Human Health and Ecological Risk Assessment

RAAF Base East Sale – Per- and Poly-fluoroalkyl Substances (PFAS) Investigations

Prepared for:
Department of Defence
26 Brindabella CCT
Canberra, ACT, 2600

Distribution

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Senversa Pty Ltd
ABN: 89 132 231 380
Level 6, 15 William Street, Melbourne VIC 3000
tel: + 61 3 9606 0070; fax: + 61 3 9606 0074
www.senversa.com.au

Primary Author		**Project Manager**	
	Lead Risk Assessor		Project Delivery Manager

Peer Review	
	PFAS Lead and Project Director

Executive Summary

Senversa Pty Ltd (Senversa) has been engaged to undertake a Human Health and Ecological Risk Assessment (HHERA) of per- and poly-fluoroalkyl substances (PFAS) impacts which have been identified on and in the vicinity of RAAF Base East Sale (the site). The HHERA forms part of the Department of Defence's response to the detection of PFAS in the environment which may be associated with the historic use of aqueous film-forming foam (AFFF) at the site. The overall objective of the HHERA is to assess risk to human health and the environment due to the presence of PFAS at the site, and in the surrounding area (the Investigation Area, as presented in **Figure 3**). The HHERA was conducted in general accordance with guidance provided in the National Environment Protection (Assessment of Site Contamination) Amendment Measure ('the NEPM') (NEPC, 2013), and the PFAS National Environmental Management Plan 2018 (NEMP) released by the National Chemicals Working Group of the Heads of EPAs Australia and New Zealand (HEPA) ("the NEMP"). For the assessment of human health risks, the HHERA has adopted health based guidance values as derived by FSANZ (2017) and recommended in the NEMP (HEPA, 2018).

The first phase of the detailed environmental investigation, the Preliminary Site Investigation (PSI) was completed by Senversa in October 2016 (Senversa, 2016) and provided a review of historical contamination sources and activities at the site and the site's environmental setting. The PSI identified areas of potential interest and data gaps in the understanding of the preliminary conceptual site model (CSM) for further environmental investigation both on and off-site which were addressed in the Detailed Site Investigation (DSI), completed by Senversa in June 2017. The DSI identified a number of PFAS exposure pathways for which additional assessment was required, due to exceedance of adopted screening criteria (or because no relevant screening criteria are available). On this basis, the DSI recommended that a HHERA be undertaken to provide a detailed evaluation of risks to receptors via the pathways identified as requiring further assessment. An Interim HHERA was completed in December 2017. The Interim HHERA drew conclusions regarding the level of risk posed, and also recommended additional works to refine the risk assessment for a number of pathways. Additional investigations have been completed, and this Final HHERA presents the refined risk assessment incorporating this additional data, and supersedes the Interim HHERA previously prepared for the site.

Additional screening has been undertaken as part of this HHERA. As part of this additional screening, key pathways associated with the greatest potential for exposure were automatically selected for inclusion in the HHERA. For all other pathways, additional screening assessment was conducted to either exclude pathways associated with low and acceptable risk, or include pathways for which further, detailed assessment was required as part of the HHERA. Where risks are assessed to be low and acceptable, no specific additional precautions are required.

Based on the results of additional screening the risks associated with the following pathways were assessed to be low and acceptable:

Recreational water contact in The Heart Morass (people and pets)

- Primary contact (e.g. swimming)
- Secondary contact (e.g. boating or during hunting / fishing from within the water)
- Passive contact (during land based activities at The Heart Morass e.g. nature visits and walks)
- Risks are low and acceptable both for people visiting The Heart Morass, and also for their pets (e.g. dogs who may swim within the Heart Morass)

Incidental contact with soil (on-site and off-site)

- During gardening
- During agricultural work

Incidental contact with water (off-site)

- Risks are low and acceptable for contact with groundwater and surface water
- During gardening with bore water or surface water (e.g. from dams or irrigation lines)
- During agricultural work (e.g. from dams or irrigation lines)

Consumption of home-grown fruit and vegetables (on-site and off-site)

- The assessment conservatively considered the consumption of home-grown produce making up to 100% of produce in the diet (off-site rural properties), or 10% of produce in the diet (for on-site receptors)
- The assessment considered uptake from soil and water used for watering home-grown produce (e.g. tank, bore or irrigation water

