

Land Treatment System Topsoil Metal and PFAS - Summary of Results and Key Findings

Recovered Water Management Solution Project

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Purpose

This summary presents soil testing results from the forested Land Treatment System (LTS), where Rotorua's treated wastewater has been irrigated since 1991. ESR was approached and referred the work to Dr Grant Northcott. The study assessed whether heavy metals and PFAS had accumulated in the topsoil at levels of concern for human health or the environment. It compared irrigated and non-irrigated soils against New Zealand ecological soil guideline values and PFAS National Environmental Management Plan guideline values.

Heavy Metals in the LTS Soil

Soil heavy metals results are provided in Table 1. All soil concentrations are mg/kg dry soil.

- The heavy metal concentrations found in the soils were low with results similar with normal background concentrations found in rural New Zealand soils.
- All heavy metals were substantially lower than both the recreational trigger values and the Eco-SGVs (eco soil guideline values) indicating no recreational or ecological concern. Even the highest concentrations found in the shallowest soil layer were nowhere near the ecological limits.
- Zinc, copper, chromium, nickel and antimony, were slightly higher in irrigated soils compared to the adjacent unirrigated soils, indicating that some metals appear to have accumulated in the surface soil after many years of irrigation, but levels remain low.

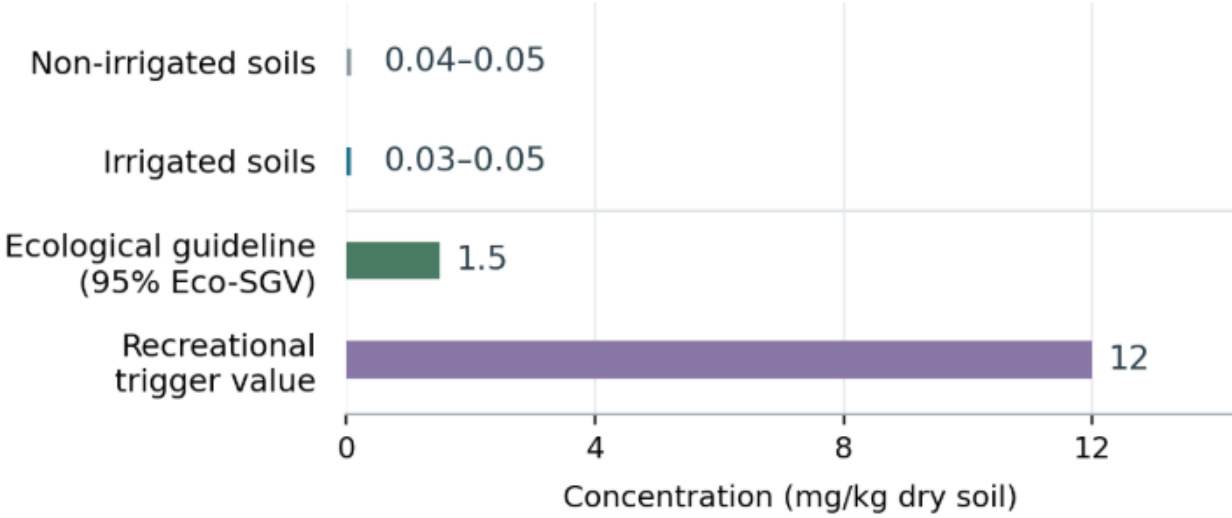
Overall, the results suggest that some metals may have accumulated in the top 0–5 cm of soil over time, which would not be unexpected after decades of irrigation. However, the concentrations remain low – substantially lower than environmental and recreation guidelines values.

Table 1. Metals in soils compared with guideline values (mg/kg)

