Otago Regional Council

Document Id: XXX

MEMORANDUM

To: **Amber Smith, Policy Analyst**

From: **Dr Erik Button, Soil and Land Scientist**

Date: **17/11/2023**

Re: **Trace element waste acceptance criteria for cleanfill sites**

Name	Role	Date Completed
Simon Beardmore, e3Scientific	Reviewer 1	30/11/2023

Purpose

Conditions are required for managing cleanfill (class 5) facilities in the proposed Land and Water Regional Plan to ensure the disposal of cleanfill material does not result in gross environmental outcomes. The intent of the conditions is that, if all are met, disposal of cleanfill material onto or into land is a permitted activity not requiring a resource consent.

Cleanfill (class 5) facilities are defined as accepting 'only virgin excavated natural material such as clay, soil, or rock, for disposal' (Waste Minimisation (Information Requirements) Regulations 2021). As such, waste acceptance criteria (WAC) are needed as a basis for acceptance of materials for cleanfill sites. The Technical Guidelines for Disposal to Land collated by the Waste Management Institute New Zealand (WasteMINZ, 2023) state that regional soil background levels for naturally occurring trace elements should be adopted as the basis for acceptance of materials for these sites. In the absence of regional background concentrations from detailed studies, national background concentrations can be used (WasteMINZ, 2023).

The predicted background concentration (PBC) dataset developed by Cavanagh et al. in 2015 was intended for use as WAC for cleanfill sites. The dataset was developed from geostatistical analysis of trace element data from regional councils, the National Soils Database and GNS Science, identifying associations with geological parameters adapted from the GNS Science geological map (Cavanagh et al., 2015). However, since August 2023 this PBC dataset has been deprecated due to the release of an updated version that includes more explanatory variables (soil order, land environments and parent material) intended to provide a nationally consistent approach to assessing background concentrations at locations that are being assessed for use as cleanfill sites (Cavanagh et al., 2023).

The updated PBC dataset uses the median (i.e., 50th), 90th, 95th and 99th percentiles as concentration 'cut-offs'. While these percentiles are based on national and not regional data, comparison with regional studies (Auckland, Wellington, and Canterbury) suggested that the updated PBC model performed reasonably well, except for under predicting the upper limits of lead and zinc. However, as the PBC draws on more data statistically than regional studies it should in general be more robust (Cavanagh et al., 2023).

Of the naturally occurring trace elements in Otago, some are anticipated to be 'naturally elevated', defined as concentrations at or greater than 95% of the national PBC dataset (i.e., 95th percentile; Cavanagh et al., 2023). In these areas concentrations may also vary significantly at smaller scales than captured in the updated PBC study (Cavanagh et al., 2023). As such, areas anticipated to be naturally elevated are suggested to possibly warrant site-specific assessment of background concentrations (Cavanagh et al., 2023).

Data and Methods

The percentile ranges for each of the trace elements of the updated PBC dataset are summarised with their predicted concentration ranges, regional extents and the WAC that applies for cleanfill site assessment, based on the 99th percentiles (as stated in the WasteMINZ Guidelines, 2023) in Table 1.

Arsenic is modelled to be likely naturally elevated in 15% of Otago (Table 1). In contrast, the mapped areas at or greater than the 95th quantile in Otago for chromium, copper, lead, nickel, and zinc are 0.3%, 0.3%, 2.3%, 0.8% and 1.2%, respectively; and boron and cadmium are not anticipated in the region at or above the 95th and 90th percentiles, respectively (Table 1). As such, arsenic is the most likely trace element to be naturally elevated in Otago. The map in Figure 1 shows where in Otago naturally elevated arsenic concentrations are anticipated (Cavanagh et al., 2023; LRIS, 2023).

The spatial data was downloaded from the LRIS (2023) clipped to the regional extent of Otago. Using ArcGIS Pro, polygon areas within the attribute table were summarised for each percentile range using the programme R and the dplyr package, sense checking the total trace element areas against the total regional area.

Table 1. The waste acceptance criteria (WAC) for the basis of cleanfill site material acceptance based on the 99th percentile of the predicted background concentration (PBC) national dataset (Cavanagh et al., 2023; WasteMINZ, 2023). Where the PBC percentile is at or above the 95th percentile, the background concentration is likely to be naturally elevated and site-specific assessment of background concentrations is recommended. See the map in Figure 1 for where these areas are anticipated to be located for arsenic.

Trace elements		Percentile ranges (%)	Extent in Otago		PBC range (mg/kg)	Class 5 clean fill WAC (mg/kg)
			km²	%[a]		
Arsenic	As	0-50	808	3	0.2-4.1	8
		50-90	19,449	64	5.9-6.5	
		90-95	5,630	19	4.1-5.9	
		95-99	4,193	14	6.5-8	Likely naturally elevated
		>99	407	1	8-18.7	
Boron	B	0-50	27,003	89	0.5 - 4.6	23
		50-90	3,417	11	4.6 - 11.7	
		90-95	67	0.2	11.7 - 16.3	
		>95	Not predicted in Otago			
Cadmium	Cd	0-50	28,421	93	0.01 - 0.08	0.35
		50-90	2,067	7	0.08 - 0.2	
		>90	Not predicted in Otago			
Chromium	Cr	0-50	19,054	62	2 - 15.5	68
		50-90	11,289	37	15.5 - 25	
		90-95	74	0.2	25 – 29.6	
		95-99	54	0.2	29.6 - 68.3	Likely naturally elevated
		>99	17	0.1	68.3 - 765	
Copper	Cu	0-50	15,417	51	3.8 - 15.7	39
		50-90	14,697	48	15.7 - 23.5	
		90-95	298	1.0	23.5 - 27.9	
		95-99	54	0.2	27.9 - 39	Likely naturally elevated
		>99	21	0.1	39 - 75.7	
Lead	Pb	0-50	6,393	21	1.3 - 11.4	21
		50-90	21,573	71	11.4 - 17.2	
		90-95	1,821	6.0	17.2 - 18.6	
		95-99	643	2.1	18.6 - 21.2	Likely naturally elevated
		>99	57	0.2	21.2 - 30.4	
Nickel	Ni	0-50	15,809	52	1.4 - 9.5	42
		50-90	13,887	46	9.5 - 14.3	
		90-95	558	1.8	14.3 - 16.4	
		95-99	217	0.7	16.4 - 41.6	Likely naturally elevated
		>99	17	0.1	41.6 - 590	
Zinc	Zn	0-50	14,409	47	11.2 - 47.5	80
		50-90	15,201	50	47.5 - 62.9	
		90-95	513	1.7	62.9 - 68.3	
		95-99	304	1.0	68.3 - 79.5	Likely naturally elevated
		>99	60	0.2	79.5 - 99.8	

