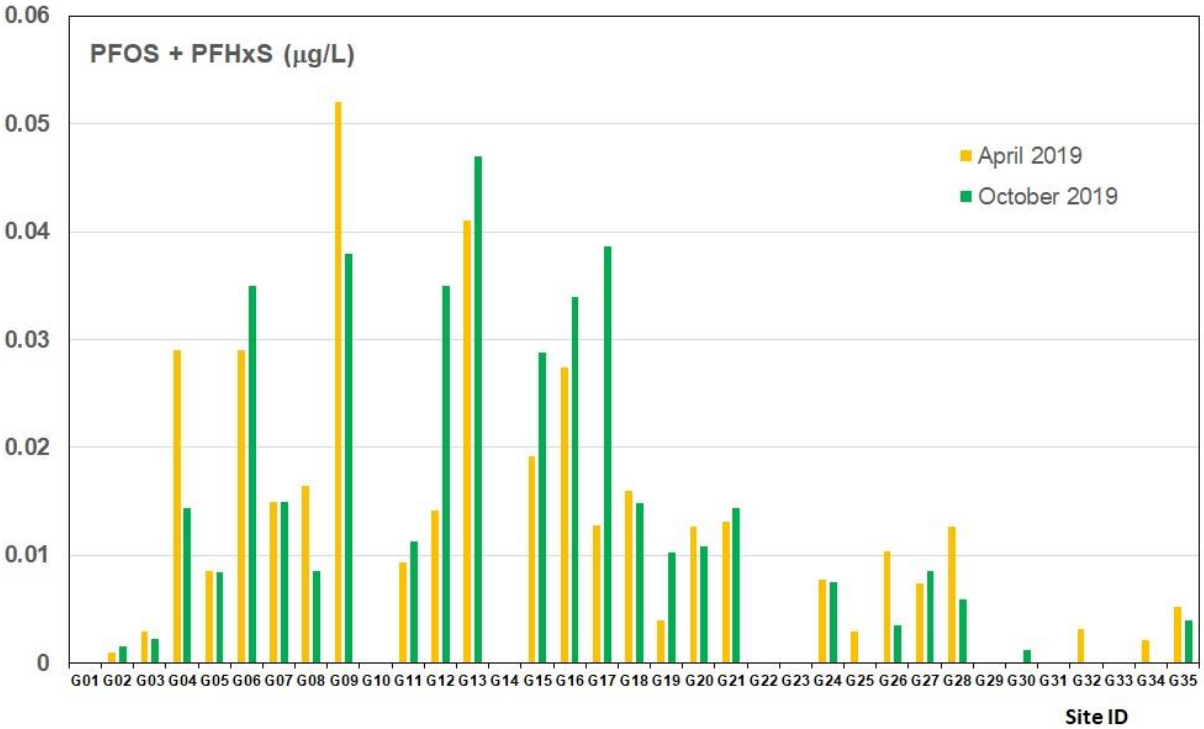

Sum of PFAS (µg/L)
April 2019
October 2019
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
S01 S02 S03 S04 S05 S06 S07 S08 S09 S10 S11 S12 S13 S14 S15 S16 S17 S18 S19 S20 S21 S22 S23 S24 S25 S26 S27 S28 S29 S30 S31 S32 S33 S34 S35 S36 S37 S38 S39 S40 S41 S42
Site ID

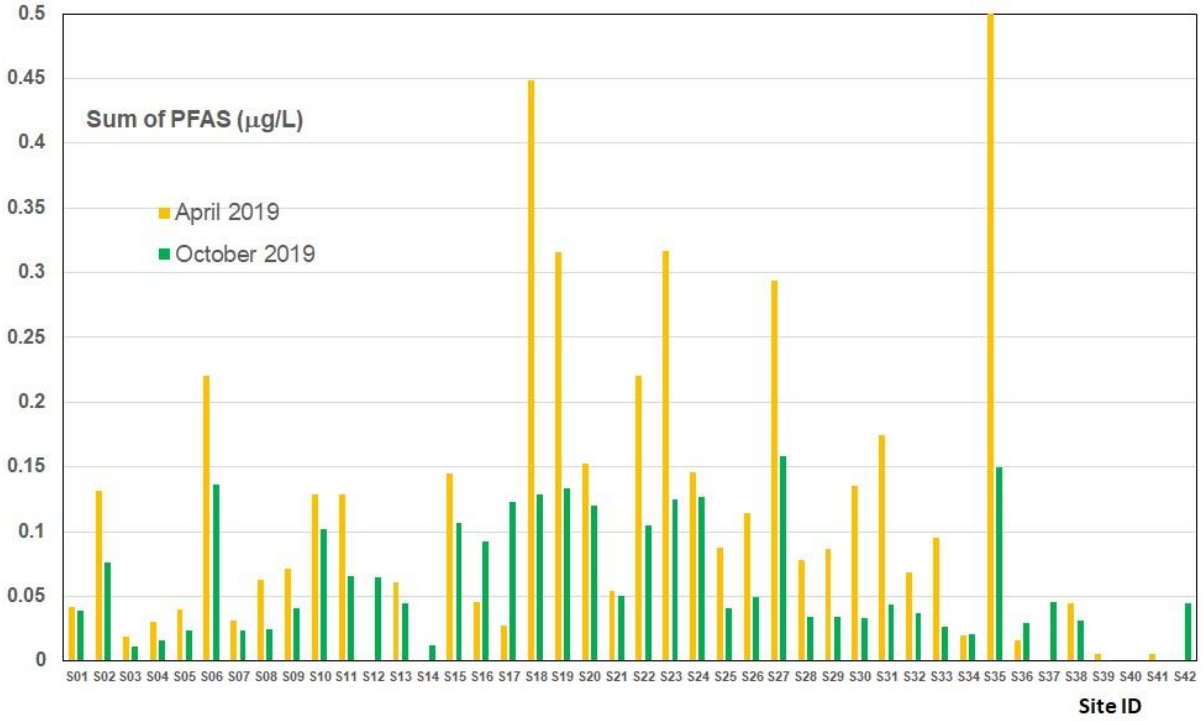
Appendix C – Groundwater PFAS concentrations: Bar graphs



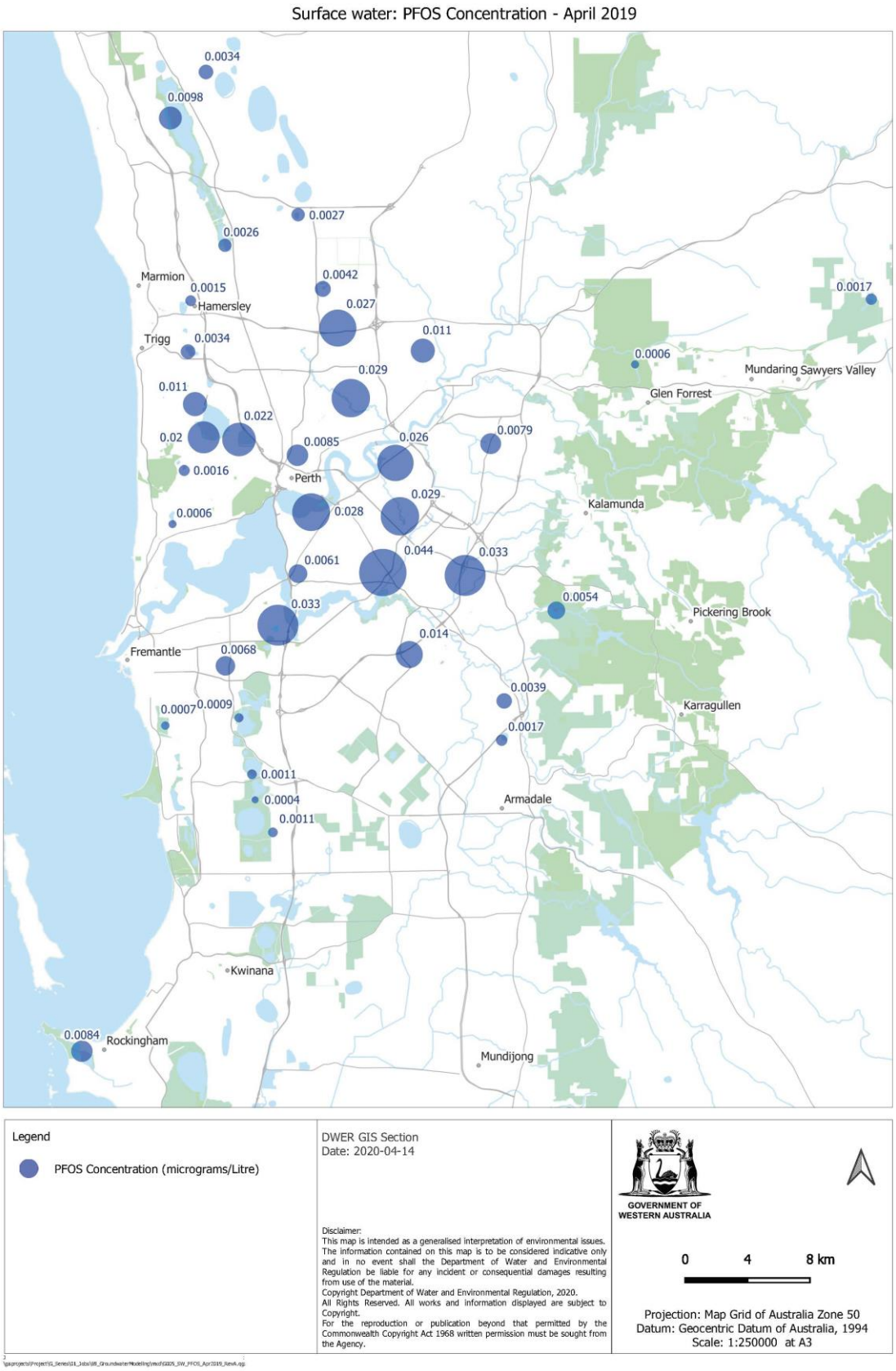



PFOA (µg/L)
April 2019
October 2019
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
G01 G02 G03 G04 G05 G06 G07 G08 G09 G10 G11 G12 G13 G14 G15 G16 G17 G18 G19 G20 G21 G22 G23 G24 G25 G26 G27 G28 G29 G30 G31 G32 G33 G34 G35
Site ID

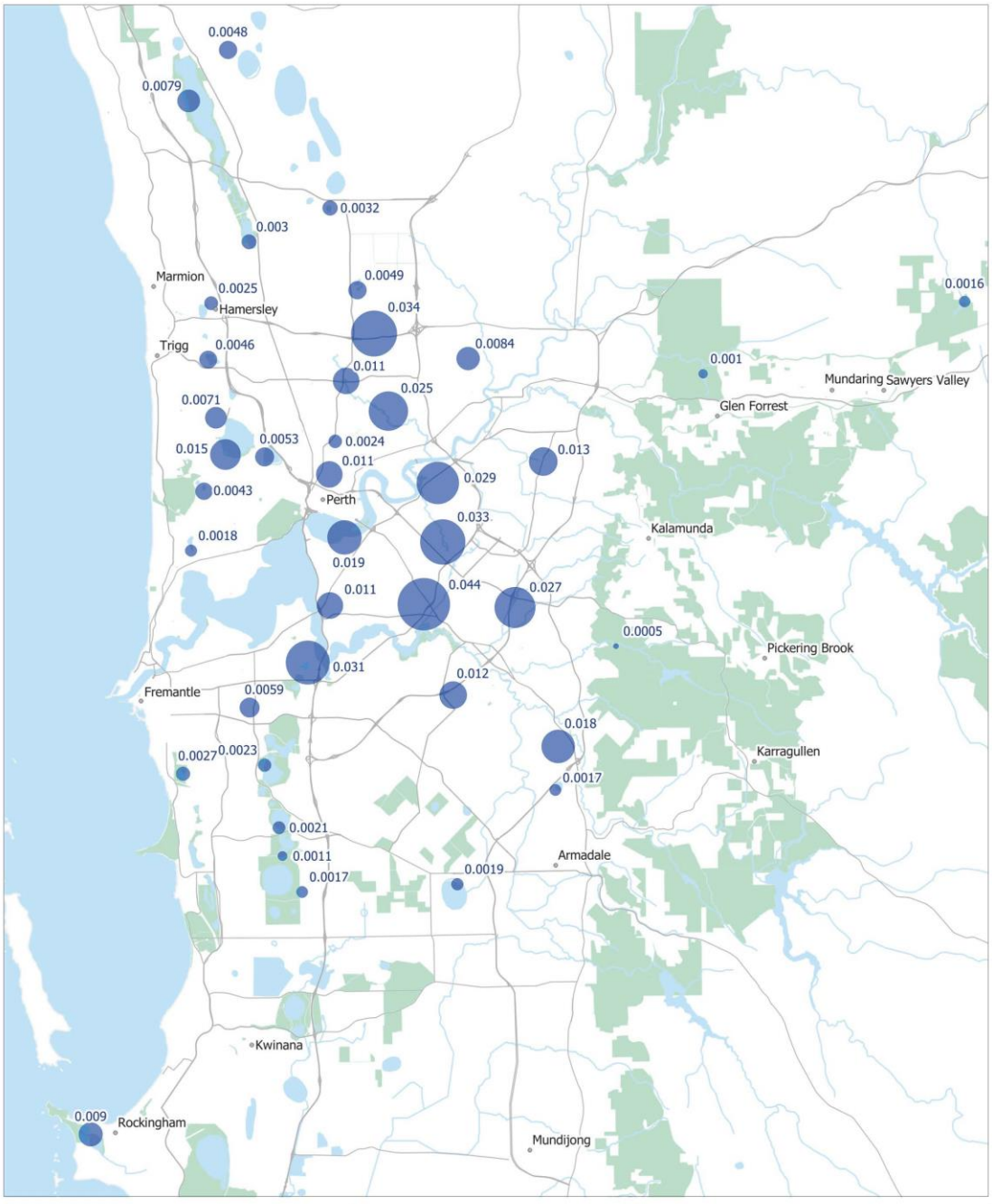

PFOS + PFHxS (µg/L)
April 2019
October 2019
0.06
0.05
0.04
0.03
0.02
0.01
0
G01 G02 G03 G04 G05 G06 G07 G08 G09 G10 G11 G12 G13 G14 G15 G16 G17 G18 G19 G20 G21 G22 G23 G24 G25 G26 G27 G28 G29 G30 G31 G32 G33 G34 G35
Site ID


Sum of PFAS (µg/L)
April 2019
October 2019
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
S01 S02 S03 S04 S05 S06 S07 S08 S09 S10 S11 S12 S13 S14 S15 S16 S17 S18 S19 S20 S21 S22 S23 S24 S25 S26 S27 S28 S29 S30 S31 S32 S33 S34 S35 S36 S37 S38 S39 S40 S41 S42
Site ID

Appendix D – Surface water PFAS concentrations: Maps



Surface water: PFOS Concentration - October 2019



Legend

PFOS Concentration (micrograms/Litre)

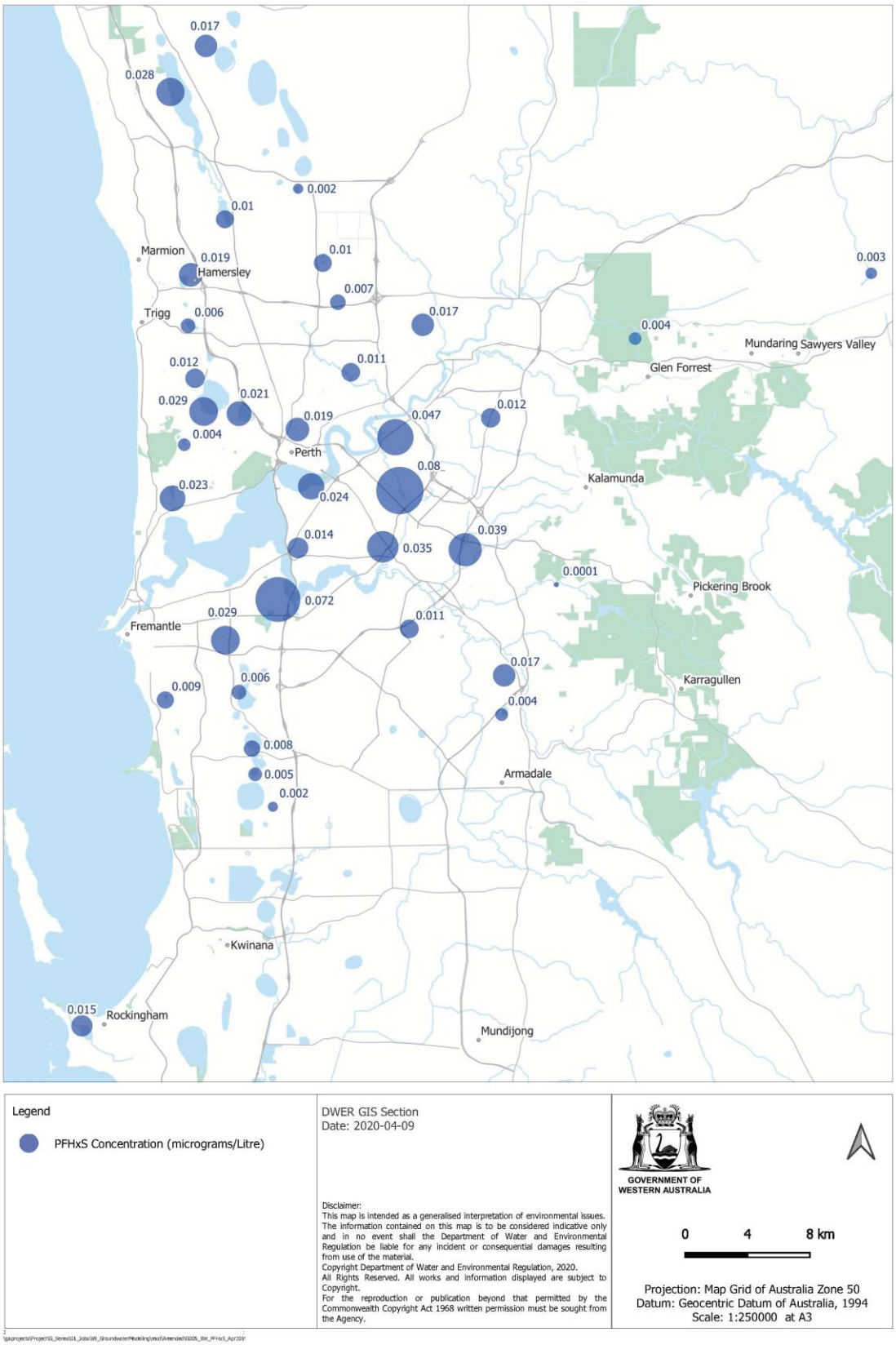
DWER GIS Section
Date: 2020-04-17

GOVERNMENT OF WESTERN AUSTRALIA

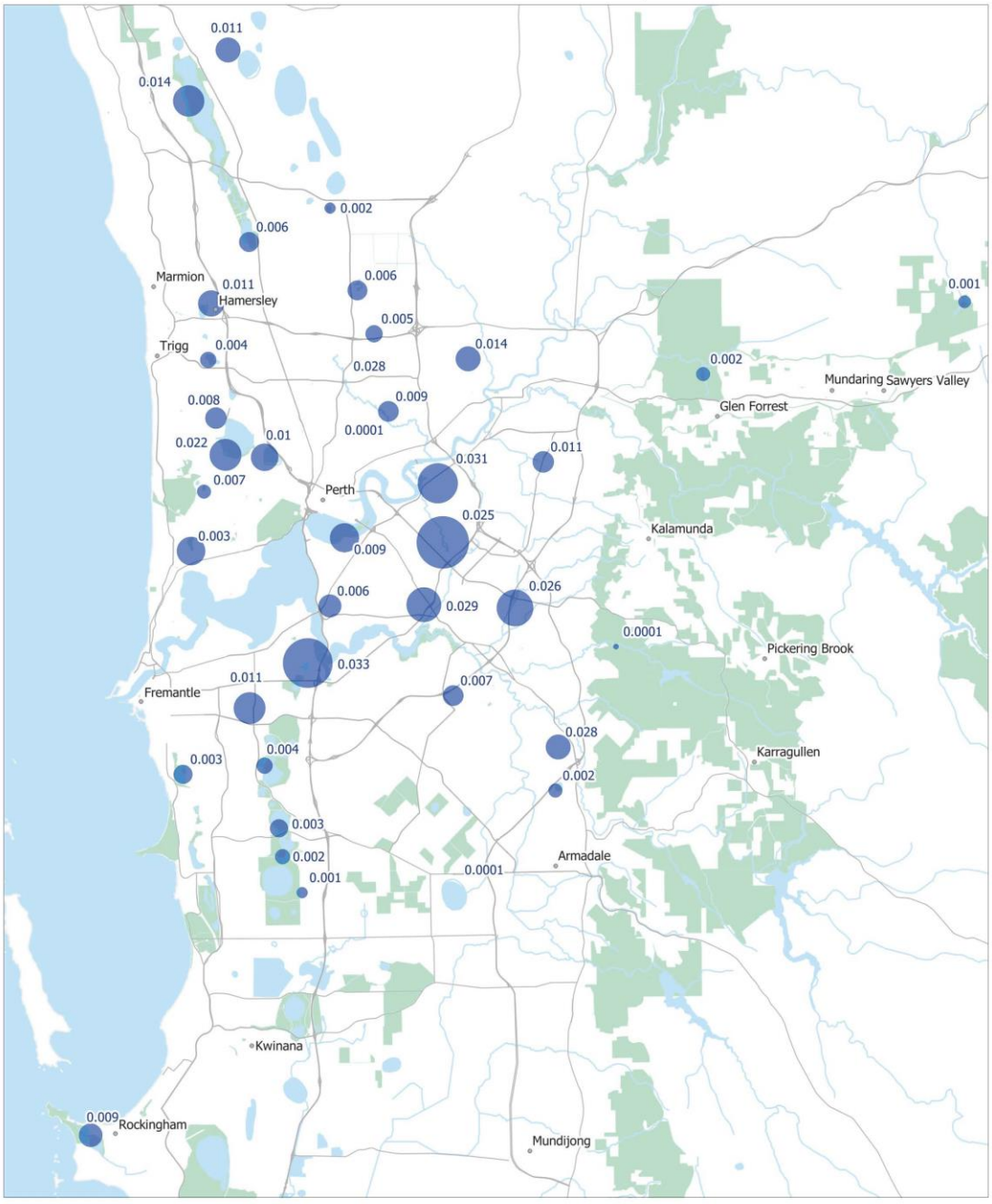
0 4 8 km

Projection: Map Grid of Australia Zone 50
Datum: Geocentric Datum of Australia, 1994
Scale: 1:250000 at A3

Surface water: PFHxS Concentration - April 2019



Surface water: PFHxS Concentration - April 2019



Legend

PFHxS Concentration (micrograms/Litre)

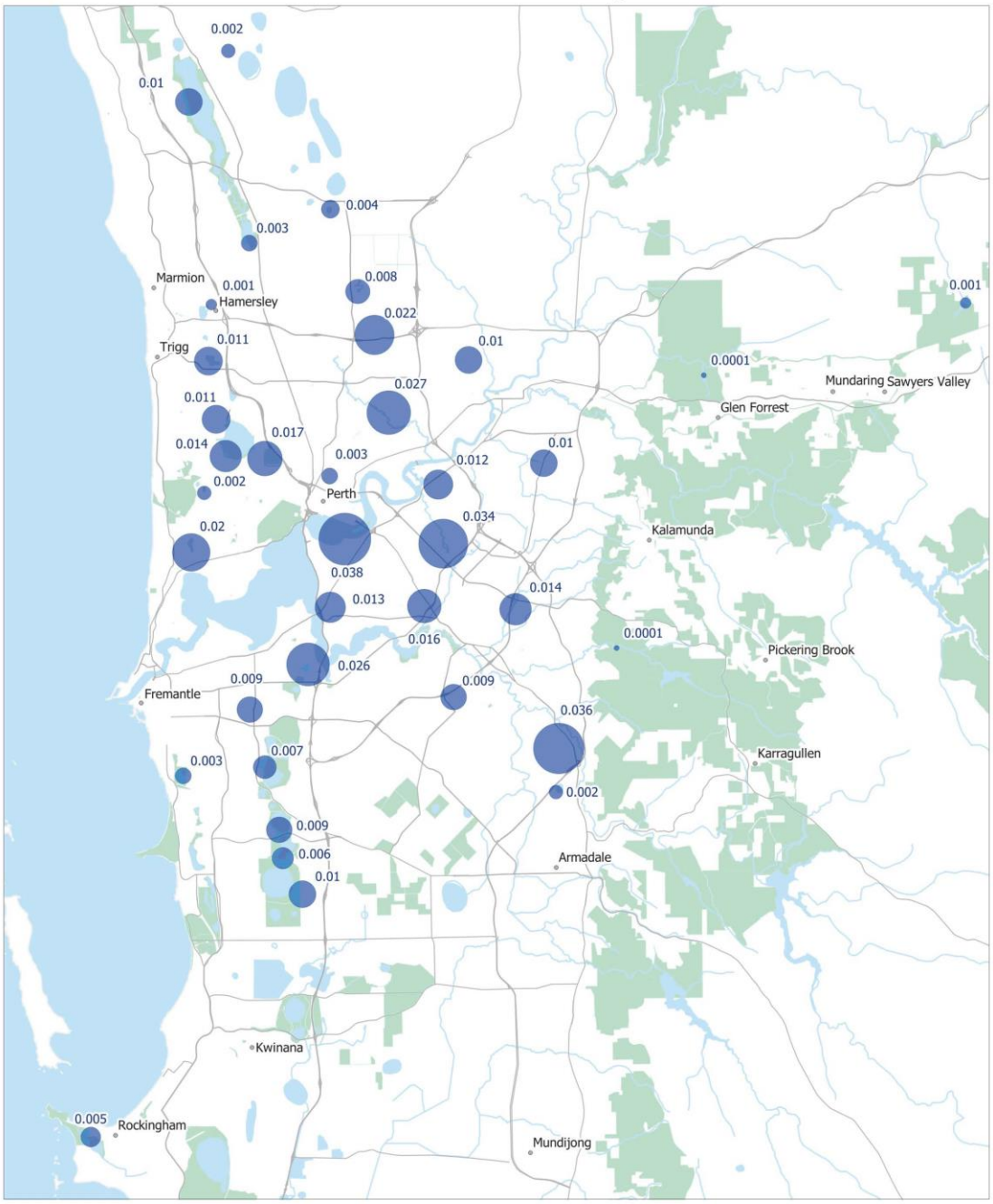
DWER GIS Section
Date: 2020-04-17

GOVERNMENT OF WESTERN AUSTRALIA

0 4 8 km

Projection: Map Grid of Australia Zone 50
Datum: Geocentric Datum of Australia, 1994
Scale: 1:250000 at A3

