Urban ground truths

Valuing soil and subsoil in urban development

March 2024

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

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Simon Upton

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Hymenophyllum pluviatile

1 Introduction

Background

In March 2023 the Parliamentary Commissioner for the Environment released a report on what is happening to green spaces in New Zealand cities. Titled *Are we building harder, hotter cities? The vital importance of urban green spaces*, it explored the pressures urban growth is placing on a range of biophysical services we take for granted, including the management of rainfall and the regulation of temperature. An expansion of impermeable surfaces can mean swifter runoff during heavy rainfall and higher temperatures as concrete and tar seal re-radiate the sun's heat.

Some of this is a result of population growth. In the year to June 2022, consent was granted for more than 50,000 new dwellings, an all-time record.[1] But it is not just a growing population that is placing pressure on green space. The built form of our cities is changing too – and has been now for at least three decades. New Zealanders are increasingly moving into townhouses or terraced units with low-maintenance shared gardens, rather than quarter-acre sections with big backyards. House sizes have expanded while section sizes have shrunk. *Are we building harder, hotter cities?* tried to quantify these effects on the services that urban green spaces provide, whether they are publicly owned parks or private yards.

While the report was able to accurately record the declining availability of green spaces in major centres such as Auckland and Hamilton and make some assessment of the loss of services that decline implies, it became clear that the fate of urban soil as part of the subdivision and development process was not well documented. The widespread contemporary practice of stripping all the soil from subdivision sites to rework the landform and provide a firm base for concrete foundations raised the question of whether this is necessary and the environmental consequences that flow from it.

1 PCE, 2023, p.4.

This report looks at:

- the key decisions and practices in the process of residential land development that can be anticipated to impact on the value of soils and the services they provide
- why these practices occur, their economic and regulatory drivers, and implications
- how local authority regulation limits or regulates the disturbance and removal of soil
- the adequacy of soil retained or reinstated on a site to provide for environmental services.

Finally, it recommends some changes to current arrangements that could help to better protect urban soils and the services they support.

Scope

Urban development focus

This report focuses on the impacts on soil during the process of residential land development in urban areas, including both new subdivision developments and major infill developments in existing urban zones.

Definitions

In this report we follow the generic definition of **topsoil** as referring to the uppermost dark, carbon-rich layer of the soil. We define **subsoil** as weathered soil layers that occur naturally below topsoil and are not enriched with organic matter (except organic soil such as peat). Subsoils can also form the root zone for plants, and a sufficient depth of appropriate subsoil is important for deep-rooted vegetation such as trees to flourish.

This report is the result of a relatively narrow follow-up inquiry focusing on the impacts of urban development on the capacity of soil to provide key environmental services. That said, it is important to acknowledge the value of healthy soil in a broader context. One working definition from a te ao Māori perspective describes **soil health** as referring to:

> "the capacity of a soil as a living ecosystem to sustain and support all forms of life (to sustain microbes, plants, animals, humans and complex interconnections), through the maintenance of te mauri, to strengthen and enhance whakapapa, taonga tuku iho, mana, oranga, wairua, and whai rawa".[2]

[2] MWLR, no date-b.

2


Ptisana salicina

The residential land development process and its impact on soil

Healthy soils, the unseen engine room of any green space, provide valuable environmental services to urban dwellers. An adequate volume of nutrient-rich, freely draining soil is essential for the vegetation that provides shade, cooling and water retention in cities along with wellbeing benefits. Soil slows the movement of stormwater as well as filtering contaminants like heavy metals. Healthy urban soil is increasingly valuable in the face of a warming climate as it buffers intense and frequent rainfall events and supports vegetation that can mitigate urban heat island effects. Support for vegetation and stormwater management are probably the two key environmental services provided by urban soils.

By the time excavators, scrapers and compactors arrive on a site destined to become a future subdivision or regenerated city block, key design choices will have been made that influence the volume and extent of healthy soil that remains there, with enduring consequences. The topography, geology and past uses of the land all influence the options for design and construction practices, as do the desired housing typology, landform, foundation design and landscaping features. The degree of soil disturbance, and the amount of soil left *in situ* or reinstated at the conclusion of the development will influence how well green spaces in that development can deliver their vital functions.

This chapter outlines some of the steps of the land development process that affect the capacity of soils to provide key environmental services. Some of the regulatory and market drivers behind these choices are analysed in greater depth in chapter two.

Master planning

Where a major new residential development, either greenfield or brownfield, is planned, the urban design vision will typically be set out in a master plan or structure plan. Master planning will be underpinned by district plan zoning and regulations. This planning phase may be led by a local authority or a developer. Where it is developer-led, master planning is a key step that developers may have commenced – at least at a high level – even before they have purchased the land.

At this stage developers will be considering how to achieve the optimal density and financial yield for their vision. The vision provided in a master plan includes the density and typology of the built form. These documents draw on the expertise of urban planners, landscape architects and civil engineers and often reflect political priorities and consultation with iwi and the community. The master planning phase will also involve the identification of key areas of green space and factor in natural hazard mitigation and a stormwater management approach. This work will likely draw on natural hazard overlays from local authorities as well as their stormwater management network knowledge.

Master planning is an iterative process and may be revisited following site investigations, after which development options may be further fleshed out. Given that decisions on housing density, suitable land levels and stormwater conveyance are made at this stage, they will influence the extent of site stripping of topsoil and the depth of cut and engineered fill, which will in turn determine the degree of soil disturbance required in a given development.

Site investigations

Geotechnical suitability

One of the first steps in residential development is a geotechnical assessment of the site to check the ground conditions for natural hazards such as soft ground, liquefaction vulnerability, and other land stability issues. Geotechnical engineers assess the suitability of the ground for the structures intended to be placed there. A detailed geotechnical investigation report will include recommendations on earthworks, foundations and ground improvements required, including removal of soils, compaction, and inclusion of aggregate or other fill. It will also specify parameters for fill that should be used in the design of cut, fill, retaining walls and foundations, as appropriate. Geotechnical investigations centre on soil from a stability perspective. They do not tend to focus on soil health.

Contamination issues

To meet territorial authority requirements the landowner also needs to establish whether the site is potentially contaminated based on historical use of the property.[1] This is usually undertaken through a preliminary site investigation by a suitably qualified contaminated land practitioner and is based on current and historical land use. In some cases a detailed site investigation is undertaken, involving the collection of field data to create a conceptual site model illustrating sources of contaminants, exposure pathways, and receptors of the potential harm.[2] Depending on the status of the land, some remediation, which at times includes excavation and disposal of the soil, may be undertaken. More on the implications related to contaminated land can be found in chapter three of this report.

1 Territorial authorities must observe and enforce the requirements of the Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011.

2 The selection of analytes, number of samples and sample depths are based on the judgement of the suitably qualified contaminated land practitioner following contaminated land guidelines (MfE, 2021, pp.35–37).

The geotechnical and contamination investigations help civil engineers and land developers determine how to proceed with the land development, including how they might subsequently manage soil on the site. The outcome of these investigations can have a strong influence on how much soil is removed and whether it is deemed appropriate for later reuse.

Earthworks

Earthworks are an activity that typically requires resource consent and, depending on the volume of the soil disturbance, this could be required from both the regional and territorial authorities (discussed further in chapter four).

Civil engineers identify areas of cut and fill on the site to achieve the desired landform for the build. The extent of earthmoving required depends on geology and topography and relevant requirements, such as the management of flood risk. If the site is steep, significant earthmoving may be undertaken to achieve the desired landform. The cut and fill balance may be a positive one (i.e. fill is exported) or a negative one (fill is imported). Civil engineering contractors will often seek to maintain a neutral cut and fill balance due to the expense of disposing of and importing fill.[3] In some places, excavation over and above the cut and fill required to achieve the desired grade is undertaken to reach good ground on which to place structures.

Depending on its depth on a site and the landscaping design, topsoil may need to be imported or exported. However, sites are typically cleared of topsoil prior to undertaking earthworks for several reasons:

- Topsoil cannot be used for engineered fill as it has high organic matter content and therefore has the potential to decompose and settle.
- Topsoil may be saved for respreading or reuse in gardens if there is space to stockpile it on site while the earthworks are underway (and there are no contamination concerns).
- Topsoil (if below a contamination threshold) has a market value and may be sold.

Typically, in the process of subdivision earthworks, the land is reshaped, often markedly so. Earthworks using engineered fill are required to be compacted to achieve long-term stability under New Zealand Standard (NZS) 4431:2022 *Engineered fill construction for lightweight structures*.[4] The common upshot is that topsoil is cleared from sites, and subsoils are often shifted and compacted with potentially significant consequences for the soil ecology and hydrology. The 2022 update to NZS 4431 requires sustainability to be considered in earthworks design, although the geotechnical engineer will sign off compliance with the standard primarily based on land stability considerations.

The geotechnical designer will include an earthworks completion report in their geotechnical completion report, and a statement of their opinion of the suitability of the land for building construction in accordance with the appropriate New Zealand standards.[5]

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3 The cost of supplying (importing) and placing clean fill for bulk earthworks can range from \$65 to \$80/m^3 (based on clay fill carted <20 km). The cost of importing fill is highly variable and sensitive to the travel distance from which it is being imported (Koru Environmental, pers. comm., 7 December 2023).