[a]extent of each percentile range relative to the total area in Otago.

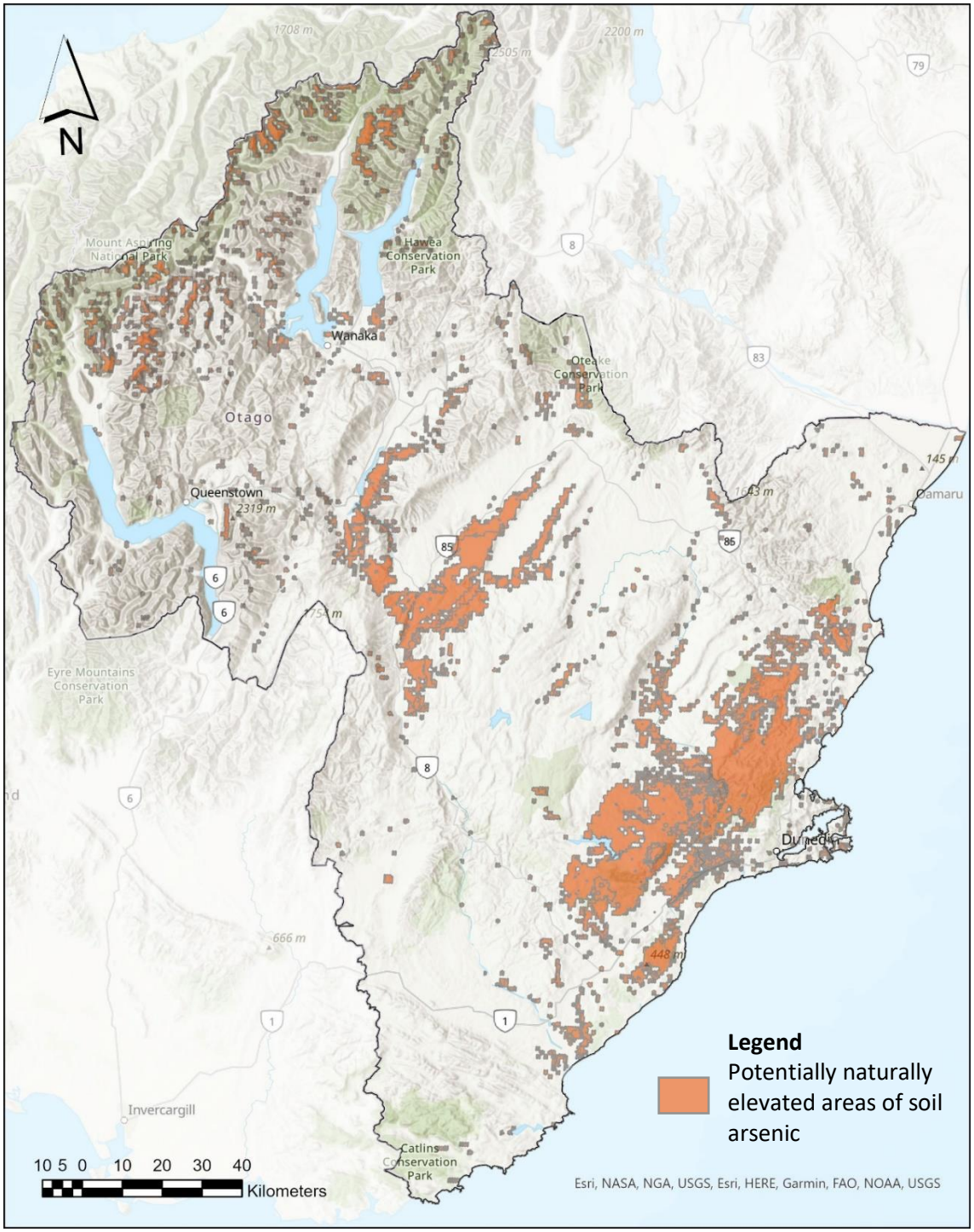

Figure 1. Areas in Otago where soil arsenic concentrations are greater than the 95th percentile of the updated predicted national soil arsenic background concentrations (LRIS, 2023). These areas are considered to likely be naturally elevated in soil arsenic (Cavanagh et al., 2023).

Recommendations

1. Use the WAC based on the updated predicted background concentrations in Table 1 as the basis for acceptance of material for Class 5 cleanfill sites.

2. Naturally elevated areas are likely located in areas mapped at or above the 95th percentile, as in Figure 1 for arsenic. These can be viewed for all trace elements at different spatial scales using the Predicted Background Trace Element Explorer & Maps (Manaaki Whenua Landcare Research, 2023) or on LRIS (2023). If a site is within a potentially naturally elevated area, a site-specific assessment is recommended to better determine the background concentrations.

References

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