Consumption of chicken eggs (off-site)

- Assessment considers potential PFAS uptake into chicken eggs based on soil and water concentrations in the broader Investigation Area, and also for specific properties on which chickens are currently raised

Commercial fisheries pathways (excluding human consumption)

- Carp as crayfish bait
- Carp as fertiliser

Drinking water (on-site and off-site)

- Drinking water supplies on-site off-site are unimpacted by PFAS from the site, and pathways of drinking water ingestion have therefore not been considered further

Terrestrial ecosystems (on-site and off-site)

- Concentrations off-site were below conservative screening levels. A further screening assessment was conducted for on-site soils, and considered the potential risks to terrestrial ecological receptors (including soil microorganisms, invertebrates and plants, and higher order predators)

The following were identified as the key pathways for further consideration in the HHERA:

Agriculture, fishing and game hunting

- Consumption of livestock and dairy products from the area
- Livestock health
- Consumption of recreationally hunted ducks
- Consumption of recreationally caught fish, or fish from commercial fisheries

Incidental contact with water

- Shallow groundwater by intrusive workers on-site
- Drain water by intrusive workers on-site
- Drain water by workers off-site

Aquatic Ecosystems

- Risks to aquatic plants and animals
- Risks to higher order predators consuming aquatic plants and animals

It is noted that there are multiple key pathways for which further assessment has been undertaken in the HHERA. It is however considered unlikely that individual receptors within the Investigation Area would be exposed to PFAS via more than one of these key pathways. In particular, local residents who may be exposed via the home consumption of livestock and dairy products did not indicate (in surveys) that they consume fish and ducks recreationally hunted from The Heart Morass. It is additionally unlikely that visitors to the area (e.g. recreational users of The Heart Morass) or public consumers of livestock, dairy products or fish would be exposed via multiple pathways. On this basis, each of these key pathways has been assessed separately for the purposes of assessing risks.

This HHERA has assessed risks both on-site, and for the off-site Investigation Area as a whole. The on-site area is considered separately, as the concentrations of PFAS are higher on-site, and the nature of the potential exposures is different. For off-site areas, the HHERA assessed whether there are potentially elevated risks across the Investigation Area as a whole (rather than on specific properties). The aim of this approach is to allow broad conclusions to be drawn for the Investigation Area as a whole.

Surface water and sediment sampling has been completed in surface waters beyond The Heart Morass (and outside the Investigation Area), including the Latrobe River, the Thomson River, Flooding Creek, Sale Common and Dowd Morass. Additional investigations included biota sampling from the Latrobe River (fish and lower order biota) and Thomson River (lower order biota only). These investigations identified PFAS concentrations within surface waters beyond The Heart Morass. The available data has been used (together with other lines of evidence) to assess the nature and extent of PFAS impacts associated with historical use of legacy AFFF on the site. Based on this it is considered that the PFAS impacts (within water, sediment, and biota) associated with historical use of legacy AFFF on the site are defined and largely contained within The Heart Morass and not migrating significantly from this area under normal Latrobe River flow conditions. Therefore, PFAS impacts identified in other surface waters (e.g. the Latrobe River, Flooding Creek, Sale Common and the Dowd Morass) are most likely attributable to wider catchment (i.e. ambient) issues. This conclusion is reached based on the elevation of the Latrobe River compared to the adjacent morass wetlands; the measured concentrations (in surface water, sediment and biota) from The Heart Morass and other surface waters; and the behavioural patterns of fish identified in the area. This assessment supports the appropriateness of the extent of the Investigation Area defined in the DSI and HHERA.

As such, while PFAS has been identified in surface waters, sediments and biota, and exposure of fish and aquatic ecological receptors to PFAS within surface waters beyond The Heart Morass (and outside the Investigation Area) is possible, the measured concentrations, and any associated exposure, are considered to be attributable to wider-catchment issues. Despite this, the HHERA has included assessment of the potential pathways associated with exposure to identified concentrations

within surface waters beyond The Heart Morass for completeness (including ecological risks and risks associated with fish consumption), even though any associated risks are considered unlikely to be solely attributable to the historical use of legacy AFFF on the site.

