

# Realising the value of urban soils

(can we afford not to?)

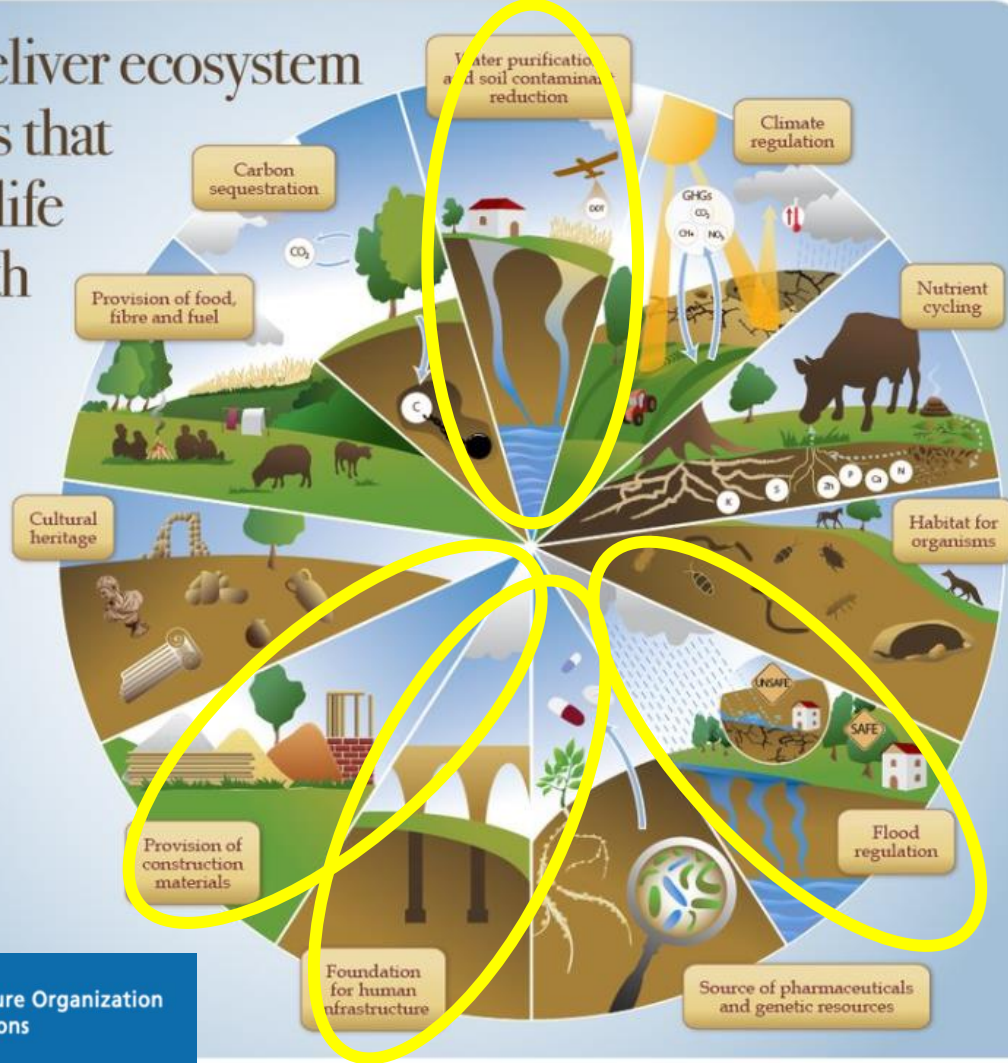
Jo Cavanagh, Robyn Simcock, Emily Mckay , Hadee Thompson-  
Morrison

