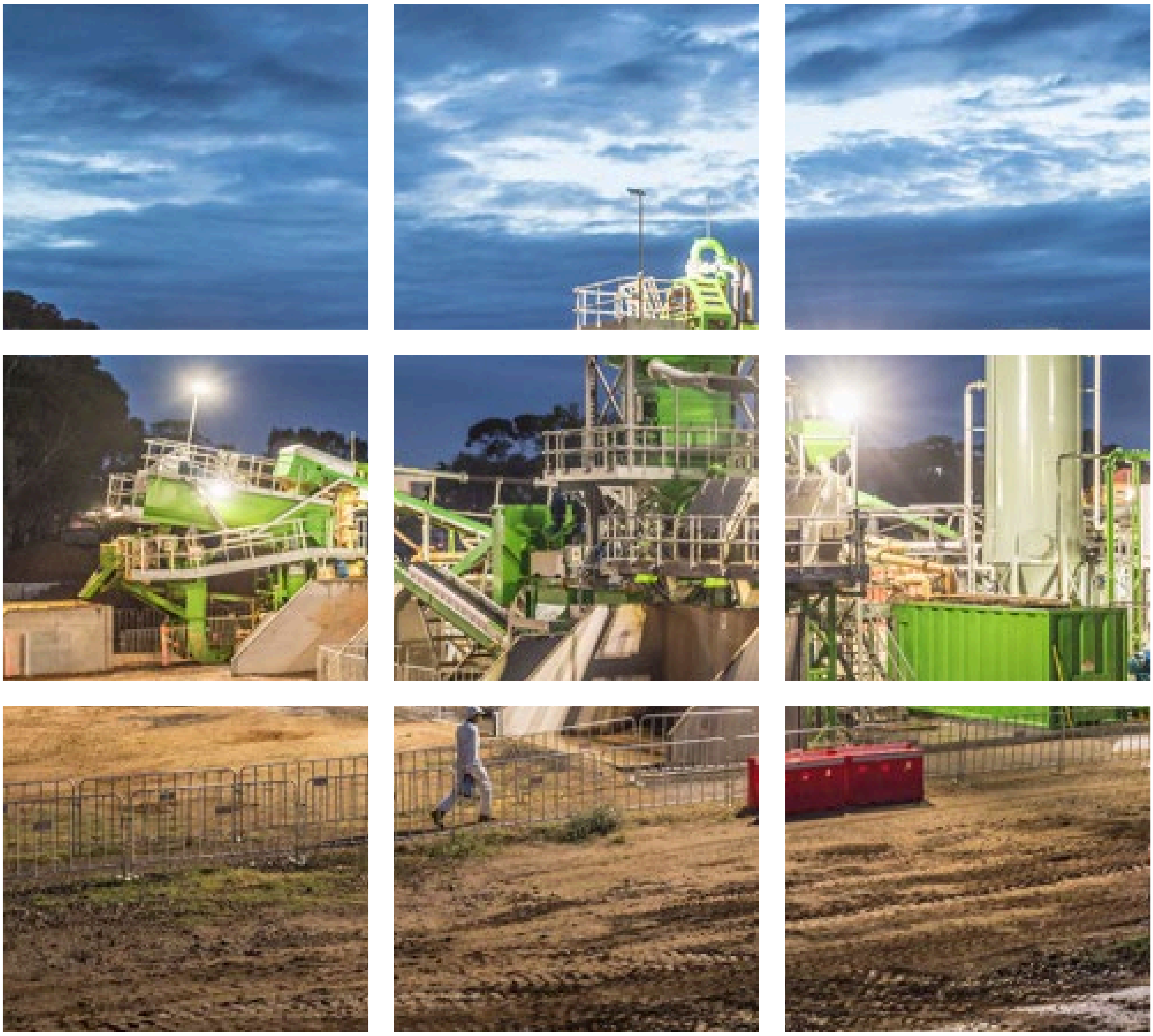
Ventia Submission - PFAS Subcommittee of the Joint Standing Committee on Foreign Affairs, Defence and Trade

Remediation of PFAS-related impacts – ongoing scrutiny and review



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1 Table of Contents

1 Introduction 2
1.1 PFAS – Focus on a sustainable solution 2
1.2 Key points of our submission..3

2 PFAS Remediation and Soil Treatment Technologies...4
2.1 Remediation scenario's 4
2.2 Commercially available technologies...6

3 Ventia SourceZone® Technology 7
3.1 Collaboration with Department of Defence 7
3.2 SourceZone Technology 7
3.3 RAAF Edinburgh POP Trial 9
3.4 Technology development 10
3.5 Essington Lewis Awards..10

4 Country Fire Authority Fiskville Remediation Project 11
4.1 PFAS water treatment 11

5 PFAS Technology Research...13
5.1 University of Newcastle ARC Linkage Project 13
5.2 University of Queensland ARC Linkage Project...14
5.3 ALGA Research and Development Grant...15

6 State and Federal Regulation of Remediation Works 16
6.1 Preferred hierarchy of remediation options...16
6.2 Licencing and approvals..16
6.3 PFAS criteria and reuse of treated soil 17
6.4 Harmonising landfill acceptance criteria 18

1 Introduction

Ventia is pleased to provide this submission to the PFAS Subcommittee of the Joint Standing Committee on Foreign Affairs, Defence and Trade in relation to the remediation of PFAS-related impacts – ongoing scrutiny and review.