Surface water: PFOA Concentration - April 2019



Legend

PFOA Concentration (micrograms/Litre)

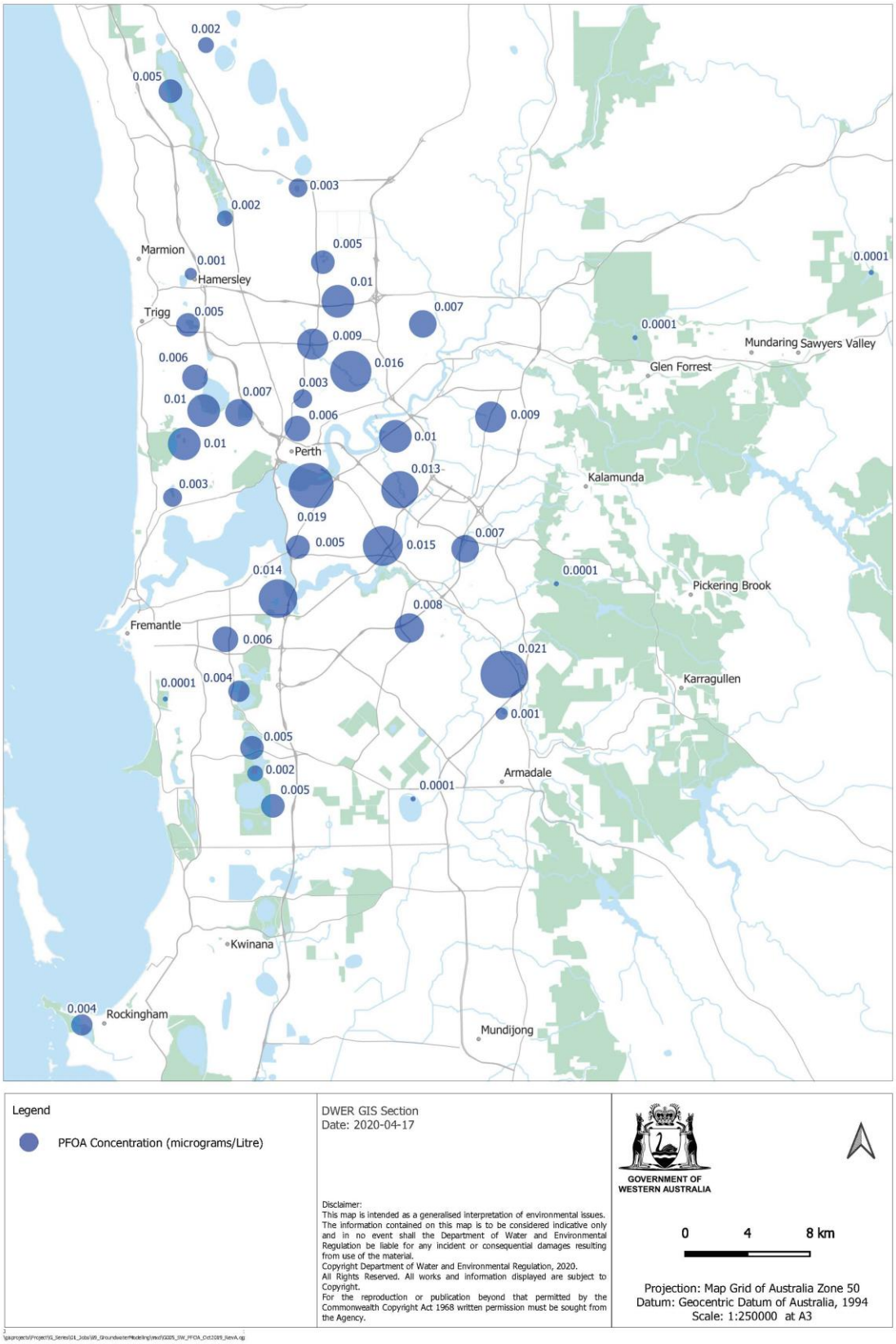
DWER GIS Section
Date: 2020-04-15

GOVERNMENT OF WESTERN AUSTRALIA

0 4 8 km

Projection: Map Grid of Australia Zone 50
Datum: Geocentric Datum of Australia, 1994
Scale: 1:250000 at A3

Surface water: PFOA Concentration - October 2019



Legend

PFOA Concentration (micrograms/Litre)

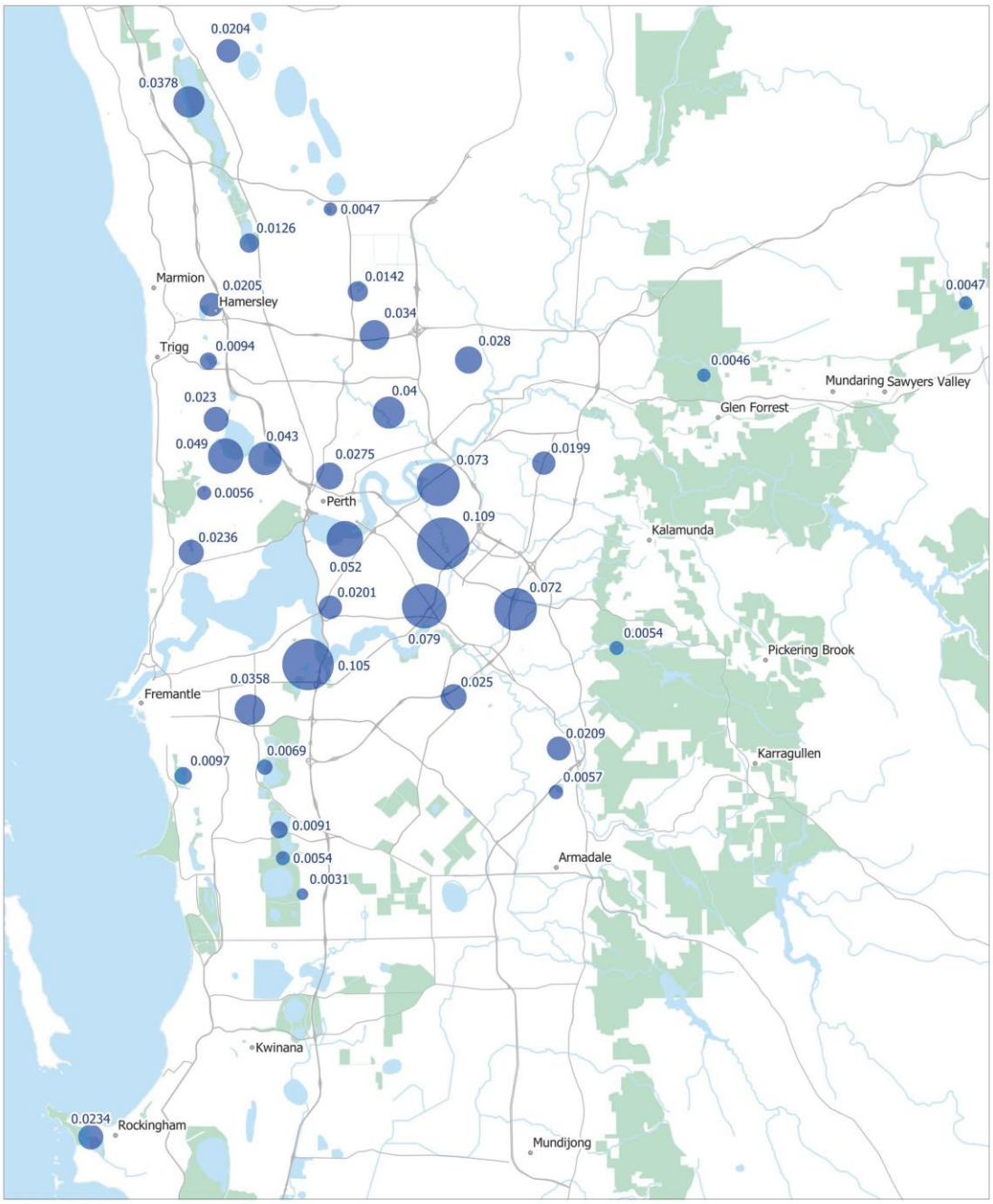
DWER GIS Section
Date: 2020-04-17

GOVERNMENT OF WESTERN AUSTRALIA

0 4 8 km

Projection: Map Grid of Australia Zone 50
Datum: Geocentric Datum of Australia, 1994
Scale: 1:250000 at A3

Surface water: PFOS & PFHxS Concentrations - April 2019



Legend

PFOS & PFHxS Concentrations (micrograms/Litre)

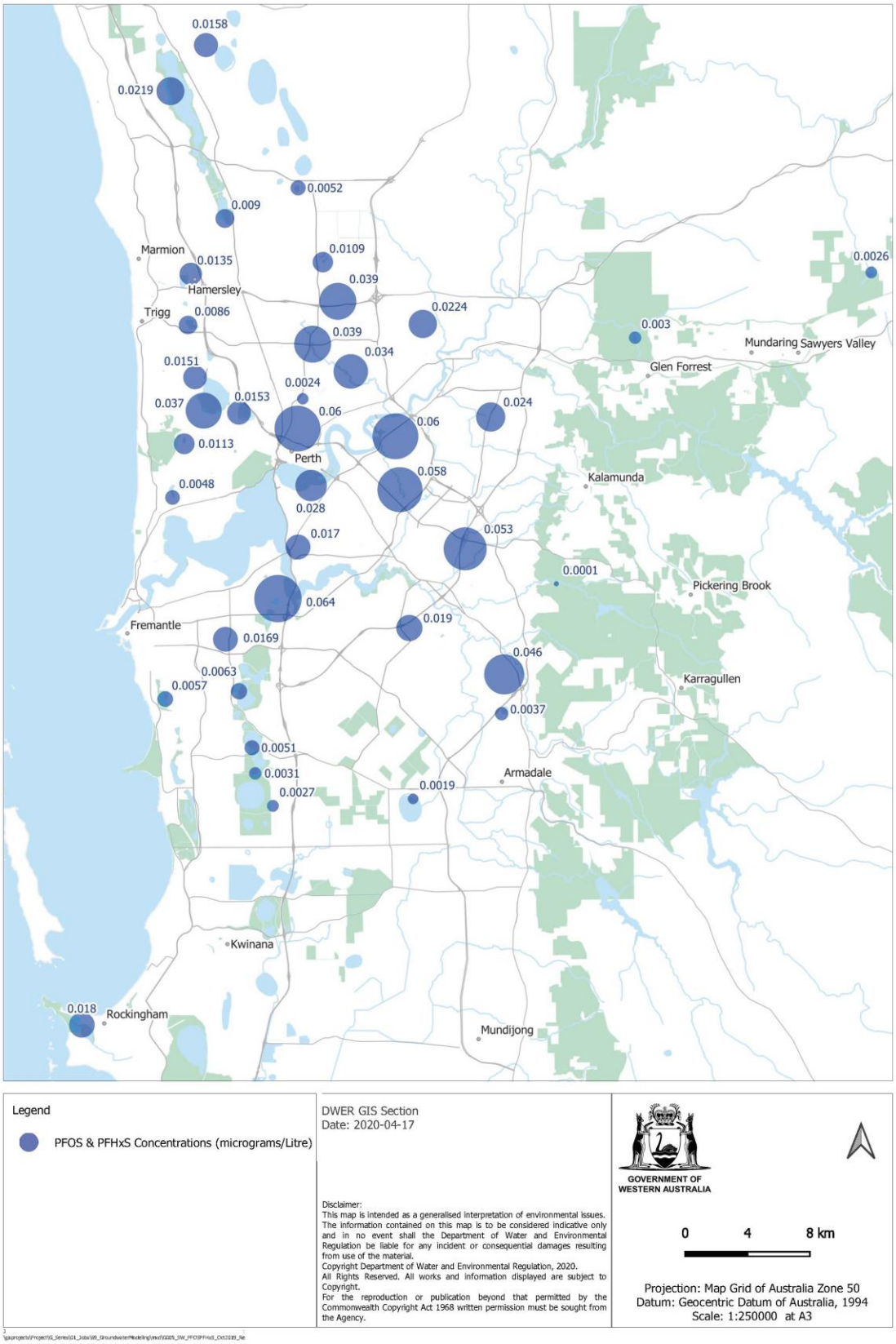
DWER GIS Section
Date: 2020-04-17

GOVERNMENT OF WESTERN AUSTRALIA

0 4 8 km

Projection: Map Grid of Australia Zone 50
Datum: Geocentric Datum of Australia, 1994
Scale: 1:250000 at A3

Surface water: PFOS & PFHxS Concentrations - October 2019



Legend

PFOS & PFHxS Concentrations (micrograms/Litre)

DWER GIS Section
Date: 2020-04-17

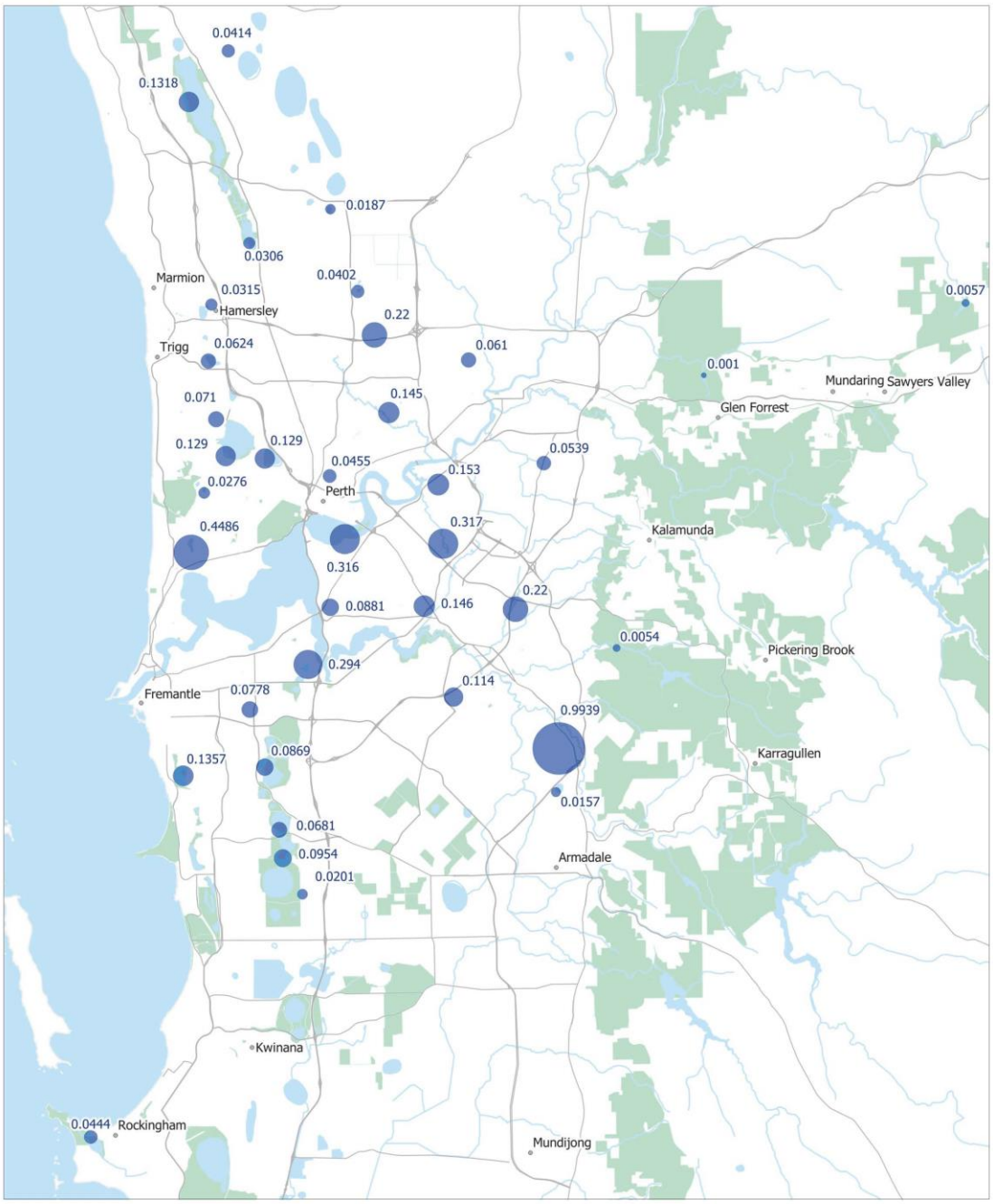
Disclaimer:
This map is intended as a generalised interpretation of environmental issues. The information contained on this map is to be considered indicative only and in no event shall the Department of Water and Environmental Regulation be liable for any incident or consequential damages resulting from use of the material.

GOVERNMENT OF WESTERN AUSTRALIA

0 4 8 km

Projection: Map Grid of Australia Zone 50
Datum: Geocentric Datum of Australia, 1994
Scale: 1:250000 at A3

Surface water: Sum of PFAS Concentrations - April 2019



Legend

Sum of PFAS Concentration (micrograms/Litre)

Note: Size of the symbol on this map does not represent the same PFAS sum value on the map for October.

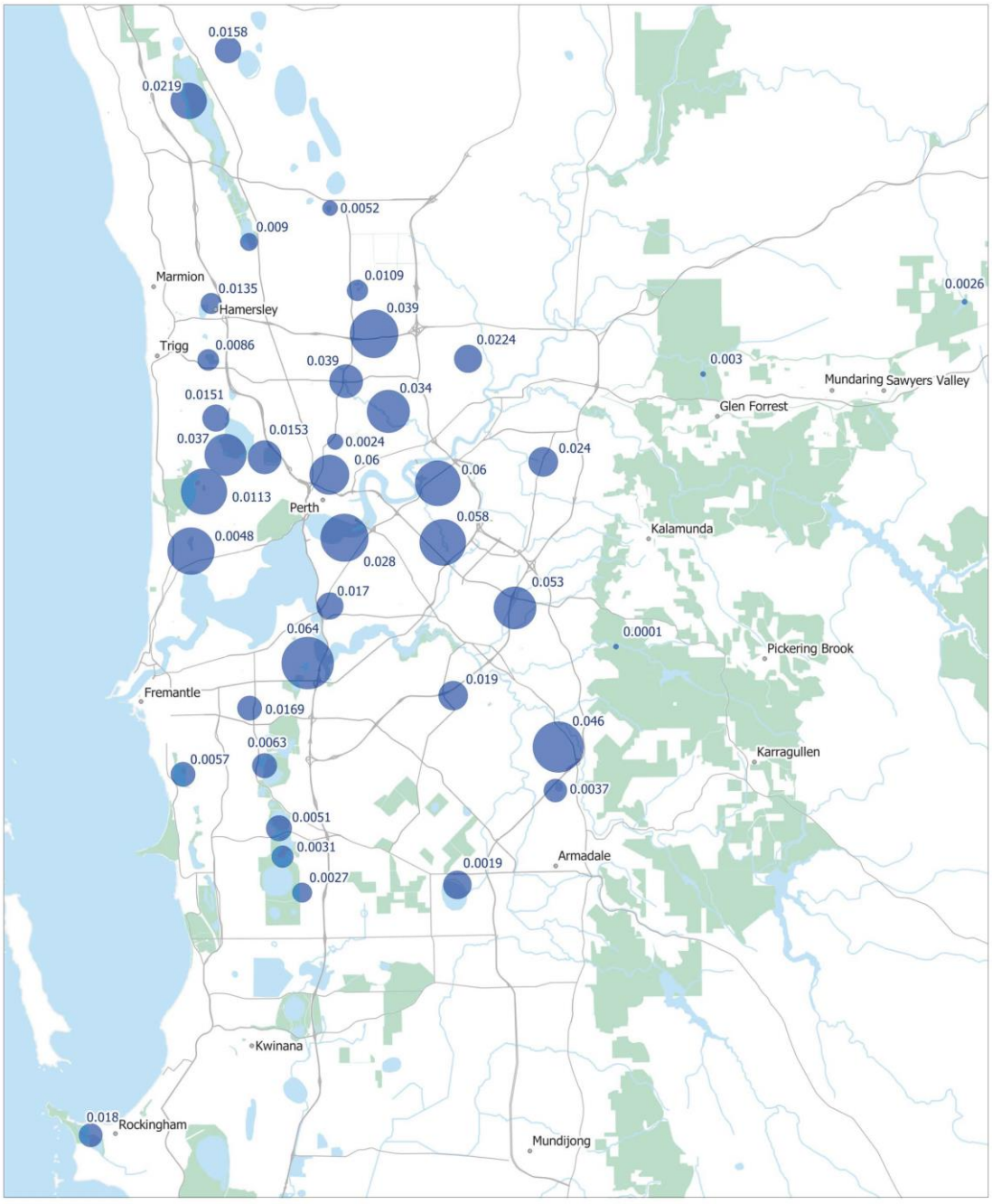
DWER GIS Section
Date: 2020-04-17

GOVERNMENT OF WESTERN AUSTRALIA

0 4 8 km

Projection: Map Grid of Australia Zone 50
Datum: Geocentric Datum of Australia, 1994
Scale: 1:250000 at A3

Surface water: Sum of PFAS Concentrations - October 2019



Legend

Sum of PFAS Concentration (micrograms/Litre)

Note: Size of the symbol on this map does not represent the same PFAS sum value as the map for April.

