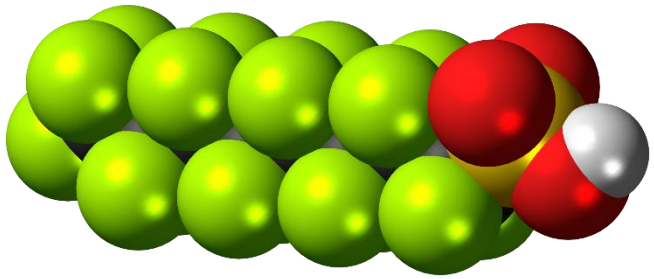
Application of Soil Amendments for Reducing PFAS Exposure and Bioavailability

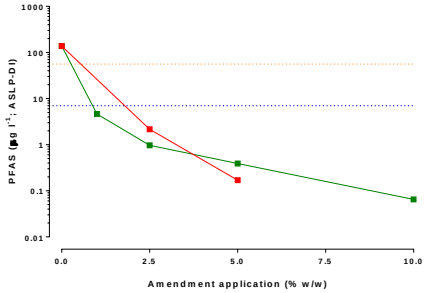
Albert L. Juhasz[a] and Richard Stewart[b]

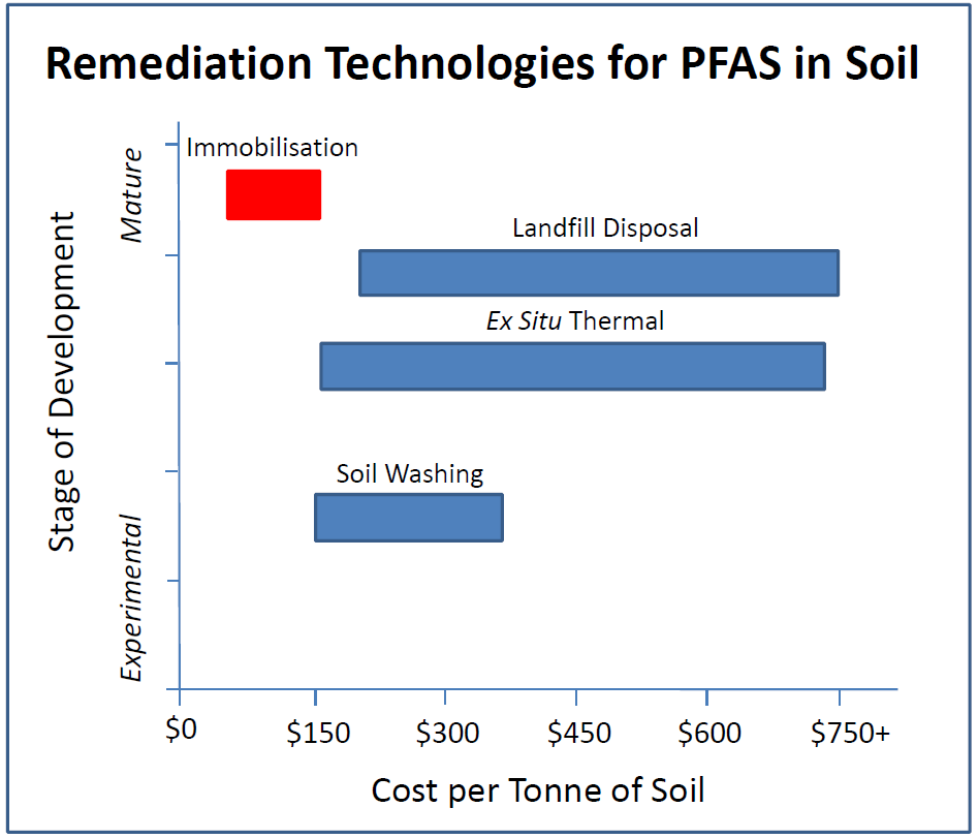
[a]*Future Industries Institute, University of South Australia, Australia*
[b]*Ziltek Pty Ltd, Adelaide, Australia*