Our submission provides an overview of the challenges of PFAS management and remediation and some of the technologies available in Australia, several of which are currently being used by Ventia to remediate per- and poly-fluoroalkyl substances (PFAS) in the environment.

The submission details information on Ventia's patented soil treatment technology – SourceZone® – and provides an overview of the Department of Defence RAAF Edinburgh Proof-of-Performance (POP) trial where the technology was first deployed and is still currently operating.

We have also provided information on the remediation of PFAS impacted soil, water and sediment at the Victorian Emergency Management Training Centre at Fiskville which is currently being undertaken by Ventia on behalf of the Country Fire Authority (CFA).

In addition, we have provided detail on the research conducted by Ventia as part of the Australia Research Council (ARC) PFAS Special Research Initiative (SRI) grants as well as the grant received from the Australasian Land & Groundwater Association (ALGA) which focused on improving measurement reliability of the PFAS Total Oxidisable Precursor (TOP) assay.

This submission also includes observations in general regarding relevant State and Federal governance and regulation of PFAS soil and groundwater remediation works based on our current and past projects and 35 years' experience in the remediation and management of complex soil contamination.

1.1 PFAS – Focus on a sustainable solution

The remediation of PFAS contamination represents a unique and global challenge. As with other contaminants in our environment, there is generally not one 'silver bullet' that will fix the problem. The risks that PFAS present to human health and the environment need to be sustainably balanced with a proportionate remediation response.

Due to the persistent, mobile, bio accumulative and toxic nature of these chemicals and their ubiquity globally, the challenge is even greater, and requires extensive and practical cooperation between government agencies, regulators, researchers and industry.

The alignment of regulatory guidelines and criteria with a range of risk-based remediation technologies and management approaches that focus on a holistic sustainable solution to the problem will provide confidence to the communities impacted by these chemicals.

Ventia has invested substantial resources and financial commitment over the past six years to addressing the challenge of remediation and removal of PFAS from our environment.

The vision of our team is to remove the most PFAS mass from the environment in the most cost-effective way possible.

We can do this through the removal and treatment of high concentration source areas that are sustainably reduced in volume. This can be achieved through our SourceZone technology (allowing 99% of the soil to be reused), with the resulting small volume of high concentration PFAS able to be destroyed via thermal destruction in the near future.

This approach removes PFAS from the environment and substantially reduces the ongoing risk of these chemicals to the health and wellbeing of our environment and our communities.

1.2 Key points of our submission

1. Ventia's SourceZone soil treatment technology provides a proven substantial **reduction in the total mass** of PFAS at a site and significantly reduces ongoing contamination risk to the environment and human health.

2. PFAS mass in **source areas** at impacted sites is the source of off-site risk and a very small amount of leaching from these source areas can result in a major offsite problem. Remediation of source areas is widely understood to be the most **cost-effective approach** to addressing PFAS risk at impacted sites.

3. **Thermal destruction** of PFAS is still not proven, however Ventia and the University of Newcastle have closed the fluorine mass balance in the laboratory (a fundamental piece of missing research) and are conducting a full-scale demonstrative field trial in 2020. This key research will provide communities with confidence that PFAS in the gas phase can also be destroyed with certainty and that emissions from thermal plants are safe.

4. If PFAS contaminated soils are to be sustainably and cost effectively managed, this needs to happen onsite and for that to occur, **site-specific reuse criteria are required** under regulatory approval. The lack of criteria discourages onsite treatment and reuse of soil.

5. **Harmonisation of PFAS national landfill** acceptance criteria must occur. Environmental regulators should adopt the criteria in each state and Territory to ensure that there is a nationally consistent approach and that PFAS impacted soils are not transported interstate for disposal.

2 PFAS Remediation and Soil Treatment Technologies

Remediation of PFAS impacted soil is a relatively new and evolving challenge. To date, much of the focus on the remediation and management of PFAS impacts in the environment has been on the management of contaminated groundwater and surface water, principally to address the risk of PFAS related harms to onsite and offsite human and environmental receptors.

As with the assessment and management of other anthropogenic contaminants in our environment, the understanding of the source-pathway-receptor relationship is critical in addressing the risk presented by PFAS in the environment.

If the source of the contamination is not managed or treated, potential risks to humans and the environment, both onsite and offsite, can continue.

2.1 Remediation scenario's

A typical PFAS-contaminated site generally consists of several source areas (such as fire training areas) with a high concentration of PFAS mass in the soil and groundwater which has contributed to localised and regional groundwater contamination due to the very mobile nature of these compounds.