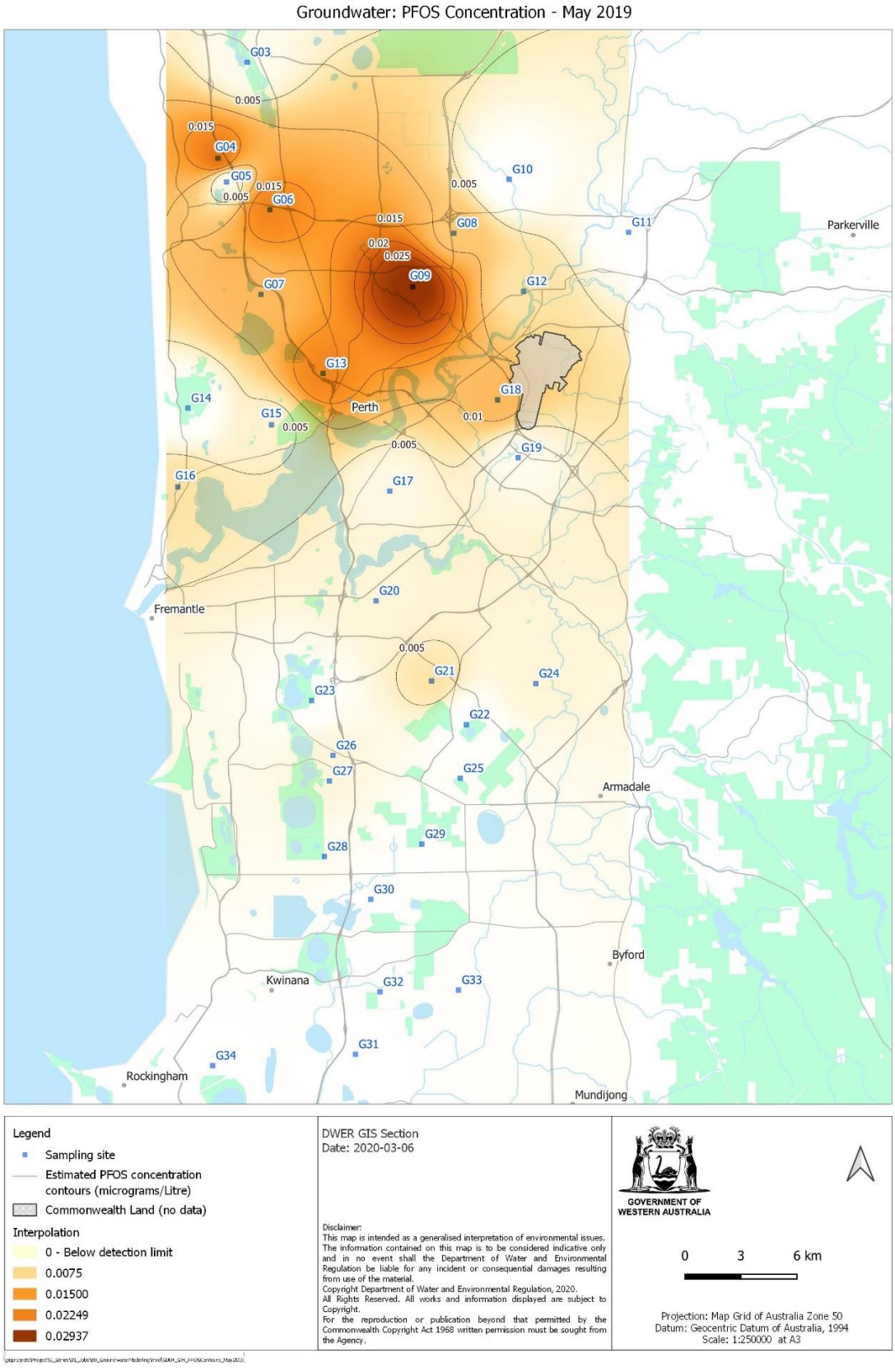
DWER GIS Section
Date: 2020-04-17

GOVERNMENT OF WESTERN AUSTRALIA

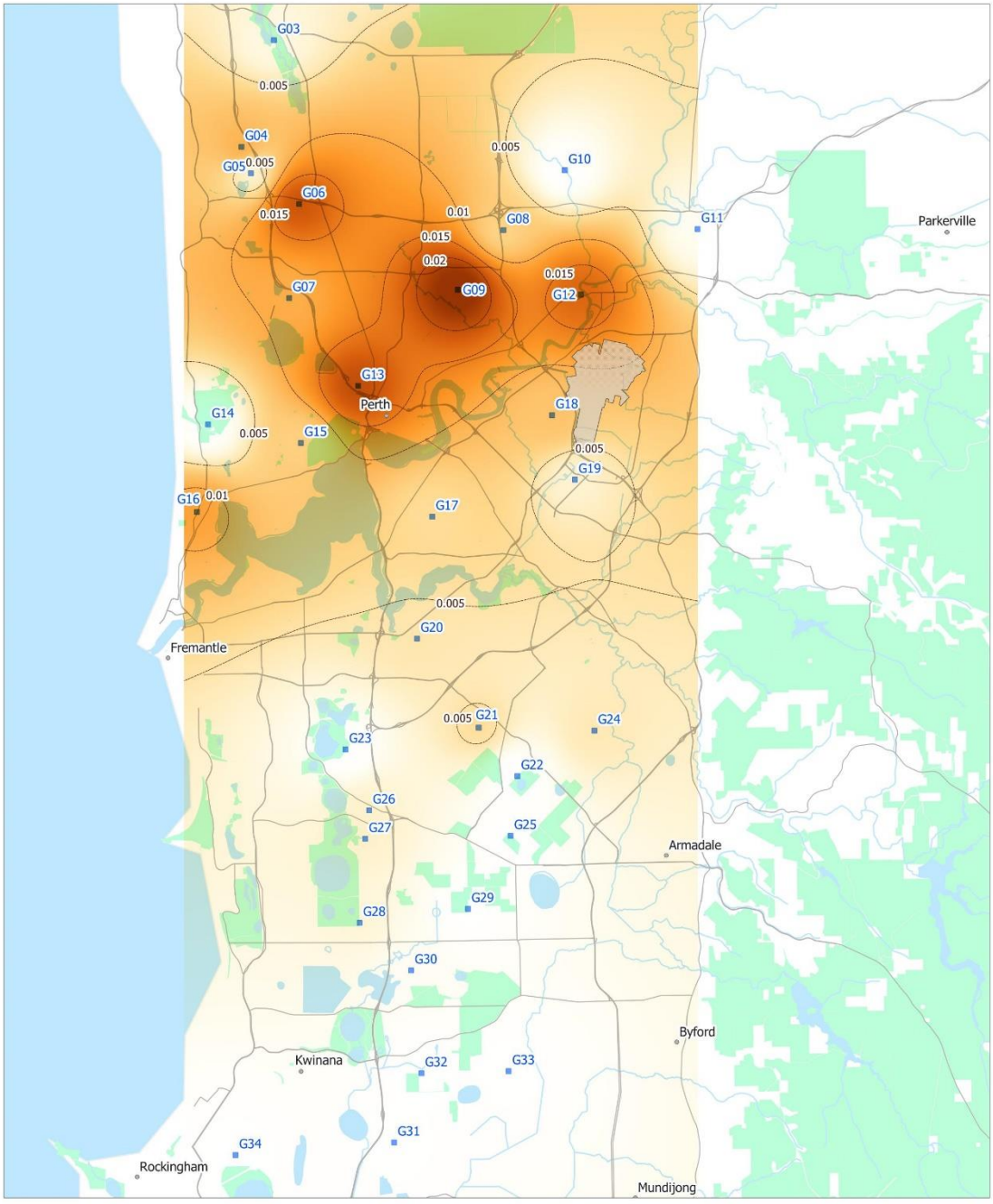
0 4 8 km

Projection: Map Grid of Australia Zone 50
Datum: Geocentric Datum of Australia, 1994
Scale: 1:250000 at A3

Appendix E – Groundwater PFAS concentrations: Contour maps



Groundwater: PFOS Concentration - November 2019



Legend

- Sampling site
- Estimated PFOS concentration contours (micrograms/Litre)
- Commonwealth Land (no data)

Interpolation

- 0 - Below detection level
- 0.0059
- 0.0119
- 0.01785
- 0.0238

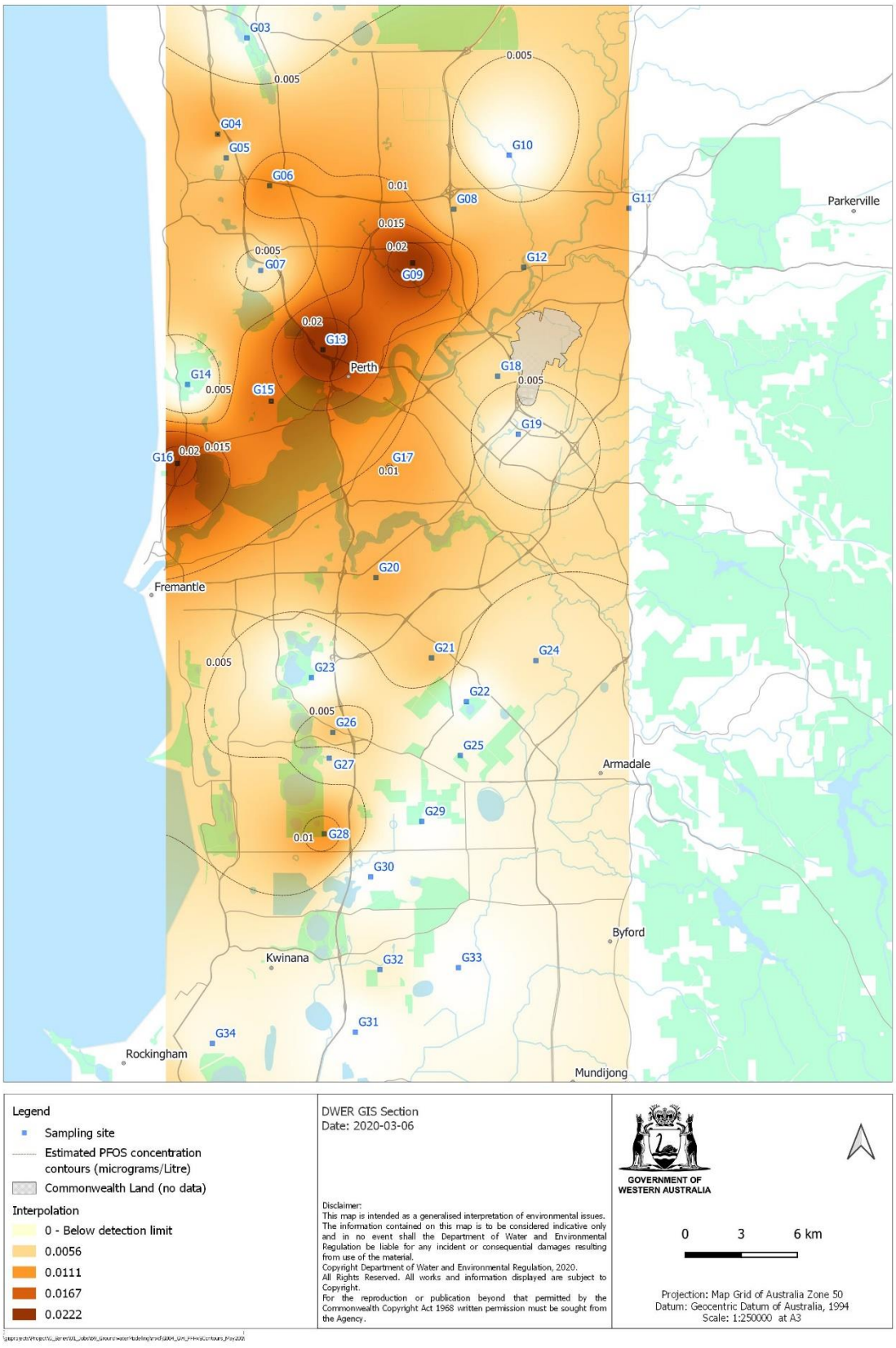
DWER GIS Section
Date: 2020-03-06

GOVERNMENT OF WESTERN AUSTRALIA

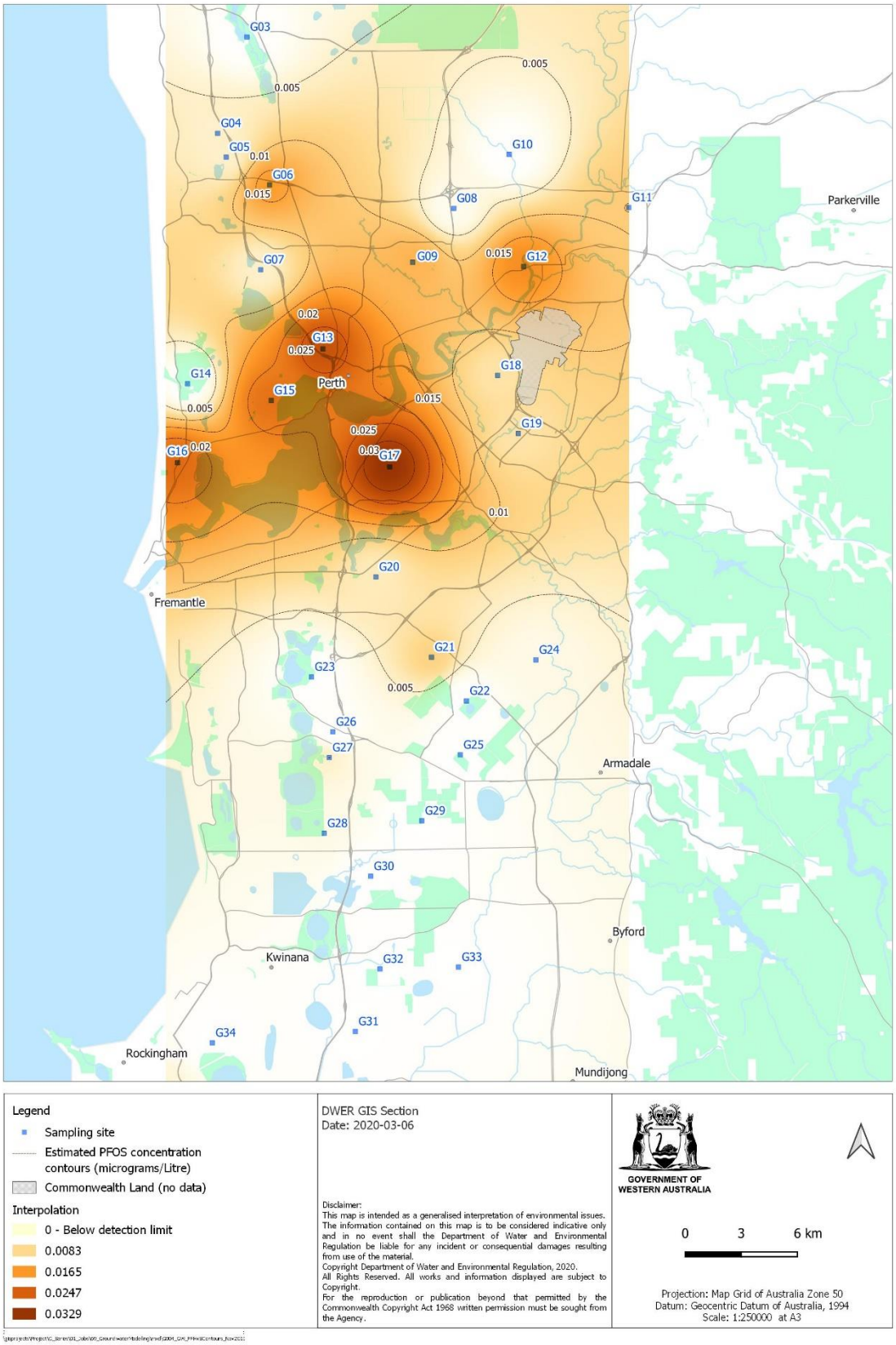
0 3 6 km

Projection: Map Grid of Australia Zone 50
Datum: Geocentric Datum of Australia, 1994
Scale: 1:250000 at A3

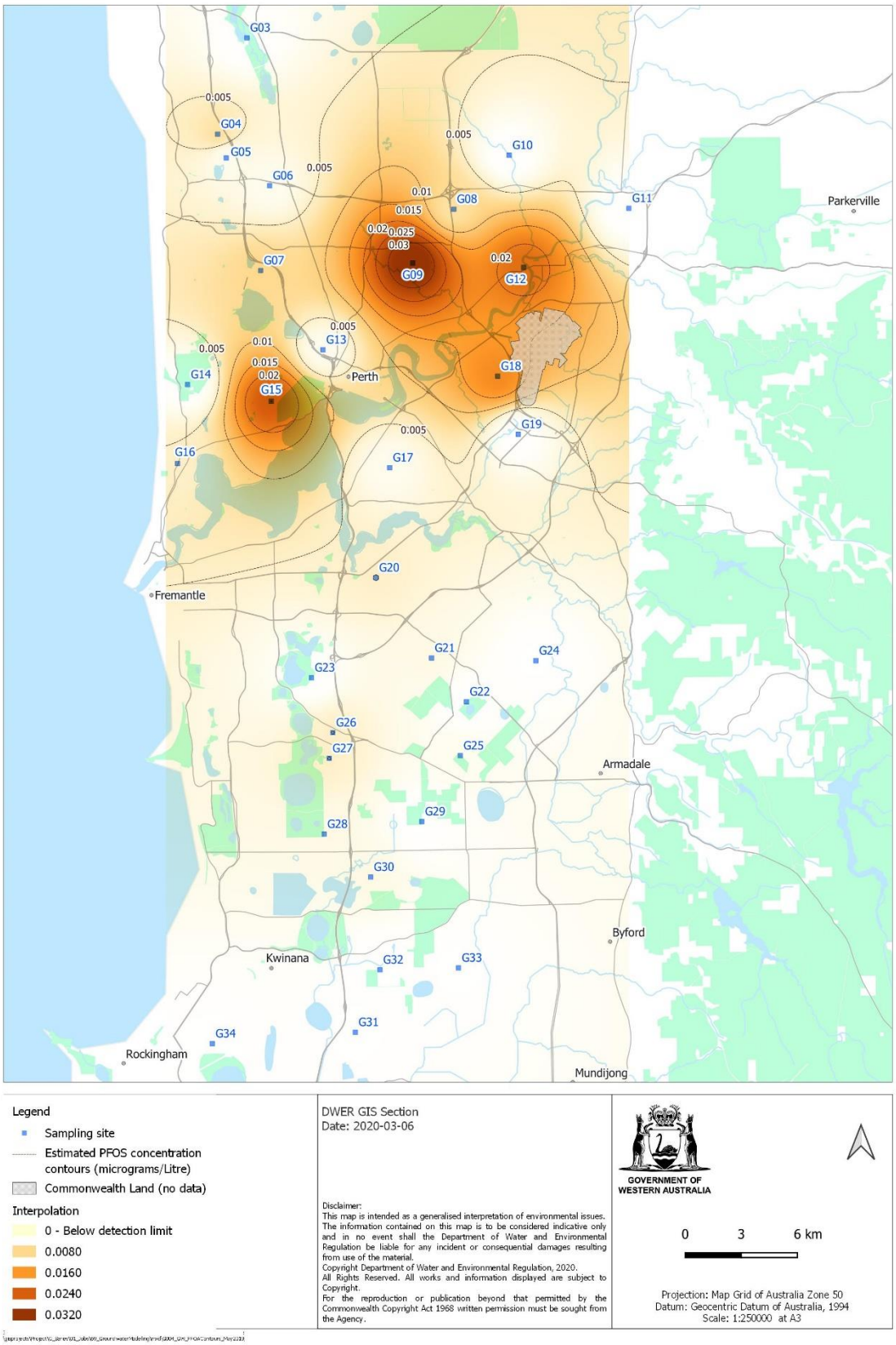
Groundwater: PFHxS Concentration - May 2019



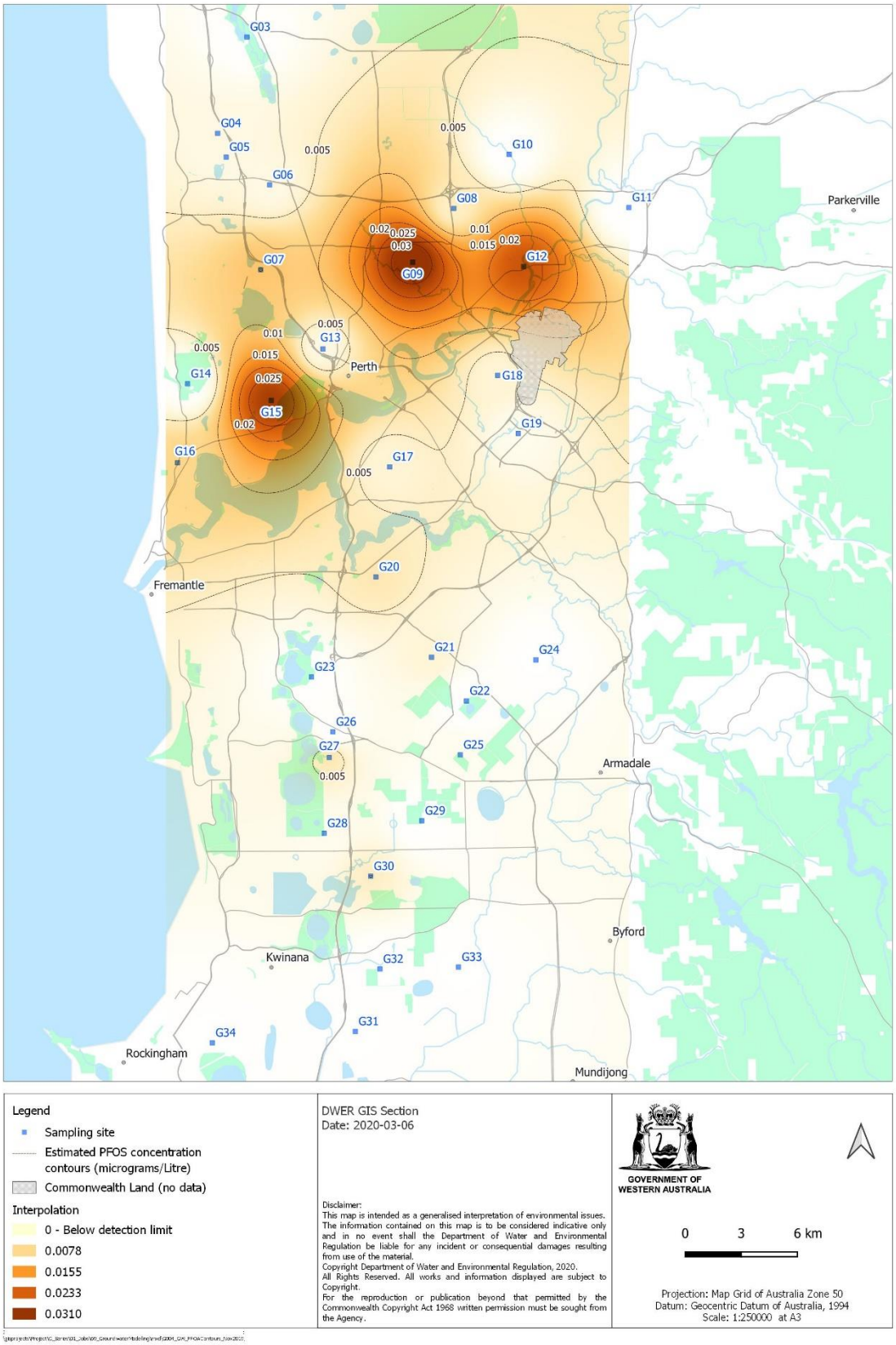
Groundwater: PFHxS Concentration - November 2019



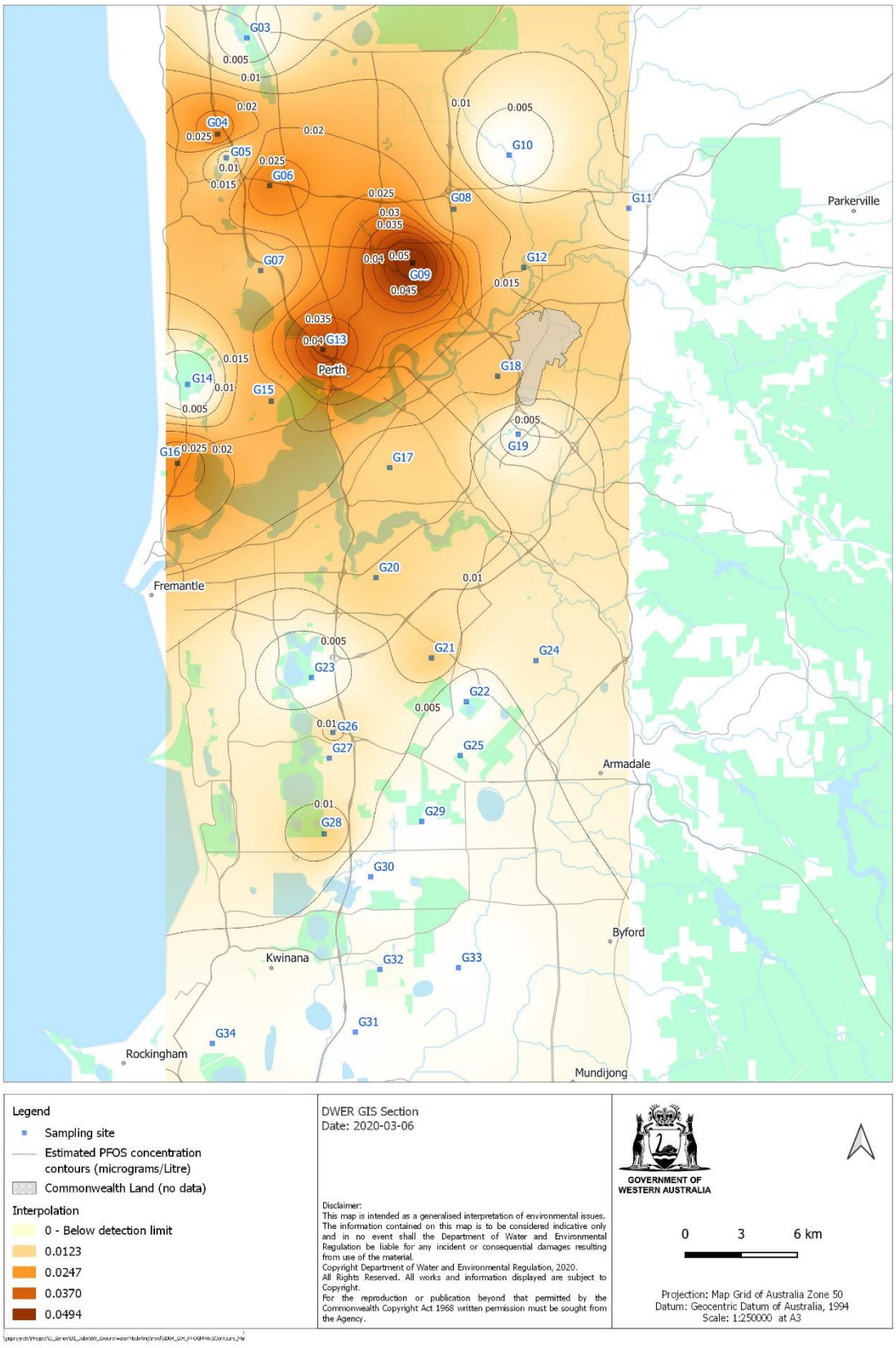
Groundwater: PFOA Concentration - May 2019



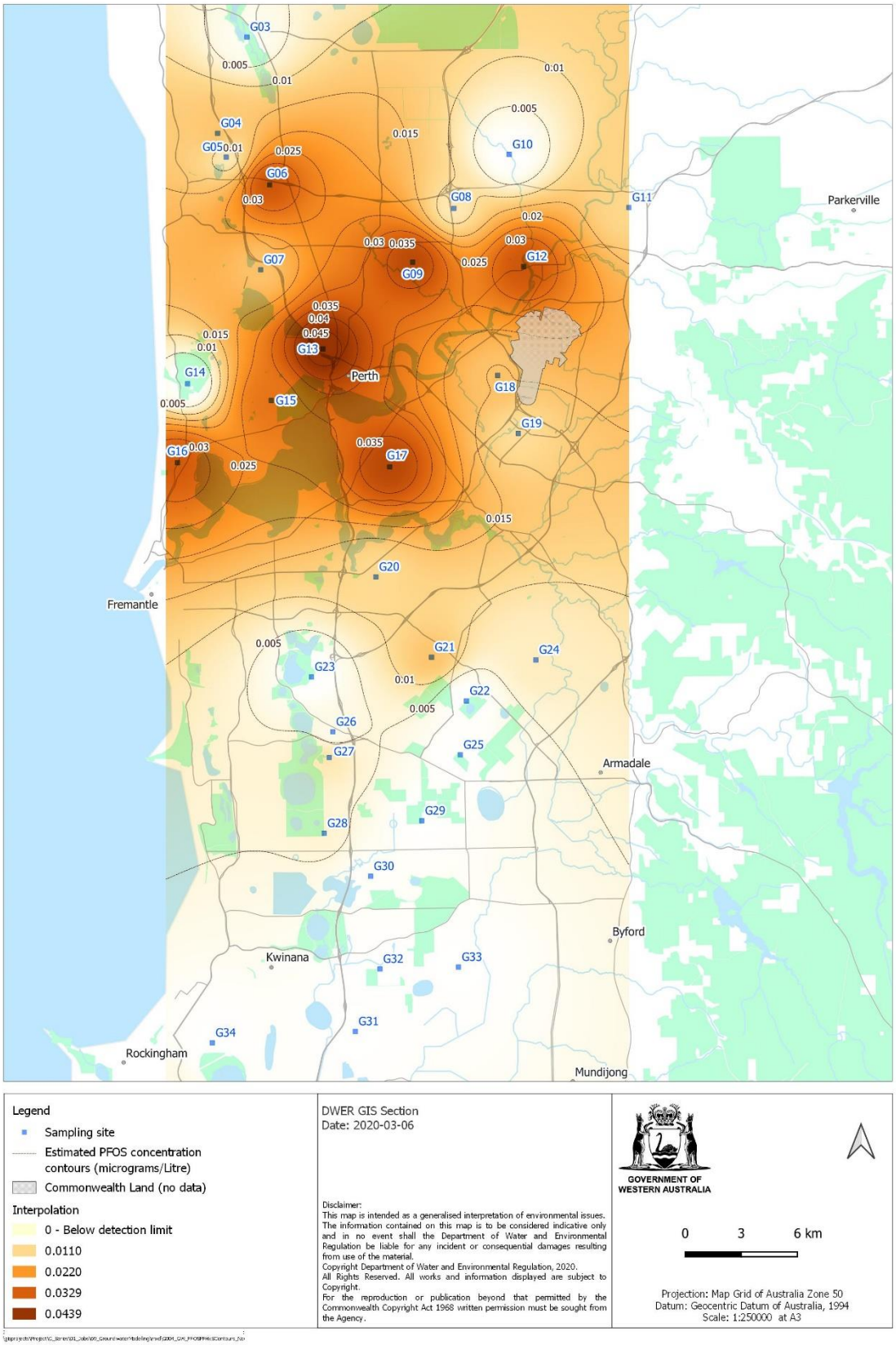
Groundwater: PFOA Concentration - November 2019