PFAS Exposure and Remediation



- High electronegativity
- High bond strength
- Limits oxidation of per-fluoro compounds
- Poly-fluoro compounds (+ precursors) may undergo transformation





PFAS Exposure and Remediation

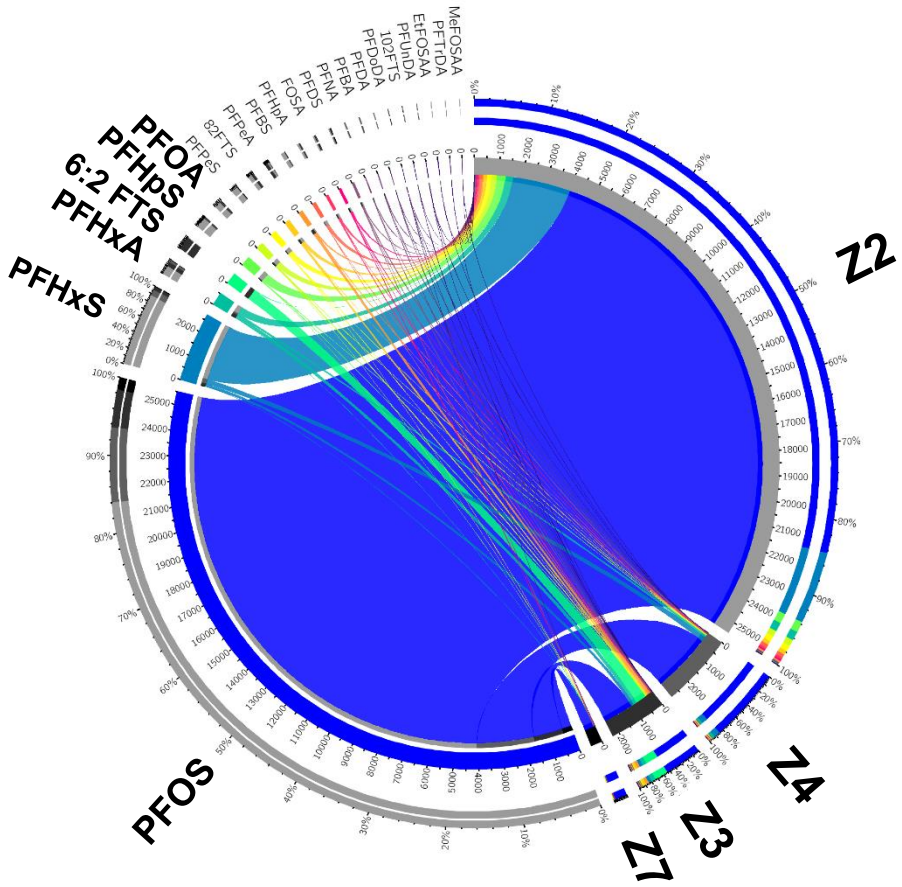
Aim: Assess the impact of soil amendments on:

1. PFAS leachability
2. PFAS bioavailability

RemBind™ technology, jointly owned by the CSIRO and Ziltek Pty Ltd, has been fully commercialised by Ziltek Pty Ltd (US Patent 8,940,958 B2)

RemBind™: Composite product comprising amorphous aluminium hydroxide, kaolin clay and activated carbon