If the source area(s) on the site are not addressed, they can continue to contribute significant contamination mass to onsite and off-site surface water and groundwater. In the source area even if the mass of PFAS in the water is a fraction (0.1 - 1.0%) of what occurs in the soil, the concentration in water can exceed criteria and create significant challenges that require addressing.

To understand how a typical PFAS contaminated site could be addressed, a hypothetical scenario was published in the Australasian Land and Groundwater Association (ALGA) journal – CRONICLE in May 2017, which was authored by Peter Nadebaum (GHD), Dr John Hunt (Ventia) and Garry Smith (Geosyntec).

The discussion in the CRONICLE article was framed in terms of a hypothetical site and was intended to be illustrative of the sorts of issues that arise on PFAS impacted sites and was not intended to be definitive advice. It does however assist stakeholders with understanding how PFAS contamination can often be distributed at a site and provides some informed insight as to how the problem can be addressed, which is useful for the purpose of this submission.

Based on this hypothetical scenario and **Figure 1** (taken from the hypothetical), there is an assumption that a large amount of the contaminant mass is concentrated in a small source area typically found where fire training or waste management practices were undertaken.

Figure 1: Assumed distribution of PFOS contamination in soil at a hypothetical site (Source – ALGA Cronicle 50)

Based on this hypothetical scenario, the distribution of soil contamination was further modelled to indicate where PFAS mass (in particular PFOS) may occur. As you can see from **Table 1** (taken from the CRONICLE article), even with some conservative assumptions, it is likely that the bulk of the PFAS mass occurs in the primary source area.

Table 1. Summary of assumed soil contamination parameters

Soil	Area (m^2)	Average depth of contamination (m)	Volume (m^3)	Mass soil (t)	Average PFOS concentration (mg/kg)	PFOS mass (kg)
Area A	10,000	3	30,000	54,000	17	900
Area B	25,000	1	25,000	45,000	2	90
Area C	750,000	0.2	150,000	270,000	0.04	10

Notes: assumed density of soil is 1.8t/m^3; concentrations are rounded.

As with all issues relating to PFAS, there has been significant evolution in the industry's understanding of the chemical complexity, behaviour, exposure and toxicity of these compounds and how they can be managed in the environment. Removal of PFAS from source areas is a responsible and pragmatic strategy to addressing PFAS impacts on the Defence Estate **that minimises the contamination legacy for future generations.**

2.2 Commercially available technologies

The preferred hierarchy for PFAS treatment and remediation options as detailed in the PFAS National Environmental Management Plan (NEMP) 2.0 is focused on **separation, treatment and destruction** in the first instance, followed by onsite encapsulation and lastly offsite removal to a specific landfill cell. The NEMP 2.0 and State and Federal Regulation of these works is discussed in more detail in **Section 6.**

More broadly, these options can be split between:

- Technologies that remove PFAS from the environment now; and
- Management activities that reduce the risk of contamination now but defer removal or additional management of PFAS to the future, creating a legacy issue that will require future generations to undertake further remediation/management.

The distinction is an important one especially when considering PFAS, which in general, do not breakdown in the environment by natural processes. Unless PFAS are removed they remain in the environment for a very long time, which is why they are known as 'Forever Chemicals'.

Commercially available technologies for the separation, treatment and destruction of PFAS contaminated soil that effectively remove PFAS from the environment are extremely limited and include:

- Ventia's SourceZone technology, and
- High temperature thermal destruction.

It should be noted at this time that there are concerns being raised in the United States of America regarding the thermal destruction of PFAS as to whether all compounds are being destroyed. In that respect, thermal destruction of PFAS is still an evolving technology and one that requires additional research and development. This issue is discussed in more detail in **Section 5.2** of this document.

Management approaches and commercially available technologies for the treatment of PFAS contaminated soil that can reduce the risk presented by PFAS — but do not remove it from the environment — include:

- Encapsulation: encapsulating the contamination with or without a leachate collection system;
- Onsite containment and/or capping: construction of a low permeability liner and/or cap;
- Immobilisation / stabilisation using amendments to reduce the leachability of PFAS; and
- Landfill disposal (available in NSW, QLD and WA, and in VIC under application to EPA Victoria).

Other technologies exist at the laboratory-scale, but few have been upscaled to field-scale and less have been upscaled with suitable scientific rigor to provide confidence they can be deployed at a large scale.

SourceZone (discussed in **Section 3** below) represents one of only a few technologies for the treatment of PFAS impacted soil that has been scientifically proven and is commercially available at full-scale.

3 Ventia SourceZone® Technology

Ventia's **patented** SourceZone technology, developed in conjunction with CleanEarth Technologies Inc of Nova Scotia, Canada, is a world first proven technology that removes PFAS from soil.