4 Standards New Zealand, 2022, p.51.

5 Standards New Zealand, 2010, schedule 2A, pp.54–55, or Standards New Zealand, 2022, Appendix D, p.79.

Once the bulk earthworks are completed, there is often an additional stage of soil disturbance. The site is stabilised, often by covering with topsoil and applying hydroseed. The developer will seek a certificate from the territorial authority to release the lots for sale, where applicable.[6] Builders then remove the soil required to create the final house-building platform so they can then lay the foundation and build the houses.

Source: Manaaki Whenua – Landcare Research

Figure 1.1: On this hilly site, significant earthworks reveal the topsoil and subsoil layers.

Foundation design and construction

Engagement with local government and industry indicates that concrete slab on ground, also known as slab on grade, is currently the most popular foundation choice. For example, in Porirua, over 90% of that district uses concrete slabs as the primary foundation choice. Concrete slabs require a flat building platform on 'good ground' (as a requirement of the Building Code, see chapter two). These may be a raft (or waffle) slab or reinforced concrete (see Figure 1.2).[7,8] This has important implications for the soil because concrete requires a flat grade for the foundation, and at times, over-excavation to reach good ground.

[6] Section 224 of the RMA refers to certificates to be issued by territorial authorities confirming as per s 223 that all roads, private roads, reserves, land vested in the authority in lieu of reserves, and private ways shown on the survey plan have been authorised and accepted by the territorial authority under the RMA and under the Local Government Act 1974.

[7] For an explanation of the differences between slab and raft foundations, see https://www.edc.co.nz/resources/foundations.

[8] Changes to reinforcement have been made since the Christchurch earthquakes (see https://www.seismicresilience.org.nz/topics/foundations/residential-foundations/shallow-foundations-residential/#slab).

With deep (piled) foundations, topsoil is typically removed, but extensive earthworks beyond that are not required as piles may be driven into the soil to achieve bearing capacity by transmitting the load to the ground (see Figure 1.3). An important consideration with regard to timber piles is their need to be treated with timber preservative to meet hazard class H5 as specified in NZS 3640:2003 *Chemical Preservation of Round and Sawn Timber*, which carries a degree of risk to the soil environment.[9]

Source: Firth Concrete

Figure 1.2: Raft type foundations (such as the Firth RibRaft foundation pictured) are installed on good ground with all topsoil removed. Layers of aggregate, timber formwork, damp proof membrane, recycled plastic or polystyrene pods and reinforcing are put in place in this concrete raft slab construction.

[9] Standards New Zealand, 2003.

Source: Stop Digging!

Figure 1.3: Ground below a piled foundation requires less earthworks than a concrete foundation.

Landscaping

Soft landscaping features on a site include gardens, lawns and tree pits. Planters may be incorporated into hard landscaping and are usually filled with planting mix rather than topsoil. The depth of topsoil required in gardens and lawns is decided in consultation with landscape architects, and may reference relevant local authority requirements and the master plan.[10] Factors that may influence the area, depth and volume of soil in landscaping features include:

- **Vegetation type**

  Lawns require shallower topsoil, whereas trees require a larger depth and volume of soil and uncompacted subsoil to thrive.

- **Grade of any slopes**

  Steep slopes may need special features such as geotextiles to avoid erosion.

- **Built area coverage on a site**

  This constrains the extent of green space (and hence the need for soil). In the context of new subdivisions, landscape architects may propose smaller green spaces per lot in return for a larger green space in a nearby park or similar reserve.

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[10] For example, Chapter 7 of *The Auckland Code of Practice for Land Development and Subdivision* (the CoP; Auckland Council, 2021) sets out specifications for topsoil quality, and minimum depths for lawns (250 mm) and garden beds (400 mm). However, industry adherence and compliance with the CoP is unknown. In addition, many landscape architects have developed their own soil specifications.

Developments may also incorporate green infrastructure and nature-based solutions such as raingardens or constructed wetlands. If on-lot stormwater retention is limited, stormwater services may be provided through green infrastructure that services a larger portion of a subdivision. These often incorporate soils in the form of engineered soil mixes.

The extent of the earthworks, including compaction and the depth, volume and area of soil replaced, will have an influence on what will grow successfully on the site.

Impacts of land development on urban soil resources

Each of the practices identified above will affect the capacity of soil to provide ongoing environmental services. The master planning process will influence drainage design and areas allocated to housing or green spaces. The geotechnical investigations will determine the level of ground improvement and remediation required. The earthworks design will determine how much cut and fill is required and the extent of compaction. Landscaping will determine how much soil is needed, including its composition and the depth and area of soil suitable for various types of vegetation. All are interrelated.

The United Kingdom Department for Environment, Food and Rural Affairs identified the following impacts of construction activity on soils.

- Soil sealing – or covering the soil with an impermeable layer – impacts on the properties of soil, as well as its drainage capacity.
- Over-compaction of the soil when heavy machinery is used impacts on drainage capacity and the ability of roots to penetrate the subsoil.
- Mixing subsoil and topsoil can reduce soil quality.
- Discarding soil results in the loss of a valuable resource.[11]

It is fair to anticipate that where housing intensification increases the extent of built coverage, some degradation or loss of soil will occur as green space with permeable soil is converted to sealed areas that support the weight of buildings and infrastructure. These impacts may be reduced through careful design or offset through the addition of green space or green infrastructure.

Three aspects of the impact of urban development on city soils are elaborated below.

Impact on vegetation growth

Vegetation in urban areas provides habitat for biodiversity, carbon sequestration and improved wellbeing for city dwellers. Trees are particularly important for shade and cooling.[12] Trees require an adequate depth and volume of soil to thrive. The soil volumes required depend on the species and other environmental factors. For example, pōhutukawa (and to some extent tōtara) can tolerate compacted, dry soil. Where their root growth is restricted, they will become small trees. By contrast, drought-intolerant species (such as pūriri and beech) have root systems that require a larger volume of soil.[13]

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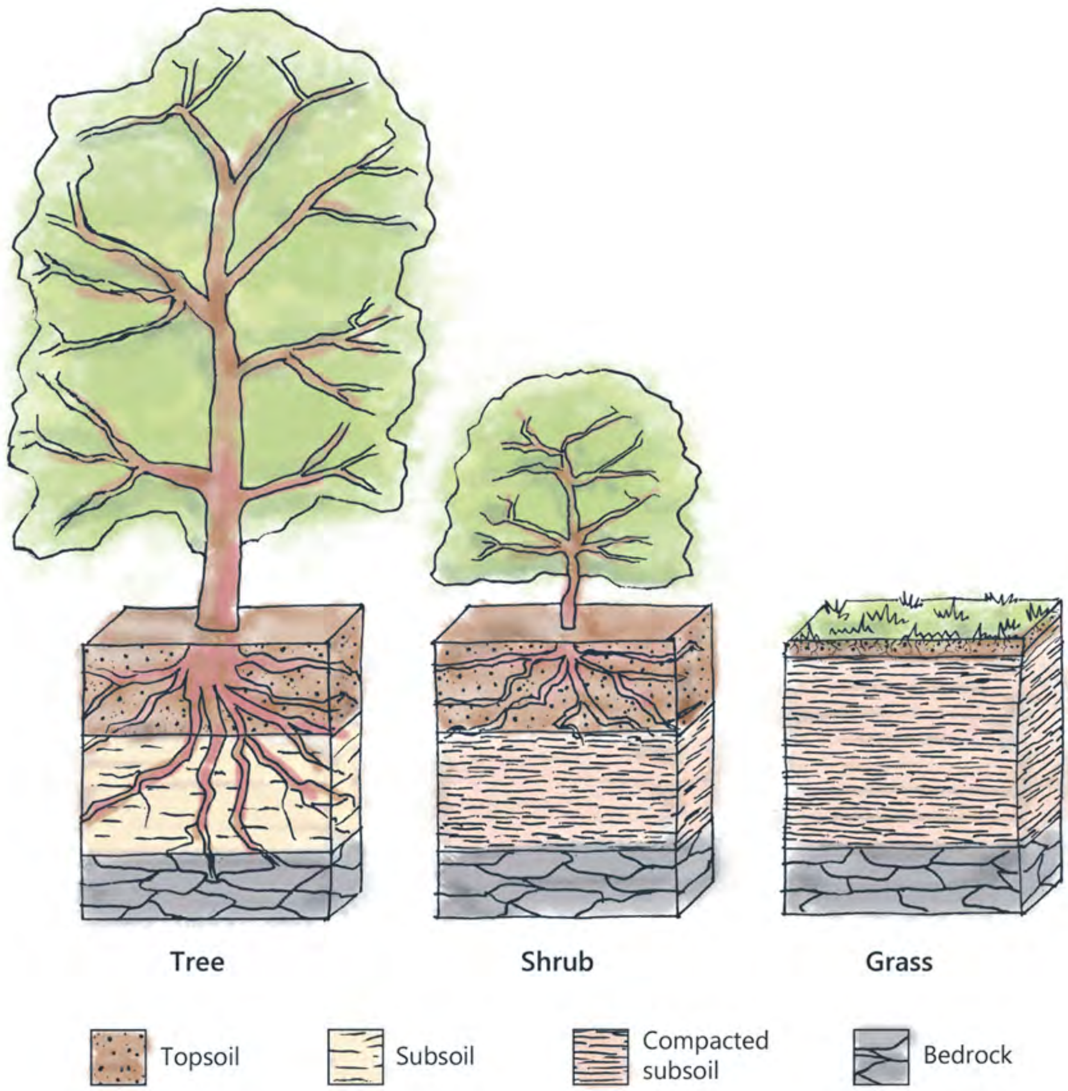
[11] DEFRA, 2009.