PFAS Exposure and Remediation – Research Approach



Bench scale immobilisation studies

RemBind™ formulations
Application rates

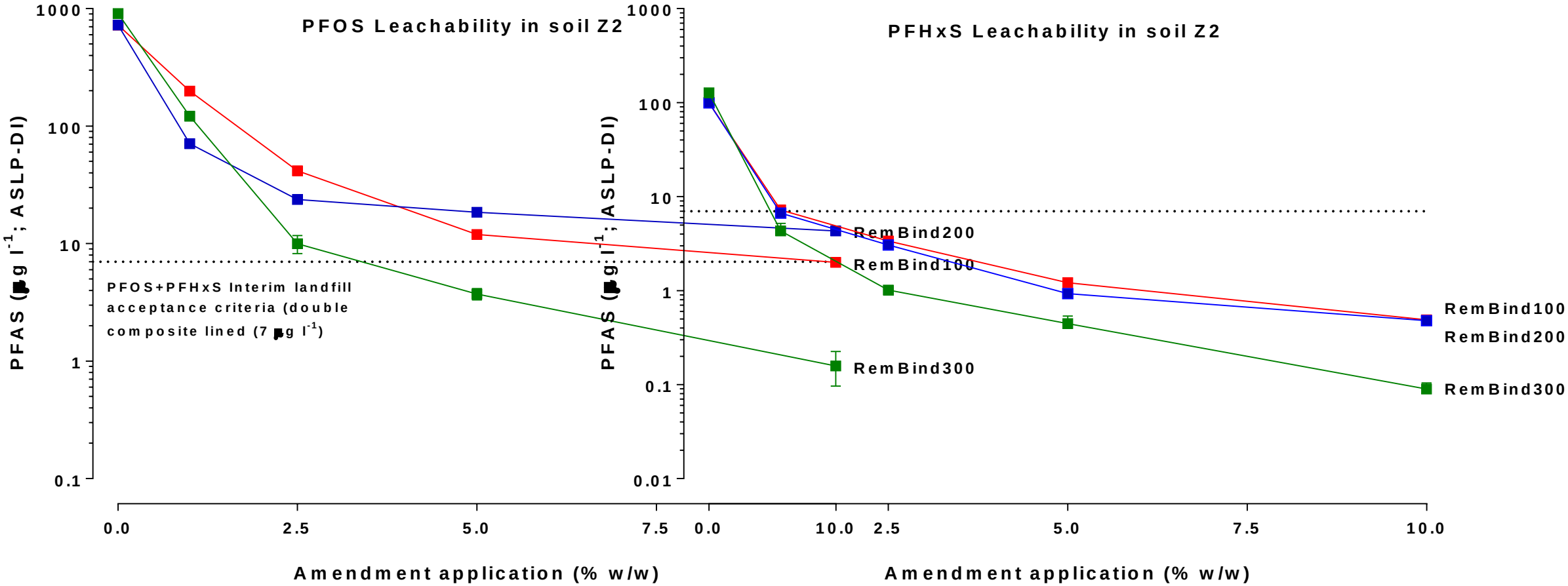
PFAS mobility

ASLP-DI
Effect of pH
MEP

PFAS bioavailability

In vivo mouse model
Fate of pure compounds
Assessment of RBA

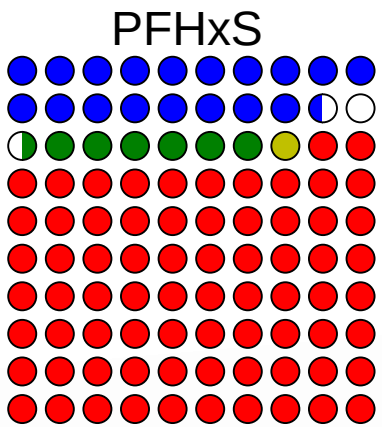
PFOS and PFHxS Leachability – Pre- and Post-Amendment