Ventia was awarded a contract by the Australian Department of Defence (Defence) in 2019 to undertake a large-scale trial of the technology, treating PFAS contaminated soil from a fire training area at the RAAF Base Edinburgh (Edinburgh), South Australia.

The trial of the technology at RAAF Edinburgh has attracted interest from across the globe and the technology trial has been visited by members of the US Navy, US Airforce, German EPA, Canada Department of National Defence, University of Stockholm, Colorado School of Mines, and locally Air Services Australia, CSIRO, SA EPA, Department of Environment and Energy, University of Adelaide, University of Newcastle, and the University of Queensland among others.

3.1 Collaboration with Department of Defence

Ventia has worked in a collaborative arrangement with Defence since 2018 to trial the SourceZone technology at full-scale.

Given this is the first time the technology has been applied at this scale, the metrics governing success had not previously been defined. A dynamic environment was therefore required where results could be discussed and reflected on. The success of the relationship with Defence rested on early collaboration and workshopping to identify and reduce risk throughout the process along with clear and consistent communication.

Defence has shown great foresight in collaborating with industry to trial technologies for treating PFAS contaminated soil where few technologies existed in the world. In this respect, they have recognised the need to pivot from groundwater treatment at their sites to addressing the source areas of the site where most of the PFAS mass exists. Their focus on soil treatment technologies is world leading in this regard.

Together, Defence and Ventia have been able to demonstrate that we can minimise the risk to humans and the environment from exposure to PFAS, turning back the clock on the significant issues associated with the historical use of PFAS at Defence bases around the country.

The primary challenge with developing a technology of this scale is understanding the problem before it has been fully defined so that a solution of appropriate scale can be developed.

Given the emerging nature of the contaminants, regulatory frameworks, analytical and investigative approaches Ventia acknowledges Defence's openness in sharing information regarding their PFAS contaminated sites and the scale of their problem with industry and encourages other government agencies to do the same.

3.2 SourceZone Technology

Typical soil washing processes are ineffective at removing PFAS from soil – especially in fine-grained silt/clay soils. Ventia's SourceZone introduces a new technology that is markedly different from traditional soil washing, and permanently removes up to 99% of PFAS contamination from soil, including silts and clays.

The primary objective of traditional soil washing is to separate contaminated soil into its size fractions (categories) and concentrate the contaminants into the fines (silt and clay) to reduce the total volume of contaminated soil.

The fines are then managed as a smaller volume, higher concentration, waste stream. The US Interstate Technology & Regulatory Council (1997) notes that traditional soil washing is not typically feasible for sites with greater than 30-50% silt/clay as the large silt/clay waste stream would make the technology uneconomical.

SourceZone uses a wet, physical and chemical process to remove PFAS from all soil fractions, including the silt/clay fraction.

The principal steps of the process involve:

- Excavation and stockpiling of soil from the contaminated soil source area;
- Sampling and testing of the stockpiled soil to assess PFAS levels;
- Feeding of contaminated soil into SourceZone using an excavator or loader;
- Soil is transported via a conveyor to the first wet process within SourceZone;
- Soil is sprayed with a wash solution to start the process of removing PFAS;
- Soil is then exposed to many individual processes, depending on the size and density of the soil particles, to enhance desorption of PFAS;
- Washed soil is then dried and stored in bunkers for further sampling and testing;
- Following confirmation of results, the soil is collected by an excavator or loader and reused as backfill within the excavation;
- Finally, the wash solution is cleaned to be reused again to wash further soil.

Key elements of SourceZone include:

- The process can treat soils at a rate of 10 tonnes per hour for clay soils and 30 tonnes per hour for sandy soils;
- The process is a net consumer of water. On average untreated soil has a moisture content of 15%. After treatment soil moisture is between 20-30%. The process therefore requires 0.5-1.5m^3/hr of water;
- SourceZone is completely bunded and lined. Any water landing on the surface is directed to a plant sump; from there the water is pumped into the plant and cleaned by the water treatment plant. When it rains, we can include the rainwater in the process;
- Dust generated from handling soil is negligible given SourceZone is a wet process;
- Noise generated from the plant is very low (measured LAeq 15 min <60 dB(A));
- The process washes all size fractions of soil including silts and clays. At RAAF Edinburgh 99.7% of the treated clay soil was reused onsite as backfill within the excavation.

Ventia's SourceZone process at the RAAF Edinburgh project is shown in **Figure 2**.

Figure 2: Ventia's PFAS soil treatment plant - SourceZone.

As SourceZone is designed to treat soils at the source of the contamination problem, PFAS is being removed from the environment at the first stage of the source-pathway-receptor process. This prevents PFAS leaching to groundwater and surface water and migrating into the surrounding environment.

3.3 RAAF Edinburgh POP Trial

Ventia's SourceZone technology underwent a Proof-of-Performance (POP) trial at RAAF Edinburgh between July 2019 and June 2020.