Bioeconomy Science Institute

# Overview

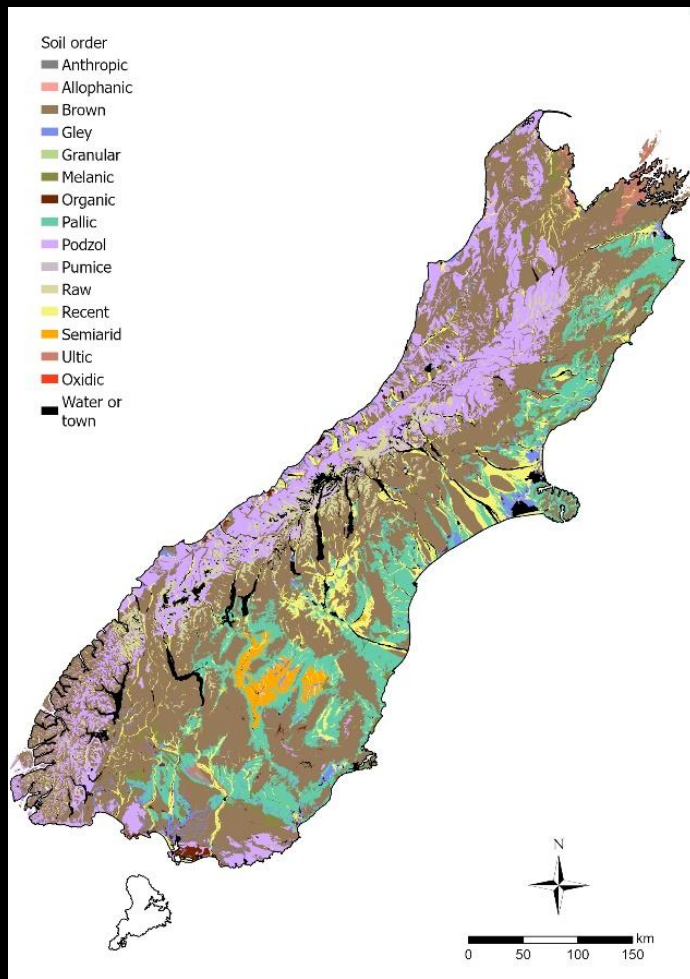
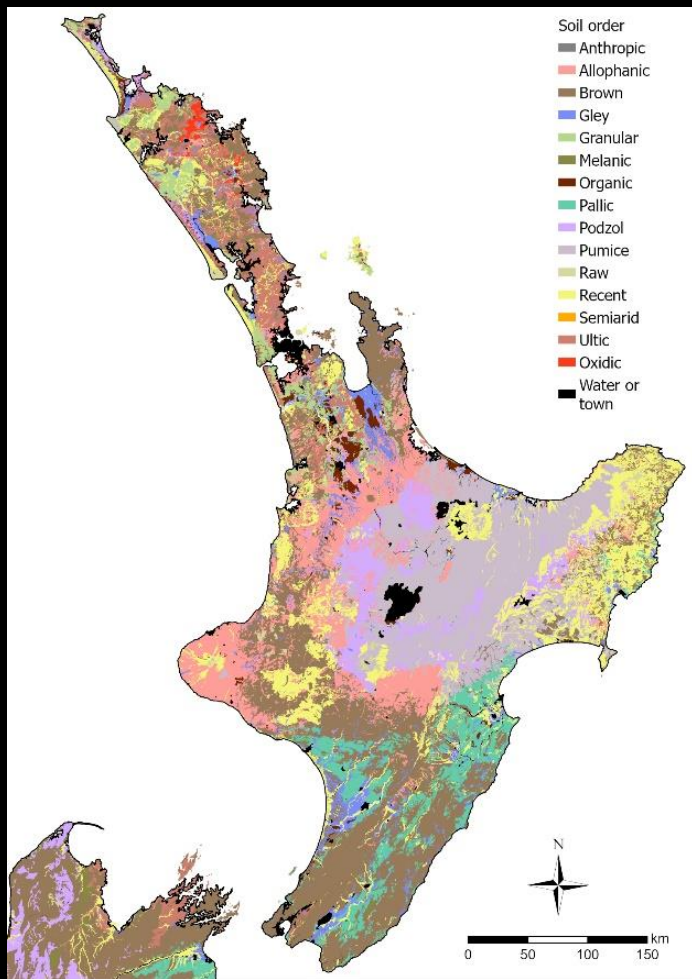
- Sustainable management of surplus soil
- The nexus of ‘background’ soil concentrations, soil contaminant guideline values, waste acceptance criteria and the management of contaminated land and surplus soils
- The role of soil in increasing the ‘sponginess’ of cities to help manage and mitigate floods and to underpin trees
- Work in progress – urban visual soil assessment & guide to improving urban soils

# Soils deliver ecosystem services that enable life on Earth



## What is soil??

“the layered material at the earth’s surface, that has resulted from chemical and biological processes and physical organisation of minerals and organic matter” –  
Natural Environment Bill



# Reclaiming Our Resources: Optimising Soil Reuse in Infrastructure and Land Development

## A strategic framework for optimising soil management – Phase 1

December 2025

### Are we building harder, hotter cities?

The vital importance of urban green spaces

March 2023



 Parliamentary Commissioner for the Environment  
Te Kaitiaki Taiao a Te Whare Pāremata



### Guidance on the sustainable management of 'surplus' soil and subsoil: consultation draft

Envirolink Grant: C09X2206

Prepared for: Contaminated Land and Waste Special Interest Group, Land Monitoring Forum

August 2023

### Urban ground truths

Valuing soil and subsoil in urban development

March 2024



 Parliamentary Commissioner for the Environment  
Te Kaitiaki Taiao a Te Whare Pāremata



#### Reclaiming Resources: Optimising Soil Reuse in Infrastructure and Development

Prepared by Rod Lidgard, CEnvP SC (Pattie Delamore Partners Limited; lead author), Tim Dee (Fulton Hogan Limited), Chris Hillman (Tonkin and Taylor Limited), Kevin Tearney, CEnvP SC (SLR Consulting), Josh Evans (Waikato Regional Council) and Sarah Newall, CEnvP SC (HAIL Environmental Limited), with the support of Madeleon de Jongh, on behalf of the WasteMINZ Contaminated Land Sector Group Steering Committee and WasteMINZ.

*Wasteful soil practices costs New Zealand infrastructure and developers billions of dollars in direct costs and time each year. Inefficient use of this finite resource costs New Zealanders billions more in emissions from cartage and disposal, losses of landfill airspace, valuable soil resources, and increased pressure on roading networks. We have a solution, and we seek financial support to create a framework for the beneficial reuse of soil.*

# Costs of unsustainable management

- Disposal costs – levy, GHG emission with soil movement
- Reducing landfill space
- **Soil resource loss**



## New Zealand Construction and Demolition Waste Baseline & Tracking Methodology Report

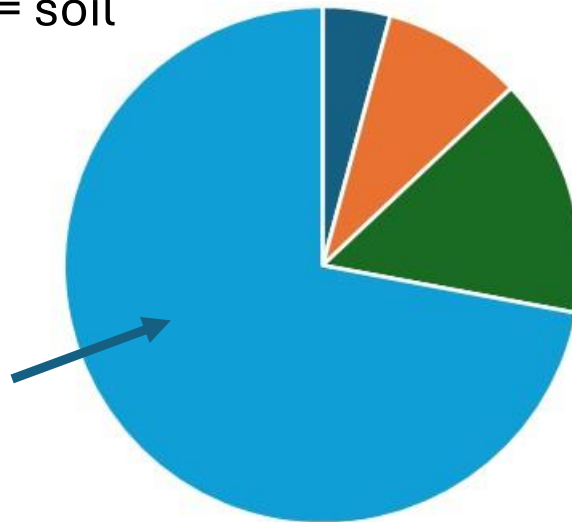
Final Report

Prepared for The Ministry for the Environment - Manatū Mō Te Taiao  
Prepared by Beca Limited

5 June 2025

27.39 Mt waste disposed to class 1-5 landfills  
87% = soil

Includes quarry  
rehabilitation =  
beneficial use?