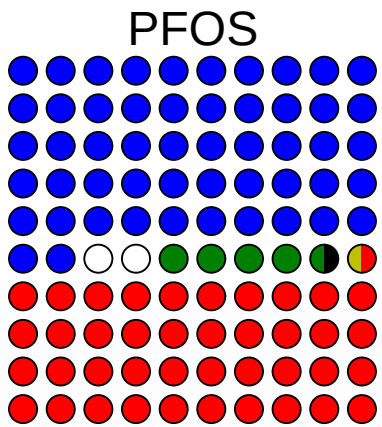


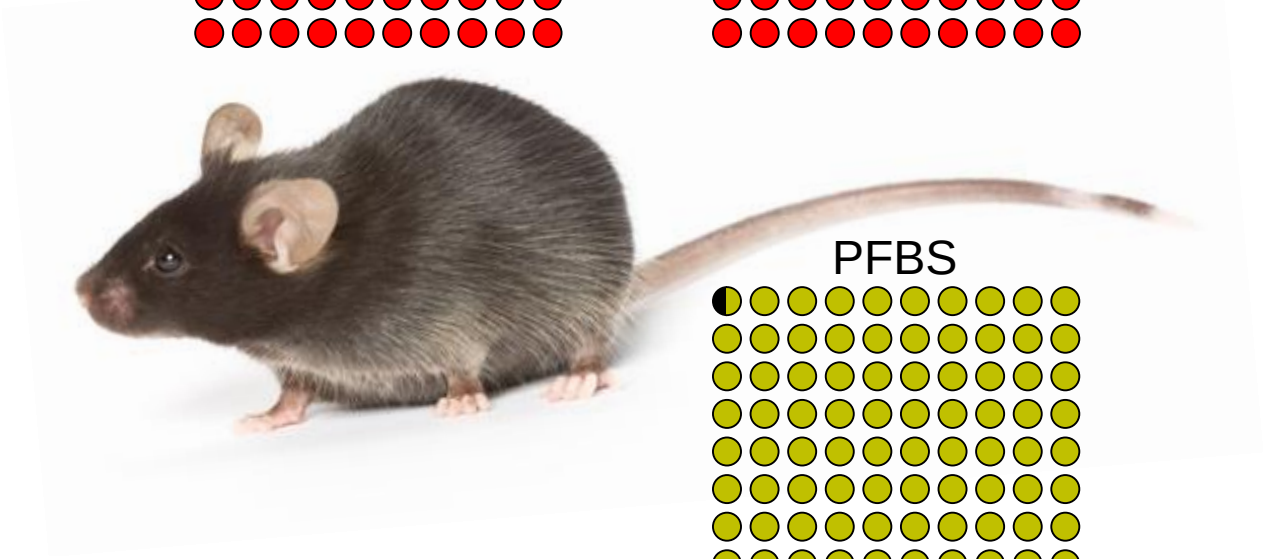
PFAS Bioavailability – Research Approach

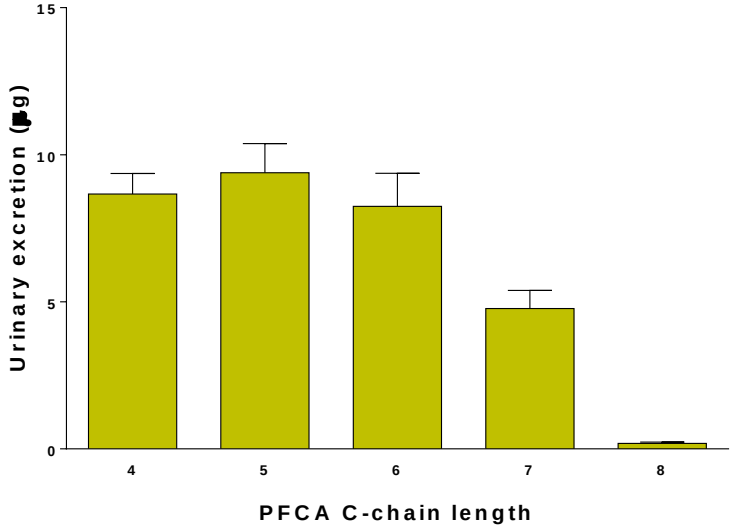
- C57BL/6 mice – well established breed
- 10 day exposure study (9 + 1)
- For each treatment – 4 operational units, each comprising 3 mice
- PFAS (0.01-1.0 µg kg^{-1}), contaminated soil (1% w/w) or amended soil (up to 10% w/w) added to AIN93G chow
- PFAS-AIN93G chow supplied *ad libitum*
- Health, consumption, excretion data monitored daily
- Following exposure, PFAS concentration in tissue / excreta is determined
- Determine dose-response and bioavailability endpoints
- Determine PFAS relative bioavailability in soil using pure compounds as the reference