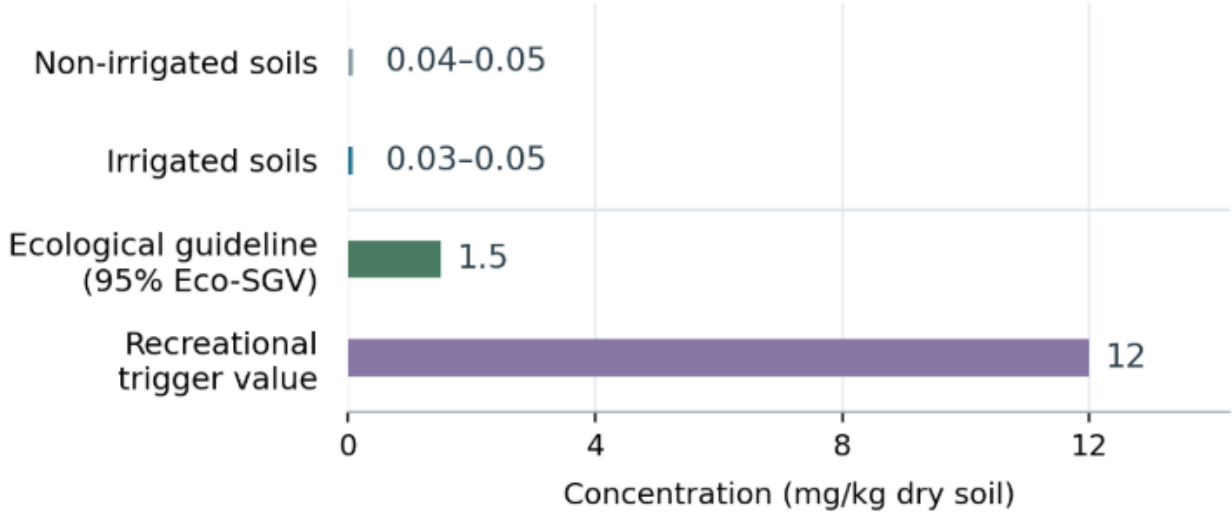
Element	Controls not irrigated	Block 1 irrigated	Block 14 irrigated	Block 4 irrigated	Block 16 irrigated	NZ rural ambient median	95% Eco-SGV	Recreational trigger value
Antimony	0.09–0.14	0.26	0.15	0.21	0.11	—	—	—
Arsenic	4–6	5	3	7	6	4	20	60
Beryllium	0.3–0.6	0.2	0.4	0.3	0.3	—	—	—
Cadmium	0.04–0.05	0.04	0.04	0.05	0.03	0.08	1.5	12
Chromium	2–3	4	2	5	3	16	200	400
Copper	5–10	11	7	11	6	16	95	190
Lead	5–7	5	4	6	6	11	290	880
Mercury	0.06–0.11	0.08	0.06	0.06	0.06	—	—	—
Nickel	0.7–1.1	1.6	1.0	1.8	1.1	9	—	—
Selenium	0.4–0.9	0.5	0.4	0.4	0.4	—	—	—
Silver	<0.4	<0.4	<0.4	<0.4	<0.4	—	—	—
Thallium	0.18–0.25	0.15	0.18	0.15	0.10	—	—	—
Zinc	17–29	48	28	40	14	48	180	285

Background, SGV and Recreational trigger values from Cavanagh, J.E. & Harmsworth, G.R. (2023). *An implementation framework for ecological soil guideline values*. Manaaki Whenua – Landcare Research Contract Report LC4311, Envirolink Tools Grant C09X2206.