- class 1-4 non-soil
- class 5 non-soil
- class 1-4 soil waste
- class 5 soil

Should/could our cleanfills be soil banks??

# What's the problem?

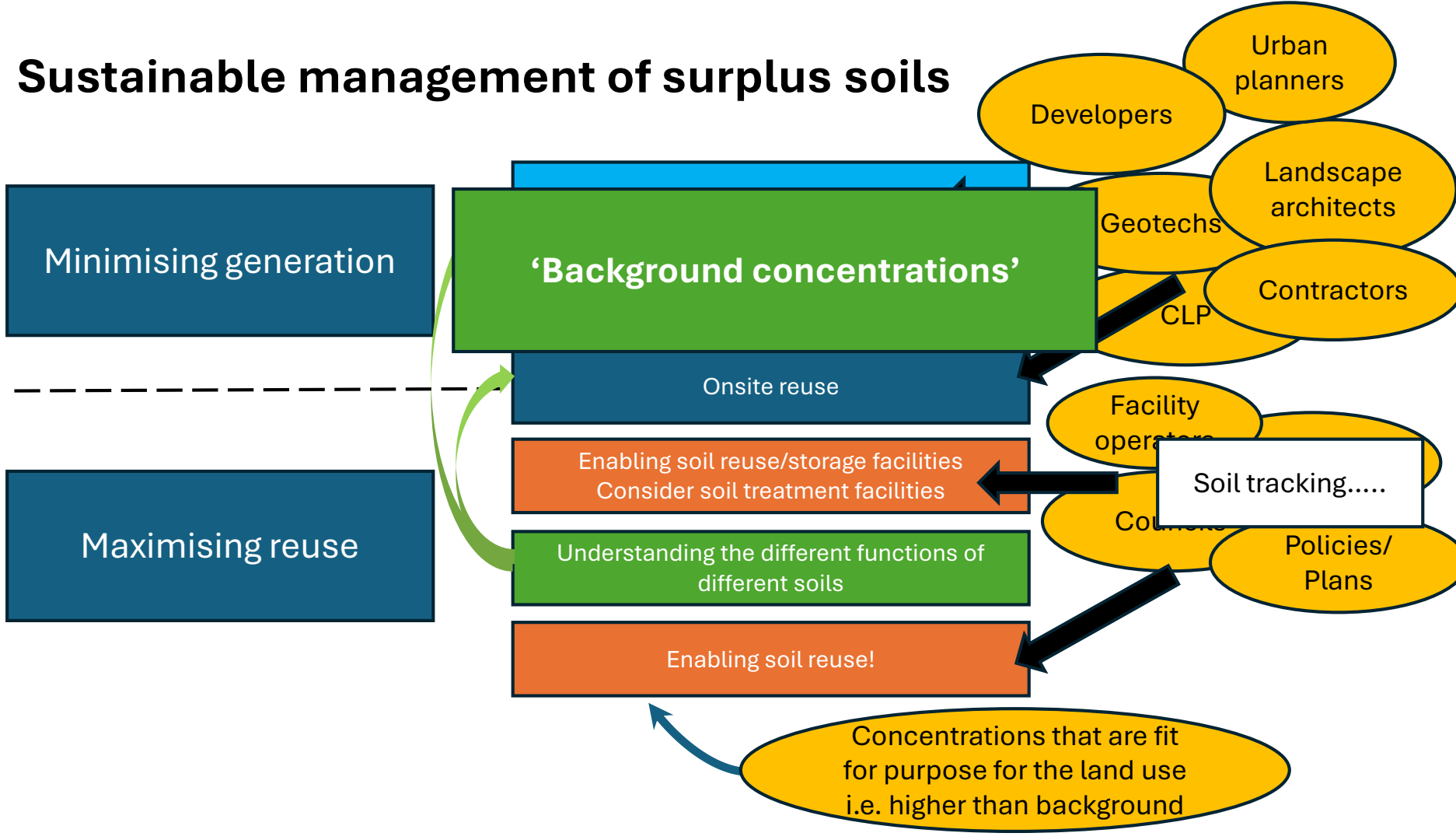
**Regulatory drivers** – NES background concs/clean-fill criteria, council conservatism and/or expertise, time for consent for storage

**Other drivers** – Geotechnical requirements, engineering standards, differing levels of scrutiny public vs private developers

**Developer drivers** – avoidance of legacy risk, building preferences, lack of storage space, lack of incentives/ disincentives

**Barriers to reuse** – lack of awareness of options, regulatory uncertainty, poor site investigations, perception of contaminants

# Sustainable management of surplus soils



# Background concentrations.....

- NES–CS 5(9) These regulations **do not** apply to a piece of land [must be HAIL]... about which a detailed site investigation exists that demonstrates that any contaminants in or on the piece of land are at, or below, background concentrations..
  - Perverse outcomes for areas with naturally elevated concentrations
- Cleanfill Waste acceptance criteria often relate to “background...”
- BUT lack of clarity around what background is, different ways in which it has been determined.....