2,579 tonnes of PFAS impacted clay (between 75% and 90% silt and clay) soil from Edinburgh was treated with SourceZone. A further 1,447 tonnes of PFAS impacted sandy (90% sand) soil from RAAF Base Williamtown in New South Wales was also brought to the site and treated using SourceZone.

Workers involved in the trial were protected from PFAS contamination via a rigorous occupational health and hygiene program developed in conjunction with independent risk assessors. Further, all water falling on the bunded plant pad was captured and treated within the plant's water treatment system. Dust was also suppressed using an automated dust suppression system and dust emissions were confirmed to be low using perimeter dust monitoring.

The successful POP trial proved the following:

- **The process can be used to treat clay soils** – all Edinburgh soils (clay soils) met the remediation criteria stipulated by Defence;

- **The process removes significant PFAS mass** – up to 99% of PFAS mass and on average 90% PFOS + PFHxS in clay soils and 98% PFOS + PFHxS in sandy soils;
- **The process removes trucks from roads and the requirement for clean backfill** – 99.7% of the Edinburgh soils were reused as backfill onsite, eliminating the financial and environmental cost of purchasing and transporting clean-fill; and
- **The process generates low volumes of waste** – from the treatment of Edinburgh soils the plant generated <0.6% waste consisting of 0.3% of Edinburgh soil that was not reused (the organics fraction of soil – sticks, leaves and roots etc) and 0.3% absorbent media used to clean the plant's wash solution. Waste material was collected and sent to a licenced waste facility for processing.

The trial removed over 46kg of PFOS + PFHxS mass from the environment. This mass of PFAS is equivalent to 9,200L of foam concentrate. Further, based on the training regime of fire fighters at RAAF Edinburgh this represents 26 years of fire-training activities. This significant amount of PFAS mass was removed from the environment.

> *A typical water treatment technology treating contaminated groundwater plumes generated from these source areas would take nearly 6 months operating 24-hours a day to remove the same mass of PFAS that SourceZone removes in one 10-hr day.*

46kg PFOS + PFHxS is equivalent to:

- 9,200L of 3M Lightwater™ AFFF concentrate.
- 310 fire-training events.
- 26 years of fire training on Defence sites.

We are currently removing c.450g PFOS / day (100t/d at ~5mg/kg) from the environment.

This is equivalent to ~1 fire-training event per day.

This is just one metric in communicating remediation success to a wider audience. Understanding the volume of foam that was used at a site and how much mass of PFAS is removed during remediation activities will assist Defence with communicating remediation progress across the estate and providing confidence to their communities that the problem is steadily being addressed.

3.4 Technology development

SourceZone has continued to treat PFAS impacted soil at RAAF Edinburgh and to date, over 12,000 tonnes of soil have successfully been treated by the technology.

We have also undertaken trials of the technology to treat PFAS impacted concrete which is another problematic area of concern for Defence, with PFAS strongly adsorbing to concrete with potentially large volumes of impacted concrete across the Defence estate. These early trials are showing promising results.

Ventia's SourceZone technology is currently available to treat PFAS contaminated soil on other sites within Australia and New Zealand. Further, Ventia is designing and building a mobile plant to be able to mobile and demobilise quickly if the need arises.

3.5 Essington Lewis Awards

Following completion of the early stages of the trial, SourceZone became a finalist in the Australian Defence Magazine Essington Lewis Awards in the Support/Services category.

The awards recognise excellence in collaboration between industry and Defence to overcome challenges or problems – ensuring the Australian Defence Force has the material it needs, when it needs it, and at a cost that represents value for money.

Further information on the Essington Lewis Awards can be found here.

4 Country Fire Authority Fiskville Remediation Project

Ventia was engaged by the Country Fire Authority (CFA) in Victoria to rehabilitate the former Victorian Emergency Management Training Centre at Fiskville (**Figure 3**). For many years, training using aqueous fire-fighting foam (AFFF) containing PFAS, was conducted at the site and soil and groundwater were impacted by these chemicals.

Rehabilitation works began in early 2019, with Ventia decommissioning the practical area drill (PAD) site, removing the training props, underground pipework and a petroleum storage system within the training area.

Figure 3: CFA Fiskville Remediation Project.

Using highly specialised technical expertise, Ventia developed a high-resolution PFAS waste characterisation program and third-party endorsed sampling, analysis and quality plan (SAQP) for PFAS contaminated structures.

The site contained four dams, the small man-made Lake Fiskville and Beremboke Creek that flows across the entire estate. The previously decommissioned PAD had many drill areas to simulate different fire-fighting scenarios, including a plane crash, service station and various building structures.

To date, the team has excavated over 150,000 m^3 of soil and treated more than 55 million litres of water on the project.

4.1 PFAS water treatment

One of the first of its kind in Victoria, Ventia installed an innovative water treatment plant (WTP) that received Victorian Environmental Protection Agency (EPA) approval to release treated water continuously back into the environment.

Approval for continuous release of treated water is contingent on strict sampling frequency and criteria, as well as comprehensive proof of performance trials being completed prior to receiving discharge approval.