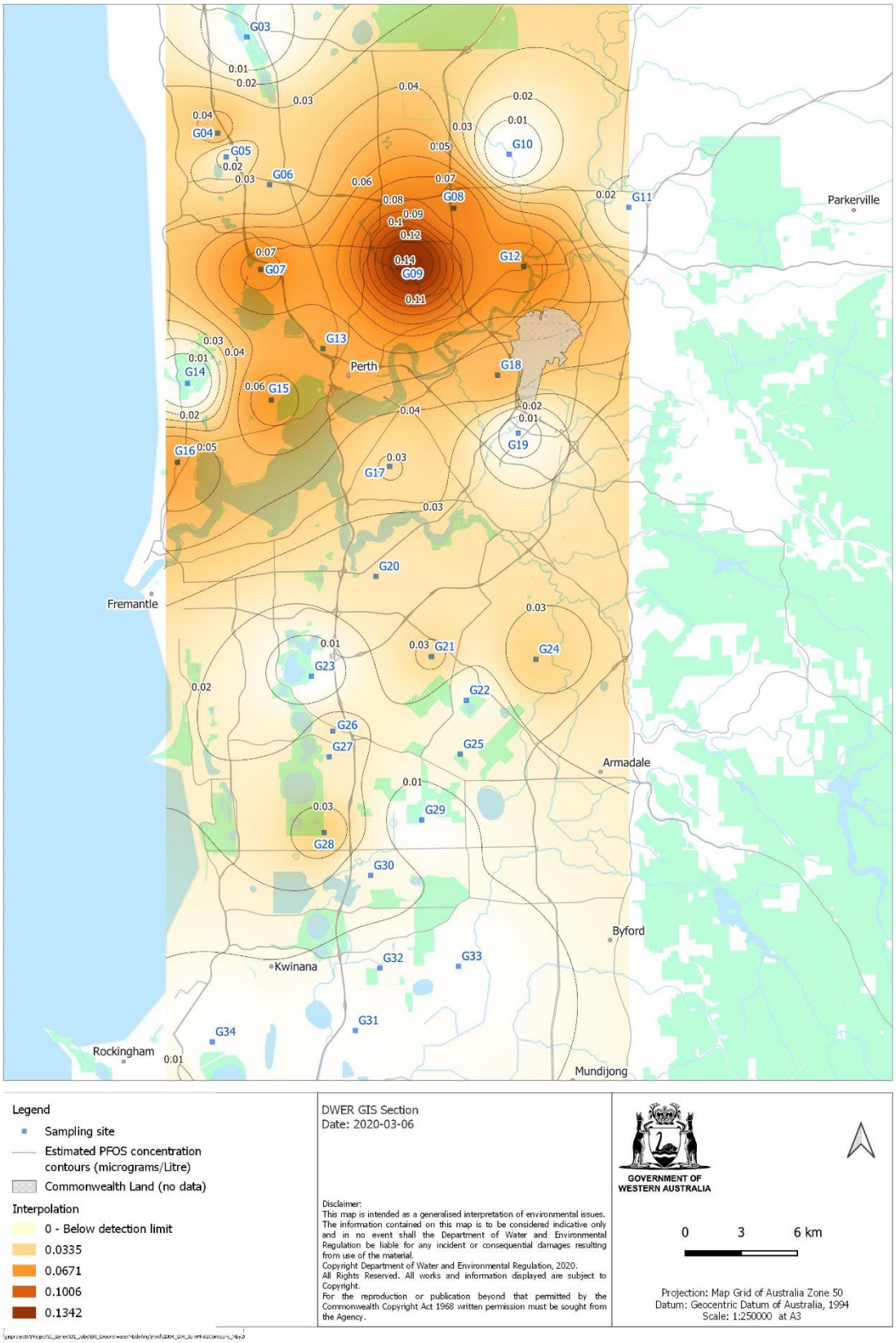
Groundwater: PFOS & PFHxS Concentration - May 2019



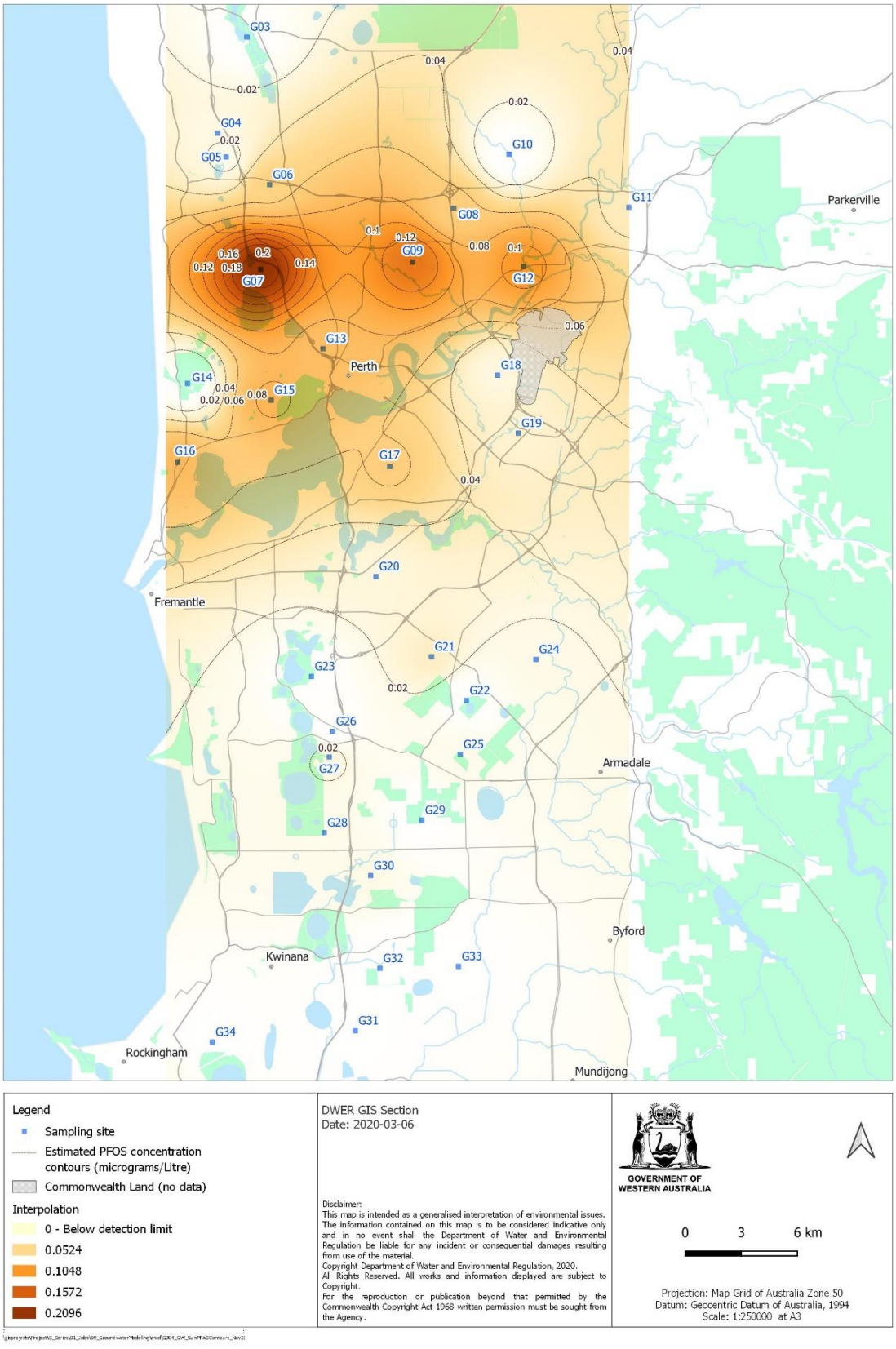
Groundwater: PFOS & PFHxS Concentration - November 2019



Groundwater: Sum of PFAS Concentrations - May 2019



Groundwater: Sum of PFAS Concentrations - November 2019



Appendix F – Tabulated results

SURFACE WATER RESULTS : APRIL 2019

	Limit of Reporting (µg/L)	DWG	Aquatic Ecosys DGV	NPUG (WA DoH)																	
Site ID#					**S07**	**S08**	**S04**	**S03**	**S05**	**S05 (FB)**	**S06**	**S09**	**S10**	**S17**	**S18**	**S11**	**S16**	**S15**	**S15(FB)**	**S13**	**S01**
Sample Date					2/04/19	2/04/19	2/04/19	2/04/19	2/04/19	2/04/19	2/04/19	3/04/19	3/04/19	3/04/19	3/04/19	3/04/19	3/04/19	3/04/19	3/04/19	3/04/19	3/04/19
PFAS ANALYSIS																					
n:2 Fluorotelomer sulfonic acids (n:2 FTSAs)- Ultra Trace																					
1H.1H.2H.2H-perfluorodecanesulfonic acid (8:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.002	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
1H.1H.2H.2H-perfluorododecanesulfonic acid (10:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
1H.1H.2H.2H-perfluorohexanesulfonic acid (4:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
1H.1H.2H.2H-perfluorooctanesulfonic acid (6:2 FTSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.034	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluoroalkyl carboxylic acids (PFCAs) - Ultra Trace																					
Perfluorobutanoic acid (PFBA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluorodecanoic acid (PFDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.003	< 0.001	< 0.001	< 0.001	< 0.001	0.001	< 0.001	0.004	< 0.001	< 0.001	< 0.001
Perfluorododecanoic acid (PFDoDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.002	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroheptanoic acid (PFHpA)	0.001				< 0.001	0.007	0.002	0.002	0.004	< 0.001	0.012	0.005	0.009	0.002	0.036	0.009	< 0.001	0.011	< 0.001	0.005	0.002
Perfluorohexanoic acid (PFHxA)	0.001				0.001	0.015	0.005	0.003	0.007	< 0.001	0.043	0.014	0.025	0.007	0.15	0.033	0.002	0.026	< 0.001	0.006	0.008
Perfluorononanoic acid (PFNA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.003	< 0.001	< 0.001	< 0.001	< 0.001	0.001	< 0.001	0.002	< 0.001	< 0.001	< 0.001
Perfluorooctanoic acid (PFOA)	0.001	0.56	19	5.6	0.001	0.011	0.003	0.004	0.008	< 0.001	0.022	0.011	0.014	0.002	0.02	0.017	0.003	0.027	< 0.001	0.01	0.002
Perfluoropentanoic acid (PFPeA)	0.001				0.002	0.015	0.003	0.004	0.004	< 0.001	0.038	0.013	0.019	0.009	< 0.001	0.01	0.002	0.031	< 0.001	0.006	0.003
Perfluorotetradecanoic acid (PFTeDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorotridecanoic acid (PFTrDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroundecanoic acid (PFUnDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroalkyl sulfonamido substances- Ultra Trace																					
2-(N-ethylperfluoro-1-octane sulfonamido)-ethanol (N-EtFOSE)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
2-(N-methylperfluoro-1-octane sulfonamido)-ethanol (N-MeFOSE)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-ethylperfluoro-1-octane sulfonamide (N-EtFOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-ethyl-perfluorooctanesulfonamidoacetic acid (N-EtFOSAA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-methylperfluoro-1-octane sulfonamide (N-MeFOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-methyl-perfluorooctanesulfonamidoacetic acid (N-MeFOSAA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluorooctane sulfonamide (FOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluoroalkyl sulfonic acids (PFSAs)- Ultra Trace																					
Perfluorobutanesulfonic acid (PFBS)	0.001				0.004	0.004	0.003	0.001	0.003	< 0.001	0.028	0.003	0.008	0.002	0.16	0.01	0.004	0.003	< 0.001	0.004	0.005
Perfluorodecanesulfonic acid (PFDS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.002	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroheptanesulfonic acid (PFHpS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorohexanesulfonic acid (PFHxS)	0.001				0.019	0.006	0.01	0.002	0.01	< 0.001	0.007	0.012	0.029	0.004	0.023	0.021	0.019	0.011	< 0.001	0.017	0.017
Perfluorooctanesulfonic acid (PFOS)	0.0001		0.00023		0.0015	0.0034	0.0026	0.0027	0.0042	< 0.0001	0.027	0.011	0.02	0.0016	0.0006	0.022	0.0085	0.029	< 0.0001	0.011	0.0034
Perfluoropentanesulfonic acid (PFPeS)	0.001				0.003	0.001	0.002	< 0.001	< 0.001	< 0.001	0.001	0.002	0.005	< 0.001	0.019	0.005	0.003	0.001	< 0.001	0.002	0.001
PFASs Summations																					
Sum (PFHxS + PFOS)	0.001	0.07		0.7	0.0205	0.0094	0.0126	0.0047	0.0142	< 0.001	0.034	0.023	0.049	0.0056	0.0236	0.043	0.0275	0.04	< 0.001	0.028	0.0204
Sum of enHealth PFAS (PFHxS + PFOS + PFOA)	0.001				0.0215	0.0204	0.0156	0.0087	0.0222	< 0.001	0.056	0.034	0.063	0.0076	0.0436	0.06	0.0305	0.067	< 0.001	0.038	0.0224
Sum of PFASs (n=30)	0.005				0.0315	0.0624	0.0306	0.0187	0.0402	< 0.005	0.22	0.071	0.129	0.0276	0.4486	0.129	0.0455	0.145	< 0.005	0.061	0.0414
Sum of US EPA PFAS (PFOS + PFOA)	0.001				0.0025	0.0144	0.0056	0.0067	0.0122	< 0.001	0.049	0.022	0.034	0.0036	0.0206	0.039	0.0115	0.056	< 0.001	0.021	0.0054
Sum of WA DWER PFAS (n=10)	0.005				0.0285	0.0614	0.0286	0.0187	0.0402	< 0.005	0.213	0.069	0.124	0.0276	0.3896	0.122	0.0385	0.138	< 0.005	0.059	0.0404
OTHER WATER QUALITY PARAMETERS																					
Temperature (degrees C)					23.1	23.8	25.4	25.7	24.5		26.5	21.5	21.1	19.3	23.2	22.0	23.7	23.7		24.3	27.8
Conductivity (microsiemens/cm)					1033	657	1587	1423	826		649	1120	1813	2613	45614	2285	1234	911		1594	3172
pH					7.81	9.71	9.47	7.77	8.23		8.12	8.00	8.28	7.72	8.84	8.53	8.10	8.45		7.53	9.01

FB = Field Blank; dup = intra-laboratory blind duplicate

SURFACE WATER RESULTS : APRIL 2019

	Limit of Reporting (µg/L)	DWG	Aquatic Ecosys DGV	NPUG (WA DoH)																	
Site ID#					**S02**	**S27**	**S27(FB)**	**S28**	**S29**	**S30**	**S31**	**S32**	**S33**	**S34**	**S39**	**S40**	**S40(FB)**	**S20**	**S20(dup)**	**S19**	**S25**
Sample Date					3/04/19	5/04/19	5/04/19	5/04/19	5/04/19	5/04/19	5/04/19	5/04/19	5/04/19	5/04/19	8/04/19	8/04/19	8/04/19	8/04/19	8/04/19	8/04/19	8/04/19
PFAS ANALYSIS																					
n:2 Fluorotelomer sulfonic acids (n:2 FTSAs)- Ultra Trace																					
1H.1H.2H.2H-perfluorodecanesulfonic acid (8:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
1H.1H.2H.2H-perfluorododecanesulfonic acid (10:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
1H.1H.2H.2H-perfluorohexanesulfonic acid (4:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
1H.1H.2H.2H-perfluorooctanesulfonic acid (6:2 FTSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluoroalkyl carboxylic acids (PFCAs) - Ultra Trace																					
Perfluorobutanoic acid (PFBA)	0.005				< 0.005	0.024	< 0.005	0.006	0.031	0.029	0.044	0.008	0.038	< 0.005	< 0.005	< 0.005	< 0.005	0.006	0.006	0.019	0.01
Perfluorodecanoic acid (PFDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.003	< 0.001
Perfluorododecanoic acid (PFDoDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroheptanoic acid (PFHpA)	0.001				0.018	0.019	< 0.001	0.004	0.006	0.003	0.004	0.008	0.006	0.002	< 0.001	< 0.001	< 0.001	0.008	0.008	0.025	0.009
Perfluorohexanoic acid (PFHxA)	0.001				0.036	0.046	< 0.001	0.007	0.014	0.008	0.022	0.016	0.016	0.003	< 0.001	< 0.001	< 0.001	0.015	0.015	0.041	0.015
Perfluorononanoic acid (PFNA)	0.001				< 0.001	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.006	0.006	0.004	< 0.001
Perfluorooctanoic acid (PFOA)	0.001	0.56	19	5.6	0.01	0.026	< 0.001	0.009	0.007	0.003	0.002	0.009	0.006	0.01	0.001	< 0.001	< 0.001	0.012	0.012	0.038	0.013
Perfluoropentanoic acid (PFPeA)	0.001				0.01	0.039	< 0.001	0.005	0.007	0.004	0.009	0.012	0.016	0.001	< 0.001	< 0.001	< 0.001	0.013	0.013	0.041	0.012
Perfluorotetradecanoic acid (PFTeDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorotridecanoic acid (PFTrDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroundecanoic acid (PFUnDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroalkyl sulfonamido substances- Ultra Trace																					
2-(N-ethylperfluoro-1-octane sulfonamido)-ethanol (N-EtFOSE)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
2-(N-methylperfluoro-1-octane sulfonamido)-ethanol (N-MeFOSE)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-ethylperfluoro-1-octane sulfonamide (N-EtFOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-ethyl-perfluorooctanesulfonamidoacetic acid (N-EtFOSAA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-methylperfluoro-1-octane sulfonamide (N-MeFOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-methyl-perfluorooctanesulfonamidoacetic acid (N-MeFOSAA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluorooctane sulfonamide (FOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluoroalkyl sulfonic acids (PFSAs)- Ultra Trace																					
Perfluorobutanesulfonic acid (PFBS)	0.001				0.013	0.012	< 0.001	0.005	0.009	0.033	0.026	0.003	0.005	0.001	< 0.001	< 0.001	< 0.001	0.008	0.008	0.008	0.005
Perfluorodecanesulfonic acid (PFDS)	0.001				< 0.001	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.08	< 0.001
Perfluoroheptanesulfonic acid (PFHpS)	0.001				< 0.001	0.007	< 0.001	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.003	0.003	0.002	0.001
Perfluorohexanesulfonic acid (PFHxS)	0.001				0.028	0.072	< 0.001	0.029	0.006	0.009	0.01	0.008	0.005	0.002	0.003	0.004	< 0.001	0.047	0.047	0.024	0.014
Perfluorooctanesulfonic acid (PFOS)	0.0001		0.00023		0.0098	0.033	< 0.0002	0.0068	0.0009	0.0007	0.0007	0.0011	0.0004	0.0011	0.0017	0.0006	< 0.0002	0.026	0.026	0.028	0.0061
Perfluoropentanesulfonic acid (PFPeS)	0.001				0.007	0.014	< 0.001	0.005	0.006	0.016	0.017	0.003	0.003	< 0.001	< 0.001	< 0.001	< 0.001	0.009	0.009	0.003	0.003
PFASs Summations																					
Sum (PFHxS + PFOS)	0.001	0.07		0.7	0.0378	0.105	< 0.001	0.0358	0.0069	0.0097	0.0107	0.0091	0.0054	0.0031	0.0047	0.0046	< 0.001	0.073	0.073	0.052	0.0201
Sum of enHealth PFAS (PFHxS + PFOS + PFOA)	0.001				0.0478	0.131	< 0.001	0.0448	0.0139	0.0127	0.0127	0.0181	0.0114	0.0131	0.0057	0.0046	< 0.001	0.085	0.085	0.09	0.0331
Sum of PFASs (n=30)	0.005				0.1318	0.294	< 0.005	0.0778	0.0869	0.1357	0.1747	0.0681	0.0954	0.0201	0.0057	< 0.005	< 0.005	0.153	0.153	0.316	0.0881
Sum of US EPA PFAS (PFOS + PFOA)	0.001				0.0198	0.059	< 0.001	0.0158	0.0079	0.0037	0.0027	0.0101	0.0064	0.0111	0.0027	< 0.001	< 0.001	0.038	0.038	0.066	0.0191
Sum of WA DWER PFAS (n=10)	0.005				0.1248	0.271	< 0.005	0.0718	0.0809	0.0897	0.1177	0.0651	0.0924	0.0201	0.0057	< 0.005	< 0.005	0.135	0.135	0.224	0.0841
OTHER WATER QUALITY PARAMETERS																					
Temperature (degrees C)					25.7	19.7		21.8	18.5	22.9	22.7	24.7	28.2	22.9	20.1	21.3		22.9	22.9	23.3	23.4
Conductivity (microsiemens/cm)					4272	1831		876	2957	20830	41392	1400	3043	638	858	604		638	638	1250	814
pH					9.15	7.45		7.87	8.04	8.48	8.33	9.48	8.02	7.80	7.64	7.99		7.80	7.80	8.71	8.79

SURFACE WATER RESULTS : APRIL 2019

	Limit of Reporting (µg/L)	DWG	Aquatic Ecosys DGV	NPUG (WA DoH)														
Site ID#					**S24**	**S38**	**S42**	**S42(dup)**	**S36**	**S36(dup)**	**S35**	**S41**	**S26**	**S22**	**S22(FB)**	**S23**	**S21**	**Trip Blank**
Sample Date					8/04/19	10/04/19	10/04/19	10/04/19	10/04/19	10/04/19	10/04/19	10/04/19	11/04/19	11/04/19	11/04/19	11/04/19	22/05/19	n/a
PFAS ANALYSIS																		
n:2 Fluorotelomer sulfonic acids (n:2 FTSAs)- Ultra Trace																		
1H.1H.2H.2H-perfluorodecanesulfonic acid (8:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
1H.1H.2H.2H-perfluorododecanesulfonic acid (10:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
1H.1H.2H.2H-perfluorohexanesulfonic acid (4:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
1H.1H.2H.2H-perfluorooctanesulfonic acid (6:2 FTSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluoroalkyl carboxylic acids (PFCAs) - Ultra Trace																		
Perfluorobutanoic acid (PFBA)	0.005				0.007	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.24	< 0.005	0.013	0.017	< 0.005	0.019	< 0.005	< 0.005
Perfluorodecanoic acid (PFDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorododecanoic acid (PFDoDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroheptanoic acid (PFHpA)	0.001				0.008	0.003	< 0.001	< 0.001	0.003	0.002	0.038	< 0.001	0.009	0.014	< 0.001	0.02	0.005	< 0.001
Perfluorohexanoic acid (PFHxA)	0.001				0.012	0.006	< 0.001	< 0.001	0.003	0.003	0.16	< 0.001	0.021	0.03	< 0.001	0.05	0.007	< 0.001
Perfluorononanoic acid (PFNA)	0.001				0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.002	0.002	< 0.001	0.001	< 0.001	< 0.001
Perfluorooctanoic acid (PFOA)	0.001	0.56	19	5.6	0.016	0.005	< 0.001	< 0.001	0.002	0.002	0.036	< 0.001	0.009	0.014	< 0.001	0.034	0.007	< 0.001
Perfluoropentanoic acid (PFPeA)	0.001				0.008	0.003	< 0.001	< 0.001	0.002	0.003	0.19	< 0.001	0.028	0.05	< 0.001	0.041	0.01	< 0.001
Perfluorotetradecanoic acid (PFTeDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorotridecanoic acid (PFTrDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroundecanoic acid (PFUnDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroalkyl sulfonamido substances- Ultra Trace																		
2-(N-ethylperfluoro-1-octane sulfonamido)-ethanol (N-EtFOSE)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
2-(N-methylperfluoro-1-octane sulfonamido)-ethanol (N-MeFOSE)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-ethylperfluoro-1-octane sulfonamide (N-EtFOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-ethyl-perfluorooctanesulfonamidoacetic acid (N-EtFOSAA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-methylperfluoro-1-octane sulfonamide (N-MeFOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-methyl-perfluorooctanesulfonamidoacetic acid (N-MeFOSAA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluorooctane sulfonamide (FOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluoroalkyl sulfonic acids (PFSAs)- Ultra Trace																		
Perfluorobutanesulfonic acid (PFBS)	0.001				0.006	0.002	< 0.001	< 0.001	< 0.001	< 0.001	0.14	< 0.001	0.003	0.01	< 0.001	0.02	0.003	< 0.001
Perfluorodecanesulfonic acid (PFDS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroheptanesulfonic acid (PFHpS)	0.001				0.004	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.004	< 0.001	< 0.001	0.003	< 0.001	0.005	< 0.001	< 0.001
Perfluorohexanesulfonic acid (PFHxS)	0.001				0.035	0.015	< 0.001	< 0.001	0.004	0.003	0.017	< 0.001	0.011	0.039	< 0.001	0.08	0.012	< 0.001
Perfluorooctanesulfonic acid (PFOS)	0.0001		0.00023		0.044	0.0084	0.0002	0.0002	0.0017	0.0014	0.0039	0.0054	0.014	0.033	< 0.0002	0.029	0.0079	< 0.0001
Perfluoropentanesulfonic acid (PFPeS)	0.001				0.005	0.002	< 0.001	< 0.001	< 0.001	< 0.001	0.045	< 0.001	0.003	0.008	< 0.001	0.018	0.002	< 0.001
PFASs Summations																		
Sum (PFHxS + PFOS)	0.001	0.07		0.7	0.079	0.0234	< 0.001	< 0.001	0.0057	0.0044	0.0209	0.0054	0.025	0.072	< 0.001	0.109	0.0199	< 0.001
Sum of enHealth PFAS (PFHxS + PFOS + PFOA)	0.001				0.095	0.0284	< 0.001	< 0.001	0.0077	0.0064	0.0569	0.0054	0.034	0.086	< 0.001	0.143	0.0299	< 0.001
Sum of PFASs (n=30)	0.005				0.146	0.0444	< 0.005	< 0.005	0.0157	0.0144	0.9939	0.0054	0.114	0.22	< 0.005	0.317	0.0539	< 0.005
Sum of US EPA PFAS (PFOS + PFOA)	0.001				0.06	0.0134	< 0.001	< 0.001	0.0037	0.0034	0.0399	0.0054	0.023	0.047	< 0.001	0.063	0.0179	< 0.001
Sum of WA DWER PFAS (n=10)	0.005				0.136	0.0424	< 0.005	< 0.005	0.0157	0.0144	0.8249	0.0054	0.108	0.207	< 0.005	0.293	0.0519	< 0.005
OTHER WATER QUALITY PARAMETERS																		
Temperature (degrees C)					26.0	22.5	20.2	20.2	22.6	22.6	31.4	23.2	22.8	23.6		23.5	14.5	
Conductivity (microsiemens/cm)					516	1020	303.9	303.9	15821	15821	26420	592	1269	2385		1610	1514	
pH					8.43	8.72	7.86	7.86	8.89	8.89	7.26	7.44	7.87	8.04		9.25	7.06	