[12] PCE, 2023, pp.32–33.

[13] Thompson-Morrison et al., 2023, p.7.

If, through the land development process, the soil volume becomes limited or subsoil is compacted on a site, the range of trees that can be successfully grown will be restricted, in some cases so severely that only shrubs will succeed (see Figure 2.1). Shading and carbon sequestration potential in these cases will be minimal.



Source: PCE

Figure 2.1: Topsoil depth and whether the subsoil is healthy or compacted affect what plants are able to be grown successfully. The shallower the topsoil or more compacted the subsoil, the smaller the plants.

Impact on urban water management

Are we building harder, hotter cities? looked at the impact of increasing the extent of impervious surfaces. Increasing the extent of impervious surfaces will result in large increases in surface runoff as the ground is sealed over.[14] Climate change is expected to result in a higher frequency and intensity of extreme rainfall events in Auckland. The greater the extent of impermeable surfaces, the greater the runoff and the need for costly engineered solutions. By contrast, forested areas – which include trees and the soil beneath – soak up the excess water that is present during rainfall events. Research by Scion from Mahurangi Forest following Cyclone Gabrielle, for example, found that forested areas stored nearly 60% of the rain within the catchment rather than contributing to flooding by increasing stream flow.[15]

If the landscape planning for a subdivision development does not provide for soils to be adequately reinstated, ameliorated or supplemented with trees and appropriate green infrastructure, the capacity of resulting green spaces to soak up and buffer excess water will be compromised. The addition of features that seal or cover soils (e.g. impervious surfaces such as buildings or roads) will further alter stormwater management potential or limitations on a site. The choices of materials used, such as retaining walls, grass (whether synthetic or natural) or paving material, will also have a bearing on the capacity of soils to slow the flow of stormwater.

Wastage

Soil loss is not an easily reversible process once soil is disposed of because of how long it takes to form naturally. How much soil is being disposed of in landfills each year is not known, but it is estimated that the bulk of the 'potentially hazardous' category in the Ministry for the Environment's reporting (800,000 tonnes per year, or just over 20% of the total) is made up of soil.[16] The ministry acknowledges that "we are currently wasting large volumes of soil by trucking it to landfills as waste during development projects, or when we manage and remediate contaminated land."[17] One individual in the waste management industry has spoken of the need to truck tens of thousands of tonnes of soil across the country with the prospect of some landfills running out of space or tightening their acceptance criteria for other reasons.[18]

The increase and extension of the waste levy is providing an increasingly pressing incentive to manage a greater proportion of soils excavated during land development, on site.

In addition to any contamination, the amount of soil that can be beneficially reused instead of discarded in the development process depends on a number of factors. These include geotechnical inputs and the cost of disposal relative to the cost of importing material.

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[14] For an increase in impervious area from 55% to 65% on a hypothetical city block, the annual stormwater runoff is estimated to increase by 25% (PCE, 2023, p.138).

[15] Scion, 2023.

[16] HAIL Environmental, 2022.

[17] MfE, 2023b, p.51. MfE intends to address issues with its data and to promote sustainable remediation and reuse of soils as part of its waste strategy (MfE, 2023b).

[18] Waste management industry member, pers. comm., 7 December 2023.

In summary

Decisions made and actions taken throughout the residential design and construction process, in line with regulatory requirements, have a strong bearing on how great an impact a particular development will have on soil. In particular, decisions about the extent of earthworks required from a geotechnical perspective, as well as the desired housing typology and landscaping, largely determine the fate of urban soils.

3

Paesia scaberula

Why soil is stripped on development sites

This chapter looks at some of the drivers behind the choices made at various points in the residential land development process discussed in chapter one. It draws on conversations with developers and regulators. The discussion turns first to regulatory drivers embedded in the Building Code and planning regulations, then to market drivers.

The discussion of these specific drivers takes place in the context of urban development nationwide. As detailed in *Are we building harder, hotter cities? The vital importance of urban green spaces*, cities such as Auckland and Hamilton have seen an increase in both infill development in brownfield areas and a denser built form in large new subdivisions. In both cases this has been associated with a reduction in green space. This is a trend that is set to continue given recent initiatives such as the Medium Density Residential Standards (MDRS), a central government initiative designed to intensify housing within populous urban zones.[1]

[1] PCE, 2023.

Regulatory drivers

The Building Code

All buildings in New Zealand must meet the minimum performance requirements of the Building Code, which "covers aspects such as structural stability, durability, protection from fire, access, moisture control, services and facilities, and energy efficiency".[2] There are various ways these standards can be met, which include acceptable solutions, verification methods and product certifications. These compliance paths, while not mandatory, carry weight because they must be accepted by building consent authorities as meeting the performance requirements of the Building Code, thereby simplifying the task confronting a developer.

The document *Acceptable Solutions and Verification Methods: For New Zealand Building Code Clause B1 Structure* includes the detail of loads to be resisted by the foundations.[3] This document also defines 'good ground' as, among other things:

> "any soil or rock capable of permanently withstanding an ultimate bearing pressure of 300 kPa … but excludes … potentially compressible ground such as topsoil, soft soils such as clay which can be moulded easily in the fingers, and uncompacted loose gravel which contains obvious voids".[4]

Also relevant is New Zealand Standard (NZS) 3604:2011 *Timber-framed buildings*.[5] This is an acceptable solution under the Building Code, which includes a set of construction requirements for small timber-framed buildings common in new urban subdivisions. Under NZS 3604:2011, which covers buildings up to ten metres in height, buildings must be constructed on good ground to be included within its scope. This means developers must either remove the topsoil – and in many cases, parts of the subsoil – to reach good ground or apply for a specific engineering design. The latter course is likely to involve more cost and complexity and is therefore less likely to be preferred (see Figure 3.1).

It is also notable that the MDRS drive a particular housing typology. The MDRS seek to enable buildings of up to three storeys with a maximum height of 11 metres plus one metre for pitched roofs.[6] However, as noted above, the scope of NZS 3604:2011 only extends to buildings with a maximum height of ten metres, with any third storey being only a partial storey (in the roof space), rather than a full storey. This means that three-storey townhouses promoted under the MDRS currently require a specific engineering design to proceed.[7]

Under NZS 3604:2011, foundations for three (partial) storeys do not incorporate piled foundations. Changes are underway to update NZS 3604:2011 to increase its scope to three full storeys,[8] including limiting the foundation choice to slab-on-grade foundations.[9]

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[2] MBIE, 2021. The Building Code is contained in schedule 1 of the Building Regulations 1992 under the Building Act 2004.

[3] "Foundations must be designed for the load combinations given in AS/NZS 1170 Part 0, as amended by B1/VM1" (MBIE, 2023, p.51).

[4] MBIE, 2023, p.15. The document does not appear to exclude from scope foundations where good ground is not established, except for in cases prone to risks of liquefaction and lateral spread.

[5] Standards New Zealand, 2011.

[6] RMA 1991, Schedule 3A, Part 1, s 11.

[7] MBIE, pers. comm., 15 August 2023.

[8] Hindley, 2021.

[9] MBIE, pers. comm., 15 August 2023.

In short, high-density housing comprising three or more storeys very likely uses concrete slab foundations at present, and this will be reflected in any future changes to NZ 3604. Soil disturbance to reach good ground will be uniformly required, at a minimum through the removal of all topsoil prior to building foundations.

Another factor that might facilitate the use of particular products is the availability of product certification to meet Building Code requirements. There are both steel screw pile and concrete raft slab systems covered by CodeMark, the Ministry of Business, Innovation and Employment's voluntary product certification scheme. While CodeMark certification has been in place for concrete foundation systems for some years, screw pile foundations were not certified until 2023.[10] Screw pile still has relatively limited market penetration, with concrete foundations predominating at present.

Source: Kāinga Ora

Figure 3.1: A Kāinga Ora housing development site in Northcote, Auckland. Topsoil is removed and the entire site is compacted to create 'good ground'.

[10] Based on a sample of product certificates accessed through the MBIE product certificate register (see https://www.building.govt.nz/building-code-compliance/product-assurance-and-certification-schemes/codemark/product-certificate-register/).

Geotechnical requirements and gradients

Beyond Building Code requirements, additional geotechnical considerations outside the footprint of the building are often applicable. These include ensuring appropriate fill and compaction to support infrastructure such as roading. These requirements rely on a geotechnical engineer's professional opinion and the application of standards, and may also be integrated into the Resource Management Act 1991 consenting process. In addition, roading gradient rules and the surface gradient of residential parcels to shed stormwater are often front of mind for developers and engineers in considering the final landform for a new development.

Roading design too can influence the volume of soil removed and green space. Road corridor widths, for example, may influence the extent of soil removal. Subdivision patterns that favour grid structure public road networks might improve connectivity, but cul-de-sac or rear lot accessways might reduce the overall extent of impervious surfaces created as public roads.[11]

Two highly relevant standards are NZS 4404:2010 *Land development and subdivision infrastructure* and NZS 4431:2022 *Engineered fill construction for lightweight structures*.[12]

For instance, NZS 4404:2010 asserts that the geo-professional "needs to be involved in the choice of final land form".[13] Specific design considerations include landform selection.

> "The final choice of landform shall represent the most desirable compromise between the development requirements and the preservation of natural features and the natural character and landscape amenity values of the site including the retention of natural watercourses. Landform selection needs to take into account low impact design principles including retention of existing landforms and natural features where possible … An earthworks approach that respects and reflects the natural topography of the site is preferred."[14]

Considerations for carrying out earthworks include:

- minimisation of the risk of damage to property occurring through ground movement, flooding or surface water runoff
- development of a more desirable roading pattern
- the efficiency of overall land use
- the need to create suitably graded areas for playing fields and other community facilities.

