Execution of a Field-Scale Planted Greenhouse PFAS Uptake Study at RAAF Base Williamtown, New South Wales, Australia

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Background/Objectives. Historical use and discharge of aqueous film forming foam (AFFF) by the Australian Department of Defence at the Royal Australian Air Force (RAAF) Base Williamtown (Base), has resulted in legacy per- and poly-fluoroalkyl substances (PFAS) impacting locations both on and off the base. Investigations undertaken at and near the Base have identified PFAS contamination in various media including soil, sediment, surface water, groundwater and biota including plants, fish and birds. Extensive use was historically made of surface water and groundwater for residential and agricultural purposes in the areas surrounding the Base, including, but not limited to, irrigating edible fruits and vegetables.

In 2017, a plant PFAS uptake study was requested to allow Defence and others to advise on fruit and vegetable irrigation practices and consumption to the local community. The data were used to refine plant uptake factors and exposure point concentrations utilized in the human health risk assessment (HHRA, 2016 and 2017), which in turn was employed to evaluate risk to human health. The objective of this study was to collect a statistically reliable and robust data set of PFAS uptake into fruit and vegetables that could be utilized to refine the uptake factors and exposure concentrations employed in the HHRA. The findings of the study were used to understand how different contaminated water concentrations affected uptake of PFAS in various species of fruit and vegetables.

Approach/Activities. The field-scale uptake study was novel in being executed at the Base, within four constructed greenhouse enclosures, using PFAS-impacted groundwater derived from RAAF Bases at Williamtown and the Army Aviation Centre Oakey (AACO), Queensland, and separate drip-irrigation trials using prepared groundwater dosages of 1 μg/L, 10 μg/L and 100 μg/L total perfluorooctanoic acid (PFOA), perfluorooctanesulfonic acid (PFOS), perfluorohexanoic acid (PFHxA) and perfluorohexane sulfonate (PFHxS). A control consisted of plants irrigated with clean groundwater derived from a groundwater well located in the Williamtown region. A total of seven test crops were studied: lettuce, tomato, cucumber, alfalfa, beet, radish, and strawberry. Tomato failed to produce during the study.

The uptake study was phased with four primary stages of activity, which included: 1) pre-design, 2) design, 3) implementation of a 90- to 120-day plant uptake study, and 4) harvesting, analysis and assessment of data.

Results/Lessons Learned. Transfer factors (TF) were reliably derived for radish, radish leaf, beet leaf, and lettuce and compare to previously reported TF. Cucumber and strawberry represented statistically stunted population pools and derived TF are less reliable. Initial and on-going hurdles included maintaining consistent environmental conditions within four separate greenhouses, plant tolerances to high-salinity groundwater derived from AACO, maintaining consistent irrigate flow to over 250 potted plants, leachate recovery, plant pest and pathogen management, plant nutrient requirements, and laboratory quality assurance and quality control. Various tips and lessons learned will be presented in the final deliverable.