FB = Field Blank; dup = intra-laboratory blind duplicate

SURFACE WATER RESULTS : OCTOBER 2019

	Limit of Reporting (µg/L)	DWG	Aquatic Ecosys DGV	NPUG (WA DoH)																	
Site ID#					**S07**	**S08**	**S06**	**S05**	**S03**	**S03(FB)**	**S04**	**S01**	**S02**	**S18**	**S17**	**S10**	**S09**	**S11**	**S16**	**S14**	**S15**
Sample Date					15/10/19	15/10/19	15/10/19	15/10/19	15/10/19	15/10/19	15/10/19	15/10/19	15/10/19	16/10/19	16/10/19	16/10/19	16/10/19	16/10/19	16/10/19	16/10/19	16/10/19
PFAS ANALYSIS																					
n:2 Fluorotelomer sulfonic acids (n:2 FTSAs)- Ultra Trace																					
1H.1H.2H.2H-perfluorodecanesulfonic acid (8:2 FTSA)	0.001				< 0.001	< 0.001	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
1H.1H.2H.2H-perfluorododecanesulfonic acid (10:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
1H.1H.2H.2H-perfluorohexanesulfonic acid (4:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
1H.1H.2H.2H-perfluorooctanesulfonic acid (6:2 FTSA)	0.005				< 0.005	< 0.005	0.013	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluoroalkyl carboxylic acids (PFCAs) - Ultra Trace																					
Perfluorobutanoic acid (PFBA)	0.005				< 0.005	< 0.005	0.006	< 0.005	< 0.005	< 0.005	< 0.005	0.008	0.01	0.084	0.01	0.01	< 0.005	0.007	< 0.005	< 0.005	0.01
Perfluorodecanoic acid (PFDA)	0.001				< 0.001	< 0.001	0.002	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.001	0.002	0.002
Perfluorododecanoic acid (PFDoDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroheptanoic acid (PFHpA)	0.001				< 0.001	0.002	0.004	0.002	0.001	< 0.001	< 0.001	0.002	0.007	0.003	0.007	0.006	0.003	0.004	0.002	< 0.001	0.005
Perfluorohexanoic acid (PFHxA)	0.001				0.002	0.005	0.015	0.003	0.002	< 0.001	0.002	0.006	0.015	0.011	0.038	0.018	0.008	0.012	0.007	0.002	0.017
Perfluorononanoic acid (PFNA)	0.001				< 0.001	< 0.001	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.001
Perfluorooctanoic acid (PFOA)	0.001	0.56	19	5.6	0.001	0.005	0.01	0.005	0.003	< 0.001	0.002	0.002	0.005	0.003	0.01	0.01	0.006	0.007	0.006	0.003	0.016
Perfluoropentanoic acid (PFPeA)	0.001				0.002	0.003	0.028	0.002	< 0.001	< 0.001	0.001	0.002	0.008	0.003	0.044	0.009	0.006	0.012	0.008	0.003	0.02
Perfluorotetradecanoic acid (PFTeDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorotridecanoic acid (PFTrDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroundecanoic acid (PFUnDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroalkyl sulfonamido substances- Ultra Trace																					
2-(N-ethylperfluoro-1-octane sulfonamido)-ethanol (N-EtFOSE)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
2-(N-methylperfluoro-1-octane sulfonamido)-ethanol (N-MeFOSE)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-ethylperfluoro-1-octane sulfonamide (N-EtFOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-ethyl-perfluorooctanesulfonamidoacetic acid (N-EtFOSAA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-methylperfluoro-1-octane sulfonamide (N-MeFOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-methyl-perfluorooctanesulfonamidoacetic acid (N-MeFOSAA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluorooctane sulfonamide (FOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluoroalkyl sulfonic acids (PFSAs)- Ultra Trace																					
Perfluorobutanesulfonic acid (PFBS)	0.001				0.003	0.001	0.017	0.001	< 0.001	< 0.001	0.002	0.003	0.006	0.013	0.003	0.007	0.002	0.005	0.004	< 0.001	0.002
Perfluorodecanesulfonic acid (PFDS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroheptanesulfonic acid (PFHpS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorohexanesulfonic acid (PFHxS)	0.001				0.011	0.004	0.005	0.006	0.002	< 0.001	0.006	0.011	0.014	0.003	0.007	0.022	0.008	0.01	0.049	< 0.001	0.009
Perfluorononanesulfonic acid (PFNS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorooctanesulfonic acid (PFOS)	0.0001		0.00023		0.0025	0.0046	0.034	0.0049	0.0032	< 0.0001	0.003	0.0048	0.0079	0.0018	0.0043	0.015	0.0071	0.0053	0.011	0.0024	0.025
Perfluoropentanesulfonic acid (PFPeS)	0.001				0.002	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.003	0.002	< 0.001	0.004	0.001	0.003	0.004	< 0.001	< 0.001
Perfluoropropanesulfonic acid (PFPrS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.005	< 0.001	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
PFASs Summations																					
Sum (PFHxS + PFOS)	0.001	0.07		0.7	0.0135	0.0086	0.039	0.0109	0.0052	< 0.001	0.009	0.0158	0.0219	0.0048	0.0113	0.037	0.0151	0.0153	0.06	0.0024	0.034
Sum of enHealth PFAS (PFHxS + PFOS + PFOA)	0.001				0.0145	0.0136	0.049	0.0159	0.0082	< 0.001	0.011	0.0178	0.0269	0.0078	0.0213	0.047	0.0211	0.0223	0.066	0.0054	0.05
Sum of PFASs (n=30)	0.005				0.0235	0.0246	0.136	0.0239	0.0112	< 0.005	0.016	0.0388	0.0759	0.1288	0.1233	0.102	0.0411	0.0653	0.092	0.0124	0.107
Sum of US EPA PFAS (PFOS + PFOA)	0.001				0.0035	0.0096	0.044	0.0099	0.0062	< 0.001	0.005	0.0068	0.0129	0.0048	0.0143	0.025	0.0131	0.0123	0.017	0.0054	0.041
Sum of WA DWER PFAS (n=10)	0.005				0.0215	0.0246	0.133	0.0239	0.0112	< 0.005	0.016	0.0388	0.0729	0.1218	0.1233	0.097	0.0401	0.0623	0.087	0.0104	0.104
OTHER WATER QUALITY PARAMETERS																					
Temperature (degrees C)					19.2	20.2	21.0	21.4	20.1		21.0	21.1	20.0	18.9	20.3	20.0	21.6	19.7	20.3	19.5	18.3
Conductivity (microsiemens/cm)					825	602	426	555	1205		1114	1902	1845	5720	1148	1227	584	1061	418	126	511
pH					7.59	7.94	7.24	8.00	7.64		8.34	7.25	8.29	8.82	7.52	8.08	8.44	8.81	7.64	6.83	7.58

FB = Field Blank

SURFACE WATER RESULTS : OCTOBER 2019

	Limit of Reporting (µg/L)	DWG	Aquatic Ecosys DGV	NPUG (WA DoH)																	
Site ID#					**S15(FB)**	**S12**	**S13**	**S27**	**S28**	**S29**	**S30**	**S31**	**S31(FB)**	**S32**	**S33**	**S34**	**S39**	**S40**	**S21**	**S23**	**S20**
Sample Date					16/10/19	16/10/19	16/10/19	17/10/19	17/10/19	17/10/19	17/10/19	17/10/19	17/10/19	17/10/19	17/10/19	17/10/19	18/10/19	18/10/19	18/10/19	18/10/19	18/10/19
PFAS ANALYSIS																					
n:2 Fluorotelomer sulfonic acids (n:2 FTSAs)- Ultra Trace																					
1H.1H.2H.2H-perfluorodecanesulfonic acid (8:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
1H.1H.2H.2H-perfluorododecanesulfonic acid (10:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
1H.1H.2H.2H-perfluorohexanesulfonic acid (4:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
1H.1H.2H.2H-perfluorooctanesulfonic acid (6:2 FTSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluoroalkyl carboxylic acids (PFCAs) - Ultra Trace																					
Perfluorobutanoic acid (PFBA)	0.005				< 0.005	< 0.005	< 0.005	0.011	< 0.005	0.012	0.009	0.012	< 0.005	0.007	0.009	< 0.005	< 0.005	< 0.005	< 0.005	0.01	0.006
Perfluorodecanoic acid (PFDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorododecanoic acid (PFDoDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroheptanoic acid (PFHpA)	0.001				< 0.001	0.003	0.003	0.008	0.002	0.002	< 0.001	0.001	< 0.001	0.004	0.001	0.002	< 0.001	< 0.001	0.004	0.007	0.006
Perfluorohexanoic acid (PFHxA)	0.001				< 0.001	0.004	0.004	0.023	0.004	0.005	0.006	0.004	< 0.001	0.009	0.004	0.004	< 0.001	< 0.001	0.006	0.018	0.014
Perfluorononanoic acid (PFNA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.003
Perfluorooctanoic acid (PFOA)	0.001	0.56	19	5.6	< 0.001	0.009	0.007	0.014	0.006	0.004	< 0.001	< 0.001	< 0.001	0.005	0.002	0.005	< 0.001	< 0.001	0.009	0.013	0.01
Perfluoropentanoic acid (PFPeA)	0.001				< 0.001	0.003	0.003	0.03	0.003	0.002	0.001	0.001	< 0.001	0.005	0.006	0.007	< 0.001	< 0.001	0.005	0.01	0.011
Perfluorotetradecanoic acid (PFTeDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorotridecanoic acid (PFTrDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroundecanoic acid (PFUnDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroalkyl sulfonamido substances- Ultra Trace																					
2-(N-ethylperfluoro-1-octane sulfonamido)-ethanol (N-EtFOSE)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
2-(N-methylperfluoro-1-octane sulfonamido)-ethanol (N-MeFOSE)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-ethylperfluoro-1-octane sulfonamide (N-EtFOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-ethyl-perfluorooctanesulfonamidoacetic acid (N-EtFOSAA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-methylperfluoro-1-octane sulfonamide (N-MeFOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-methyl-perfluorooctanesulfonamidoacetic acid (N-MeFOSAA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluorooctane sulfonamide (FOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluoroalkyl sulfonic acids (PFSAs)- Ultra Trace																					
Perfluorobutanesulfonic acid (PFBS)	0.001				< 0.001	0.004	0.003	0.005	0.002	0.003	0.008	0.013	< 0.001	0.002	0.001	< 0.001	< 0.001	< 0.001	0.002	0.006	0.005
Perfluorodecanesulfonic acid (PFDS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroheptanesulfonic acid (PFHpS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.001
Perfluorohexanesulfonic acid (PFHxS)	0.001				< 0.001	0.028	0.014	0.033	0.011	0.004	0.003	0.003	< 0.001	0.003	0.002	0.001	0.001	0.002	0.011	0.025	0.031
Perfluorononanesulfonic acid (PFNS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorooctanesulfonic acid (PFOS)	0.0001		0.00023		< 0.0001	0.011	0.0084	0.031	0.0059	0.0023	0.0027	0.0014	< 0.0001	0.0021	0.0011	0.0017	0.0016	0.001	0.013	0.033	0.029
Perfluoropentanesulfonic acid (PFPeS)	0.001				< 0.001	0.003	0.002	0.003	< 0.001	< 0.001	0.001	0.002	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.002	0.003
Perfluoropropanesulfonic acid (PFPrS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.003	0.006	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.001	0.001
PFASs Summations																					
Sum (PFHxS + PFOS)	0.001	0.07		0.7	< 0.001	0.039	0.0224	0.064	0.0169	0.0063	0.0057	0.0044	< 0.001	0.0051	0.0031	0.0027	0.0026	0.003	0.024	0.058	0.06
Sum of enHealth PFAS (PFHxS + PFOS + PFOA)	0.001				< 0.001	0.048	0.0294	0.078	0.0229	0.0103	0.0057	0.0044	< 0.001	0.0101	0.0051	0.0077	0.0026	0.003	0.033	0.071	0.07
Sum of PFASs (n=30)	0.005				< 0.005	0.065	0.0444	0.158	0.0339	0.0343	0.0337	0.0434	< 0.005	0.0371	0.0261	0.0207	< 0.005	< 0.005	0.05	0.125	0.12
Sum of US EPA PFAS (PFOS + PFOA)	0.001				< 0.001	0.02	0.0154	0.045	0.0119	0.0063	0.0027	0.0014	< 0.001	0.0071	0.0031	0.0067	0.0016	0.001	0.022	0.046	0.039
Sum of WA DWER PFAS (n=10)	0.005				< 0.005	0.062	0.0424	0.155	0.0339	0.0343	0.0297	0.0354	< 0.005	0.0371	0.0261	0.0207	< 0.005	< 0.005	0.05	0.122	0.112
OTHER WATER QUALITY PARAMETERS																					
Temperature (degrees C)						24.7	21.8	21.9	21.1	19.7	20.3	19.6		20.5	20.5	23.3	19.1	21.3	21.1	24.2	22.8
Conductivity (microsiemens/cm)						1116	1105	915	517	1542	1001	2794		1217	1320	596	830	592	798	935	847
pH						6.97	7.32	8.25	8.72	8.42	9.28	8.63		8.37	7.67	7.51	7.74	8.19	7.71	9.20	8.05

FB = Field Blank

SURFACE WATER RESULTS : OCTOBER 2019

	Limit of Reporting (µg/L)	DWG	Aquatic Ecosys DGV	NPUG (WA DoH)																	
Site ID#					**S15(FB)**	**S12**	**S13**	**S27**	**S28**	**S29**	**S30**	**S31**	**S31(FB)**	**S32**	**S33**	**S34**	**S39**	**S40**	**S21**	**S23**	**S20**
Sample Date					16/10/19	16/10/19	16/10/19	17/10/19	17/10/19	17/10/19	17/10/19	17/10/19	17/10/19	17/10/19	17/10/19	17/10/19	18/10/19	18/10/19	18/10/19	18/10/19	18/10/19
PFAS ANALYSIS																					
n:2 Fluorotelomer sulfonic acids (n:2 FTSAs)- Ultra Trace																					
1H.1H.2H.2H-perfluorodecanesulfonic acid (8:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
1H.1H.2H.2H-perfluorododecanesulfonic acid (10:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
1H.1H.2H.2H-perfluorohexanesulfonic acid (4:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
1H.1H.2H.2H-perfluorooctanesulfonic acid (6:2 FTSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluoroalkyl carboxylic acids (PFCAs) - Ultra Trace																					
Perfluorobutanoic acid (PFBA)	0.005				< 0.005	< 0.005	< 0.005	0.011	< 0.005	0.012	0.009	0.012	< 0.005	0.007	0.009	< 0.005	< 0.005	< 0.005	< 0.005	0.01	0.006
Perfluorodecanoic acid (PFDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorododecanoic acid (PFDoDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroheptanoic acid (PFHpA)	0.001				< 0.001	0.003	0.003	0.008	0.002	0.002	< 0.001	0.001	< 0.001	0.004	0.001	0.002	< 0.001	< 0.001	0.004	0.007	0.006
Perfluorohexanoic acid (PFHxA)	0.001				< 0.001	0.004	0.004	0.023	0.004	0.005	0.006	0.004	< 0.001	0.009	0.004	0.004	< 0.001	< 0.001	0.006	0.018	0.014
Perfluorononanoic acid (PFNA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.003
Perfluorooctanoic acid (PFOA)	0.001	0.56	19	5.6	< 0.001	0.009	0.007	0.014	0.006	0.004	< 0.001	< 0.001	< 0.001	0.005	0.002	0.005	< 0.001	< 0.001	0.009	0.013	0.01
Perfluoropentanoic acid (PFPeA)	0.001				< 0.001	0.003	0.003	0.03	0.003	0.002	0.001	0.001	< 0.001	0.005	0.006	0.007	< 0.001	< 0.001	0.005	0.01	0.011
Perfluorotetradecanoic acid (PFTeDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorotridecanoic acid (PFTrDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroundecanoic acid (PFUnDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroalkyl sulfonamido substances- Ultra Trace																					
2-(N-ethylperfluoro-1-octane sulfonamido)-ethanol (N-EtFOSE)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
2-(N-methylperfluoro-1-octane sulfonamido)-ethanol (N-MeFOSE)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-ethylperfluoro-1-octane sulfonamide (N-EtFOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-ethyl-perfluorooctanesulfonamidoacetic acid (N-EtFOSAA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-methylperfluoro-1-octane sulfonamide (N-MeFOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-methyl-perfluorooctanesulfonamidoacetic acid (N-MeFOSAA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluorooctane sulfonamide (FOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluoroalkyl sulfonic acids (PFSAs)- Ultra Trace																					
Perfluorobutanesulfonic acid (PFBS)	0.001				< 0.001	0.004	0.003	0.005	0.002	0.003	0.008	0.013	< 0.001	0.002	0.001	< 0.001	< 0.001	< 0.001	0.002	0.006	0.005
Perfluorodecanesulfonic acid (PFDS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroheptanesulfonic acid (PFHpS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.001
Perfluorohexanesulfonic acid (PFHxS)	0.001				< 0.001	0.028	0.014	0.033	0.011	0.004	0.003	0.003	< 0.001	0.003	0.002	0.001	0.001	0.002	0.011	0.025	0.031
Perfluorononanesulfonic acid (PFNS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorooctanesulfonic acid (PFOS)	0.0001		0.00023		< 0.0001	0.011	0.0084	0.031	0.0059	0.0023	0.0027	0.0014	< 0.0001	0.0021	0.0011	0.0017	0.0016	0.001	0.013	0.033	0.029
Perfluoropentanesulfonic acid (PFPeS)	0.001				< 0.001	0.003	0.002	0.003	< 0.001	< 0.001	0.001	0.002	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.002	0.003
Perfluoropropanesulfonic acid (PFPrS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.003	0.006	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.001	0.001
PFASs Summations																					
Sum (PFHxS + PFOS)	0.001	0.07		0.7	< 0.001	0.039	0.0224	0.064	0.0169	0.0063	0.0057	0.0044	< 0.001	0.0051	0.0031	0.0027	0.0026	0.003	0.024	0.058	0.06
Sum of enHealth PFAS (PFHxS + PFOS + PFOA)	0.001				< 0.001	0.048	0.0294	0.078	0.0229	0.0103	0.0057	0.0044	< 0.001	0.0101	0.0051	0.0077	0.0026	0.003	0.033	0.071	0.07
Sum of PFASs (n=30)	0.005				< 0.005	0.065	0.0444	0.158	0.0339	0.0343	0.0337	0.0434	< 0.005	0.0371	0.0261	0.0207	< 0.005	< 0.005	0.05	0.125	0.12
Sum of US EPA PFAS (PFOS + PFOA)	0.001				< 0.001	0.02	0.0154	0.045	0.0119	0.0063	0.0027	0.0014	< 0.001	0.0071	0.0031	0.0067	0.0016	0.001	0.022	0.046	0.039
Sum of WA DWER PFAS (n=10)	0.005				< 0.005	0.062	0.0424	0.155	0.0339	0.0343	0.0297	0.0354	< 0.005	0.0371	0.0261	0.0207	< 0.005	< 0.005	0.05	0.122	0.112
OTHER WATER QUALITY PARAMETERS																					
Temperature (degrees C)						24.7	21.8	21.9	21.1	19.7	20.3	19.6		20.5	20.5	23.3	19.1	21.3	21.1	24.2	22.8
Conductivity (microsiemens/cm)						1116	1105	915	517	1542	1001	2794		1217	1320	596	830	592	798	935	847
pH						6.97	7.32	8.25	8.72	8.42	9.28	8.63		8.37	7.67	7.51	7.74	8.19	7.71	9.20	8.05

FB = Field Blank

SURFACE WATER RESULTS : OCTOBER 2019

	Limit of Reporting (µg/L)	DWG	Aquatic Ecosys DGV	NPUG (WA DoH)													
Site ID#					**S20(FB)**	**S19**	**S25**	**S38**	**S42**	**S37**	**S36**	**S36(FB)**	**S35**	**S41**	**S22**	**S26**	**S24**
Sample Date					18/10/19	18/10/19	18/10/19	22/10/19	22/10/19	22/10/19	22/10/19	22/10/19	22/10/19	22/10/19	22/10/19	22/10/19	22/10/19
PFAS ANALYSIS																	
n:2 Fluorotelomer sulfonic acids (n:2 FTSAs)- Ultra Trace																	
1H.1H.2H.2H-perfluorodecanesulfonic acid (8:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
1H.1H.2H.2H-perfluorododecanesulfonic acid (10:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
1H.1H.2H.2H-perfluorohexanesulfonic acid (4:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
1H.1H.2H.2H-perfluorooctanesulfonic acid (6:2 FTSA)	0.005				< 0.005	0.007	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluoroalkyl carboxylic acids (PFCAs) - Ultra Trace																	
Perfluorobutanoic acid (PFBA)	0.005				< 0.005	0.011	0.008	< 0.005	< 0.005	0.035	< 0.005	< 0.005	0.021	< 0.005	0.007	< 0.005	0.005
Perfluorodecanoic acid (PFDA)	0.001				< 0.001	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorododecanoic acid (PFDoDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.02	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroheptanoic acid (PFHpA)	0.001				< 0.001	0.011	0.003	0.002	< 0.001	< 0.001	0.001	< 0.001	0.009	< 0.001	0.004	0.004	0.007
Perfluorohexanoic acid (PFHxA)	0.001				< 0.001	0.028	0.006	0.004	< 0.001	0.003	0.002	< 0.001	0.016	< 0.001	0.012	0.008	0.009
Perfluorononanoic acid (PFNA)	0.001				< 0.001	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorooctanoic acid (PFOA)	0.001	0.56	19	5.6	< 0.001	0.019	0.005	0.004	< 0.001	< 0.001	0.001	< 0.001	0.021	< 0.001	0.007	0.008	0.015
Perfluoropentanoic acid (PFPeA)	0.001				< 0.001	0.024	0.002	0.002	< 0.001	0.006	0.002	< 0.001	0.01	< 0.001	0.013	0.008	0.008
Perfluorotetradecanoic acid (PFTeDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorotridecanoic acid (PFTrDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroundecanoic acid (PFUnDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroalkyl sulfonamido substances- Ultra Trace																	
2-(N-ethylperfluoro-1-octane sulfonamido)-ethanol (N-EtFOSE)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
2-(N-methylperfluoro-1-octane sulfonamido)-ethanol (N-MeFOSE)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-ethylperfluoro-1-octane sulfonamide (N-EtFOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-ethyl-perfluorooctanesulfonamidoacetic acid (N-EtFOSAA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-methylperfluoro-1-octane sulfonamide (N-MeFOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-methyl-perfluorooctanesulfonamidoacetic acid (N-MeFOSAA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	0.04	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluorooctane sulfonamide (FOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluoroalkyl sulfonic acids (PFSAs)- Ultra Trace																	
Perfluorobutanesulfonic acid (PFBS)	0.001				< 0.001	0.003	< 0.001	0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.024	< 0.001	0.006	0.002	0.005
Perfluorodecanesulfonic acid (PFDS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroheptanesulfonic acid (PFHpS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.002
Perfluorohexanesulfonic acid (PFHxS)	0.001				< 0.001	0.009	0.006	0.009	0.003	< 0.001	0.002	< 0.001	0.028	< 0.001	0.026	0.007	0.029
Perfluorononanesulfonic acid (PFNS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorooctanesulfonic acid (PFOS)	0.0001		0.00023		< 0.0001	0.019	0.011	0.009	0.0017	0.0019	0.0017	< 0.0001	0.018	0.0005	0.027	0.012	0.044
Perfluoropentanesulfonic acid (PFPeS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.003	< 0.001	0.003	< 0.001	0.003
Perfluoropropanesulfonic acid (PFPrS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
PFASs Summations																	
Sum (PFHxS + PFOS)	0.001	0.07		0.7	< 0.001	0.028	0.017	0.018	0.0047	0.0019	0.0037	< 0.001	0.046	< 0.001	0.053	0.019	0.073
Sum of enHealth PFAS (PFHxS + PFOS + PFOA)	0.001				< 0.001	0.047	0.022	0.022	0.0047	0.0019	0.0047	< 0.001	0.067	< 0.001	0.06	0.027	0.088
Sum of PFASs (n=30)	0.005				< 0.005	0.133	0.041	0.031	0.0447	0.0459	0.0297	< 0.005	0.15	< 0.005	0.105	0.049	0.127
Sum of US EPA PFAS (PFOS + PFOA)	0.001				< 0.001	0.038	0.016	0.013	0.0017	0.0019	0.0027	< 0.001	0.039	< 0.001	0.034	0.02	0.059
Sum of WA DWER PFAS (n=10)	0.005				< 0.005	0.131	0.041	0.031	< 0.005	0.0459	0.0097	< 0.005	0.147	< 0.005	0.102	0.049	0.122
OTHER WATER QUALITY PARAMETERS																	
Temperature (degrees C)						23.8	22.3	20.6	21.0		23.5		23.8	23.6	25.9	23.9	28.2
Conductivity (microsiemens/cm)						883	386	1086	386		15032		3049	478	1230	799	533
pH						8.35	10.52	8.59	8.22		8.98		8.89	7.93	8.39	7.57	7.91
# FB = Field Blank																	