Proxy for negligible risk to human health and environment

## **Determination and use of background concentrations of trace elements in soil in Otago and Southland**

**Envirolink Grant: 2518-ORC17**

October 2025

Jo Cavanagh, Hadee Thompson-Morrison, Stephen McNeill

*Manaaki Whenua – Landcare Research, a group of the Bioeconomy Science Institute*

Dave Bull

*HAIL Environmental*

Simon Beardmore

*e3Scientific*

Contract Report registration number: 2526-0042

Prepared for: Otago Regional Council and Environment Southland

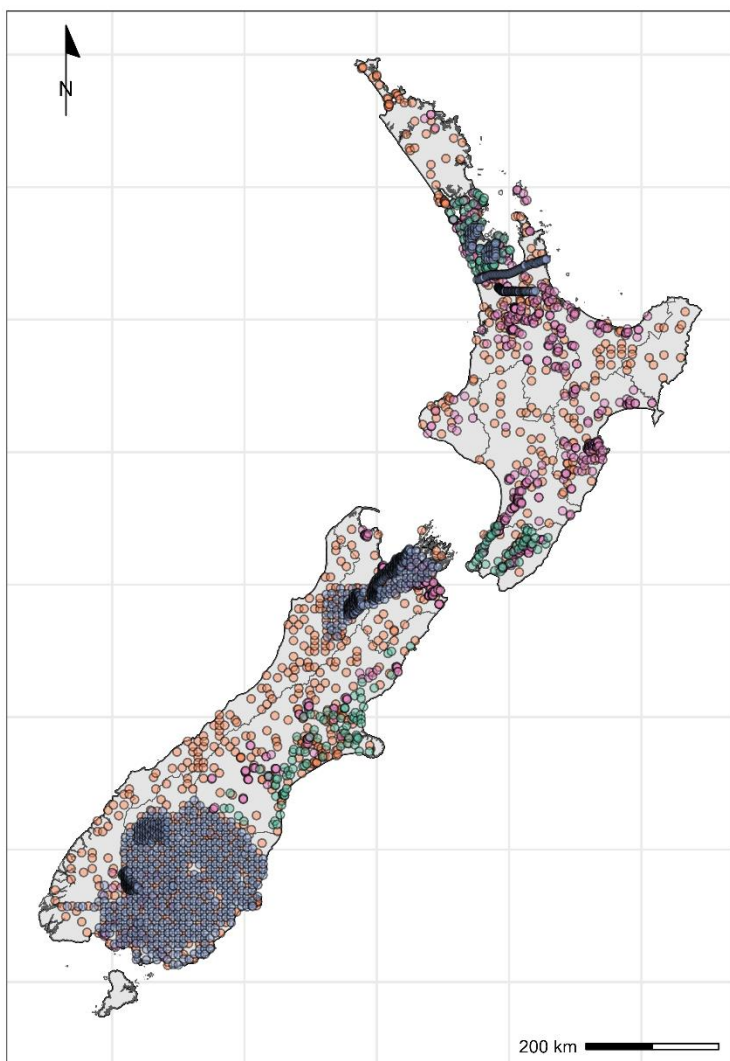
### **Disclaimer**

*This report has been prepared by the New Zealand Institute for Bioeconomy Science Ltd for Otago Regional Council and Environment Southland. If used by other parties, no warranty or representation is given as to its accuracy and no liability is accepted for loss or damage arising directly or indirectly from reliance on the information in it.*

© The New Zealand Institute for Bioeconomy Ltd and Otago Regional Council and Environment Southland  
2025

# Principles

- Soil is a valuable resource, and opportunities to protect, minimise removal and enable beneficial re-use should be encouraged.
- Risks associated with anthropogenic contamination should be negligible.
- Risks associated with naturally elevated concentrations should be identified and managed appropriately.
- When applied as criteria for clean fill, an adequate margin for error should be allowed so that exceeding a clean fill threshold by a minor margin will not inadvertently create contaminated land.
- In general, the unrestricted re-use of soil should be allowed.
- Spatially simple