[11] Walker Landscape Architects, pers. comm., 30 November 2023.
[12] Standards New Zealand, 2010, 2022.
[13] Standards New Zealand, 2010, p.45.
[14] Standards New Zealand, 2010, p.49.

Another consideration incorporated into NZS 4404:2010 and cited in some specific council rules is road gradients. Some developers cite roading gradients as the rationale for significant soil stripping. For example, the Auckland Transport Code of Practice notes that for Category A roads (arterials, primary and secondary roads), gradients should not be steeper than 12.5%, or above 8% for those fronting commercial or industrial zones.[15] For Category B roads the requirements are prescribed in NZS 4404:2010, with variable requirements depending on the intended land use.[16] NZ Transport Agency Waka Kotahi (NZTA) also sets out accessibility considerations for footpath design, noting that gradients of more than 8% are difficult to negotiate independently.[17] In these ways, infrastructure and accessibility considerations may be leading councils in some places to incentivise developers to level hilly sites.

'Final landform' and 'gradient' were the rationale for considerable soil disturbance provided by one developer working with an approximately 20-hectare site with hilly topography in the Greater Wellington area. In this case, over half a million cubic metres of earth was moved to reach an overall landform that was desirable to purchasers, with the developer explaining the need to remove trees and soil to reach good ground to shape the new landform in a way that would "make the ultimate landform efficient rather than a series of slopes and valleys".[18]

This developer was also subject to roading gradient rules that had an influence on decisions around landform. While the rationale above relates to guidance available in NZS 4404:2010, market drivers for foundation design were also a factor in the choice of building foundations and land development for sale. These factors are discussed further below.

National environmental standard

When regulating land use, in accordance with their functions,[19] territorial authorities must apply the National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health (NESCS).[20] The NESCS applies to activities taking place on land that is potentially contaminated due to historical or current use as referenced in the Hazardous Activities and Industry List (HAIL).[21] The NESCS sets standards for priority contaminants that are likely to be found based on this land use, and areas of discretion where these standards are exceeded, including the need to remediate in some cases.[22]

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15 Auckland Transport, 2013, p.166.

16 Auckland Transport, 2013, p.166; Standards New Zealand, 2010, pp.66–77.

17 NZTA, 2023.

18 Developer, pers. comm., 7 June 2023.

19 RMA 1991, s 31(1)(b)(iia).

20 Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011.

21 MfE, 2012, pp.10, 13.

22 The NESCS users' guide says the NESCS "does not require testing for the entire set of priority contaminants on every piece of land, only for those contaminants that are likely to be found because of the historical land use. The 12 priority contaminants are: arsenic, boron, cadmium, chromium, copper, lead, mercury, benzo(a)pyrene, DDT, dieldrin, PCP and dioxin (including dioxin-like PCBs)" (MfE, 2012, p.8). The NESCS sets contaminant standards for five land use scenarios: "rural/lifestyle block, residential, high-density residential, parks/recreational, commercial/industrial outdoor worker (unpaved)" (MfE, 2012, p.8).

Certain activities, including soil disturbance and subdivision, are covered, but the regulations do not apply if a detailed site investigation shows contaminants below background levels.[23] In line with permitted activity criteria, excavated earth is often interpreted as needing to be disposed of at a landfill or other 'appropriate facility', rather than be reused on site.[24] This can result in wastage of soils that are potentially only lightly contaminated.

In a greenfield context, HAIL categories relevant to residential developments include a broad range of prior land use activities. Examples of contaminants caused by common rural land practices include cadmium in soils as a result of legacy broadscale application of superphosphate, and use or storage of pesticides that, while no longer used, can be persistent in soils.[25] Greenfield residential developments are considered to be the second-largest source for surplus soil generation after infrastructure development.[26] Surplus soils are soils "that have been disturbed through land and infrastructure development or natural processes (e.g. landslips, silt/sediment) and are unable to be beneficially used on-site".[27]

In a brownfield context, while residential land is less frequently classed as HAIL,[28] the 'halo' around a house is at times assumed to be contaminated and is excavated as a precautionary move by some developers. This is standard practice in Kāinga Ora state housing redevelopment, for example, where, for housing stock that was poorly maintained in the past, the assumption is made that there will be residual contamination based on typical levels of lead paint and asbestos found in the soils around the house. This material is removed at the demolition of the building (two metres out from the footprint and 200 millimetres deep).[29]

Where soil has been determined to be contaminated, this soil may commonly be excavated and disposed to landfill, even if only lightly contaminated – for several reasons, including rules around reuse and facility acceptance criteria.[30] For efficiency reasons, contractors may also remove additional soils over and above what is strictly necessary for regulatory purposes.

> "To ensure you are only removing contaminated soil you would need to test specific sections. This requires time to obtain samples, send to the lab for testing and wait for results. Often, contractors will just remove large sections of soil in and around areas of suspected contamination as it is often much quicker. It does, however, mean that a lot more soil is removed and disposed off-site than is necessary. It also means more imported fill is required to replace this."[31]

Regardless of the reason for soil stripping, the presence of contaminants will limit the extent to which the soil, once excavated, can be reused on that or other sites.

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[23] Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011, s 5(9).

[24] Cavanagh et al., 2023, p.13.

[25] MfE, 2023a, pp.37–41.

[26] Based on workshop held with a "wide range of end-users, including contaminated land practitioners and local authorities" (Thompson-Morrison et al., 2023, p.12).

[27] Cavanagh et al., 2023, p.4.

[28] Pattle Delamore Partners, pers. comm., 4 July 2023.

[29] Kāinga Ora, pers. comm., 24 July 2023.

[30] Thompson-Morrison et al., 2023, p.13.

[31] Developer, pers. comm., 10 August 2023.

Concern was raised that excessive soil removal in some instances is being driven by councils interpreting the NESCS in an overly conservative way. Some councils require consent for every instance where soil containing contaminants above background level is moved beyond a site boundary, regardless of whether it is HAIL land or not. Others allow some movement of soil to adjoining sites to occur without consent. Some developers see this approach – combined with low landfill costs – as influential in the decision to 'dig and dump' soils that are above background contamination levels but do not necessarily pose appreciable risk and could otherwise be kept in place for lower risk land uses or reused in other developments nearby.

The relative ease of soil disposal is relevant. Take, for example, this comment from a consultant in the land development industry: "Low landfill costs versus high land value (with the highest value for land free from any LIM-tags) has always been a driver (and still is even with landfill levies)."[32] Another driver for generation of surplus soils is the "desire to avoid legacy risk (i.e. by leaving contamination on-site that is noted on LIMs or requires specific ongoing management that may reduce the value of land/general saleability)."[33]

There is work underway to improve the reuse potential of surplus soils. A wide range of stakeholders are involved in seeking to address this, including an MBIE Envirolink-funded project undertaken for regional councils by Manaaki Whenua – Landcare Research (MWLR) that encourages sustainable management of surplus soils, and considers te ao Māori implications of the issue. Increasing landfill levies will also likely influence the choice of whether to reuse soil on site rather than dispose of it.[34]

To summarise, regulation and geotechnical requirements require *some* soil to be excavated. But there are additional drivers that relate more to the current market, which are explored below.

Market drivers

Yield and profitability

A strong consideration for developers is to maximise yield – that is, both to build more dwellings and to minimise the amount of each site that is not built on. Incentives to maximise yield are commercial in nature and are also encouraged by the government as part of the drive for intensification and the creation of thousands of new dwellings each year. The yield incentive, unless countered by other mitigating factors, will likely sway a development in favour of more, larger building platforms at the expense of greenspace underlain by soil. That said, maximising development yield need not always come at the expense of soil – building upwards offers developers a way of increasing yield while maximising the extent of greenspace on a given site.

[32] Pattle Delamore Partners, pers. comm., 16 August 2023.

[33] Cavanagh et al., 2023, p.3.

[34] "The levy is currently set at $20 per tonne (excluding GST) on all waste sent to class 1 municipal landfills. The rate for class 1 landfills is progressively increasing over the next couple of years up to $60 per tonne from 1 July 2024. Class 2 construction and demolition fills are subject to a levy of $20 per tonne (excluding GST) on all waste sent to landfill from 1 July 2022, and $30 per tonne from 1 July 2024" (MfE, 2022).

Additionally, land development practice often involves more excavation than is strictly necessary for the construction of structures due to the geotechnical reasons described above, even though the cost of earthworks is significant. For example, for a 17-hectare greenfield development in Hawke's Bay, one developer cited a figure of $2.8 million to strip soil on site to a depth of 300 millimetres.[35] Despite the considerable cost, industry engagement indicates that there are strong market drivers to undertake expensive, large-scale earthworks to achieve a flat, build-ready site.

There also appears to be some regional variation in the extent to which extensive earthworks are seen as necessary in preparing sites for sale. For instance, one geotechnical engineer observed differences between Christchurch and Nelson. In Christchurch, on the Port Hills and adjoining sloping ground, sections are commonly sold in their natural sloping state and the purchaser builds pile foundations or undertakes the minimum cut and fill earthworks. By contrast, in Nelson, he had observed land developers frequently opt to undertake widescale earthworks to create flat building platforms for sale.[36]

Foundation choice

Concrete foundations require flat building platforms on good ground, and engagement with local government and developers indicates that concrete slab foundation is strongly prevalent in current building practice in New Zealand. Several stakeholder comments from distinct quarters indicated that there is a *market preference* for concrete rather than simply developer choice. There was convergence in the comments around the efficiency and supply chain aspects of concrete.