GROUNDWATER RESULTS : MAY 2019

	Limit of Reporting (µg/L)	DWG	Aquatic Ecosys DGV	NPUG (WA DoH)																	
Site ID#					**G21**	**G24**	**G22**	**G22(Rin)**	**G25**	**G30**	**G30(dup)**	**G14**	**G07**	**G06**	**G06(FB)**	**G05**	**G05(dup)**	**G04**	**G08**	**G08(Rin)**	**G08(FB)**
Sample Date					30/04/19	30/04/19	30/04/19	30/04/19	1/05/19	1/05/19	1/05/19	2/05/19	2/05/19	3/05/19	3/05/19	3/05/19	3/05/19	3/05/19	6/05/19	6/05/19	6/05/19
PFAS ANALYSIS																					
n:2 Fluorotelomer sulfonic acids (n:2 FTSAs)- Ultra Trace																					
1H.1H.2H.2H-perfluorodecanesulfonic acid (8:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
H.1H.2H.2H-perfluorododecanesulfonic acid (10:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
1H.1H.2H.2H-perfluorohexanesulfonic acid (4:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
1H.1H.2H.2H-perfluorooctanesulfonic acid (6:2 FTSA)	0.005				< 0.005	0.015	0.01	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluoroalkyl carboxylic acids (PFCAs) - Ultra Trace																					
Perfluorobutanoic acid (PFBA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	0.005	< 0.005	< 0.005	< 0.005	0.028	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.011	< 0.005	< 0.005
Perfluorodecanoic acid (PFDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorododecanoic acid (PFDoDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroheptanoic acid (PFHpA)	0.001				0.002	< 0.001	< 0.001	< 0.001	0.001	0.001	0.001	< 0.001	0.003	< 0.001	< 0.001	< 0.001	< 0.001	0.002	0.009	< 0.001	< 0.001
Perfluorohexanoic acid (PFHxA)	0.001				0.006	0.001	< 0.001	< 0.001	0.003	0.003	0.003	< 0.001	0.007	0.001	< 0.001	0.002	0.002	0.002	0.013	< 0.001	< 0.001
Perfluorononanoic acid (PFNA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorooctanoic acid (PFOA)	0.001	0.56	19	5.6	0.003	< 0.001	< 0.001	< 0.001	0.002	0.003	0.003	< 0.001	0.008	0.002	< 0.001	0.002	0.002	0.007	0.007	< 0.001	< 0.001
Perfluoropentanoic acid (PFPeA)	0.001				0.004	0.002	< 0.001	< 0.001	0.001	0.004	0.005	< 0.001	0.01	0.001	< 0.001	0.003	0.003	< 0.001	0.017	< 0.001	< 0.001
Perfluorotetradecanoic acid (PFTeDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorotridecanoic acid (PFTrDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroundecanoic acid (PFUnDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroalkyl sulfonamido substances- Ultra Trace																					
2-(N-ethylperfluoro-1-octane sulfonamido)-ethanol (N-EtFOSE)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
2-(N-methylperfluoro-1-octane sulfonamido)-ethanol (N-MeFOSE)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-ethylperfluoro-1-octane sulfonamide (N-EtFOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-ethyl-perfluorooctanesulfonamidoacetic acid (N-EtFOSAA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-methylperfluoro-1-octane sulfonamide (N-MeFOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-methyl-perfluorooctanesulfonamidoacetic acid (N-MeFOSAA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluorooctane sulfonamide (FOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluoroalkyl sulfonic acids (PFSAs)- Ultra Trace																					
Perfluorobutanesulfonic acid (PFBS)	0.001				0.002	0.007	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.002	0.001	< 0.001	0.002	0.002	0.004	0.005	< 0.001	< 0.001
Perfluorodecanesulfonic acid (PFDS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroheptanesulfonic acid (PFHpS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorohexanesulfonic acid (PFHxS)	0.001				0.007	0.004	< 0.001	< 0.001	0.002	< 0.001	< 0.001	< 0.001	0.004	0.012	< 0.001	0.007	0.006	0.01	0.007	< 0.001	< 0.001
Perfluorooctanesulfonic acid (PFOS)	0.0001		0.00023		0.0061	0.0037	< 0.0001	0.0004	0.001	0.0005	0.0004	0.0002	0.011	0.017	< 0.0001	0.0029	0.0026	0.019	0.0094	0.0001	< 0.0001
Perfluoropentanesulfonic acid (PFPeS)	0.001				0.001	0.002	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.001	< 0.001	< 0.001	< 0.001
PFASs Summations																					
Sum (PFHxS + PFOS)	0.001	0.07		0.7	0.0131	0.0077	< 0.001	< 0.001	0.003	< 0.001	< 0.001	< 0.001	0.015	0.029	< 0.001	0.0099	0.0086	0.029	0.0164	< 0.001	< 0.001
Sum of enHealth PFAS (PFHxS + PFOS + PFOA)	0.001				0.0161	0.0077	< 0.001	< 0.001	0.005	0.0035	0.0034	< 0.001	0.023	0.031	< 0.001	0.0119	0.0106	0.036	0.0234	< 0.001	< 0.001
Sum of PFASs (n=30)	0.005				0.0311	0.0347	0.01	< 0.005	0.015	0.0115	0.0124	< 0.005	0.073	0.034	< 0.005	0.0189	0.0176	0.045	0.0784	< 0.005	< 0.005
Sum of US EPA PFAS (PFOS + PFOA)	0.001				0.0091	0.0037	< 0.001	< 0.001	0.003	0.0035	0.0034	< 0.001	0.019	0.019	< 0.001	0.0049	0.0046	0.026	0.0164	< 0.001	< 0.001
Sum of WA DWER PFAS (n=10)	0.005				0.0301	0.0327	0.01	< 0.005	0.015	0.0115	0.0124	< 0.005	0.073	0.034	< 0.005	0.0189	0.0176	0.044	0.0784	< 0.005	< 0.005
OTHER WATER QUALITY PARAMETERS																					
Temperature (degrees C)					21.0	24.7	21.5		21.3	19.7	19.7	20.4	21.8	23.1		20.8	20.8	20.9	21.6		
Conductivity (microsiemens/cm)					278	1487	343		328	301	301	1462	344	1186		7.6	7.6	836	945		
pH					5.23	6.33	5.15		5.04	5.30	5.30	7.25	6.36	6.53		6.78	6.78	7.13	5.10		
Redox Potential (mV)					-165.2	-229.0	-138.2		-168.9	-144.9	-144.9	-106.5	+132.6	+169.5		-207.6	-207.6	-135.5	-136.0		

FB = Field Blank; Rin = Rinsate Blank; dup = intra-laboratory blind duplicate

GROUNDWATER RESULTS : MAY 2019

	Limit of Reporting (µg/L)	DWG	Aquatic Ecosys DGV	NPUG (WA DoH)																	
Site ID#					**G19**	**G18**	**G18(FB)**	**G17**	**G17(Rin)**	**G35**	**G34**	**G31**	**G31(FB)**	**G32**	**G32(dup)**	**G16**	**G15**	**G03**	**G20**	**G20(dup)**	**G20(FB)**
Sample Date					8/05/19	8/05/19	8/05/19	8/05/19	8/05/19	9/05/19	9/05/19	9/05/19	9/05/19	9/05/19	9/05/19	10/05/19	10/05/19	10/05/19	13/05/19	13/05/19	13/05/19
PFAS ANALYSIS																					
n:2 Fluorotelomer sulfonic acids (n:2 FTSAs)- Ultra Trace																					
1H.1H.2H.2H-perfluorodecanesulfonic acid (8:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
H.1H.2H.2H-perfluorododecanesulfonic acid (10:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
1H.1H.2H.2H-perfluorohexanesulfonic acid (4:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
1H.1H.2H.2H-perfluorooctanesulfonic acid (6:2 FTSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluoroalkyl carboxylic acids (PFCAs) - Ultra Trace																					
Perfluorobutanoic acid (PFBA)	0.005				< 0.005	< 0.005	< 0.005	0.007	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluorodecanoic acid (PFDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorododecanoic acid (PFDoDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroheptanoic acid (PFHpA)	0.001				0.001	0.003	< 0.001	0.002	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.003	0.005	< 0.001	0.002	0.002	< 0.001
Perfluorohexanoic acid (PFHxA)	0.001				0.001	0.005	< 0.001	0.002	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.002	0.002	0.01	0.004	< 0.001	0.003	0.004	< 0.001
Perfluorononanoic acid (PFNA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorooctanoic acid (PFOA)	0.001	0.56	19	5.6	< 0.001	0.018	< 0.001	0.002	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.005	0.025	< 0.001	0.005	0.006	< 0.001
Perfluoropentanoic acid (PFPeA)	0.001				< 0.001	0.003	< 0.001	0.002	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.001	0.002	0.006	0.001	< 0.001	0.002	0.004	< 0.001
Perfluorotetradecanoic acid (PFTeDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorotridecanoic acid (PFTrDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroundecanoic acid (PFUnDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroalkyl sulfonamido substances- Ultra Trace																					
2-(N-ethylperfluoro-1-octane sulfonamido)-ethanol (N-EtFOSE)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
2-(N-methylperfluoro-1-octane sulfonamido)-ethanol (N-MeFOSE)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-ethylperfluoro-1-octane sulfonamide (N-EtFOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-ethyl-perfluorooctanesulfonamidoacetic acid (N-EtFOSAA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-methylperfluoro-1-octane sulfonamide (N-MeFOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-methyl-perfluorooctanesulfonamidoacetic acid (N-MeFOSAA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluorooctane sulfonamide (FOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluoroalkyl sulfonic acids (PFSAs)- Ultra Trace																					
Perfluorobutanesulfonic acid (PFBS)	0.001				< 0.001	0.002	< 0.001	0.002	< 0.001	0.006	0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.004	0.004	< 0.001	0.001	0.001	< 0.001
Perfluorodecanesulfonic acid (PFDS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroheptanesulfonic acid (PFHpS)	0.001				< 0.001	0.002	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.003	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorohexanesulfonic acid (PFHxS)	0.001				0.002	0.005	< 0.001	0.01	< 0.001	0.005	0.002	< 0.001	< 0.001	0.003	0.003	0.021	0.015	0.001	0.009	0.01	< 0.001
Perfluorooctanesulfonic acid (PFOS)	0.0001		0.00023		0.002	0.011	< 0.0001	0.0028	< 0.0001	0.0002	0.0001	< 0.0001	< 0.0001	0.0002	0.0002	0.0064	0.0042	0.0019	0.0037	0.0036	< 0.0001
Perfluoropentanesulfonic acid (PFPeS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.002	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.003	0.003	< 0.001	< 0.001	< 0.001	< 0.001
PFASs Summations																					
Sum (PFHxS + PFOS)	0.001	0.07		0.7	0.004	0.016	< 0.001	0.0128	< 0.001	0.0052	0.0021	< 0.001	< 0.001	0.0032	0.0032	0.0274	0.0192	0.0029	0.0127	0.0136	< 0.001
Sum of enHealth PFAS (PFHxS + PFOS + PFOA)	0.001				0.004	0.034	< 0.001	0.0148	< 0.001	0.0052	0.0021	< 0.001	< 0.001	0.0032	0.0032	0.0324	0.0442	0.0029	0.0177	0.0196	< 0.001
Sum of PFASs (n=30)	0.005				0.006	0.049	< 0.005	0.0298	< 0.005	0.0132	< 0.005	< 0.005	< 0.005	0.0062	0.0072	0.0584	0.0642	< 0.005	0.0257	0.0306	< 0.005
Sum of US EPA PFAS (PFOS + PFOA)	0.001				0.002	0.029	< 0.001	0.0048	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.0114	0.0292	0.0019	0.0087	0.0096	< 0.001
Sum of WA DWER PFAS (n=10)	0.005				0.006	0.047	< 0.005	0.0298	< 0.005	0.0112	< 0.005	< 0.005	< 0.005	0.0062	0.0072	0.0554	0.0582	< 0.005	0.0257	0.0306	< 0.005
OTHER WATER QUALITY PARAMETERS																					
Temperature (degrees C)					23.6	23.2		20.4		20.9	21.0	21.8		22.9	22.9	21.4	21.1	20.5	21.0	21.0	
Conductivity (microsiemens/cm)					196	273		488		738	875	704		526	526	4967	3165	4100	1175	1175	
pH					5.99	6.23		5.26		7.90	7.51	6.75		5.55	5.55	7.71	7.43	6.29	5.34	5.34	
Redox Potential (mV)					+61.0	-124.0		-80.3		+181.0	-11.8	-138.0		-106.8	-106.8	+151.4	+194.8	-4.2	+140.8	+140.8	

FB = Field Blank; Rin = Rinsate Blank; dup = intra-laboratory blind duplicate

GROUNDWATER RESULTS : MAY 2019

	Limit of Reporting (µg/L)	DWG	Aquatic Ecosys DGV	NPUG (WA DoH)															
Site ID#					**G20(Rin)**	**G23**	**G02**	**G02(FB)**	**G01**	**G13**	**G11**	**G10**	**G10(dup)**	**G09**	**G12**	**G12(FB)**	**G26**	**G26(Rin)**	**G27**
Sample Date					13/05/19	13/05/19	14/05/19	14/05/19	14/05/19	14/05/19	15/05/19	15/05/19	15/05/19	15/05/19	15/05/19	15/05/19	17/05/19	17/05/19	17/05/19
PFAS ANALYSIS																			
n:2 Fluorotelomer sulfonic acids (n:2 FTSAs)- Ultra Trace																			
1H.1H.2H.2H-perfluorodecanesulfonic acid (8:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
H.1H.2H.2H-perfluorododecanesulfonic acid (10:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
1H.1H.2H.2H-perfluorohexanesulfonic acid (4:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
1H.1H.2H.2H-perfluorooctanesulfonic acid (6:2 FTSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluoroalkyl carboxylic acids (PFCAs) - Ultra Trace																			
Perfluorobutanoic acid (PFBA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.006	0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluorodecanoic acid (PFDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.005	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorododecanoic acid (PFDoDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroheptanoic acid (PFHpA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.001	< 0.001	< 0.001	< 0.001	0.009	0.009	< 0.001	0.002	< 0.001	0.002
Perfluorohexanoic acid (PFHxA)	0.001				< 0.001	< 0.001	0.006	< 0.001	< 0.001	0.005	< 0.001	< 0.001	< 0.001	0.016	0.005	< 0.001	0.003	< 0.001	0.003
Perfluorononanoic acid (PFNA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.003	0.011	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorooctanoic acid (PFOA)	0.001	0.56	19	5.6	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.002	< 0.001	< 0.001	< 0.001	0.034	0.022	< 0.001	0.005	< 0.001	0.005
Perfluoropentanoic acid (PFPeA)	0.001				< 0.001	< 0.001	0.008	< 0.001	< 0.001	0.001	< 0.001	< 0.001	< 0.001	0.011	0.003	< 0.001	0.002	< 0.001	0.003
Perfluorotetradecanoic acid (PFTeDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorotridecanoic acid (PFTrDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroundecanoic acid (PFUnDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroalkyl sulfonamido substances- Ultra Trace																			
2-(N-ethylperfluoro-1-octane sulfonamido)-ethanol (N-EtFOSE)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
2-(N-methylperfluoro-1-octane sulfonamido)-ethanol (N-MeFOSE)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-ethylperfluoro-1-octane sulfonamide (N-EtFOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-ethyl-perfluorooctanesulfonamidoacetic acid (N-EtFOSAA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-methylperfluoro-1-octane sulfonamide (N-MeFOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-methyl-perfluorooctanesulfonamidoacetic acid (N-MeFOSAA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluorooctane sulfonamide (FOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluoroalkyl sulfonic acids (PFSAs)- Ultra Trace																			
Perfluorobutanesulfonic acid (PFBS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.004	0.007	< 0.001	< 0.001	0.003	0.003	< 0.001	< 0.001	< 0.001	0.001
Perfluorodecanesulfonic acid (PFDS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroheptanesulfonic acid (PFHpS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorohexanesulfonic acid (PFHxS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.024	0.009	< 0.001	< 0.001	0.022	0.008	< 0.001	0.007	< 0.001	0.004
Perfluorooctanesulfonic acid (PFOS)	0.0001		0.00023		< 0.0001	0.0004	0.001	0.0032	0.0001	0.017	0.0004	< 0.0001	0.0005	0.03	0.0062	0.0004	0.0034	0.0001	0.0034
Perfluoropentanesulfonic acid (PFPeS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.003	0.001	< 0.001	< 0.001	0.001	0.001	< 0.001	< 0.001	< 0.001	< 0.001
PFASs Summations																			
Sum (PFHxS + PFOS)	0.001	0.07		0.7	< 0.001	< 0.001	0.001	0.0032	< 0.001	0.041	0.0094	< 0.001	< 0.001	0.052	0.0142	< 0.001	0.0104	< 0.001	0.0074
Sum of enHealth PFAS (PFHxS + PFOS + PFOA)	0.001				< 0.001	< 0.001	0.001	0.0032	< 0.001	0.043	0.0094	< 0.001	< 0.001	0.086	0.0362	< 0.001	0.0154	< 0.001	0.0124
Sum of PFASs (n=30)	0.005				< 0.005	< 0.005	0.015	< 0.005	< 0.005	0.057	0.0174	< 0.005	< 0.005	0.141	0.0732	< 0.005	0.0224	< 0.005	0.0214
Sum of US EPA PFAS (PFOS + PFOA)	0.001				< 0.001	< 0.001	0.001	0.0032	< 0.001	0.019	< 0.001	< 0.001	< 0.001	0.064	0.0282	< 0.001	0.0084	< 0.001	0.0084
Sum of WA DWER PFAS (n=10)	0.005				< 0.005	< 0.005	0.015	< 0.005	< 0.005	0.054	0.0164	< 0.005	< 0.005	0.131	0.0612	< 0.005	0.0224	< 0.005	0.0214
OTHER WATER QUALITY PARAMETERS																			
Temperature (degrees C)						21.0	21.5		20.5	22.6	21.5	22.2	22.2	25.2	22.9		20.7		21.9
Conductivity (microsiemens/cm)						765	552		498	700	2548	562	562	1824	2627		586		782
pH						5.09	5.84		5.28	5.89	6.92	5.92	5.92	7.62	6.45		6.40		6.22
Redox Potential (mV)						+25.0	+25.1		-160.4	-50.0	+24.0	+24.0	+24.0	-168.0	+12.6		+7.1		+130.4
# FB = Field Blank; Rin = Rinsate Blank; dup = intra-laboratory blind duplicate																			

GROUNDWATER RESULTS : MAY 2019

	Limit of Reporting (µg/L)	DWG	Aquatic Ecosys DGV	NPUG (WA DoH)				
Site ID#					**G28**	**G29**	**G29(FB)**	**G33**
Sample Date					17/05/19	17/05/19	17/05/19	17/05/19
PFAS ANALYSIS								
n:2 Fluorotelomer sulfonic acids (n:2 FTSAs)- Ultra Trace								
1H.1H.2H.2H-perfluorodecanesulfonic acid (8:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001
H.1H.2H.2H-perfluorododecanesulfonic acid (10:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001
1H.1H.2H.2H-perfluorohexanesulfonic acid (4:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001
1H.1H.2H.2H-perfluorooctanesulfonic acid (6:2 FTSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005
Perfluoroalkyl carboxylic acids (PFCAs) - Ultra Trace								
Perfluorobutanoic acid (PFBA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005
Perfluorodecanoic acid (PFDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001
Perfluorododecanoic acid (PFDoDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroheptanoic acid (PFHpA)	0.001				0.005	< 0.001	< 0.001	< 0.001
Perfluorohexanoic acid (PFHxA)	0.001				0.008	< 0.001	< 0.001	< 0.001
Perfluorononanoic acid (PFNA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001
Perfluorooctanoic acid (PFOA)	0.001	0.56	19	5.6	0.003	< 0.001	< 0.001	< 0.001
Perfluoropentanoic acid (PFPeA)	0.001				0.004	< 0.001	< 0.001	< 0.001
Perfluorotetradecanoic acid (PFTeDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001
Perfluorotridecanoic acid (PFTrDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroundecanoic acid (PFUnDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroalkyl sulfonamido substances- Ultra Trace								
2-(N-ethylperfluoro-1-octane sulfonamido)-ethanol (N-EtFOSE)	0.005				< 0.005	< 0.005	< 0.005	< 0.005
2-(N-methylperfluoro-1-octane sulfonamido)-ethanol (N-MeFOSE)	0.005				< 0.005	< 0.005	< 0.005	< 0.005
N-ethylperfluoro-1-octane sulfonamide (N-EtFOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005
N-ethyl-perfluorooctanesulfonamidoacetic acid (N-EtFOSAA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005
N-methylperfluoro-1-octane sulfonamide (N-MeFOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005
N-methyl-perfluorooctanesulfonamidoacetic acid (N-MeFOSAA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005
Perfluorooctane sulfonamide (FOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005
Perfluoroalkyl sulfonic acids (PFSAs)- Ultra Trace								
Perfluorobutanesulfonic acid (PFBS)	0.001				0.002	< 0.001	< 0.001	< 0.001
Perfluorodecanesulfonic acid (PFDS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroheptanesulfonic acid (PFHpS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001
Perfluorohexanesulfonic acid (PFHxS)	0.001				0.011	< 0.001	< 0.001	< 0.001
Perfluorooctanesulfonic acid (PFOS)	0.0001		0.00023		0.0017	0.0004	0.0009	0.0005
Perfluoropentanesulfonic acid (PFPeS)	0.001				0.001	< 0.001	< 0.001	< 0.001
PFASs Summations								
Sum (PFHxS + PFOS)	0.001	0.07		0.7	0.0127	< 0.001	< 0.001	< 0.001
Sum of enHealth PFAS (PFHxS + PFOS + PFOA)	0.001				0.0157	< 0.001	< 0.001	< 0.001
Sum of PFASs (n=30)	0.005				0.0357	< 0.005	< 0.005	< 0.005
Sum of US EPA PFAS (PFOS + PFOA)	0.001				0.0047	< 0.001	< 0.001	< 0.001
Sum of WA DWER PFAS (n=10)	0.005				0.0347	< 0.005	< 0.005	< 0.005
OTHER WATER QUALITY PARAMETERS								
Temperature (degrees C)					22.7	19.2		23.4
Conductivity (microsiemens/cm)					632	291		253
pH					5.64	4.06		3.87
Redox Potential (mV)					-118.4	+41.6		+103.1
# FB = Field Blank; Rin = Rinsate Blank; dup = intra-laboratory blind duplicate								