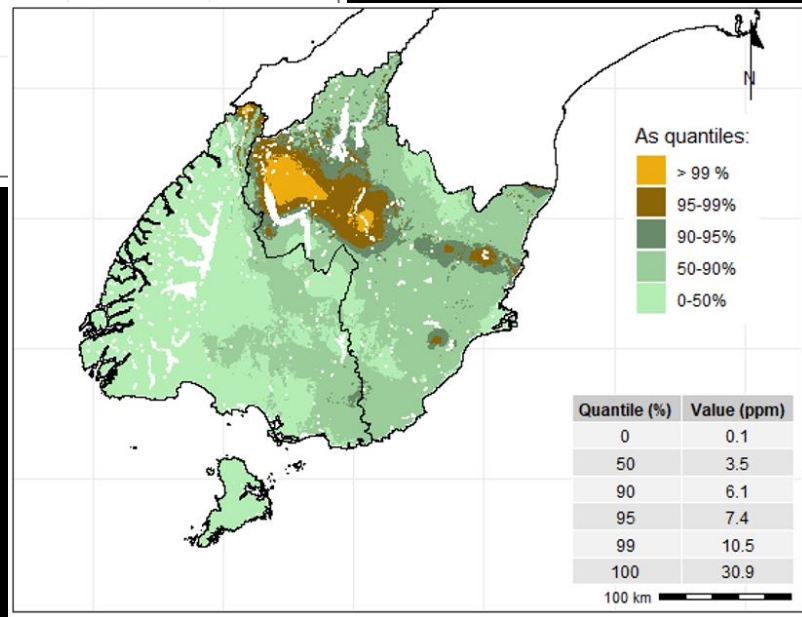
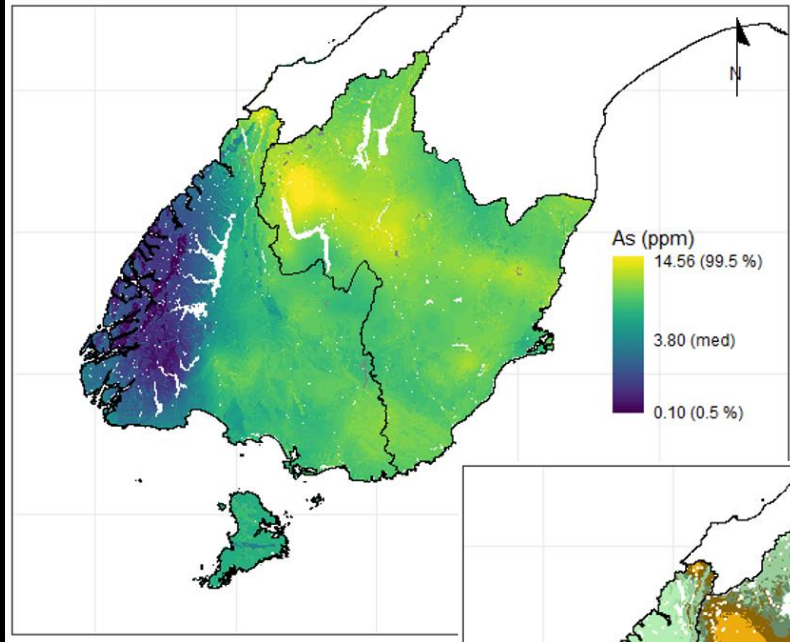
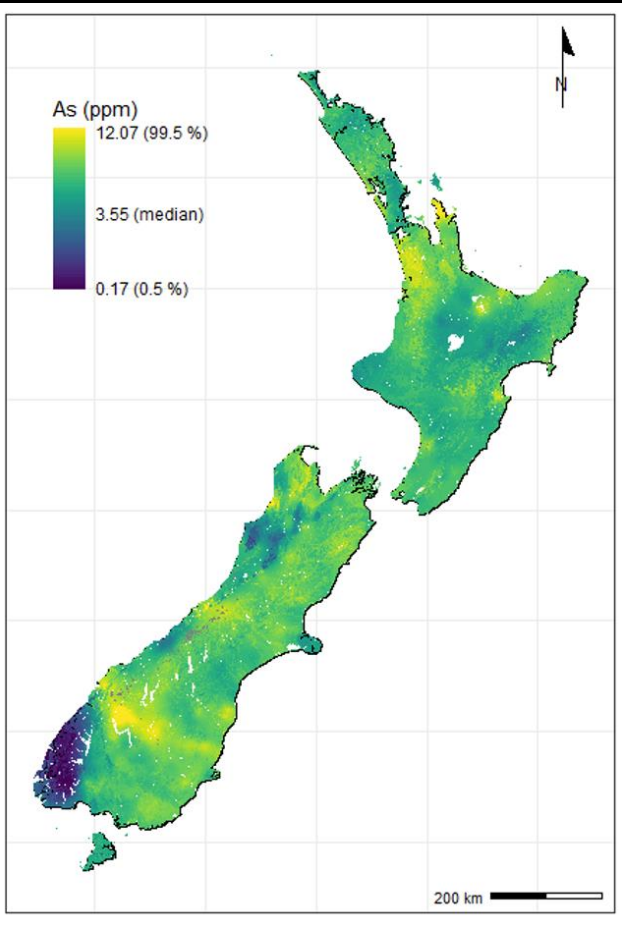
# Risk-based background concentrations

Source of data:

- ACWB
- GNS
- RGS
- RC

- Upper estimates (95<sup>th</sup> and 99<sup>th</sup> percentile) of ambient\* background concentrations were determined from these data
- 95% protection level Eco-SGV
- Rural residential SCS
  
- Modelling used to determine areas of naturally elevated concentration

\*ambient = 'Background,' 'Forestry,' and 'Grazing' that was not 'High Producing Exotic Grassland'



# Risk-based background concentrations

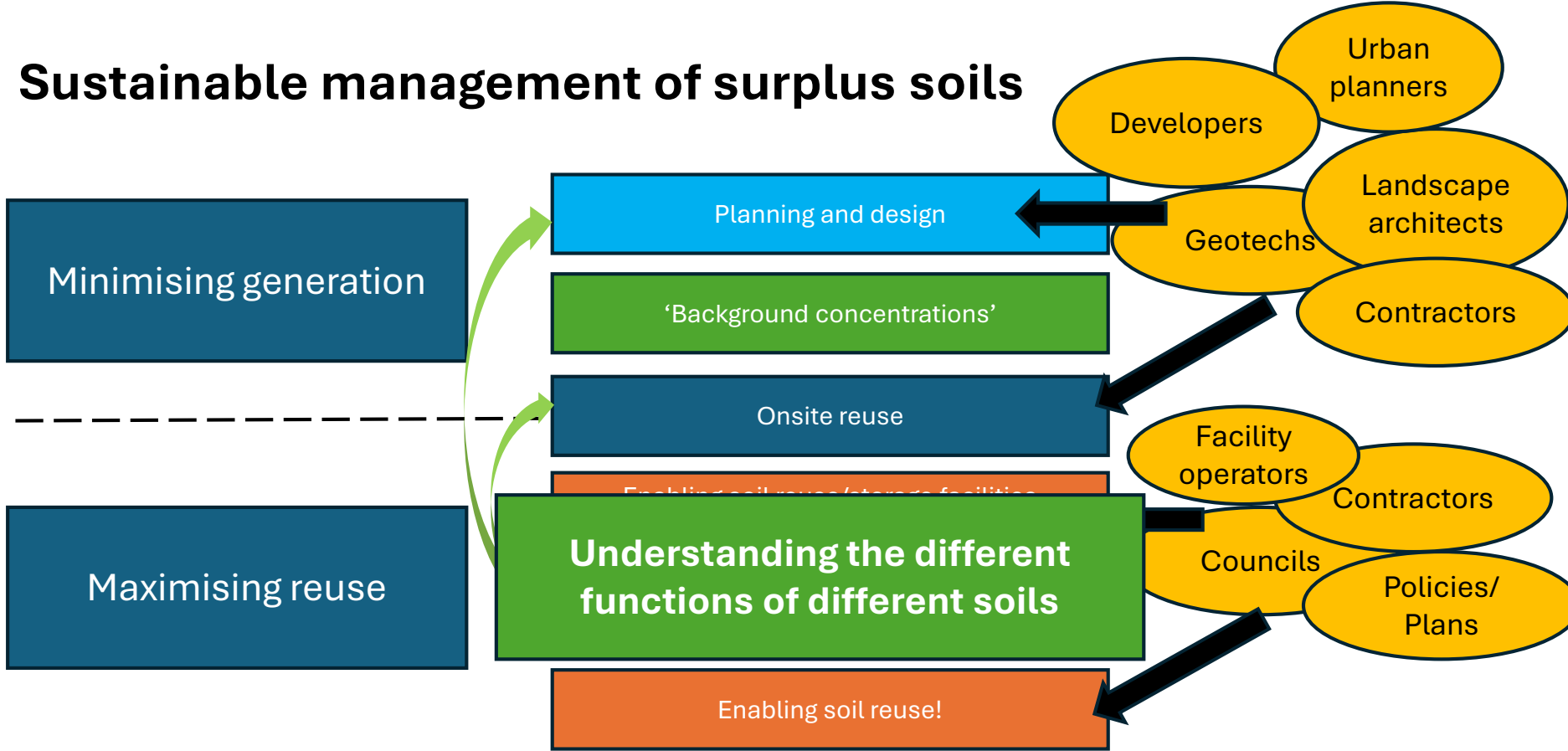
Element	Criterion (mg/kg)	Basis
Arsenic	12	National 95 <sup>th</sup> %ile ambient, which is below the derived value of 13 mg/kg for rural residential in MfE 2011c <sup>a</sup>
Boron	9	Otago–Southland 99 <sup>th</sup> %ile, all land use
Cadmium	0.6 <sup>b</sup>	Equidistant between national 95 <sup>th</sup> %ile and rural residential SCS
Chromium (elevated)	630 <sup>b</sup>	Otago–Southland 99 <sup>th</sup> %ile elevated, all land use
Chromium (non-elevated)	120 <sup>b</sup>	Equidistant between Otago–Southland 95 <sup>th</sup> %ile and Eco-SGV
Copper	80	Equidistant between national 95 <sup>th</sup> %ile and typical Eco-SGV
Mercury	0.3	National 99 <sup>th</sup> %ile all land use
Nickel (elevated)	890 <sup>b</sup>	Otago–Southland 99 <sup>th</sup> %ile, elevated, all land use
Nickel (non-elevated)	30 <sup>b</sup>	Equidistant between Otago–Southland 95 <sup>th</sup> %ile and CCME SQG <sub>e</sub>
Lead	95	Equidistant between national 95 <sup>th</sup> %ile and rural residential SCS
Zinc	150	Equidistant between national 95 <sup>th</sup> %ile and typical Eco-SGV