A cap lining system, designed by CFA's Environmental Consultant, is being used to encapsulate PFAS impacted soil on site within an area called the In-situ Soil Management Area (ISSMA), shown in **Figure 4**.

PFAS-impacted soil was excavated from various parts of the site, environmentally classified and then backfilled within the ISSMA. Extensive environmental and occupational hygiene management controls were put in place for the handling of the impacted materials. Numerous quality control requirements and measure are in place which also included auditor approval of hold points during the construction phase.

The ISSMA measures approximately 100,000m^2 in area. At the base, two large internal drainage sumps have been lined with a complex multilayered lining system, which, coupled with the ISSMA's internal drainage system, will collect any leachate that infiltrates the cap lining system.

The finished containment cell measures approx. 120,000m3 and includes an extensive leachate collection system.

Figure 4 ISSMA July 2020

Clean material and topsoil will be placed over the cap lining system and revegetated with an approved indigenous seed mix.

This large-scale project required complex waste stream management for contaminants present on site, including PFAS and PFAS impacted asbestos.

In just a few short months, our Ventia team will be re-establishing the native landscape and handing back the rehabilitated, historic site to the CFA.

We are proud to be involved with such a significant rehabilitation project that will help inform the management of other PFAS-impacted sites, across Australia and the world.

5 PFAS Technology Research

PFAS, being an emerging contaminant, requires significant research to be undertaken across all aspects of the environmental industry to gain the required minimum knowledge to effectively manage the contaminant.

There are still significant gaps in knowledge in keys areas such as human health toxicology, PFAS behavior in the environment and remediation of PFAS in soil and water. This presents many challenges to an industry that is trying to manage and remediate the PFAS problem now before key fundamental knowledge has been developed. To undertake a successful PFAS remediation project therefore a significant focus on research is required.

Ventia takes pride in investing heavily in the research and development of PFAS remediation technologies, and the environmental industry in general, so that remedial solutions can be applied with certainty.

Following is a summary of three of Ventia's PFAS research projects.

The Australian Research Council (ARC) announced up to $13 million in grants as part of the national PFAS Remediation Research Program.

Ventia was pleased to support two of the awarded projects, under the program:

- University of Queensland (UQ) project lead by Professor Jochen Mueller; and
- University of Newcastle (UoN) in partnership with Suez Ventia Joint Venture (SVJV) led by Professor's Eric Kennedy and Michael Stockenhuber.

Over $2 million of funding has been provided by the ARC to these two projects and Ventia and the SVJV have committed cash and in-kind support to this critical research.

The grants enable Ventia's on the ground experience to be combined with the research of some of the world's leading academics in seeking solutions to environmental concerns surrounding PFAS.

Related links to the projects are found here:

- https://www.arc.gov.au/grants/linkage-program/special-research-initiatives/pfas-remediation-research-program
- https://www.uq.edu.au/news/article/2018/08/36-million-contamination-research
- https://www.newcastle.edu.au/newsroom/featured-news/arc-awards-uon-$1.5m-to-develop-pfas-remediation-solutions

The third research project was awarded by the inaugural Australasian Land and Groundwater Association (ALGA) Research and Development Grant.

All three projects are described further below.

5.1 University of Newcastle ARC Linkage Project

World experts Professor Eric Kennedy and Michael Stockenhuber (University of Newcastle) and their teams are investigating the thermal decomposition of PFAS compounds. The work will underpin the development and application of technology used to destroy PFAS compounds.

There is currently little research or information available about the fate of breakdown compounds when PFAS is subjected to elevated temperatures; rather, there is an abundance of misconceptions.

How PFAS breaks down in a thermal environment is dependent on the conditions encountered in a thermal process. If those conditions are not optimal you may end up with problems relating to gaseous emissions. The research at the University of Newcastle involves the fundamental study of the breakdown behaviour of PFAS under a variety of conditions.

The research findings to date have been very interesting. Different breakdown products have been made, depending on the conditions used in the laboratory.

The research finds are planned to be tested in a world-first full scale demonstration in late 2020. The large-scale trials will be conducted using the SVJV soil treatment facility at Dandenong, Victoria. Commissioned and licensed by the EPA Victoria in 2019, the facility uses the latest thermal desorption and stabilisation technologies, and currently treats Category A and B contaminated soils.

This vital research is ensuring that PFAS is adequately destroyed during treatment and not inadvertently discharged to the atmosphere as undetected treatment by-products. This is an exciting and significant contribution to the scientific community and remediation industry globally.

5.2 University of Queensland ARC Linkage Project

The University of Queensland (UQ) project, headed by Professor Jochen Mueller, aims to assess the applicability of Ventia's SourceZone technology and immobilisation as cost-effective techniques for the remediation of Australian soils contaminated with PFAS.

The project expects to establish the efficacy of the remediation of a range of PFAS, including many of the thousands of polyfluorinated precursors, which few have been identified and even fewer have characterised with any level of detail.