- "The market wants slab on grade."[37]
- "We have explored [using timber piled foundations], cost for cost it is similar [to concrete], personally we quite like it. But the buyers do not – as they associate a timber piled floor with old villas, ventilation and damp issues. [We were] led by wanting to reduce the concrete with its associated carbon emissions. So we looked into timber, but market feedback was not supportive or positive."[38]
- "Our buildings are three stories so need to put in concrete slab." (This developer commented that if they wanted to put in timber piles they would have had to be 15 metres high because of the type of soils.)[39]
- "Concrete slab is the most efficient platform that the supply chain can respond to at speed … and from a time and cost perspective and for supply chain [reasons we] want to be offering up good ground as per [NZS] 3604 – most efficient platform that the supply chain can respond to at speed." (Particular constraints in the supply chain include the availability of equipment, labour and suitably skilled contractors.)[40]
- "NZS 3604 build ready (de-risking the sites) enables predictable outcomes, as the owner doesn't have to engineer the site themselves. Seeing the words 'special engineering design' is a detractor for sale."[41]

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[35] Developer, pers. comm., 25 May 2023.
[36] Eliot Sinclair, pers. comm., 2 October 2023.
[37] Developer, pers. comm., 29 June 2023.
[38] Developer, pers. comm., 8 August 2023.
[39] Developer, pers. comm., 25 May 2023.
[40] Developer, pers. comm., 7 June 2023.
[41] Developer, pers. comm., 29 June 2023.

Preparing flat sites for concrete slab is perceived as most readily taking advantage of available methods and techniques in the building sector: the market is currently well set up for concrete slab foundations. With the available skills and workforce being oriented towards a certain earthworks and foundation formula, construction matching these specifications is likely to be cheaper, further reinforcing the likelihood that concrete slab foundation will be the default choice.

There was, however, a divergence of opinions in the reasons *why* slab-on-grade foundations were preferred to piled foundations in the current market. Some noted that concrete was less noisy underfoot, but others preferred wood for its seismic performance. A small number of individuals mentioned their preference for timber piled foundations. Some developers are also adopting the use of screw piles in some locations, so the preference for concrete is not universal.

Land development is a capital-intensive business that is usually financed through borrowing, often in stages so that financial institutions can manage their risk. To minimise finance costs, developers have an incentive to develop the land quickly. As developers hit each development 'milestone', finance institutions are then prepared to release further funding. In this context, the developer of one 30-lot development in the upper North Island said it had costed and compared the options of screw piles with concrete waffle slab foundations – the latter requiring excavation to a depth of two metres of clay to reach good ground. While the cost was roughly similar, this developer opted for the concrete waffle slab, which suggests that choices may, to some extent, be driven by familiarity with the most commonly used techniques.

Extent of earthworks

Developers, influenced by market preferences and the specifications of their civil engineering contractors, are frequently opting to strip large swathes of soil rather than just the areas that are strictly necessary for foundations or contaminated land as required by regulation. Regulators and developers provided a number of comments to that end. One regulator in the building space said it is "because it is more efficient. It is more cost effective to scrape the whole section rather than scrape out specific sections."[42] Some developers inferred that it was more challenging to work with a patchwork of selectively scraped sections.

Discussions with developers reinforced the efficiency considerations noted above but introduced some more nuanced ideas. One developer said that their civil engineering contractor would opt to bulk scrape rather than spend more time assessing actual ground conditions before selectively excavating soil.

> "You are potentially scraping soil, loading up and carting [soil] elsewhere onsite (or offsite) that may be perfectly fine where it is. Then of course, sourcing and importing more fill to replace this is even worse!"[43]

In his view, only scraping soil where needed could result in cost and time saving during construction. Some spoke of the need for speed to complete the scheduled works to stabilise the land and offer it up for sale: "[We need to] complete a stage [of the subdivision] per earthworks season. October to May."

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[42] Regulator, pers. comm., 8 May 2023.

[43] Developer, pers. comm., 14 August 2023.

In summary

Looking at the issues of foundation choice and the extent of earthworks, two conclusions emerge. Firstly, the preparation of build-ready flat land enables concrete slab on ground to be delivered in a uniform way, which provides a predictable process for house building. Secondly, with regard to both soil preparation by civil engineering companies and foundation choice by builders, *efficiency* is a prime driver. While there is not uniform agreement that wholescale excavation is always the most efficient or cost-effective approach, current regulatory and market drivers encourage it.

Cyathea cunninghamii

4

How local authorities mitigate the impacts of urban development on soils

Councils have a range of tools available under the Resource Management Act 1991 and other legislation to mitigate the harmful effects of development activities on soil.[1] This chapter explores the tools available and the approach of regional councils to residential developments as well as the detailed specifications applied by councils at the district level during subdivision consenting.

Regional councils

Regional councils are responsible for the integrated management of natural and physical resources within their region.[2] They are responsible for managing the effects of using freshwater, land, air and coastal waters by developing regional policy statements and the issuing of consents.

When regulating the environmental effects of residential development, functions relevant to soil include:

- control of land use for the purpose of soil conservation, maintenance of water quality and quantity and the avoidance or mitigation of natural hazards[3]
- controlling discharges into or onto land, air or water[4]
- managing stormwater discharge and diversion.[5]

Regional councils are also responsible for implementing key pieces of national direction, some of which have a strong focus on urban development.

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1 The Local Government Act 2002 is also highly relevant to council functions, as it requires local authorities to conduct long-term planning for infrastructure, and provides the ability to levy development contributions as money or land from developers to pay for the impact of new developments on infrastructure. Under s 101B of this Act, certain kinds of assets must be planned for, while others, such as green infrastructure, are included at the discretion of the council.

2 RMA 1991, s 30(1)(a).

3 RMA 1991, s 30(1)(c).

4 RMA 1991, s 30(1)(f).

5 RMA 1991, s 30(1)(e) and (f).

Consenting earthworks

Regional councils are charged with soil conservation, which requires "avoiding, remedying, or mitigating soil erosion and maintaining the physical, chemical, and biological qualities of soil".[6] Some of these responsibilities derive from the Soil Conservation and Rivers Control Act 1941. In line with these responsibilities, regional councils require consent for bulk earthworks.

In bulk earthwork consenting, regional councils place a strong emphasis on mitigating the adverse effects of sediment discharge that may be shed when large-scale earthmoving takes place. Sediment can damage receiving environments, degrading habitats when waterways become laden with silt. Sediment and erosion control measures commonly required to reduce sediment discharge loads include staging earthworks, stabilising exposed areas, and installing perimeter controls and retention devices.[7]

The practical focus of regional councils when they are consenting earthworks seems to be narrowly focused on managing sediment and erosion rather than conserving the properties of soil *per se*. This focus on erosion control may owe its origins to the historical roots of the legislation in rural soil conservation programmes. Interestingly, Greater Wellington Regional Council and Waikato Regional Council describe their functions as relating to land use – and particularly erosion – in the rural context.[8]

Maintaining the 'physical, chemical, and biological qualities of soil' *in addition to* managing soil erosion, and regardless of whether the soil is found in an urban or rural area, is integral to the soil conservation function of regional councils as defined by legislation. A goal such as minimising the volume of earth moved or keeping areas of high-quality soils intact might be a better way of framing that function.

Stormwater management

In addition to engineered reticulated networks, stormwater management relies on natural and landscaped soils, and increasingly on green infrastructure such as wetlands. Urban development involves the creation of new impervious surfaces and altered stormwater flow. It can alter the natural water cycle in a catchment with consequences for the surrounding natural and built environment, including flooding and reduced ecological health.[9]

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6 RMA 1991, s 2. Regional councils' responsibilities for soil conservation are described in RMA 1991, s 30.

7 See, for example, GWRC, 2021, pp.7–9.

8 The Regional Soil Plan for the Wellington Region "allows most soil and vegetation disturbance activities to be carried out without a resource consent. Only large scale soil and vegetation disturbance activities on steep, erosion prone land are controlled" (GWRC, 2000, p.v). Also, Waikato Regional Council "reduces erosion through large scale soil conservation schemes. Trees are planted on hills and stream banks, gullies and waterways are fenced to prevent stock access, and land has been retired" (Waikato Regional Council, no date).

9 WSP, 2020, pp.16–17.

Regional council roles in relation to stormwater range from attenuating peak flows from storms to prevent flooding through to treating contaminants from stormwater flowing over impervious surfaces.[10] Regions manage this in different ways and in a different sequence. That said, it is commonplace for regional councils to issue consents, including global stormwater consents (also called network or comprehensive discharge consents), in urban areas that provide for a certain level of development activity without needing a consent.[11] District councils that provide local infrastructure typically hold these global consents while also issuing land use consents for subdivision. The global consents include engineering requirements for the conveyance of stormwater.

Some regions also require the development of an integrated catchment management plan (ICMP), which is a "single, evidence based document that examines a specific hydrological catchment and its associated infrastructure networks to identify future infrastructure needs and development requirements".[12] ICMPs typically take into account soil variables, including soakage suitability. They may be developed through a structure plan or as a condition of consent via a comprehensive stormwater discharge consent for a district council.

Box 4.1 illustrates the way the stormwater effects of development are managed in different regions.