It is additionally emphasised that this HHERA is based on the available data. While extensive investigation data has been collected from across the Investigation Area (and in some areas outside the Investigation Area), there is limited data regarding the temporal variability in PFAS concentrations.

Overall summary of potentially elevated risks

The HHERA has identified potentially elevated risks associated with the following pathways:

- Home-consumption of meat, offal and milk raised on-site at high consumption rates. It is noted that the grazier does not currently consume beef raised on-site, and there are currently no dairy cows on-site, and so a pathway of home-consumption of cattle meat, offal and milk raised on-site is currently inactive. It is however noted that sheep are raised on-site for home consumption, and there are considered to be potentially elevated risks associated with home-consumption of lamb raised on-site at high consumption rates (based on a conservative assessment).
- Home consumption of duck meat and duck liver recreationally hunted from The Heart Morass even at low consumption rates (i.e. 1 serve of duck/month).
- Home consumption of fish caught recreationally from The Heart Morass (while noting that risks are low and acceptable at lower consumption rates in some locations).
- Public consumption of commercially caught fish from The Heart Morass (in the area of the Eastern Main Drain Outlet only).
- Home consumption of eels and carp caught recreationally from the Latrobe River (high consumption rates only).
- Exposure to aquatic ecological receptors in surface waters in the Investigation Area, and to higher-order predators consuming biota from these areas as part of their diet. Marginally potentially elevated ecological risks are identified for the Latrobe River.

The identification of potentially elevated risks does not necessarily indicate that there will be adverse effects, but instead that management of risks may be warranted.

The risks associated with other pathways considered in detail in the HHERA were assessed to be low and acceptable. Where risks are assessed to be low and acceptable, no specific additional precautions or management are required. This includes pathways of:

- public consumption of meat, milk or offal raised on-site.
- home consumption or public consumption of meat, milk or offal raised off-site.
- public consumption of commercially caught fish from The Heart Morass (with the exception of the area around the Eastern Main Drain Outlet).
- public consumption of commercially caught fish (other than eels and carp) from the Latrobe River (regardless of consumption rate) or of eels and carp from the Latrobe River (at lower consumption rates).
- home consumption of recreationally caught fish from the Latrobe River.
- incidental groundwater contact on-site, or contact in drains on-site or off-site.
- livestock health (on-site and off-site).

Risk associated with the consumption of livestock and dairy products from the area, and risk to livestock health

On-site

Potential risks to public consumers (of meat, offal and milk raised on-site and entering the public food supply) are assessed to be low and acceptable.

- The primary assessment considers a scenario where meat enters a broader regional or national market. Risks associated with this scenario are more than 10 times below the acceptable level.
- The risk assessment also considers (as part of the sensitivity analysis) a scenario where a larger proportion of meat in an individual's diet (10%) is sourced from the Investigation Area. This is protective of a scenario where there is a local sales channel, such that multiple purchases of meat from the investigation area by a single purchaser are plausible. Risks were also assessed to be low and acceptable for this scenario.
- For milk, it is noted that there are currently no dairy cows on-site, and so a pathway of public consumption of milk raised on-site is currently inactive, but is also assessed to be associated with low and acceptable risks.

There is considered to be a potentially elevated risk associated with the home-consumption of meat, offal and milk raised on-site (at high consumption rates). It is noted that the grazier has indicated they do not currently consume beef raised on-site, and there are currently no dairy cows on-site. Therefore, a pathway of home-consumption of cattle meat, offal and milk raised on-site is currently inactive. It is however noted that sheep are raised on-site for home consumption, and there are considered to be potentially elevated risks associated with home-consumption of lamb raised on-site (at high consumption rates). PFAS concentrations are generally lower in the eastern area of the site where sheep are raised, and as such the assessment of potential risks for home-consumption of beef is likely to be conservative for assessment of the potential risks associated with home-consumption of lamb.

Risks to livestock health on-site are assessed to be low and acceptable, indicating that no specific additional precautions or management are required for this pathway.

Off-site

Potential risks to home consumers (of meat, offal and milk raised off-site) are assessed to be low and acceptable, indicating that no specific additional precautions or management are required for this pathway.