# Additional contaminants\*

Element	Criterion (mg/kg)	Basis
TPH C7–C9 <sup>a</sup>	55	Half Eco-SGV (Cavanagh & Harmsworth 2023)
TPH C10–C14	58	Derived from MfE Guidelines for Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand 1999, revised 2011. Table 4.15 (WasteMINZ 2023a)
TPH C15–C34	150 (coarse soil <sup>b</sup> ) 650 (fine soil <sup>c</sup> )	Half Eco-SGV (Cavanagh & Harmsworth 2023)
PAH – BaP-eq	1	Empirical limit indicative of the presence of roading coal tar (WasteMINZ 2023b)
∑DDTs	0.5	Soil concentration above which DDTs in milk solids increase (Fonterra 2024)
Asbestos, fines, and fibrous asbestos	<0.001%	Quantification limit for respirable fibre risk; asbestos fibres may be present (BRANZ 2024)
PFOS and PFHxS	0.003	Human health investigation level for residential with garden / accessible soil (HEPA 2025)

\* Contaminants for which it was considered useful to have criteria for  
DOES NOT define the range of contaminants that must be assessed

# Sustainable management of surplus soils



# Soils as sponges and sponge cities



## Compaction of urban soils: understanding the feasibility of potential solutions for amelioration of urban soils to reduce flood risk

### Workstream 2. Soil monitoring by MWLR

June 2025

Robyn Simcock, Emily McKay  
Manaaki Whenua – Landcare Research

Allycia Van De Laar  
(previously Manaaki Whenua Landcare Research)