GROUNDWATER RESULTS : NOVEMBER 2019

	Limit of Reporting (µg/L)	DWG	Aquatic Ecosys DGV	NPUG (WA DoH)																	
Site ID#					**G14**	**G14(Rin)**	**G07**	**G07(FB)**	**G06**	**G05**	**G04**	**G04(FB)**	**G03**	**G01**	**G01(dup)**	**G01(FB)**	**G08**	**G08(Rin)**	**G09**	**G09(FB)**	**G02**
Sample Date					1/11/19	1/11/19	1/11/19	1/11/19	1/11/19	4/11/19	4/11/19	4/11/19	4/11/19	4/11/19	4/11/19	4/11/19	5/11/19	5/11/19	5/11/19	5/11/19	6/11/19
PFAS ANALYSIS																					
n:2 Fluorotelomer sulfonic acids (n:2 FTSAs)- Ultra Trace																					
1H.1H.2H.2H-perfluorodecanesulfonic acid (8:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
1H.1H.2H.2H-perfluorododecanesulfonic acid (10:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
1H.1H.2H.2H-perfluorohexanesulfonic acid (4:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
1H.1H.2H.2H-perfluorooctanesulfonic acid (6:2 FTSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluoroalkyl carboxylic acids (PFCAs) - Ultra Trace																					
Perfluorobutanoic acid (PFBA)	0.005				< 0.005	< 0.005	0.16	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.007	< 0.005	0.008	< 0.005	< 0.005
Perfluorodecanoic acid (PFDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.006	< 0.001	< 0.001
Perfluorododecanoic acid (PFDoDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroheptanoic acid (PFHpA)	0.001				< 0.001	< 0.001	0.004	< 0.001	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.007	< 0.001	0.01	< 0.001	< 0.001
Perfluorohexanoic acid (PFHxA)	0.001				< 0.001	< 0.001	0.013	< 0.001	0.003	0.003	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.016	< 0.001	0.022	< 0.001	< 0.001
Perfluorononanoic acid (PFNA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.003	< 0.001	< 0.001
Perfluorooctanoic acid (PFOA)	0.001	0.56	19	5.6	< 0.001	< 0.001	0.01	< 0.001	0.003	0.003	0.003	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.005	< 0.001	0.033	< 0.001	< 0.001
Perfluoropentanoic acid (PFPeA)	0.001				< 0.001	< 0.001	0.009	< 0.001	0.002	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.016	< 0.001	0.009	< 0.001	< 0.001
Perfluorotetradecanoic acid (PFTeDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorotridecanoic acid (PFTrDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroundecanoic acid (PFUnDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroalkyl sulfonamido substances- Ultra Trace																					
2-(N-ethylperfluoro-1-octane sulfonamido)-ethanol (N-EtFOSE)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
2-(N-methylperfluoro-1-octane sulfonamido)-ethanol (N-MeFOSE)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-ethylperfluoro-1-octane sulfonamide (N-EtFOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-ethyl-perfluorooctanesulfonamidoacetic acid (N-EtFOSAA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-methylperfluoro-1-octane sulfonamide (N-MeFOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-methyl-perfluorooctanesulfonamidoacetic acid (N-MeFOSAA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluorooctane sulfonamide (FOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluoroalkyl sulfonic acids (PFSAs)- Ultra Trace																					
Perfluorobutanesulfonic acid (PFBS)	0.001				< 0.001	< 0.001	0.002	< 0.001	0.008	0.002	0.002	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.002	< 0.001	0.003	< 0.001	0.002
Perfluorodecanesulfonic acid (PFDS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroheptanesulfonic acid (PFHpS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.002	< 0.001	< 0.001
Perfluorohexanesulfonic acid (PFHxS)	0.001				< 0.001	< 0.001	0.005	< 0.001	0.016	0.005	0.005	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.002	< 0.001	0.013	< 0.001	< 0.001
Perfluorononanesulfonic acid (PFNS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorooctanesulfonic acid (PFOS)	0.0001		0.00023		< 0.0001	< 0.0001	0.01	< 0.0001	0.019	0.0034	0.0094	< 0.0001	0.0023	< 0.0001	< 0.0001	< 0.0001	0.0065	< 0.0001	0.025	< 0.0001	0.0016
Perfluoropentanesulfonic acid (PFPeS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	0.004	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.002	< 0.001	< 0.001
Perfluoropropanesulfonic acid (PFPrS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
PFASs Summations																					
Sum (PFHxS + PFOS)	0.001	0.07		0.7	< 0.001	< 0.001	0.015	< 0.001	0.035	0.0084	0.0144	< 0.001	0.0023	< 0.001	< 0.001	< 0.001	0.0085	< 0.001	0.038	< 0.001	0.0016
Sum of enHealth PFAS (PFHxS + PFOS + PFOA)	0.005				< 0.001	< 0.001	0.025	< 0.001	0.038	0.0114	0.0174	< 0.001	0.0023	< 0.001	< 0.001	< 0.001	0.0135	< 0.001	0.071	< 0.001	0.0016
Sum of PFASs (n=30)	0.001				< 0.005	< 0.005	0.213	< 0.005	0.057	0.0164	0.0204	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.0615	< 0.005	0.136	< 0.005	< 0.005
Sum of US EPA PFAS (PFOS + PFOA)	0.005				< 0.001	< 0.001	0.02	< 0.001	0.022	0.0064	0.0124	< 0.001	0.0023	< 0.001	< 0.001	< 0.001	0.0115	< 0.001	0.058	< 0.001	0.0016
Sum of WA DWER PFAS (n=10)					< 0.005	< 0.005	0.213	< 0.005	0.052	0.0164	0.0204	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.0615	< 0.005	0.123	< 0.005	< 0.005
OTHER WATER QUALITY PARAMETERS																					
Temperature (degrees C)					20.5		21.4		21.5	19.8	19.5		20.2	19.7	19.7		20.1		24.7		20.0
Conductivity (microsiemens/cm)					1266		261		575	538	706		811	254	254		185		562		442
pH					7.31		6.59		7.25	7.68	7.80		6.55	6.03	6.03		6.12		7.62		5.79
Redox Potential (mV)					+131.3		+153.8		+134.4	-19.7	11.1		-133.6	-223.6	-223.6		-157.1		-207.0		-21.7

FB = Field Blank; Rin = Rinsate Blank; dup = intra-laboratory blind duplicate

GROUNDWATER RESULTS : NOVEMBER 2019

	Limit of Reporting (µg/L)	DWG	Aquatic Ecosys DGV	NPUG (WA DoH)																	
Site ID#					**G11**	**G18**	**G18(dup)**	**G18(FB)**	**G18(Rin)**	**G12**	**G10**	**G10(FB)**	**G10(Rin)**	**G17**	**G19**	**G19(FB)**	**G21**	**G22**	**G22(FB)**	**G25**	**G24**
Sample Date					6/11/19	6/11/19	6/11/19	6/11/19	7/11/19	7/11/19	7/11/19	7/11/19	8/11/19	8/11/19	8/11/19	8/11/19	11/11/19	11/11/19	11/11/19	11/11/19	11/11/19
PFAS ANALYSIS																					
n:2 Fluorotelomer sulfonic acids (n:2 FTSAs)- Ultra Trace																					
1H.1H.2H.2H-perfluorodecanesulfonic acid (8:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
1H.1H.2H.2H-perfluorododecanesulfonic acid (10:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
1H.1H.2H.2H-perfluorohexanesulfonic acid (4:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
1H.1H.2H.2H-perfluorooctanesulfonic acid (6:2 FTSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluoroalkyl carboxylic acids (PFCAs) - Ultra Trace																					
Perfluorobutanoic acid (PFBA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.009	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.011	0.007
Perfluorodecanoic acid (PFDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorododecanoic acid (PFDoDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroheptanoic acid (PFHpA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.008	< 0.001	< 0.001	< 0.001	0.002	0.006	< 0.001	0.002	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorohexanoic acid (PFHxA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.005	< 0.001	< 0.001	< 0.001	0.004	0.005	< 0.001	0.005	< 0.001	< 0.001	0.003	0.001
Perfluorononanoic acid (PFNA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.015	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorooctanoic acid (PFOA)	0.001	0.56	19	5.6	< 0.001	0.004	0.004	< 0.001	< 0.001	0.025	< 0.001	< 0.001	< 0.001	0.004	0.002	< 0.001	0.004	< 0.001	< 0.001	0.002	< 0.001
Perfluoropentanoic acid (PFPeA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.005	< 0.001	0.003	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorotetradecanoic acid (PFTeDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorotridecanoic acid (PFTrDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroundecanoic acid (PFUnDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroalkyl sulfonamido substances- Ultra Trace																					
2-(N-ethylperfluoro-1-octane sulfonamido)-ethanol (N-EtFOSE)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
2-(N-methylperfluoro-1-octane sulfonamido)-ethanol (N-MeFOSE)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-ethylperfluoro-1-octane sulfonamide (N-EtFOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-ethyl-perfluorooctanesulfonamidoacetic acid (N-EtFOSAA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-methylperfluoro-1-octane sulfonamide (N-MeFOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-methyl-perfluorooctanesulfonamidoacetic acid (N-MeFOSAA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluorooctane sulfonamide (FOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluoroalkyl sulfonic acids (PFSAs)- Ultra Trace																					
Perfluorobutanesulfonic acid (PFBS)	0.001				0.019	0.003	0.003	< 0.001	< 0.001	0.005	< 0.001	< 0.001	< 0.001	0.005	0.001	< 0.001	0.003	< 0.001	< 0.001	< 0.001	0.002
Perfluorodecanesulfonic acid (PFDS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroheptanesulfonic acid (PFHpS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.003	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorohexanesulfonic acid (PFHxS)	0.001				0.01	0.007	0.007	< 0.001	< 0.001	0.018	< 0.001	< 0.001	0.002	0.033	0.007	< 0.001	0.009	< 0.001	< 0.001	< 0.001	0.003
Perfluorononanesulfonic acid (PFNS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorooctanesulfonic acid (PFOS)	0.0001		0.00023		0.0013	0.0079	0.0081	< 0.0001	0.001	0.017	< 0.0001	< 0.0001	0.0012	0.0056	0.0033	< 0.0001	0.0054	< 0.0001	< 0.0001	< 0.0001	0.0045
Perfluoropentanesulfonic acid (PFPeS)	0.001				0.002	< 0.001	< 0.001	< 0.001	< 0.001	0.002	< 0.001	< 0.001	< 0.001	0.003	< 0.001	< 0.001	0.002	< 0.001	< 0.001	< 0.001	0.001
Perfluoropropanesulfonic acid (PFPrS)	0.001				0.005	< 0.001	< 0.001	< 0.001	< 0.001	0.002	< 0.001	< 0.001	< 0.001	0.002	< 0.001	< 0.001	0.001	< 0.001	< 0.001	< 0.001	< 0.001
PFASs Summations																					
Sum (PFHxS + PFOS)	0.001	0.07		0.7	0.0113	0.0149	0.0151	< 0.001	0.001	0.035	< 0.001	< 0.001	0.0032	0.0386	0.0103	< 0.001	0.0144	< 0.001	< 0.001	< 0.001	0.0075
Sum of enHealth PFAS (PFHxS + PFOS + PFOA)	0.005				0.0113	0.0189	0.0191	< 0.001	0.001	0.06	< 0.001	< 0.001	0.0032	0.0426	0.0123	< 0.001	0.0184	< 0.001	< 0.001	0.002	0.0075
Sum of PFASs (n=30)	0.001				0.0373	0.0219	0.0221	< 0.005	< 0.005	0.106	< 0.005	< 0.005	< 0.005	0.0616	0.0293	< 0.005	0.0344	< 0.005	< 0.005	0.016	0.0185
Sum of US EPA PFAS (PFOS + PFOA)	0.005				0.0013	0.0119	0.0121	< 0.001	0.001	0.042	< 0.001	< 0.001	0.0012	0.0096	0.0053	< 0.001	0.0094	< 0.001	< 0.001	0.002	0.0045
Sum of WA DWER PFAS (n=10)					0.0303	0.0219	0.0221	< 0.005	< 0.005	0.087	< 0.005	< 0.005	< 0.005	0.0536	0.0293	< 0.005	0.0314	< 0.005	< 0.005	0.016	0.0175
OTHER WATER QUALITY PARAMETERS																					
Temperature (degrees C)					20.8	22.2	22.2			20.9	20.2			19.3	22.9		19.6	20.1		19.7	22.5
Conductivity (microsiemens/cm)					1296	385	385			1250	290			652	229		308	358		467	526
pH					6.24	6.52	6.52			6.07	5.63			5.49	5.86		5.32	5.10		5.92	6.42
Redox Potential (mV)					+133.3	-139.5	-139.5			+115.6	-45.5			-123.2	-80.3		-60.4	-4.5		-133.9	-62.5

FB = Field Blank; Rin = Rinsate Blank; dup = intra-laboratory blind duplicate

GROUNDWATER RESULTS : NOVEMBER 2019

	Limit of Reporting (µg/L)	DWG	Aquatic Ecosys DGV	NPUG (WA DoH)														
Site ID#					**G30**	**G20**	**G28**	**G27**	**G27(FB)**	**G23**	**G33**	**G32**	**G26**	**G26(FB)**	**G34**	**G35**	**G35(FB)**	**G29**
Sample Date					11/11/19	12/11/19	12/11/19	12/11/19	12/11/19	12/11/19	13/11/19	13/11/19	13/11/19	13/11/19	14/11/19	14/11/19	14/11/19	14/11/19
PFAS ANALYSIS																		
n:2 Fluorotelomer sulfonic acids (n:2 FTSAs)- Ultra Trace																		
1H.1H.2H.2H-perfluorodecanesulfonic acid (8:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
1H.1H.2H.2H-perfluorododecanesulfonic acid (10:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
1H.1H.2H.2H-perfluorohexanesulfonic acid (4:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
1H.1H.2H.2H-perfluorooctanesulfonic acid (6:2 FTSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluoroalkyl carboxylic acids (PFCAs) - Ultra Trace																		
Perfluorobutanoic acid (PFBA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluorodecanoic acid (PFDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorododecanoic acid (PFDoDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroheptanoic acid (PFHpA)	0.001				0.002	0.002	0.002	0.003	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorohexanoic acid (PFHxA)	0.001				0.006	0.003	0.005	0.004	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorononanoic acid (PFNA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorooctanoic acid (PFOA)	0.001	0.56	19	5.6	0.005	0.006	0.002	0.006	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoropentanoic acid (PFPeA)	0.001				0.004	0.002	0.002	0.003	< 0.001	< 0.001	< 0.001	0.002	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorotetradecanoic acid (PFTeDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorotridecanoic acid (PFTrDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroundecanoic acid (PFUnDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroalkyl sulfonamido substances- Ultra Trace																		
2-(N-ethylperfluoro-1-octane sulfonamido)-ethanol (N-EtFOSE)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
2-(N-methylperfluoro-1-octane sulfonamido)-ethanol (N-MeFOSE)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-ethylperfluoro-1-octane sulfonamide (N-EtFOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-ethyl-perfluorooctanesulfonamidoacetic acid (N-EtFOSAA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-methylperfluoro-1-octane sulfonamide (N-MeFOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-methyl-perfluorooctanesulfonamidoacetic acid (N-MeFOSAA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluorooctane sulfonamide (FOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluoroalkyl sulfonic acids (PFSAs)- Ultra Trace																		
Perfluorobutanesulfonic acid (PFBS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.005	< 0.001	< 0.001
Perfluorodecanesulfonic acid (PFDS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroheptanesulfonic acid (PFHpS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorohexanesulfonic acid (PFHxS)	0.001				< 0.001	0.006	0.003	0.005	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.004	< 0.001	< 0.001
Perfluorononanesulfonic acid (PFNS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorooctanesulfonic acid (PFOS)	0.0001		0.00023		0.0012	0.0048	0.0029	0.0036	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0035	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Perfluoropentanesulfonic acid (PFPeS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.002	< 0.001	< 0.001
Perfluoropropanesulfonic acid (PFPrS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.002	< 0.001	< 0.001
PFASs Summations																		
Sum (PFHxS + PFOS)	0.001	0.07		0.7	0.0012	0.0108	0.0059	0.0086	< 0.001	< 0.001	< 0.001	< 0.001	0.0035	< 0.001	< 0.001	0.004	< 0.001	< 0.001
Sum of enHealth PFAS (PFHxS + PFOS + PFOA)	0.005				0.0062	0.0168	0.0079	0.0146	< 0.001	< 0.001	< 0.001	< 0.001	0.0035	< 0.001	< 0.001	0.004	< 0.001	< 0.001
Sum of PFASs (n=30)	0.001				0.0182	0.0238	0.0169	0.0246	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.013	< 0.005	< 0.005
Sum of US EPA PFAS (PFOS + PFOA)	0.005				0.0062	0.0108	0.0049	0.0096	< 0.001	< 0.001	< 0.001	< 0.001	0.0035	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Sum of WA DWER PFAS (n=10)					0.0182	0.0238	0.0169	0.0246	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.009	< 0.005	< 0.005
OTHER WATER QUALITY PARAMETERS																		
Temperature (degrees C)					19	21.1	21.6	20.7		20.2	21.1	20.8	21.6		20.7	21.5		18.6
Conductivity (microsiemens/cm)					355	712	669	494		455	115	542	128		1229	813		157.6
pH					6.00	5.39	6.28	6.28		5.46	3.83	5.59	5.90		7.38	7.87		3.76
Redox Potential (mV)					+125.6	-145.7	-138.6	+97.4		-111.1	+96.8	-82.4	+90.0		-141.0	+81.5		-72.4
# FB = Field Blank; Rin = Rinsate Blank; dup = intra-laboratory blind duplicate																		

GROUNDWATER RESULTS : NOVEMBER 2019

	Limit of Reporting (µg/L)	DWG	Aquatic Ecosys DGV	NPUG (WA DoH)					
Site ID#					**G16**	**G15**	**G15(FB)**	**G13**	**G31**
Sample Date					15/11/19	15/11/19	15/11/19	15/11/19	13/11/19
PFAS ANALYSIS									
n:2 Fluorotelomer sulfonic acids (n:2 FTSAs)- Ultra Trace									
1H.1H.2H.2H-perfluorodecanesulfonic acid (8:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
1H.1H.2H.2H-perfluorododecanesulfonic acid (10:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
1H.1H.2H.2H-perfluorohexanesulfonic acid (4:2 FTSA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
1H.1H.2H.2H-perfluorooctanesulfonic acid (6:2 FTSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluoroalkyl carboxylic acids (PFCAs) - Ultra Trace									
Perfluorobutanoic acid (PFBA)	0.005				0.006	< 0.005	< 0.005	< 0.005	< 0.005
Perfluorodecanoic acid (PFDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorododecanoic acid (PFDoDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroheptanoic acid (PFHpA)	0.001				0.004	0.003	< 0.001	0.001	< 0.001
Perfluorohexanoic acid (PFHxA)	0.001				0.014	0.005	< 0.001	0.008	< 0.001
Perfluorononanoic acid (PFNA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorooctanoic acid (PFOA)	0.001	0.56	19	5.6	0.008	0.029	< 0.001	0.003	< 0.001
Perfluoropentanoic acid (PFPeA)	0.001				0.004	0.002	< 0.001	< 0.001	< 0.001
Perfluorotetradecanoic acid (PFTeDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorotridecanoic acid (PFTrDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroundecanoic acid (PFUnDA)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroalkyl sulfonamido substances- Ultra Trace									
2-(N-ethylperfluoro-1-octane sulfonamido)-ethanol (N-EtFOSE)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
2-(N-methylperfluoro-1-octane sulfonamido)-ethanol (N-MeFOSE)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-ethylperfluoro-1-octane sulfonamide (N-EtFOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-ethyl-perfluorooctanesulfonamidoacetic acid (N-EtFOSAA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-methylperfluoro-1-octane sulfonamide (N-MeFOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
N-methyl-perfluorooctanesulfonamidoacetic acid (N-MeFOSAA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluorooctane sulfonamide (FOSA)	0.005				< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Perfluoroalkyl sulfonic acids (PFSAs)- Ultra Trace									
Perfluorobutanesulfonic acid (PFBS)	0.001				0.004	0.006	< 0.001	0.005	< 0.001
Perfluorodecanesulfonic acid (PFDS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluoroheptanesulfonic acid (PFHpS)	0.001				< 0.001	0.003	< 0.001	0.002	< 0.001
Perfluorohexanesulfonic acid (PFHxS)	0.001				0.023	0.022	< 0.001	0.027	< 0.001
Perfluorononanesulfonic acid (PFNS)	0.001				< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Perfluorooctanesulfonic acid (PFOS)	0.0001		0.00023		0.011	0.0068	< 0.0001	0.02	< 0.0001
Perfluoropentanesulfonic acid (PFPeS)	0.001				0.003	0.004	< 0.001	0.005	< 0.001
Perfluoropropanesulfonic acid (PFPrS)	0.001				< 0.001	0.001	< 0.001	0.003	< 0.001
PFASs Summations									
Sum (PFHxS + PFOS)	0.001	0.07		0.7	0.034	0.0288	< 0.001	0.047	< 0.001
Sum of enHealth PFAS (PFHxS + PFOS + PFOA)	0.005				0.042	0.0578	< 0.001	0.05	< 0.001
Sum of PFASs (n=30)	0.001				0.077	0.0818	< 0.005	0.074	< 0.005
Sum of US EPA PFAS (PFOS + PFOA)	0.005				0.019	0.0358	< 0.001	0.023	< 0.001
Sum of WA DWER PFAS (n=10)					0.074	0.0738	< 0.005	0.064	< 0.005
OTHER WATER QUALITY PARAMETERS									
Temperature (degrees C)					21.2	21.2		21.2	20.5
Conductivity (microsiemens/cm)					1399	684		651	267
pH					7.05	6.63		5.96	6.02
Redox Potential (mV)					-88.8	+91.4		-125.9	-166.9
# FB = Field Blank; Rin = Rinsate Blank; dup = intra-laboratory blind duplicate									

SURFACE WATER INTER-LABORATORY DUPLICATES

	Limit of Reporting (µg/L)	Limit of Reporting (µg/L)	DWG	99% Aquatic Ecosys DGV	NPUG (WA DoH)														
	Lab 1	Lab2				Lab 1	Lab2	RPD(%)	Lab 1	Lab2	RPD(%)	Lab 1	Lab2	RPD(%)	Lab 1	Lab2	RPD(%)	Lab 1	Lab2	RPD(%)
Site ID#						**S05**	**S05**		**S27**	**S27**		**S40**	**S40**		**S36**	**S36**		**S26**	**S26**	
Sample Date						2/04/19	2/04/19		5/4/19	5/4/19		8/4/19	8/4/19		10/4/19	10/4/19		11/4/19	11/4/19	
PFAS ANALYSIS																				
n:2 Fluorotelomer sulfonic acids (n:2 FTSAs)- Ultra Trace																				
1H.1H.2H.2H-perfluorodecanesulfonic acid (8:2 FTSA)	0.001	0.001				< 0.001	< 0.001		< 0.001	< 0.001		< 0.001	< 0.001		< 0.001	< 0.001		< 0.001	< 0.001	
1H.1H.2H.2H-perfluorododecanesulfonic acid (10:2 FTSA)	0.001	0.001				< 0.001	< 0.001		< 0.001	< 0.001		< 0.001	< 0.001		< 0.001	< 0.001		< 0.001	< 0.001	
1H.1H.2H.2H-perfluorohexanesulfonic acid (4:2 FTSA)	0.001	0.001				< 0.001	< 0.001		< 0.001	< 0.001		< 0.001	< 0.001		< 0.001	< 0.001		< 0.001	< 0.001	
1H.1H.2H.2H-perfluorooctanesulfonic acid (6:2 FTSA)	0.005	0.001				< 0.005	< 0.001		< 0.005	< 0.001		< 0.005	< 0.001		< 0.005	< 0.001		< 0.005	0.007	33.3
Perfluoroalkyl carboxylic acids (PFCAs) - Ultra Trace																				
Perfluorobutanoic acid (PFBA)	0.005	0.005				< 0.005	<0.05		0.024	<0.05		< 0.005	<0.05		< 0.005	<0.05		0.013	<0.05	117.0
Perfluorodecanoic acid (PFDA)	0.001	0.001				< 0.001	< 0.001		< 0.001	< 0.001		< 0.001	< 0.001		< 0.001	< 0.001		0.001	0.001	0.0
Perfluorododecanoic acid (PFDoDA)	0.001	0.001				< 0.001	< 0.001		< 0.001	< 0.001		< 0.001	< 0.001		< 0.001	< 0.001		< 0.001	< 0.001	
Perfluoroheptanoic acid (PFHpA)	0.001	0.001				0.004	0.004	0.0	0.019	0.015	23.5	< 0.001	< 0.001		0.003	0.002	40.0	0.009	0.01	10.5
Perfluorohexanoic acid (PFHxA)	0.001	0.001				0.007	0.007	0.0	0.046	0.057	21.4	< 0.001	< 0.001		0.003	0.003	0.0	0.021	0.03	35.3
Perfluorononanoic acid (PFNA)	0.001	0.001				< 0.001	< 0.001		0.001	0.001	0.0	< 0.001	< 0.001		< 0.001	< 0.001		0.002	0.002	0.0
Perfluorooctanoic acid (PFOA)	0.001	0.0004	0.56	19	5.6	0.008	0.008	0.0	0.026	0.022	16.7	< 0.001	0.0005	66.7	0.002	0.002	0.0	0.009	0.009	0.0
Perfluoropentanoic acid (PFPeA)	0.001	0.001				0.004	0.004	0.0	0.039	0.057	37.5	< 0.001	< 0.001		0.002	< 0.001		0.028	0.026	7.4
Perfluorotetradecanoic acid (PFTeDA)	0.001	0.001				< 0.001	< 0.001		< 0.001	< 0.001		< 0.001	< 0.001		< 0.001	< 0.001		< 0.001	< 0.001	
Perfluorotridecanoic acid (PFTrDA)	0.001	0.001				< 0.001	< 0.001		< 0.001	< 0.001		< 0.001	< 0.001		< 0.001	< 0.001		< 0.001	< 0.001	
Perfluoroundecanoic acid (PFUnDA)	0.001	0.001				< 0.001	< 0.001		< 0.001	< 0.001		< 0.001	< 0.001		< 0.001	< 0.001		< 0.001	< 0.001	
Perfluoroalkyl sulfonamido substances- Ultra Trace																				
2-(N-ethylperfluoro-1-octane sulfonamido)-ethanol (N-EtFOSE)	0.005	0.001				< 0.005	< 0.001		< 0.005	< 0.001		< 0.005	< 0.001		< 0.005	< 0.001		< 0.005	< 0.001	
2-(N-methylperfluoro-1-octane sulfonamido)-ethanol (N-MeFOSE)	0.005	0.001				< 0.005	< 0.001		< 0.005	< 0.001		< 0.005	< 0.001		< 0.005	< 0.001		< 0.005	< 0.001	
N-ethylperfluoro-1-octane sulfonamide (N-EtFOSA)	0.005	0.001				< 0.005	< 0.001		< 0.005	< 0.001		< 0.005	< 0.001		< 0.005	< 0.001		< 0.005	< 0.001	
N-ethyl-perfluorooctanesulfonamidoacetic acid (N-EtFOSAA)	0.005	0.001				< 0.005	< 0.001		< 0.005	< 0.001		< 0.005	< 0.001		< 0.005	< 0.001		< 0.005	< 0.001	
N-methylperfluoro-1-octane sulfonamide (N-MeFOSA)	0.005	0.001				< 0.005	< 0.001		< 0.005	< 0.001		< 0.005	< 0.001		< 0.005	< 0.001		< 0.005	< 0.001	
N-methyl-perfluorooctanesulfonamidoacetic acid (N-MeFOSAA)	0.005	0.001				< 0.005	< 0.001		< 0.005	< 0.001		< 0.005	< 0.001		< 0.005	< 0.001		< 0.005	< 0.001	
Perfluorooctane sulfonamide (FOSA)	0.005	0.001				< 0.005	< 0.001		< 0.005	< 0.001		< 0.005	< 0.001		< 0.005	< 0.001		< 0.005	< 0.001	
Perfluoroalkyl sulfonic acids (PFSAs)- Ultra Trace																				
Perfluorobutanesulfonic acid (PFBS)	0.001	0.001				0.003	0.002	40.0	0.012	0.01	18.2	< 0.001	< 0.001		< 0.001	< 0.001		0.003	0.003	0.0
Perfluorodecanesulfonic acid (PFDS)	0.001	0.001				< 0.001	<0.001		0.001	<0.001	0.0	< 0.001	< 0.001		< 0.001	< 0.001		< 0.001	< 0.001	
Perfluoroheptanesulfonic acid (PFHpS)	0.001	0.001				< 0.001	<0.001		0.007	0.002	111.1	< 0.001	< 0.001		< 0.001	< 0.001		< 0.001	< 0.001	
Perfluorohexanesulfonic acid (PFHxS)	0.001	0.0002				0.01	0.066	147.4	0.072	0.066	8.7	0.004	0.004	0.0	0.004	0.003	28.6	0.011	0.012	8.7
Perfluorooctanesulfonic acid (PFOS)	0.0001	0.0002		0.00023		0.0042	0.006	35.3	0.033	0.042	24.0	0.0006	0.0009	40.0	0.0017	0.002	16.2	0.014	0.018	25.0
Perfluoropentanesulfonic acid (PFPeS)	0.001	0.001				<0.001	0.002	66.7	0.014	0.024	52.6	< 0.001	< 0.001		< 0.001			0.003	0.005	50.0
PFASs Summations																				
Sum (PFHxS + PFOS)	0.001	0.005	0.07		0.7	0.0142	0.016	11.9	0.105	0.11	4.7	0.0046	0.005	8.3	0.0057	0.005	13.1	0.025	0.03	18.2
Sum of enHealth PFAS (PFHxS + PFOS + PFOA)	0.001	NR				0.0222	0.08	113.1	0.131	0.13	0.8	0.0046	0.0054	16.0	0.0077	0.007	9.5	0.034	0.039	13.7
Sum of PFASs (n=30)	0.005	0.005				0.0402	0.043	6.7	0.294	0.3	2.0	< 0.005	0.005	0.0	0.0157	0.012	26.7	0.114	0.12	5.1
Sum of US EPA PFAS (PFOS + PFOA)	0.001	NR				0.0122	0.014	13.7	0.059	0.064	8.1	< 0.001	0.0014	33.3	0.0037	0.004	7.8	0.023	0.027	16.0
Sum of WA DWER PFAS (n=10)	0.005	0.005				0.0402	0.041	2.0	0.271	0.27	0.4	< 0.005	0.005	0.0	0.0157	0.012	26.7	0.108	0.11	1.8