Potential risks to public consumers (of meat, offal and milk raised off-site and entering the public food supply) are assessed to be low and acceptable. The estimated risks for all off-site pathways to public consumers are at least 30 times below the acceptable level. Given this large margin of safety, there is therefore a relatively high level of confidence that risks to public consumers of meat, offal and milk raised off-site are low and acceptable.

Risks to livestock health off-site are assessed to be low and acceptable, indicating that no specific additional precautions or management are required for this pathway.

Consumption of recreationally hunted ducks

Based on the assessment, there is concluded to be a potentially elevated risk associated with the home consumption of duck meat and duck liver recreationally hunted from The Heart Morass even at low consumption rates (i.e. 1 serve of duck/month). The identification of potentially elevated risks does not necessarily indicate that there will be adverse effects, but instead that management of risks and/or further investigation/assessment may be warranted.

It is noted that there is no known commercial duck hunting from The Heart Morass. As such the HHERA focusses on assessing the risks associated with consumption of recreationally hunted duck.

Consumption of recreationally caught fish, or fish from commercial fisheries

The Heart Morass

Recreational fishing

Overall, it is concluded that potential risks associated with consumption of recreationally caught fish from The Heart Morass are potentially elevated, even at lower consumption rates, although it is noted that there are certain locations and fish types for which the risks are assessed (based on the measured concentrations at these locations) to be low and acceptable at lower consumption rates.

Notably, in the far eastern extent of The Heart Morass (Location 7), risks are assessed to be low and acceptable for consumption rates of 1 serve/week or less. In the western portion of the main body (Location 5) and the Latrobe River Outlets, risks are assessed to be low and acceptable for consumption rates of 1 serve/month or less.

Commercial fisheries

Risks to public consumers are assessed as potentially elevated for fish caught in the vicinity of the Eastern Main Drain outlet, but are low and acceptable for fish caught from other locations.

For eels caught in the vicinity of the Eastern Main Drain outlet, ranching (where smaller eels from The Heart Morass are transferred to freshwaters in other areas to increase weight before being harvested for consumption) would likely be effective in reducing risks to a low and acceptable level.

Latrobe River

Recreational fishing

Overall it is concluded that potential risks associated with consumption of recreationally caught eels from The Latrobe River are low and acceptable for consumption rates of 1 serve/month or less. For carp, risks are low and acceptable for consumption rates of 1 serve/week or less, and for riverine recreational species found in the river (red fin, yellow belly, mullet, and estuary perch) risks are low and acceptable at all consumption levels.

The risk profile does not change significantly between the up-gradient and down-gradient locations, with a minority of the eel and carp samples from both sampling locations associated with potentially elevated risks at high consumption levels.

Commercial fisheries

Based on the range in PFOS+PFHxS in fish sampled from the Latrobe River, the risks associated with all samples are low and acceptable and are also low and acceptable when the 95%UCL is assessed; this includes the conservative assessment of consumption of 2 serves/year (over one or several meals). It is concluded that the risks associated with a public consumption pathway are low and acceptable.

Incidental contact with groundwater and drain water on-site, or drain water off-site

It is concluded that the potential risk to on-site intrusive workers (maintenance and construction) associated with PFOS, PFHxS and PFOA in groundwater (or to the cumulative exposure to PFOS, PFHxS and PFOA in soil and groundwater) is low and acceptable. However, if large scale construction takes place on site then reasonable precautions to limit construction workers contact with groundwater should be employed, consistent with Defence's management systems and procedures for PFAS management to be implemented by Defence personnel and Contractors. These conclusions are also considered to apply for on-site (Base) personnel undertaking training exercises, as the potential exposure frequency and duration is likely to be lower for Base personnel than for intrusive or construction workers.

As the maximum concentrations measured in shallow groundwater are higher than the concentrations measured in the open drainage network, and the potential for exposure by workers is considered to be similar in nature, these conclusions are also considered applicable for on-site or off-site workers entering the open drainage network. It is additionally noted there is limited data for temporal variability of drain concentrations, but that shallow groundwater is likely to be discharging into the open drain network; this further indicates the appropriateness of using the shallow groundwater concentrations to assess the likely levels of risk associated with both shallow groundwater contact, and also water contact within the open drainage network.