Box 4.1: Managing stormwater effects of development in different regions

Auckland

The Healthy Waters department of Auckland Council holds a network discharge consent (NDC), which is a single consent containing a comprehensive set of requirements for use across the existing and future urban areas of the Auckland Region. Instead of requiring private consents for the diversion and discharge of stormwater, developments can be covered under the NDC where they meet the requirements.[13] Greenfield and large brownfield areas may need to develop a specific stormwater management plan (SMP) for a stormwater catchment. Developing an SMP requires giving consideration to, among other things, "the existing hydrological and environmental features of the area" and the "appropriate scaling of Water Sensitive Design applications". The SMP "should be prepared, reviewed and updated in line with the Structure Plan/Subdivision design process".[14]

Auckland is divided up into wider hydrological catchments, each with a catchment management plan that sets out the wider stormwater approach.[15] That said, the requirement to prepare an SMP is triggered by the scale of a development rather than the scale of a catchment or sub-catchment. This means that unless the catchment-related effects have been considered at the structure planning stage, development planning may overlook the impact of soil removal on the wider hydrology of the area.

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10 RMA 1991, s 30(1).

11 Conwell, 2021.

12 Phillips and Savage, 2017, p.4.

13 Auckland Council, 2019.

14 Auckland Council, no date, p.2. This document also refers to Auckland Unitary Plan provisions that address ground soakage, the presence of peat soils, having an integrated stormwater management approach and reducing the potential to cause flooding (Auckland Council, 2022a).

15 Auckland Council, no date.

Waikato

Waikato Regional Council encourages developers to submit earthworks and stormwater consents for major residential developments, where required, at the same time that they apply for a subdivision and earthworks consent with the district council. However, some stormwater discharge activities are permitted activities. Stormwater discharge from an urban area can be a permitted activity if it can meet the criteria stated in the Waikato Regional Plan. These include developments being less than one hectare in area, the rate of the discharge with respect to flooding, and the potential for adverse effects on receiving environments.[16] Regional guidelines encourage good practice including by reducing the rate of runoff from development lots and design to retain the "initial abstraction" volume of runoff.[17]

Hamilton City Council must comply with the city's comprehensive stormwater discharge consent issued by the regional council and must ensure private developers comply where this is relevant. There is also a requirement for developers in certain circumstances to prepare ICMPs or a sub-catchment ICMP.[18] The Hamilton City Council District Plan sets out a suite of information requirements for full ICMPs and sub-catchment ICMPs. With respect to soil, they must address:

- minimising the effects of urban development and managing runoff from the different relief and soil types in an integrated manner
- sustaining groundwater levels in peat soils as far as practicable
- retaining a hydrological cycle close to the pre-development hydrological cycle as far as practicable.[19]

All new greenfield areas must have a structure plan and an ICMP prepared by Hamilton City Council in place before development begins. Full ICMPs are required to be certified by the regional council as part of the conditions of the comprehensive stormwater discharge consent. There are, for example, ICMPs in place for the Rotokauri, Rototuna and Peacocke growth cells.

Outside of the Hamilton metropolitan area, ICMPs to encompass catchment-scale impacts to the hydrological cycle are less likely to exist. Consideration of stormwater effects in these settings is likely to be more piecemeal.

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16 Waikato Regional Council, 2012, section 3.5.11.

17 Waikato Regional Council, 2020b, p.ii. A new volume control criterion is included (in addition to existing peak flow control and water quality treatment criteria) requiring developments to be designed to retain (reuse or soak) the initial abstraction volume of runoff. This criterion is to help offset the effects of impervious areas.

18 If more than 40 additional residential units or more than 40 additional allotments are created on any site, or any land involving more than 3 ha (HCC, 2016).

19 HCC, 2016.

Bay of Plenty

In the Bay of Plenty, Plan Change 92 is underway to introduce Medium Density Residential Standards to Ōmokoroa and Te Puke. For Ōmokoroa this requires rezoning existing residential zoned land to medium density residential. Western Bay of Plenty District Council holds a comprehensive stormwater consent issued by the Bay of Plenty Regional Council for Ōmokoroa, which is in the process of renewal. The renewal will be expected to address water quality outcomes, controls for avoiding erosion of gully systems, and habitat protection and restoration.[20]

However, this zoning change has impacts for stormwater management, summed up in this submission from a Principal Planner at Bay of Plenty Regional Council:

> "Changing the land use from rural/ greenfields to an urban development impacts the quantity and potentially the quality of stormwater discharges."
>
> "The Regional Natural Resources Plan contains rules which provide for permitted stormwater discharges and requires consent for large rates of stormwater discharges or contaminated stormwater discharges, however, there is no requirement to obtain consent at the planning/subdivision stage, prior to the discharge occurring. This leads to earthworks and/or subdivision consents being granted prior to considering the potential effects of stormwater flows."
>
> "For assessment of stormwater effects to be considered in the subdivision consent, there needs to be a stormwater planning framework, per catchment, for an entire structure plan area so that stormwater management can be planned for holistically, in an integrated manner that avoids the potential cumulative effects of individual assessments."
>
> "In Ōmokoroa there are steep erodible gully in some areas, wetlands and high coastal biodiversity areas in the final receiving environment that requires protection through a planning framework pre-development."[21]

While regional councils have the primary responsibility for assessing and managing ecological effects, they are not always in a position to influence decisions on developments taken by district councils exercising their land use functions. This is partly because of permitted activity rules that exist in most regions. In some cases, this is also due to the sequence in which the consents are applied for. Where earthworks consents are granted prior to stormwater consents, environmental managers at a regional level are not in a strong position to anticipate the full effects of changing landforms on stormwater flows until it may be too late to adequately mitigate them.

On the basis of this enquiry's investigations, it appears that there is insufficient integration when it comes to considering and managing the effects on soil of rezoning and converting rural areas into largely impervious surfaces. Where there is the potential for cumulative effects from multiple developments to occur in a given catchment, the impact of this gap may be particularly harmful. The gap in oversight is likely to be especially apparent in the absence of an ICMP, which tends to be the case in many smaller districts.

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[20] Western Bay of Plenty District Council, 2022, p.71.

[21] Bosch, 2023, pp.2–4.

Water-sensitive urban design

In addition to integrated catchment management planning, water-sensitive urban design is being adopted in elements of subdivision planning. This approach uses the natural processes of soil and plants to manage stormwater in urban design (see Figure 4.1).[22] An example of this approach is detailed in Auckland Council guidance. In a greenfield context this approach might entail 'intensified or clustered' development in the most appropriate areas of a catchment. In a brownfield context, this could look like congregating buildings into part of the site and retrofitting green infrastructure such as raingardens, living roofs and swales.[23]

In 2020, the Ministry for the Environment commissioned WSP to undertake a stocktake of regional plan provisions that had adopted concepts such as water-sensitive urban design. The stocktake found that few plans "have a fully developed policy framework that takes an integrated approach to stormwater management, including both the role of mana whenua and the incorporation of WSD [water-sensitive design] and mimicking of natural processes".[24] This review also found that integrated catchment-based approaches were a work in progress.

Another consideration is the role for trees in urban stormwater guidance. Vegetation – including trees – is valuable for stormwater management, with urban vegetation helping to retain a sizeable proportion of the water resulting from extreme rainfall events.[25] However, some stormwater guidelines tend to discourage the planting of trees within bioretention devices like raingardens and swales – for example, those in Auckland and Wellington.[26] One rationale provided for this is that the filter media needs to be replaced over time and the presence of large trees would inhibit this scheduled maintenance.[27] Some guidelines do, however, allow for trees in raingardens.

22 See MWLR (no date-a).
23 Lewis et al., 2015, p.11.
24 WSP, 2020, p.49.
25 PCE, 2023, p.29.
26 Cunningham et al., 2017; Farrant et al., 2019.
27 Farrant et al., 2019, p.105.

Source: Founders Development

Figure 4.1: The 10-hectare Richmond project in Mount Wellington, Auckland is a medium density residential development. Extensive landscaping and comprehensive stormwater planning helped the development withstand Auckland's January 2023 floods.[28]

National direction

Three pieces of national direction have a bearing on residential development and the role of urban soils.

Regional councils need to begin adopting into their regional plans recent changes to the **National Policy Statement for Freshwater Management 2020 (NPS-FM)** and **National Environmental Standards for Freshwater (NES-F)** that are intended "to prevent further loss of New Zealand's valuable natural inland wetlands and associated ecosystems".[29] These amendments include new rules for urban development activities in proximity to wetlands, such as set-backs for earthworks.[30] The wetlands provisions in the NPS-FM and the NES-F will further support housing intensification in place of development outward.[31]

28 See https://www.stuff.co.nz/life-style/homed/real-estate/131559591/the-medium-density-housing-developments-that-defied-the-auckland-floods--this-is-how-they-did-it.

29 MfE and MPI, 2023, p.7.

30 Resource Management (National Environmental Standards for Freshwater) Regulations 2020, Part 3, Subpart 1 – Natural inland wetlands.

31 PCE, 2023, p.6.

New protections have also recently been put in place for highly productive land through the **National Policy Statement for Highly Productive Land 2022 (NPS-HPL)**. About 15% of New Zealand's land area is described as highly productive land suitable for food production (comprising the first three land-use capability classes (LUC 1–3)).[32] Over the last 20 years, some 35,000 hectares of highly productive land has been lost to urban or rural residential development in New Zealand.[33] Seeking to address this trend, the Government developed a policy "to direct new housing development away from highly productive land, where possible".[34] This was gazetted in September 2022. Under this national direction all regional councils must begin to map, identify and avoid urban development on highly productive land.