The project will provide a scientific basis for understanding the benefits and limitations associated with SourceZone and immobilisation techniques and a more comprehensive understanding of potential future liabilities associated with formation of PFAS from precursors remaining in remediated soils.

The project draws on the expertise of preeminent PFAS researchers in Australia and the United States including:

- Professor Jochen Mueller – University of Queensland
- Dr Jennifer Braeunig – University of Queensland
- Dr Emma Knight – University of Queensland
- Ms Kristie Thompson – University of Queensland
- Miss Rose Nguyen – University of Queensland
- Professor Michael McLaughlin – University of Adelaide
- Dr Shervin Kabiri – University of Adelaide
- Dr Rai Kookana – CSIRO
- Dr Divina Navarro – CSIRO
- Professor Christopher Higgins – Colorado School of Mines
- Mr John Corfield – Brisbane Airport Corporation Pty Ltd
- Professor Jennifer Field – Oregon State University
- Dr Craig Barnes – Air Services Australia Pty Ltd
- Mr Charles Grimison – Ventia Pty Ltd

5.3 ALGA Research and Development Grant

Ventia — in collaboration with the National Measurement Institute (NMI), Australian Laboratory Services (ALS) and Eurofins Environment Testing Australia (Eurofins) — was awarded the inaugural Australasian Land and Groundwater Association (ALGA) Research and Development Grant to conduct an inter-laboratory assessment of the PFAS total oxidisable precursor (TOP) assay.

The study provided much-needed research and advice regarding the reliability of the TOP assay and was a substantial contribution to development of the contaminated land industry in Australia and New Zealand.

The PFAS TOP assay was first developed in 2012 as a method for identifying non-target PFAS and provided a better understanding of the extent of overall PFAS contamination present within a sample.

Quantifying non-target PFAS is important to better understand ongoing sources of chemicals in the PFAS family, including PFOS and PFOA, both at contaminated sites and in the waste industry (sewage treatment effluents, biosolids, landfill leachates).

The ability to reliably quantify non-target PFAS is an important tool for anyone involved in the long-term regulation, management and remediation of PFAS contamination. Currently the TOP assay has not been adopted as widely as it perhaps could be given a common perception that it is not sufficiently robust to allow quantitative consideration of non-target PFAS in environmental regulation.

Findings of the project indicate that if standardised laboratory approaches to the application of the PFAS TOP assay in water samples are applied, results can be generated that are robust and reliable between laboratories.

Recommendations from the project will improve interpretation of TOP assay results and strengthen the potential for TOP assay data to be included in regulation as a quantitative tool.

Further, the project references performance criteria proposed within the Heads of EPAs Australia and New Zealand (HEPA) (2018) PFAS National Environmental Management Plan (NEMP) and provides recommendations to the relevance of this criteria where necessary. Subsequently the research was referenced in NEMP 2.0.

In summary, the research project:

- Conducted an inter-laboratory study to evaluate the laboratories' methods for the TOP assay;
- Compared and assessed the participating laboratories' accuracy in the measurement of PFAS before and after application of the TOP assay;
- Developed recommendations for the assessment and application of TOP assay data; and
- Developed performance criteria for national guidance documents.

Click here to read the full report, and the recommendations proposed on ALGA's website.

6 State and Federal Regulation of Remediation Works

In general, Australia has taken a proactive and leading role in regulating PFAS at the national level. The coming together of the Heads of EPAs (HEPA) and formulation of a national PFAS guidance — PFAS National Environmental Management Plan Version 2.0 (NEMP 2.0) — is progressive and sensible. It helps companies like Ventia to develop solutions for our clients within the boundaries of a defined framework.

6.1 Preferred hierarchy of remediation options

Australia's preferred hierarchy of options in the ASC NEPM for site clean-up and management of soil contamination is:

- On-site treatment of soil contamination, so that the risk associated with the contaminant is reduced to an acceptable level;
- Off-site treatment of excavated soil, so that the risk associated with the contaminant is reduced to an acceptable level, after which it is returned to the site.

If it is not possible to implement one of two above, then other options for consideration can include:

- Removal of contaminated soil to an approved site or facility, and replacement with clean fill where necessary;
- Containment of the contamination on-site either in-situ with appropriate controls that reduce the risk to an acceptable level, or in an appropriately designed and managed containment facility;
- Adoption of a less sensitive land use or controls for on-site activities that will reduce the need for remedial works.