These conclusions are also considered to apply for on-site (Base) personnel undertaking training exercises, as the potential exposure frequency and duration is likely to be lower for on-site (Base) personnel than for intrusive or construction workers.

Pathways to aquatic ecological receptors, including higher order predators consuming aquatic biota

The Heart Morass

- Reported PFOS concentrations in surface water from The Heart Morass were above the screening level for assessment of adverse effects due to direct contact exposure by aquatic species and bioaccumulation within aquatic ecosystems.
- Reported PFOS concentrations in aquatic biota (including plants, invertebrates and fish) and ducks exceeded relevant dietary screening concentrations for the protection of a range of relevant bird receptors.

Overall, it is not considered possible to exclude potential adverse effects to ecological receptors within The Heart Morass, although it is emphasised that for species which source only a portion of their diet from within the Investigation Area, risks are likely to be lower than indicated in this assessment. The identification of potentially elevated risks does not necessarily indicate that there will be adverse effects, but instead that management of risks and/or further investigation/assessment may be warranted.

The measured PFAS concentrations in ducks exceed avian diet screening levels; however, it is noted that these ducks themselves are migratory and are likely to source their diet widely (not just from The Heart Morass); as such, while the measured concentrations pose potentially elevated risks to predators eating these ducks as part of their diet, there is a level of uncertainty around whether the measured PFAS concentrations in ducks relate solely to exposure in The Heart Morass, or to other potential sources in the area.

Latrobe River

- Reported PFOS concentrations in the Latrobe River were below the screening level for assessment of adverse effects due to direct contact exposure by aquatic species, but above the screening level and bioaccumulation within aquatic ecosystems.
- Based on the reported PFOS concentrations in aquatic plants and invertebrates, risks were assessed to be low and acceptable for a range of relevant bird receptors.

- Based on the reported PFOS concentrations in fish, risks were assessed to be low and acceptable for a range of relevant bird receptors (waterbirds and eagles), but could not be excluded for all birds (a marginal risk was identified based on the default screening level).

Overall, it is not considered possible to entirely exclude potential adverse effects to higher-order predators consuming biota from within the Latrobe River, although the risks were assessed as generally low and acceptable (marginal at worst), and it is emphasised that for species which source only a portion of their diet from this area, risks are likely to be lower than indicated in this assessment. The identification of potentially elevated risks does not necessarily indicate that there will be adverse effects.

Relationship of identified PFAS impacts in the Latrobe River to wider catchment issues

The Heart Morass is assessed as unlikely to be a significant source of PFAS in the Latrobe River. The presence of PFAS impacts in the Latrobe River (and other up-gradient and down-gradient surface water bodies in the area) is considered most likely attributable to wider catchment issues, than solely from impacts migrating from the site. This includes the PFAS identified in surface water, sediment and biota (plants, invertebrates and fish) from the Latrobe River.

The extent of PFAS impact to surface water, sediment and aquatic plants as a result of Defence's use of AFFF on the site is therefore assessed to be largely contained to The Heart Morass and not migrating significantly from this area under normal Latrobe River flow conditions. As such, while marginally potentially elevated risks are identified for the Latrobe River (both marginal risks via ecological bioaccumulation pathways, and risks associated with the consumption of recreationally caught carp and eels at high consumption rates), such risks are considered most likely a wider catchment issue, and should be managed accordingly as part of a catchment wide approach.

Next Steps

The identification of potentially elevated risks does not necessarily indicate that there will be adverse effects, but instead that management of risks and/or further investigation/assessment may be warranted. Potentially elevated risks cannot be excluded for a number of pathways, based on the currently available data. The collection of additional data, including further assessment of extent and temporal variability, may assist with refining the current assessment of the potentially elevated risks, and the requirement for management measures.

Given the understanding of the risks, it is understood that Defence has committed to identify and prioritise management actions to address health, environmental and community issues arising from the identified PFAS impacts that can be implemented in the short, medium and long term. This is the next step in the investigations program and possible management actions will be presented in a site specific PFAS Management Area Plan (PMAP) to be developed for the site.

This executive summary must be read in conjunction with the full report.

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