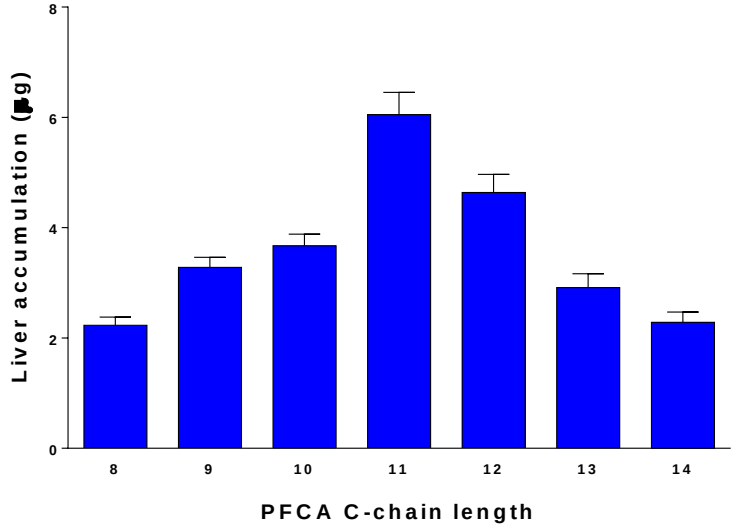
Assessment of *In Vivo* PFAS Distribution