This is supported by the preferred hierarchy of treatment and remediation options presented in the NEMP 2.0 and summarised as follows:

1. **Separation, treatment and destruction**. This involves on-site or off-site treatment of the PFAS-contaminated material so that it is destroyed, removed, or the associated risk is reduced to an acceptable level.
2. **On-site encapsulation in constructed stockpiles or engineered storage and containment facilities, with or without chemical immobilisation**. If the source site is hydrogeologically appropriate, on-site encapsulation may acceptably manage on- and off-site risks to direct and indirect beneficial uses and environmental values of soils, surface water, groundwater, and biota.
3. **Off-site removal to a specific landfill cell**. This may or may not include immobilisation prior to landfill disposal, noting that the conditions in the landfill may reverse or diminish the immobilisation chemistry in ways that are difficult to predict. Immobilisation prior to landfill disposal may require environmental regulatory approval. Leachate should be captured and treated to remove PFAS and the removed PFAS should be destroyed.

6.2 Licencing and approvals

In practice, Option 1 described in the ASC NEPM and NEMP 2.0 is only applicable to large remediation sites due to the costs and duration of the approvals and licensing process, which varies in complexity from state to state, with NSW and Victoria being the most complex.

Option 2 occurs infrequently, and only at sites that have the storage space or area for containment. In an urban setting many remediation sites are development sites with basements and are net soil exporters, meaning excess clean fill is available at minimum cost in many locations.

Given the relatively small size of the remediation market in Australia, there is usually a hiatus between onsite projects, which mean that remediation plant is stored between projects and experienced staff lost, making the onsite treatment model even more inefficient and expensive. Many brownfield development sites have contamination issues, but most could not be developed within the timeframe that it would take to gain approvals and licenses for onsite remediation.

The obvious solution from an efficiency, time, cost and environmental outcome perspective for small to medium contaminated site remediation projects is the development of a network of licensed contaminated soil treatment facilities.

It is only recently that significant offsite treatment facilities have been established and then only in Victoria, mainly because they are not recognised as critical infrastructure by state governments and supported as such.

It is extremely difficult to establish soil treatment facilities (other than in Victoria) due to entrenched public opposition to the siting of waste infrastructure in general and lack of government support to do so. The result is that disposal of contaminated soil to landfill and onsite encapsulation and sterilisation of land continues to be the usual remediation solution for soil contamination on most of the small to medium contaminated sites.

6.3 PFAS criteria and reuse of treated soil

NEMP 2.0 contains a range of site assessment investigation criteria for soil, groundwater, biota, drinking water and landfill disposal. Site reuse criteria are to be established by the process of site-specific risk assessment.

This effectively means that treated soil will often be reused onsite or landfilled, because offsite reuse would require a risk assessment to be undertaken for any potential receiving site, with associated costs and delays and stigma of receiving soil that is perceived to be contaminated. Few treatment technologies can treat soil to below detection limits for PFAS but even soil that is treated to below the detection limit for PFAS requires approval for reuse (for example, as clean fill offsite), which must be negotiated on a case-by-case basis.

The lack of clarity around reuse criteria and defaulting to laboratory detection limits as reuse criteria adds significant time and cost to PFAS treatment projects if onsite use or containment is not possible.

More importantly, it provides a disincentive for onsite treatment and encourages the disposal of soil to landfill or onsite containment (deferring the problem to the future), when treatment is the only effective way to reduce the mass of PFAS in the environment and the associated risks to human health and the environment in the long term.

It is acknowledged that future work undertaken by the National Chemicals Working Group (NCWG) as part of the NEMP work program will focus on six themes, two of which will focus on:

> '*…the further development of indirect and direct ecological guideline values for soil, PFAA behaviour and the influence of soil chemistry, and guidance on managing PFAS in soil, such as potential criteria for reuse of soil*'; and
>
> '*development of additional guidance on managing PFAS in resource recovery for non-organic and organic waste, and sampling of unusual matrices including those found in construction waste*'.

Ventia believes this work stream is critical in establishing viable treatment solutions for PFAS. As such, Ventia believes it is appropriate and necessary that the NCWG engages with industry, in a collaborative way and that the engagement is more than just token industry briefings or request for comments. The environmental industry in Australia has significant, and often leading, knowledge in many of these areas and could help the NCWG achieve a high quality, inclusive outcome in a shorter timeframe.

6.4 Harmonising landfill acceptance criteria

Landfill disposal criteria are presented within NEMP 2.0, however; not all state regulators are adopting the criteria in a consistent way. The NSW EPA, for example, adopted interim landfill criteria in 2016 which are significantly less stringent than the criteria within the PFAS NEMP 2.0. The leachate criteria presented in the NEMP 2.0 for double-composite lined landfills is 7 µg/L (via ASLP). The current landfill criteria for the equivalent NSW waste category — restricted solid waste — is 200 µg/L (via TCLP) or at least 28x less stringent (the discrepancy may be even higher given differences between the leaching methods).

Until the NEMP 2.0 criteria is adopted, the less stringent criteria in NSW will mean orders of magnitude more PFAS contaminated waste will be sent to landfill rather than treated with technologies that remove or destroy PFAS. This means that most of the technologies currently available, and aligning with the ASC NEPM and NEMP 2.0 hierarchy, will not be viable.

Further Discussion

Ventia is available for further discussion on the topics addressed by this submission.

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