NR = value not reported

SURFACE WATER INTER-LABORATORY DUPLICATES

	Limit of Reporting (µg/L)	Limit of Reporting (µg/L)	DWG	99% Aquatic Ecosys DGV	NPUG (WA DoH)															
	Lab 1	Lab2				Lab 1	Lab2	RPD(%)	Lab 1	Lab2	RPD(%)	Lab 1	Lab2	RPD(%)	Lab 1	Lab2	RPD(%)	Lab 1	Lab2	RPD(%)
Site ID#						**S08**	**S08**		**S17**	**S17**		**S28**	**S28**		**S21**	**S21**		**S35**		
Sample Date						15/10/19	15/10/19		16/10/19	16/10/19		17/10/19	17/10/19		18/10/19	18/10/19		22/10/19		
PFAS ANALYSIS																				
n:2 Fluorotelomer sulfonic acids (n:2 FTSAs)- Ultra Trace																				
1H.1H.2H.2H-perfluorodecanesulfonic acid (8:2 FTSA)	0.001	0.001				< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001	
1H.1H.2H.2H-perfluorododecanesulfonic acid (10:2 FTSA)	0.001	0.001				< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001	
1H.1H.2H.2H-perfluorohexanesulfonic acid (4:2 FTSA)	0.001	0.001				< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001	
1H.1H.2H.2H-perfluorooctanesulfonic acid (6:2 FTSA)	0.005	0.001				< 0.005	<0.001		< 0.005	<0.001		< 0.005	<0.001		< 0.005	<0.001		< 0.005	<0.001	
Perfluoroalkyl carboxylic acids (PFCAs) - Ultra Trace																				
Perfluorobutanoic acid (PFBA)	0.005	0.005				< 0.005	0.006	18.2	0.01	0.014	33.3	< 0.005	0.006	18.2	< 0.005	0.005	0.0	0.021	0.024	13.3
Perfluorodecanoic acid (PFDA)	0.001	0.001				< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001	
Perfluorododecanoic acid (PFDoDA)	0.001	0.001				< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001	
Perfluoroheptanoic acid (PFHpA)	0.001	0.001				0.002	0.002	0.0	0.007	0.008	13.3	0.002	0.002	0.0	0.004	0.004	0.0	0.009	0.01	10.5
Perfluorohexanoic acid (PFHxA)	0.001	0.001				0.005	0.006	18.2	0.038	0.048	23.3	0.004	0.005	22.2	0.006	0.008	28.6	0.016	0.021	27.0
Perfluorononanoic acid (PFNA)	0.001	0.001				< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001	
Perfluorooctanoic acid (PFOA)	0.001	0.0004	0.56	19	5.6	0.005	0.0059	16.5	0.01	0.011	9.5	0.006	0.0062	3.3	0.009	0.011	20.0	0.021	0.025	17.4
Perfluoropentanoic acid (PFPeA)	0.001	0.001				0.003	0.005	50.0	0.044	0.048	8.7	0.003	0.004	28.6	0.005	0.005	0.0	0.01	0.018	57.1
Perfluorotetradecanoic acid (PFTeDA)	0.001	0.001				< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001	
Perfluorotridecanoic acid (PFTrDA)	0.001	0.001				< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001	
Perfluoroundecanoic acid (PFUnDA)	0.001	0.001				< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001	
Perfluoroalkyl sulfonamido substances- Ultra Trace																				
2-(N-ethylperfluoro-1-octane sulfonamido)-ethanol (N-EtFOSE)	0.005	0.001				< 0.005	<0.001		< 0.005	<0.001		< 0.005	<0.001		< 0.005	<0.001		< 0.005	<0.001	
2-(N-methylperfluoro-1-octane sulfonamido)-ethanol (N-MeFOSE)	0.005	0.001				< 0.005	<0.001		< 0.005	<0.001		< 0.005	<0.001		< 0.005	<0.001		< 0.005	<0.001	
N-ethylperfluoro-1-octane sulfonamide (N-EtFOSA)	0.005	0.001				< 0.005	<0.001		< 0.005	<0.001		< 0.005	<0.001		< 0.005	<0.001		< 0.005	<0.001	
N-ethyl-perfluorooctanesulfonamidoacetic acid (N-EtFOSAA)	0.005	0.001				< 0.005	<0.001		< 0.005	<0.001		< 0.005	<0.001		< 0.005	<0.001		< 0.005	<0.001	
N-methylperfluoro-1-octane sulfonamide (N-MeFOSA)	0.005	0.001				< 0.005	<0.001		< 0.005	<0.001		< 0.005	<0.001		< 0.005	<0.001		< 0.005	<0.001	
N-methyl-perfluorooctanesulfonamidoacetic acid (N-MeFOSAA)	0.005	0.001				< 0.005	<0.001		< 0.005	<0.001		< 0.005	<0.001		< 0.005	<0.001		< 0.005	<0.001	
Perfluorooctane sulfonamide (FOSA)	0.005	0.001				< 0.005	<0.001		< 0.005	<0.001		< 0.005	<0.001		< 0.005	<0.001		< 0.005	<0.001	
Perfluoroalkyl sulfonic acids (PFSAs)- Ultra Trace																				
Perfluorobutanesulfonic acid (PFBS)	0.001	0.001				0.001	0.001	0.0	0.003	0.003	0.0	0.002	0.002	0.0	0.002	0.003	40.0	0.024	0.025	4.1
Perfluorodecanesulfonic acid (PFDS)	0.001	0.001				< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001	
Perfluoroheptanesulfonic acid (PFHpS)	0.001	0.001				< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001		< 0.001	0.002	66.7
Perfluorohexanesulfonic acid (PFHxS)	0.001	0.0002				0.004	0.0045	11.8	0.007	0.0082	15.8	0.011	0.013	16.7	0.011	0.016	37.0	0.028	0.033	16.4
Perfluorooctanesulfonic acid (PFOS)	0.0001	0.0002		0.00023		0.0046	0.0047	2.2	0.0043	0.0049	13.0	0.0059	0.0056	5.2	0.013	0.014	7.4	0.018	0.017	5.7
Perfluoropentanesulfonic acid (PFPeS)	0.001	0.001				< 0.001	<0.001		< 0.001	0.002	66.7	< 0.001	0.002	66.7	< 0.001	0.003	100.0	0.003	0.008	90.9
PFASs Summations																				
Sum (PFHxS + PFOS)	0.001	0.005	0.07		0.7	0.0086	0.009	4.5	0.0113	0.013	14.0	0.0169	0.018	6.3	0.024	0.03	22.2	0.046	0.05	8.3
Sum of enHealth PFAS (PFHxS + PFOS + PFOA)	0.001	NR				0.0136	0.0151	10.5	0.0213	0.0241	12.3	0.0229	0.0248	8.0	0.033	0.041	21.6	0.067	0.075	11.3
Sum of PFASs (n=30)	0.005	0.005				0.0246	0.036	37.6	0.1233	0.15	19.5	0.0339	0.046	30.3	0.05	0.069	31.9	0.15	0.18	18.2
Sum of US EPA PFAS (PFOS + PFOA)	0.001	NR				0.0096	0.0106	9.9	0.0143	0.0159	10.6	0.0119	0.0118	0.8	0.022	0.025	12.8	0.039	0.042	7.4
Sum of WA DWER PFAS (n=10)	0.005	0.005				0.0246	0.036	37.6	0.1233	0.15	19.5	0.0339	0.043	23.7	0.05	0.065	26.1	0.147	0.17	14.5

NR = value not reported

GROUNDWATER INTER-LABORATORY DUPLICATES

	Limit of Reporting (µg/L)	Limit of Reporting (µg/L)	DWG	99% Aquatic Ecosys DGV	NPUG (WA DoH)														
	Lab 1	Lab2				Lab 1	Lab2	RPD(%)	Lab 1	Lab2	RPD(%)	Lab 1	Lab2	RPD(%)	Lab 1	Lab2	RPD(%)	Lab 1	Lab2	RPD(%)
Site ID#						**G30**	**G30***		**G34**	**G34***		**G20**	**G20***		**G11**	**G11***		**G10**	**G10**	
Sample Date						1/5/19	1/05/19		9/5/19	9/5/19		13/5/19	13/5/19		15/5/19	15/5/19		7/11/19	7/11/19	
PFAS ANALYSIS																				
n:2 Fluorotelomer sulfonic acids (n:2 FTSAs)- Ultra Trace																				
1H.1H.2H.2H-perfluorodecanesulfonic acid (8:2 FTSA)	0.001	0.001				< 0.001	< 0.01		< 0.001	< 0.01		< 0.001	< 0.01		< 0.001	< 0.01		< 0.001	<0.001	
1H.1H.2H.2H-perfluorododecanesulfonic acid (10:2 FTSA)	0.001	0.001				< 0.001	< 0.01		< 0.001	< 0.01		< 0.001	< 0.01		< 0.001	< 0.01		< 0.001	<0.001	
1H.1H.2H.2H-perfluorohexanesulfonic acid (4:2 FTSA)	0.001	0.001				< 0.001	< 0.01		< 0.001	< 0.01		< 0.001	< 0.01		< 0.001	< 0.01		< 0.001	<0.001	
1H.1H.2H.2H-perfluorooctanesulfonic acid (6:2 FTSA)	0.005	0.001				< 0.005	< 0.01		< 0.005	< 0.01		< 0.005	< 0.01		< 0.005	< 0.01		< 0.005	<0.001	
Perfluoroalkyl carboxylic acids (PFCAs) - Ultra Trace																				
Perfluorobutanoic acid (PFBA)	0.005	0.005				< 0.005	< 0.05		< 0.005	< 0.005		< 0.005	< 0.05		< 0.005	< 0.05		< 0.005	<0.005	
Perfluorodecanoic acid (PFDA)	0.001	0.001				< 0.001	< 0.01		< 0.001	< 0.001		< 0.001	< 0.01		< 0.001	< 0.01		< 0.001	<0.001	
Perfluorododecanoic acid (PFDoDA)	0.001	0.001				< 0.001	< 0.01		< 0.001	< 0.001		< 0.001	< 0.01		< 0.001	< 0.01		< 0.001	<0.001	
Perfluoroheptanoic acid (PFHpA)	0.001	0.001				0.001	< 0.01	0.0	< 0.001	< 0.001		0.002	< 0.01	0.0	< 0.001	< 0.01		< 0.001	<0.001	
Perfluorohexanoic acid (PFHxA)	0.001	0.001				0.003	< 0.01	0.0	< 0.001	< 0.001		0.003	< 0.01	0.0	< 0.001	< 0.01		< 0.001	<0.001	
Perfluorononanoic acid (PFNA)	0.001	0.001				< 0.001	< 0.01		< 0.001	< 0.001		< 0.001	< 0.01		< 0.001	< 0.01		< 0.001	<0.001	
Perfluorooctanoic acid (PFOA)	0.001	0.0004	0.56	19	5.6	0.003	< 0.01	0.0	< 0.001	< 0.0004		0.005	< 0.01	0.0	< 0.001	< 0.01		< 0.001	<0.0004	
Perfluoropentanoic acid (PFPeA)	0.001	0.001				0.004	< 0.01	0.0	< 0.001	< 0.001		0.002	< 0.01		< 0.001	< 0.01		< 0.001	<0.001	
Perfluorotetradecanoic acid (PFTeDA)	0.001	0.001				< 0.001	< 0.01		< 0.001	< 0.001		< 0.001	< 0.01		< 0.001	< 0.01		< 0.001	<0.001	
Perfluorotridecanoic acid (PFTrDA)	0.001	0.001				< 0.001	< 0.01		< 0.001	< 0.001		< 0.001	< 0.01		< 0.001	< 0.01		< 0.001	<0.001	
Perfluoroundecanoic acid (PFUnDA)	0.001	0.001				< 0.001	< 0.01		< 0.001	< 0.001		< 0.001	< 0.01		< 0.001	< 0.01		< 0.001	<0.001	
Perfluoroalkyl sulfonamido substances- Ultra Trace																				
2-(N-ethylperfluoro-1-octane sulfonamido)-ethanol (N-EtFOSE)	0.005	0.001				< 0.005	< 0.01		< 0.005	< 0.001		< 0.005	< 0.01		< 0.005	< 0.01		< 0.005	<0.001	
2-(N-methylperfluoro-1-octane sulfonamido)-ethanol (N-MeFOSE)	0.005	0.001				< 0.005	< 0.01		< 0.005	< 0.001		< 0.005	< 0.01		< 0.005	< 0.01		< 0.005	<0.001	
N-ethylperfluoro-1-octane sulfonamide (N-EtFOSA)	0.005	0.001				< 0.005	< 0.01		< 0.005	< 0.001		< 0.005	< 0.01		< 0.005	< 0.01		< 0.005	<0.001	
N-ethyl-perfluorooctanesulfonamidoacetic acid (N-EtFOSAA)	0.005	0.001				< 0.005	< 0.01		< 0.005	< 0.001		< 0.005	< 0.01		< 0.005	< 0.01		< 0.005	<0.001	
N-methylperfluoro-1-octane sulfonamide (N-MeFOSA)	0.005	0.001				< 0.005	< 0.01		< 0.005	< 0.001		< 0.005	< 0.01		< 0.005	< 0.01		< 0.005	<0.001	
N-methyl-perfluorooctanesulfonamidoacetic acid (N-MeFOSAA)	0.005	0.001				< 0.005	< 0.01		< 0.005	< 0.001		< 0.005	< 0.01		< 0.005	< 0.01		< 0.005	<0.001	
Perfluorooctane sulfonamide (FOSA)	0.005	0.001				< 0.005	< 0.01		< 0.005	< 0.001		< 0.005	< 0.01		< 0.005	< 0.01		< 0.005	<0.001	
Perfluoroalkyl sulfonic acids (PFSAs)- Ultra Trace																				
Perfluorobutanesulfonic acid (PFBS)	0.001	0.001				< 0.001	< 0.01		0.001	0.001	0.0	0.001	< 0.01	0.0	0.007	< 0.01	0.0	< 0.001	<0.001	
Perfluorodecanesulfonic acid (PFDS)	0.001	0.001				< 0.001	< 0.01		< 0.001	< 0.001		< 0.001	< 0.01		< 0.001	< 0.01		< 0.001	<0.001	
Perfluoroheptanesulfonic acid (PFHpS)	0.001	0.001				< 0.001	< 0.01		< 0.001	< 0.001		< 0.001	< 0.01		< 0.001	< 0.01		< 0.001	<0.001	
Perfluorohexanesulfonic acid (PFHxS)	0.001	0.0002				< 0.001	< 0.01		0.002	0.002	0.0	0.009	< 0.01	0.0	0.009	< 0.01	0.0	< 0.001	<0.0002	
Perfluorooctanesulfonic acid (PFOS)	0.0001	0.0002		0.00023		0.0005	< 0.01	0.0	0.0001	0.0002	66.7	0.0037	< 0.01	0.0	0.0004	< 0.01	0.0	< 0.0001	<0.0002	
Perfluoropentanesulfonic acid (PFPeS)	0.001	0.001				< 0.001	< 0.01		< 0.001	0.001	0.0	< 0.001	< 0.01		0.001	< 0.01	0.0	< 0.001	<0.001	
PFASs Summations																				
Sum (PFHxS + PFOS)	0.001	0.005	0.07		0.7	< 0.001	< 0.05		0.0021	< 0.005	0.0	0.0127	< 0.05	0.0	0.0094	< 0.05	0.0	< 0.001	<0.005	
Sum of enHealth PFAS (PFHxS + PFOS + PFOA)	0.001	NR				0.0035	NR		0.0021	NR		0.0177	NR		0.0094	NR		< 0.001	NR	
Sum of PFASs (n=30)	0.005	0.005				0.0115	< 0.05	0.0	< 0.005	< 0.005	0.0	0.0257	< 0.05	0.0	0.0174	< 0.05	0.0	< 0.005	<0.005	
Sum of US EPA PFAS (PFOS + PFOA)	0.001	NR				0.0035	NR		< 0.001	NR		0.0087	NR		< 0.001	NR		< 0.001	NR	
Sum of WA DWER PFAS (n=10)	0.005	0.005				0.0115	< 0.05	0.0	< 0.005	< 0.005	0.0	0.0257	< 0.05	0.0	0.0164	< 0.05	0.0	< 0.005	<0.005	

*** Due to suspended solids in the water samples, Laboratory 2 did not report results for these samples at 'Ultratrace' limits of reporting. NR = value not reported**

GROUNDWATER INTER-LABORATORY DUPLICATES

	Limit of Reporting (µg/L)	Limit of Reporting (µg/L)	DWG	99% Aquatic Ecosys DGV	NPUG (WA DoH)									
	Lab 1	Lab2				Lab 1	Lab2	RPD(%)	Lab 1	Lab2	RPD(%)	Lab 1	Lab2	RPD(%)
Site ID#						**G19**	**G19**		**G28**	**G28**		**G32**	**G32**	
Sample Date						8/11/19	8/11/19		12/11/19	12/11/19		13/11/19	13/11/19	
PFAS ANALYSIS														
n:2 Fluorotelomer sulfonic acids (n:2 FTSAs)- Ultra Trace														
1H.1H.2H.2H-perfluorodecanesulfonic acid (8:2 FTSA)	0.001	0.001				< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001	
1H.1H.2H.2H-perfluorododecanesulfonic acid (10:2 FTSA)	0.001	0.001				< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001	
1H.1H.2H.2H-perfluorohexanesulfonic acid (4:2 FTSA)	0.001	0.001				< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001	
1H.1H.2H.2H-perfluorooctanesulfonic acid (6:2 FTSA)	0.005	0.001				< 0.005	<0.001		< 0.005	<0.001		< 0.005	<0.001	
Perfluoroalkyl carboxylic acids (PFCAs) - Ultra Trace														
Perfluorobutanoic acid (PFBA)	0.005	0.005				< 0.005	<0.005		< 0.005	<0.005		< 0.005	<0.005	
Perfluorodecanoic acid (PFDA)	0.001	0.001				< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001	
Perfluorododecanoic acid (PFDoDA)	0.001	0.001				< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001	
Perfluoroheptanoic acid (PFHpA)	0.001	0.001				0.006	0.007	15.4	0.003	0.001	100.0	< 0.001	<0.001	
Perfluorohexanoic acid (PFHxA)	0.001	0.001				0.005	0.006	18.2	0.004	0.005	22.2	< 0.001	0.002	66.7
Perfluorononanoic acid (PFNA)	0.001	0.001				< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001	
Perfluorooctanoic acid (PFOA)	0.001	0.0004	0.56	19	5.6	0.002	0.0027	29.8	0.006	0.002	100.0	< 0.001	0.0004	85.7
Perfluoropentanoic acid (PFPeA)	0.001	0.001				0.005	0.007	33.3	0.003	0.004	28.6	0.002	0.002	0.0
Perfluorotetradecanoic acid (PFTeDA)	0.001	0.001				< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001	
Perfluorotridecanoic acid (PFTrDA)	0.001	0.001				< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001	
Perfluoroundecanoic acid (PFUnDA)	0.001	0.001				< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001	
Perfluoroalkyl sulfonamido substances- Ultra Trace														
2-(N-ethylperfluoro-1-octane sulfonamido)-ethanol (N-EtFOSE)	0.005	0.001				< 0.005	<0.001		< 0.005	<0.001		< 0.005	<0.001	
2-(N-methylperfluoro-1-octane sulfonamido)-ethanol (N-MeFOSE)	0.005	0.001				< 0.005	<0.001		< 0.005	<0.001		< 0.005	<0.001	
N-ethylperfluoro-1-octane sulfonamide (N-EtFOSA)	0.005	0.001				< 0.005	<0.001		< 0.005	<0.001		< 0.005	<0.001	
N-ethyl-perfluorooctanesulfonamidoacetic acid (N-EtFOSAA)	0.005	0.001				< 0.005	<0.001		< 0.005	<0.001		< 0.005	<0.001	
N-methylperfluoro-1-octane sulfonamide (N-MeFOSA)	0.005	0.001				< 0.005	<0.001		< 0.005	<0.001		< 0.005	<0.001	
N-methyl-perfluorooctanesulfonamidoacetic acid (N-MeFOSAA)	0.005	0.001				< 0.005	<0.001		< 0.005	<0.001		< 0.005	<0.001	
Perfluorooctane sulfonamide (FOSA)	0.005	0.001				< 0.005	<0.001		< 0.005	<0.001		< 0.005	<0.001	
Perfluoroalkyl sulfonic acids (PFSAs)- Ultra Trace														
Perfluorobutanesulfonic acid (PFBS)	0.001	0.001				0.001	<0.001	0.0	< 0.001	<0.001		< 0.001	<0.001	
Perfluorodecanesulfonic acid (PFDS)	0.001	0.001				< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001	
Perfluoroheptanesulfonic acid (PFHpS)	0.001	0.001				< 0.001	<0.001		< 0.001	<0.001		< 0.001	<0.001	
Perfluorohexanesulfonic acid (PFHxS)	0.001	0.0002				0.007	0.0073	4.2	0.005	0.0047	6.2	< 0.001	0.0014	33.4
Perfluorooctanesulfonic acid (PFOS)	0.0001	0.0002		0.00023		0.0033	0.0023	35.7	0.0036	0.003	18.2	< 0.0001	<0.0002	
Perfluoropentanesulfonic acid (PFPeS)	0.001	0.001				< 0.001	<0.001		< 0.001	0.001	0.0	< 0.001	<0.001	
PFASs Summations														
Sum (PFHxS + PFOS)	0.001	0.005	0.07		0.7	0.0103	0.01	3.0	0.0086	0.008	7.2	< 0.001	<0.005	
Sum of enHealth PFAS (PFHxS + PFOS + PFOA)	0.001	NR				0.0123	0.0123		0.0146	0.0097		< 0.001	NR	
Sum of PFASs (n=30)	0.005	0.005				0.0293	0.032	8.8	0.0246	0.021	17.2	< 0.005	0.005	0.0
Sum of US EPA PFAS (PFOS + PFOA)	0.001	NR				0.0053	0.005		0.0096	0.005		< 0.001	NR	
Sum of WA DWER PFAS (n=10)	0.005	0.005				0.0293	0.032	8.8	0.0246	0.02	20.6	< 0.005	0.005	0.0

*** Due to suspended solids in the water samples, Laboratory 2 did not report results for these samples at 'Ultratrace' limits of reporting. NR = value not reported**

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