Finally, the **National Policy Statement on Urban Development (NPS-UD)** and the **Medium Density Residential Standards (MDRS)** will increase zoning permissiveness and will require Tier 1 councils (including some regional councils) to allow for medium density housing in most residential areas, and multi-storey apartments in city centres and along transport corridors. The MDRS enable growth within cities, including infill development, which tends to increase the extent of soil and vegetation removed to create impermeable surfaces.[35]

Among the objectives of the NPS-UD there are some that relate to environmental services. These include an objective to reduce emissions and increase resilience to the current and future effects of climate change. Supporting urban soils is important if this is to be achieved.

An important consideration is that the policies above do not provide protection for soil within areas already zoned as urban, unless this soil is located within an area defined as a wetland – and even then there is a potential regulatory pathway to development. With recent amendments, local authorities must now "ensure that there is sufficient development capacity in relation to housing and business land to meet the expected demands of the region".[36] This entails providing for urban development through zoning and other planning instruments over specified time horizons, and enabling adequate infrastructure to support that development.[37] It has been noted that "there is ongoing tension between the need to cater for the increasing demand for urban development on the one hand, and the need to preserve the diminishing areas of high-quality soils on the other."[38]

The combined effect of these provisions gives regional councils a central role in mitigating harmful impacts on soil and their environmental values. However, the extent to which regional councils can exercise this role in urban growth areas may be somewhat limited in practice due to the structure of planning rules and the push to free up land for development. It is even possible that admirable measures to protect off-limits areas such as highly productive land and wetlands could inadvertently place more pressure on existing urban soils, as this is where urban development will be concentrated.

[32] MfE and Stats NZ, 2021.

[33] MfE and MPI, 2022, p.1. Stats NZ also measures this via its land fragmentation indicator, and cites a 54% loss of highly productive land between 2002 and 2019 (MfE and Stats NZ, 2021).

[34] MfE and MPI, 2022, p.2.

[35] PCE, 2023, p.7.

[36] RMA 1991, s 30(1)(ba).

[37] RMA 1991, s 30(5), and NPS-UD, policies 3.2–3.7.

[38] Grinlinton, 2023, p.1.

Territorial authorities

Territorial authorities have responsibility for land use under their district plans. This includes the issuing of subdivision consents, which requires submission of a detailed scheme plan showing the detailed development design. Through their consenting role, territorial authorities have wide ranging powers to impose conditions, supported in some cases by engineering codes of practice for subdivisions.[39]

Many councils impose a maximum built coverage standard, which ranges from 35% to 55% of the site. A smaller number of councils impose maximum impervious areas (e.g. 60% in Auckland) and minimum landscaped areas (40% in Auckland). Nationally, the MDRS lack a maximum impervious coverage standard. They do, however, include a maximum building coverage area of 50% and require that a minimum of 20% of a development site be retained as landscaped area, although the latter may be interpreted in a way that allows some impermeable structures to be included.[40] The extent of impervious surface coverage versus landscaped area has a considerable impact on the way water moves through a city. Increasing the impervious area from 20% to 60% potentially increases runoff by a factor of 20.[41]

Territorial authorities also grant earthworks consents for soil disturbance. There is some overlap here with the responsibilities of regional councils. As discussed above, regional councils are interested in larger consents that can present sediment and erosion control risks.[42]

Soil specifications at district level

The Parliamentary Commissioner for the Environment commissioned MWLR to collate selected councils' proposed and operative requirements relating to topsoil or soil – hereafter referred to as 'soil specifications' – covering the most populous cities in New Zealand.[43] The work covered both regulatory requirements and guidance included in subdivision codes of practice and similar documents, and captured some national-level standards.

MWLR assessed the adequacy of these requirements from an ecosystem services perspective, covering the following key areas:

- topsoil composition, minimum depth, volume and area
- condition of the subsoil in the context of the provision of a root zone for plants
- implications for vegetation provision
- implications for stormwater management.

[39] PCE, 2023, p.88.

[40] For example, the Auckland Unitary Plan allows up to 25% of landscaped areas to include additional landscape features, including paved areas and uncovered decks (Auckland Council, 2018, p.13).

[41] PCE, 2023, p.30.

[42] Quality Planning, no date.

[43] Thompson-Morrison et al., 2023. Information from the following unitary and territorial local authorities was collated, representing Tier 1 urban environments as defined under the NPS-UD: Auckland Council, Waikato District Council, Hamilton City Council, Tauranga City Council, Western Bay of Plenty District Council, Waipā District Council, Wellington City Council, Hutt City Council, Upper Hutt City Council, Porirua City Council, Kāpiti Coast District Council, Christchurch City Council, Selwyn District Council, and Waimakariri District Council.

Some key findings from the report are discussed below.

Definitions

The MWLR report found that definitions – in particular, those of topsoil and subsoil – vary considerably across the documents assessed. Regarding topsoil, only 5 of 39 documents reviewed included a definition, although 16 of them included a specification of topsoil and or soil properties. Similarly, most documents reviewed do not define subsoil or rooting depth.

Topsoil

MWLR reports the benefits associated with topsoil depth and composition. The benefits of depth are twofold:

- A greater level of ecosystem services can be provided by deep topsoil (around 300 millimetres) combined with deep, freely drained rooting depth (up to 900 millimetres, including topsoil depth, and no less than 600 millimetres). These characteristics underpin versatile and productive soils that allow a wide range of plants, including shrubs and trees, to thrive.[44]
- The cost of retrofitting green infrastructure can be reduced when topsoil and rooting depths are already sufficient to support the growth of large trees.

Urban grassed areas are normally the most extensive green areas in urban developments, and most council documents specify shallow topsoil – usually ranging from 75 to 150 millimetres (Table 4.1), with the notable exception of the Auckland Code of Practice for Land Development and Subdivision, which provides for 250 millimetres.[45] However, urban grass areas on shallow topsoil are vulnerable to drought in dry conditions and water-logging in wet conditions.[46] Topsoil specifications for garden beds and areas with shrubs are typically twice the depth of topsoil required for grass. The contrasting depth of soil provided for by various soil specifications is illustrated in Figure 4.2.

[44] Thompson-Morrison et al., 2023, citing Hewitt, 2004.

[45] Auckland Council, 2021, p.18.

[46] Thompson-Morrison et al., 2023, p.1.

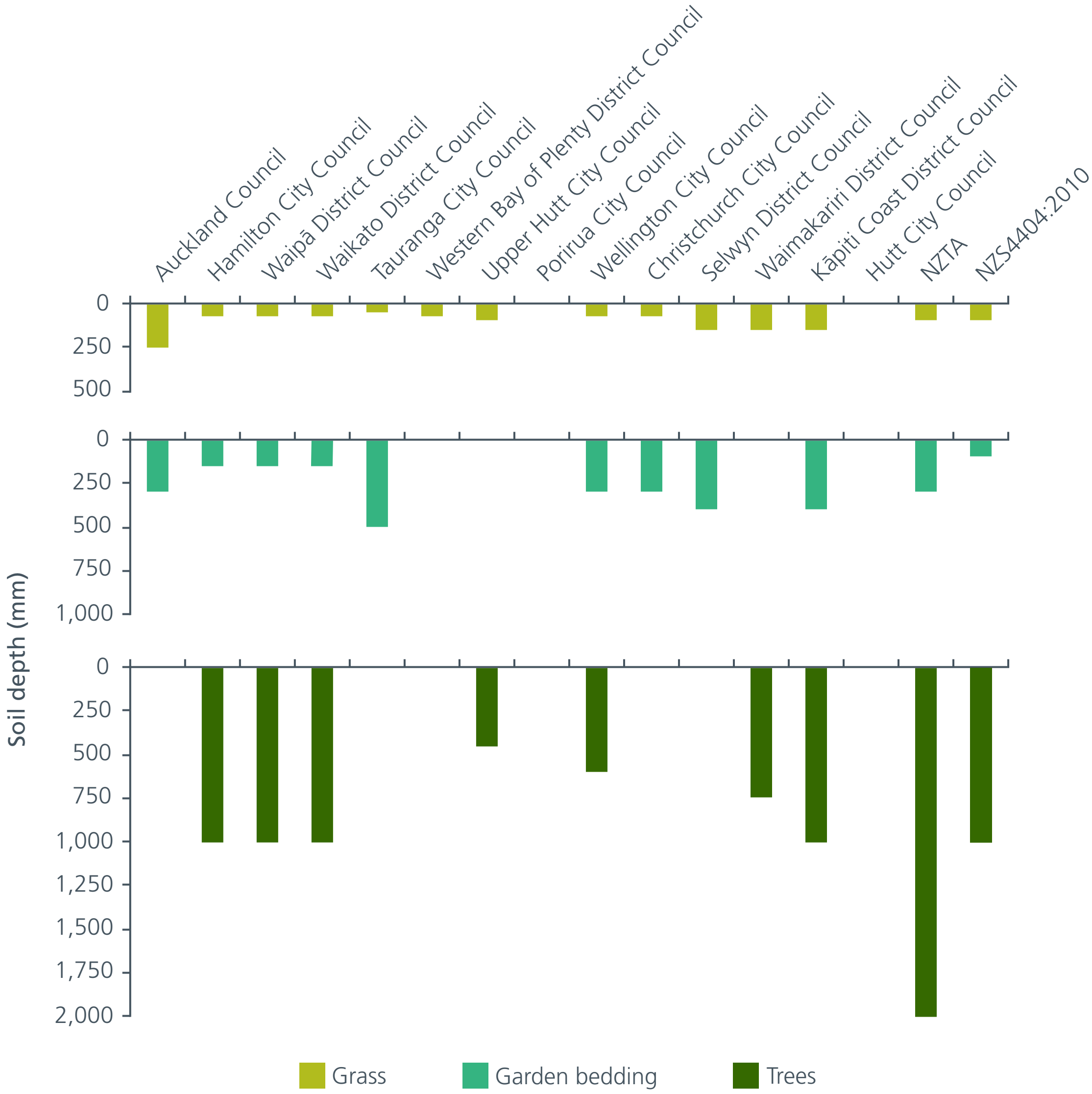
Table 4.1: Specifications of selected territorial authorities, NZ Transport Agency Waka Kotahi (NZTA) and Standards New Zealand for topsoil depth in different landscaped areas.