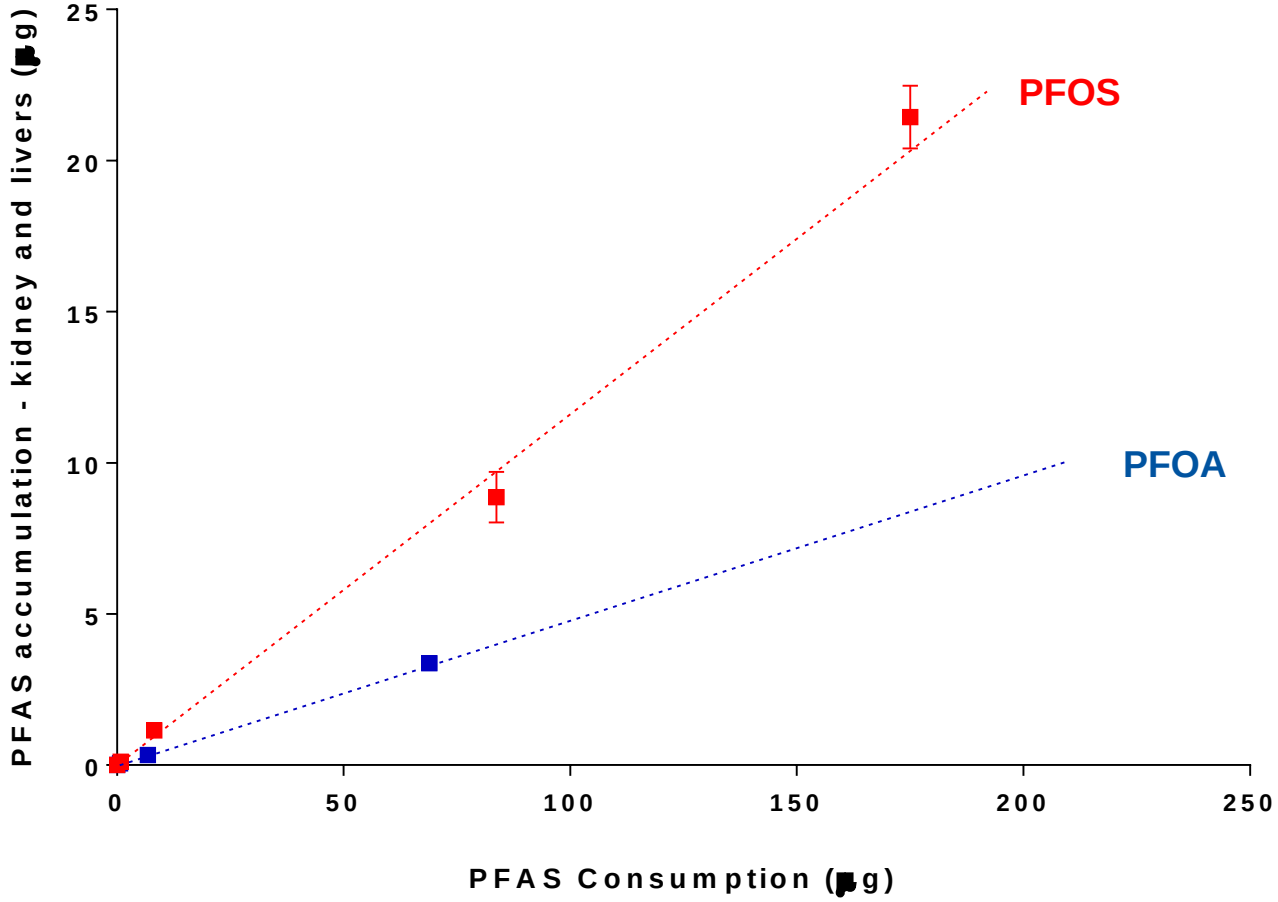




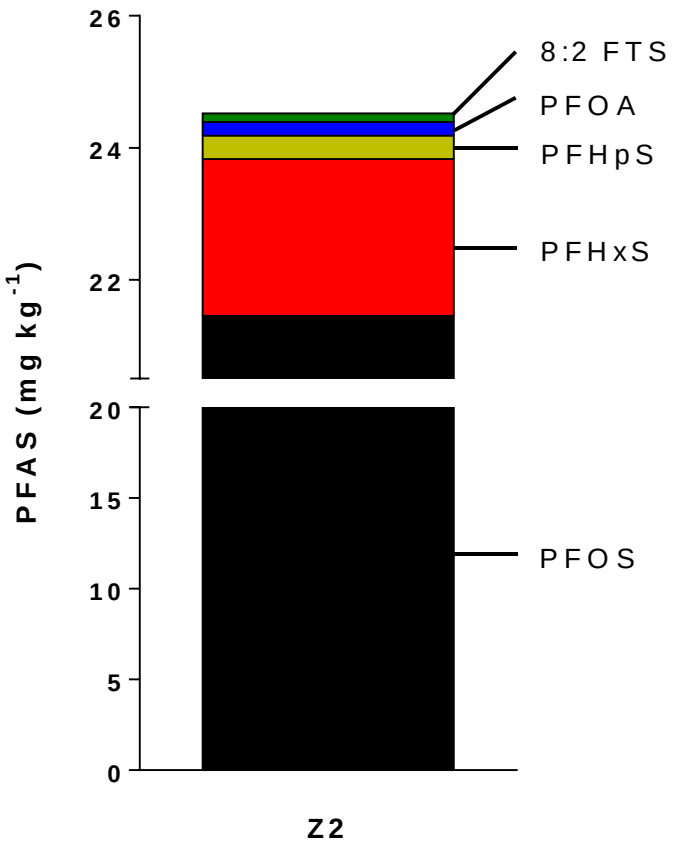


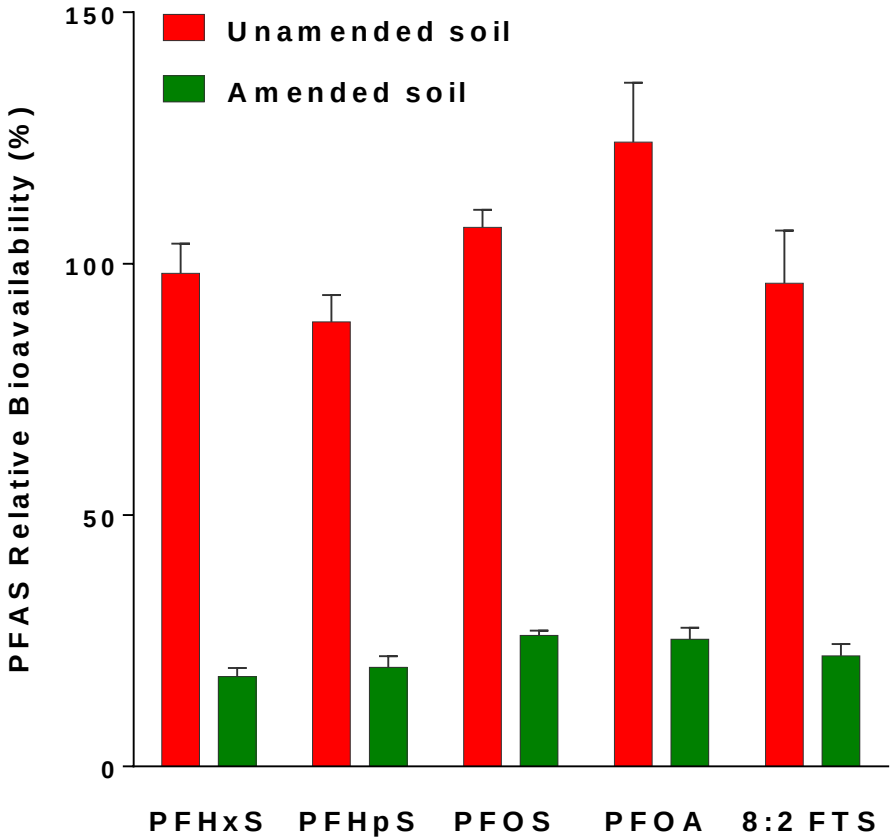
Assessment of PFAS Bioavailability

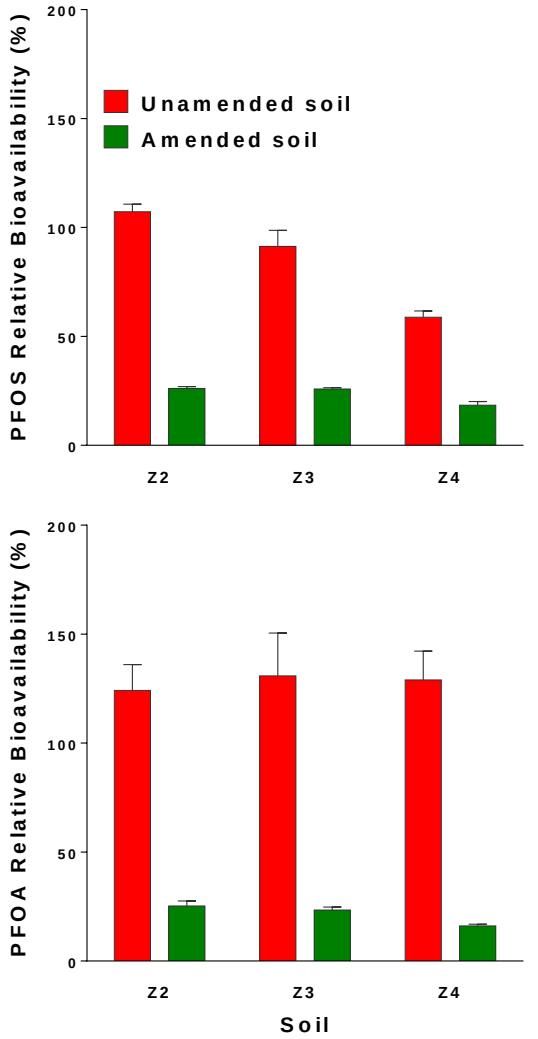
- Short-chain PFAS were excreted in the urine; PFCA were excreted to a greater extent than PFSA.
- Urinary excretion decreased with increasing perfluoralkyl chain length.
- PFAS accumulated in the liver; increasing accumulation with increasing carbon chain length was observed for PFCA up to a cut off of C11.
- Linear dose-responses were observed; urinary excretion (PFBS, C4-C6 PFCA), accumulation in organs and / or carcass.



Assessment of PFAS Relative Bioavailability







Conclusions

- Amendment of PFAS-contaminated soil with Rembind™ (at 5% w/w) reduced PFAS leachability by > 99%
- Dose-response studies highlighted differences in PFAS fate *in vivo* → this has implications for bioavailability endpoint monitoring.
- PFAS RBA in contaminated soil was reduced by > 75% when soil was amended with 5% w/w Rembind™.
- Future research includes the development of new Rembind™ formulations that can further reduce PFAS RBA.