Manaaki Whenua Contract Report: LC4627

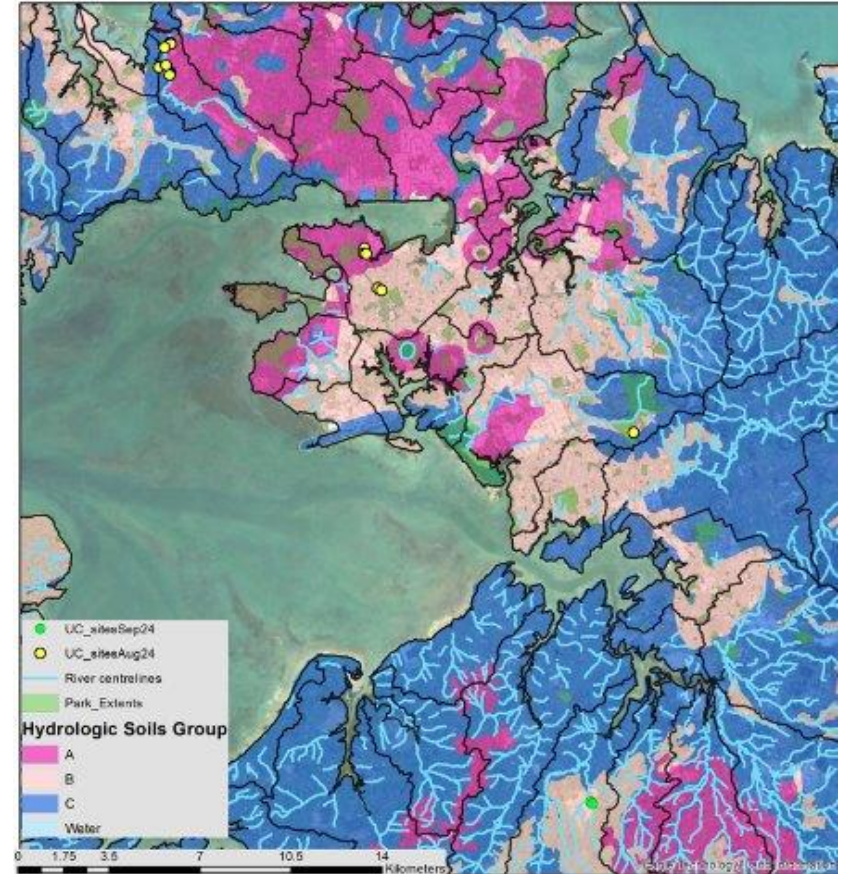
Prepared for: Auckland Council



Sponge City Illustration – [focus.cbbc.org](http://focus.cbbc.org)

## Sites and Method

- locate soils in Hydrological Soil Groups A, B, C using Council maps
- HSG A – Highly permeable (volcanic geology – cerise colour)
- HSG B – moderately permeable (salmon colour)
- HSG C – limited permeability (Waitemata geology – blue colour)
- Target ‘greenspace’, i.e. parks and road verges in grass and trees



# H S G A : 'v o l c a n i c ' s o i l s

## P a r k s

Near-natural soil (park edge)



### >90 cm rooting depth

Well drained = never ponds

### H S G A mapped, A confirmed

High permeability throughout

High quality soil

Large, healthy mature trees

100 mm profile water storage

Earth-worked soil (park centre)



### 35 cm rooting depth

Poorly drained and flat = winter ponding

### H S G A mapped, D confirmed

High permeability topsoil over subsoil with low permeability (<4 mm/hr @ 35 cm depth)

Poor quality soil (shallow, winter w-table 10 cm)

Struggling young puriri trees (restricted roots)

32 mm profile water storage



Near-natural soil (riparian area)

**60 cm rooting depth**

Imperfectly drained, rolling slope

**HSG B mapped, B confirmed**

Healthy young trees **if no mulch used**

62 mm profile storage



**HSG B 'Alluvial' soils**

New road verges



or



**40 cm rooting depth maximum**

Imperfectly drained & low slope

**HSG B mapped, C confirmed**

Mod. healthy young street trees

28 mm profile storage

# Key findings

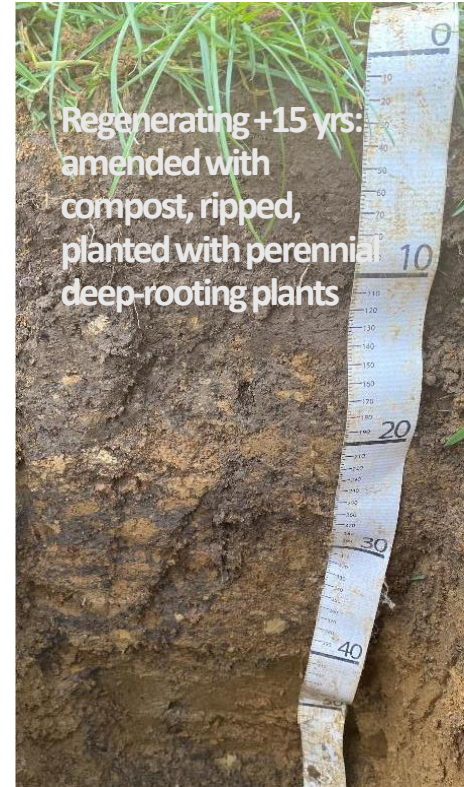
- Mapped HSG class did not reflect actual class for areas that had been recently earthworked ('developed') due to truncation and/or compacted fill (often with gravels)
  - Need to ground-truth HSG, soil depth after development
- Replaced topsoils in grass regained rapid to moderate topsoil permeability but subsoils were impermeable or slowly permeable and had perched water tables, low water storage, long periods of saturation in the absence of artificial drainage
- Need to **prevent damage** or remediate soils to retain function of high-performing soils (including ability to support shrubs/trees)

Means flood modelling results are wrong

Grass helps topsoil but...