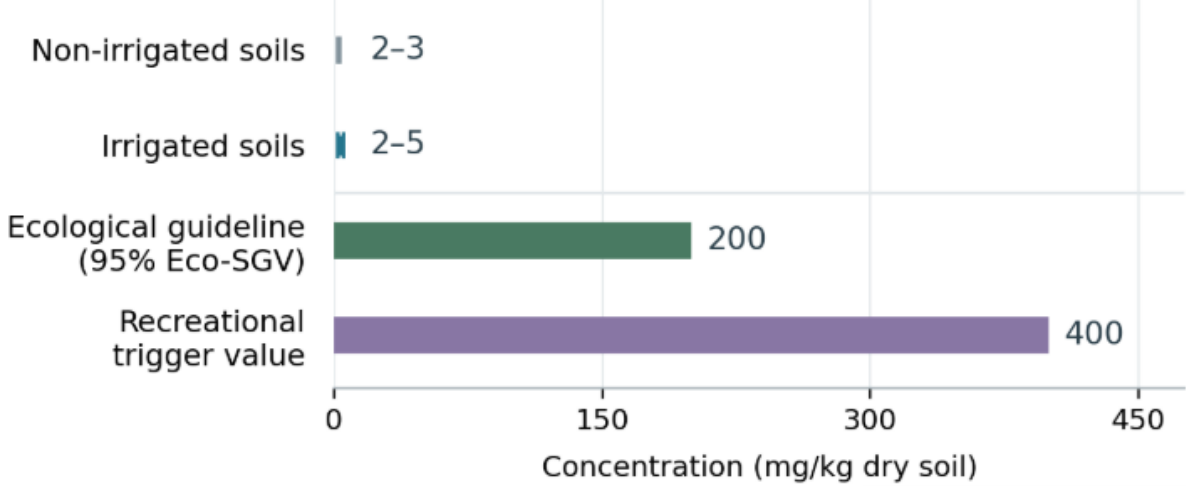
Cadmium



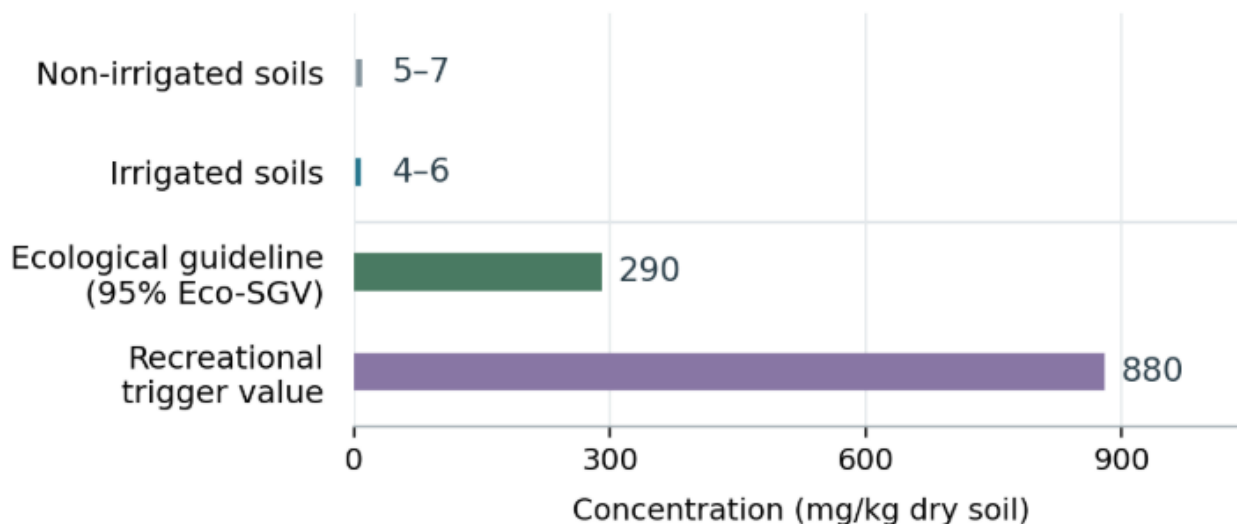
Cadmium



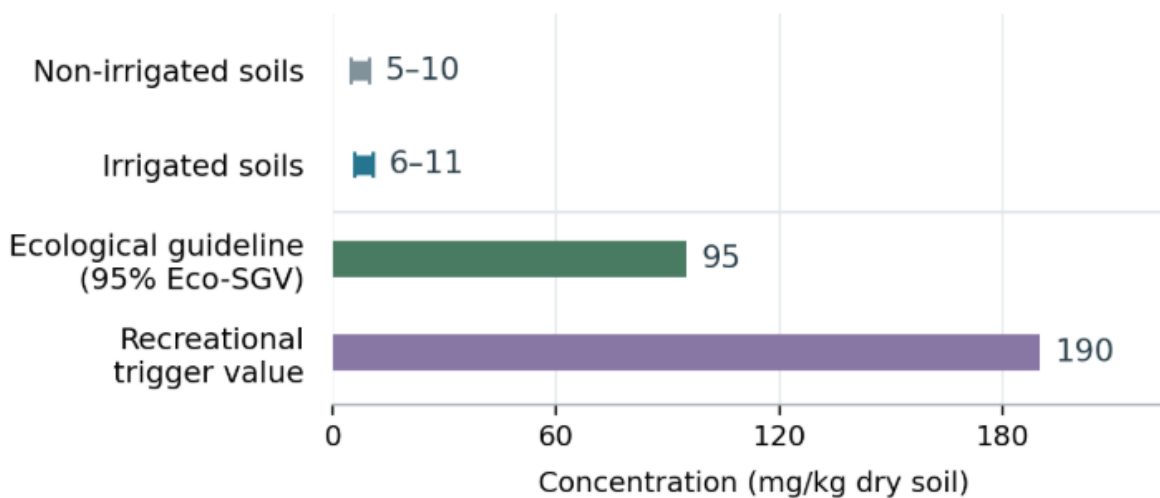
Chromium



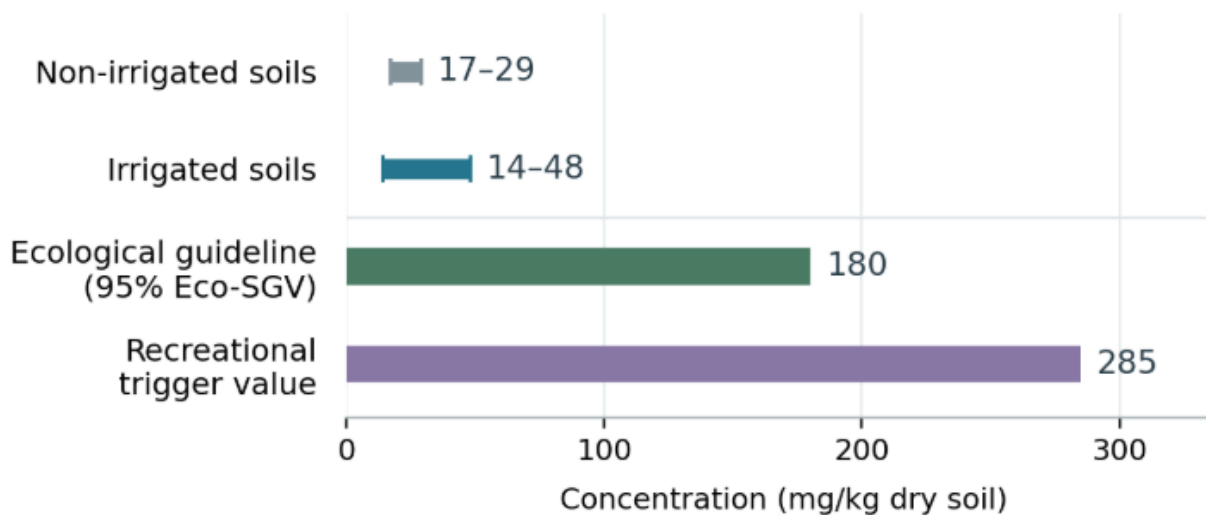
Lead



Copper



Zinc



PFAS

The results show very low level of PFAS concentrations in the forest, well below levels of concern.

The concentrations are well below the relevant human-health and direct ecological guidelines values. The highest PFOS result is around 250 times lower than these guideline values, indicating that the measured concentrations are not at levels of concern for people, plant, or animals through direct contact with soil.

The highest PFOS results were 0.004 mg/kg, only slightly above the conservative screening benchmark for potential indirect food-chain exposure of 0.003 mg/kg. This screening value addresses the potential transfer of PFAS through terrestrial food chains, for example from soil to plants or invertebrates and then to wildlife. It is intentionally conservative and is not a concentration at which ecological effects are expected to occur.

Table 2. Summary of PFAS soil results (mg/kg). PFAS National Environmental Management Plan (NEMP) 3.1 guideline values