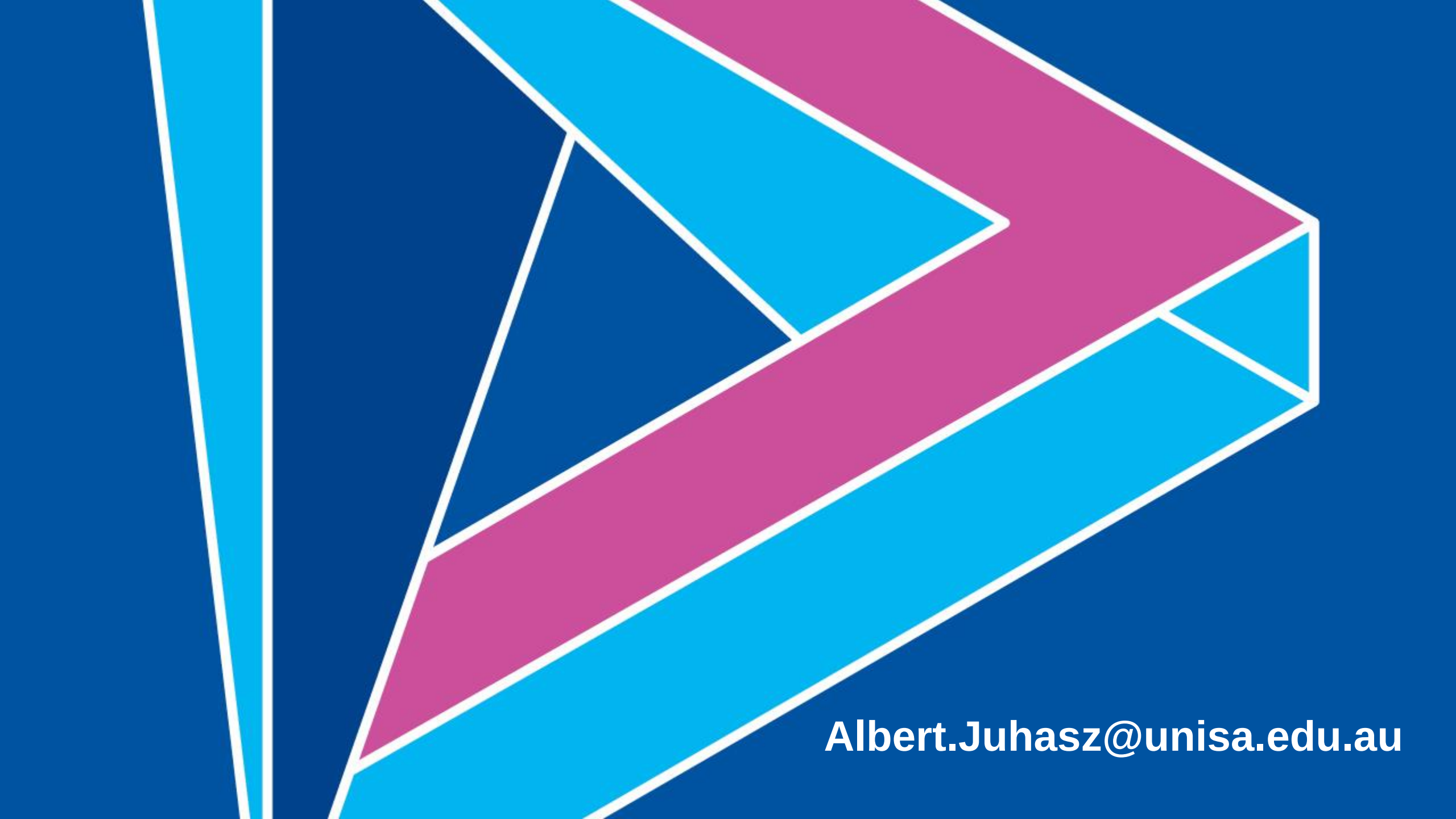
Acknowledgements

University of South Australia

SAHMRI
South Australian Health & Medical Research Institute

ziltek

ALS



Albert.Juhasz@unisa.edu.au