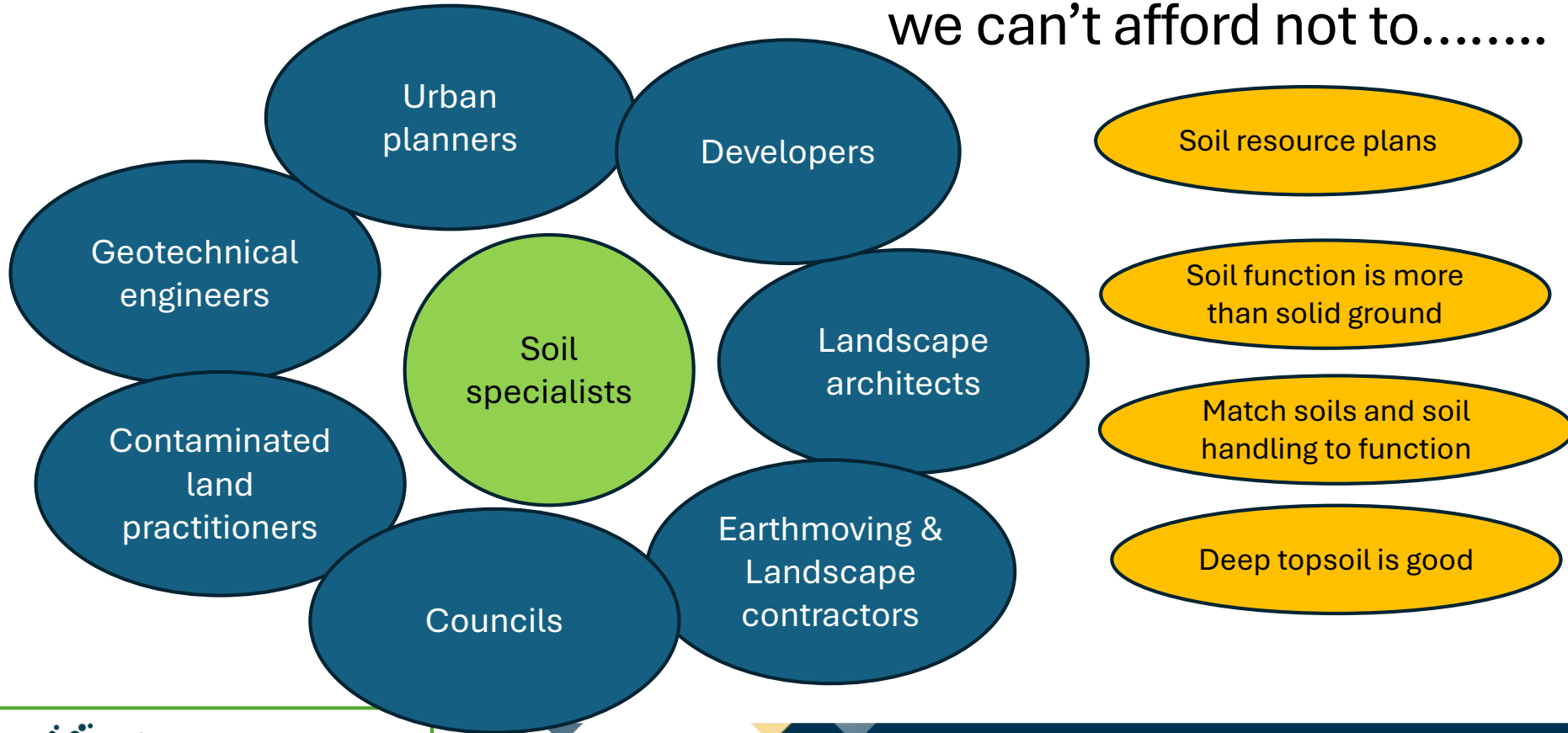
# Next steps

- Refine mapping of urban soils
  - by age, development history and section size, LIDAR?
- **Urban visual soil assessment** including understanding 'origin' soil
  - Focus, top 1m
- Develop techniques to remediate different soils and damages at different scales (park to verge) and how to specify this in policy



# Realising the value of urban soil.....

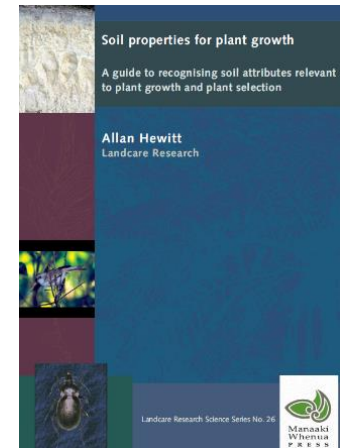
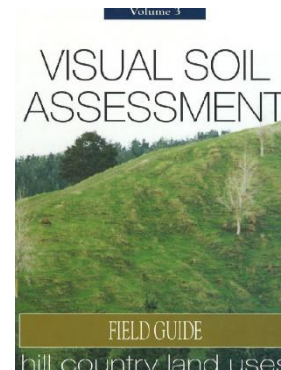
we can't afford not to.....



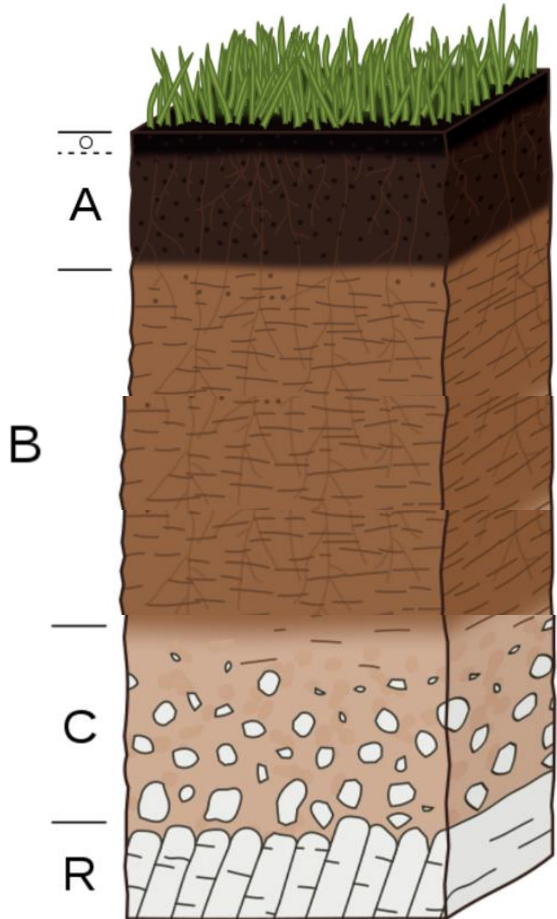
# Urban Visual Soil Assessment

- Assesses soil quality for:
  - growing trees
  - stormwater management – indicates water infiltration, storage and release into underlying aquifers or surface waters.
  - horticulture and mara kai (resilient food systems, both perennial and annual crops)
  - native ecosystems, e.g. remnants and areas to be restored.
- Also suitable for non-urban heavily earthworked sites (dams, mines, roads)

- Doesn't assess:
  - Ability of soil to bear the weight of buildings, roads and structures without deformation (Geotech!)
  - Underground structures/potential for acid-sulfate soils



# An ideal urban soil profile.....



0  
← • 'topsoil'

30  
← 'upper subsoil' - this layer defines Hydrologic Soils Group, rooting zone

60  
← 'deeper subsoil' - this is the 'golden layer' that identifies highly versatile soils, healthy trees and horticultural crops and highest water storage

90