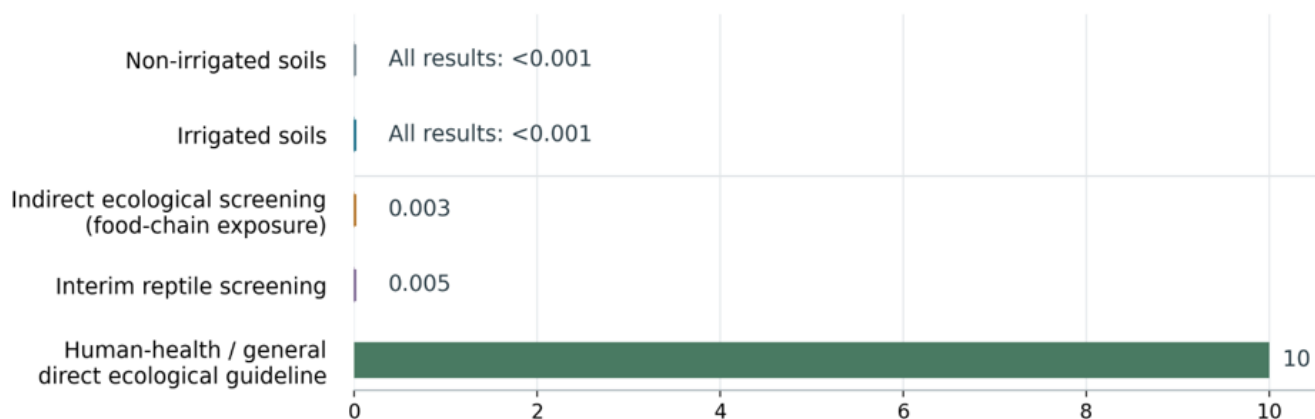
	PFAS			
	PFOS	PFOS + PFHxS	PFOA	PFAS Sum of 30
Human health – public open space (HIL C)		1	10	
Ecological – direct exposure (all land uses)	1		10	
Interim ecological - indirect exposure (food-chain exposure)*	0.003		0.003	
Controls (not irrigated)	<0.001 - 0.002	<0.001 - 0.002	<0.001	<0.001- 0.002
Block 1	0.004	0.004	<0.001	0.008
Block 4	0.001	0.001	<0.001	0.003
Block 14	0.004	0.004	<0.001	0.005
Block 16	<0.001	<0.001	<0.001	<0.001

* The indirect ecological values are conservative screening benchmarks for potential food-chain exposure. They are not toxicity or effects thresholds, and a concentration above a screening value does not in itself demonstrate ecological harm or an unacceptable ecological risk

PFOA in soils compared with guideline values

All soil results: <0.001 mg/kg — more than 10,000 times below the 10 mg/kg guidelines

Topsoil 0–5 cm • Soil ranges and guideline values shown on the same scale



PFOS in soils compared with guideline values

Highest soil result: 0.004 mg/kg — 250 times below the direct ecological guideline

Topsoil 0–5 cm • Soil ranges and guideline values shown on the same scale