Authority or standard	Grass (mm)	Garden bedding (mm)	Trees[a] (mm)
Auckland Council	250	300–400	Sufficient to provide for the lifetime of the tree
Hamilton City Council	75 (berms)	150–300 (other planted areas)	1,000
Waipā District Council	75 (berms)	150–300 (other planted areas)	1,000
Waikato District Council	75 (berms)	150–300 (other planted areas)	1,000
Tauranga City Council	50–100	500	Depth relative to the species and ground conditions
Western Bay of Plenty District Council	75	–	–
Upper Hutt City Council	100	–	450
Porirua City Council	–	–	–
Wellington City Council	75	300	600
Christchurch City Council	75–100	300	Relative to depth of root ball
Selwyn District Council	150	400	Relative to depth of root ball
Waimakariri District Council	150 deeper than root spread	–	Relative to depth of root spread, minimum 750
Kāpiti Coast District Council	150	400[b]	1,000[b]
Hutt City Council	–	–	–
NZTA	100	300	2,000
NZS 4404:2010	100	100	1,000

Notes:

[a] Volume, alongside depth, is also a key consideration for tree resilience and size.

[b] Only applicable to plantings in the 'Meadows Precinct', which has its own unique design guidelines.



Source: PCE

Figure 4.2: Specifications of selected territorial authorities, NZTA and Standards New Zealand for minimum topsoil depth in different landscaped areas.

There can be risks associated with topsoil that is *too* deep, especially when it is high in organic matter and not supported by adequate subsoil. Problems are created when topsoil, particularly compost-enriched topsoil, is placed at depths where air exchange is slow and/or in areas where water can pond.[47] Excess organic matter content in topsoil placed at depth means that there is potential for anaerobic soil conditions and plant stress. Another consideration is that soils shrink over time as organic matter decomposes.[48]

[47] Thompson-Morrison et al., 2023, p.4, citing Leake and Haege, 2014.

[48] Thompson-Morrison et al., 2023, p.6.

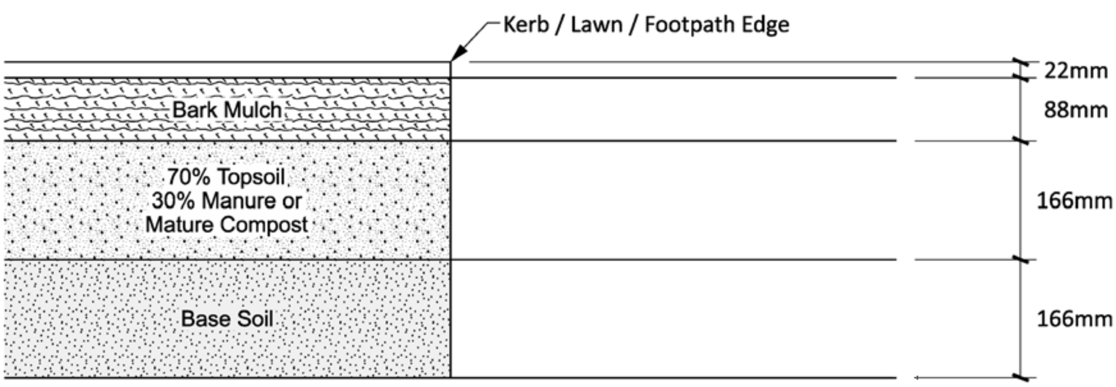
No council documents inspected specified maximum topsoil or soil depths, although some identified limitations imposed by steeper slopes, and maximum mulch depths are often included. Specific surface treatments can be used to create an appropriate environment for planting.[49] Similarly, maximum levels of organic matter were not specified in any document.

Subsoil

As for topsoil, most guidance does not define depths for rooting or subsoil. The MWLR report states that:

> "if a root zone depth is not specified, topsoil is likely to be placed over un-ameliorated subgrade fill which typically has low permeability, low pore space, minimal ability to store or retain stormwater and, high soil strength. Roots cannot enter such materials unless they are de-compacted."[50]

Although specifying subsoil properties is important to deliver ecosystem services, few of the councils reviewed distinguish topsoil from underlying soil layers. The Waikato Local Authority Shared Services' *Regional Infrastructure Technical Specifications (RITS)* are an exception, requiring a 'base soil' (subsoil) and supporting its guidelines with schematic cross sections.[51] MWLR recommends that urban soil guidelines specify soils (and root zones) that enable deep-rooted tree growth and attenuation of large rainfall events. Figure 4.3 shows a soil profile that could be used to specify different layers of soil, including subsoil.



Source: Waikato Local Authority Shared Services, 2018

Figure 4.3: An example of a soil profile that could be used in soil specifications to include topsoil, subsoil and mulch.

[49] Thompson-Morrison et al., 2023, p.7.
[50] Thompson-Morrison et al., 2023, p.4.
[51] Waikato Local Authority Shared Services, 2018, p.571.

Vegetation

Soils providing deeper rooting depths with larger root volumes typically support vegetation that delivers a greater range and intensity of ecosystem services. With a warming climate, shade trees will need to perform a lot of heavy lifting in keeping our cities cooler. They can provide measurable air temperature cooling of between 0.4 and 4.5 °C.[52]

Across territorial authorities, depth and volume specifications vary widely. Authorities specify volume in very different ways. For example:

- In the Waikato region, depth and diameter depends on the grade of the tree size being proposed. For a tree in a 45-litre pot or bag, the specification is one-metre depth by one-metre diameter, while a 90-litre grade requires one-metre depth by 2.5 metres in diameter.[53]
- In the Porirua Proposed District Plan, depth and volume are calculated relative to berm width and tree diameter. For example, trees with a stem diameter of less than 300 millimetres at a height of 1.5 metres above ground would require a minimum soil volume of 10 cubic metres and a minimum berm width of 1.5 metres. Trees over 600 millimetres in diameter at maturity would require a minimum soil volume of 20 cubic metres.[54]
- In Christchurch, depth and volume of planting holes are calculated in relation to the size of the root ball – for example, twice the width and twice the depth of the root ball.[55]

In addition, the volume of soil specified by current documents ranges from a mere one cubic metre to a more generous 15 cubic metres, varying by authority and by the size of the tree. Where the volume for tree pits is at the lower end of this scale, it is questionable whether this will be sufficient in the case of heavily compacted or otherwise hostile subsoils. One landscape architect consulted during this investigation pointed out that trees tend to become stunted in such conditions.[56]

The MWLR report found there is a tension between enabling the affordable inclusion of trees in areas that would otherwise lack them, and managing the risk that minimum depths (and volumes) become the default design. The potential upshot is that the only trees that can be planted are small trees (e.g. ornamental cherries) or trees tolerant of restricted root zones (e.g. pōhutukawa). Trees such as pūriri and beech are intolerant of drought so require much deeper subsoil and larger rooting volumes or irrigation.[57] While some extent of trade-off can be made between soil depth and volume, providing adequate soil profile to support large trees like these is essential to ensure the provision of shade and help mitigate urban heat island effects. Compacted subsoil in the development process with insufficient topsoil overlay is likely reducing the growth potential of trees in many urban settings.

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52 PCE, 2023, pp.32–33.

53 Waikato Local Authority Shared Services, 2018, p.558.

54 PCC, 2022, INF-Table 2.

55 Christchurch City Council, 2022, p.14.

56 Walker Landscape Architects, pers. comm., 3 November 2023.

57 Thompson-Morrison et al., 2023, p.7.

In addition, Auckland Council has found that the Auckland Unitary Plan is "not sufficiently effective or efficient" at achieving landscaping outcomes. This report noted that:

> "many sites were poorly landscaped and lacked the amount of planting shown in the consented landscape plans. This suggests shortcomings in monitoring and compliance in ensuring approved landscape plans are properly implemented. There were also issues around the types of landscaping (particularly lack of trees or planting for future mature trees)."[58]

In summary, territorial authority specifications relating to the depth and volume of soil to support vegetation are highly variable, and in some areas insufficient. The depth of topsoil to support grass – which makes up large swathes of greenspace in cities – is relatively thin and therefore likely to provide limited environmental benefits for urban dwellers and increase the costs of establishing trees.

Stormwater management services supported by soils

Most documents reviewed focused on soil specifications relating to grass or vegetation, with only three documents specifying soil depths in relation to stormwater management of the green space. Yet both plants and soil provide stormwater management benefits in urban green spaces. This contrasts with the multiple guidance documents available for engineered stormwater treatment devices.[59]

MWLR reports that large-scale subdivision practices have a quantifiable impact on the runoff potential of soils. Typical large-scale subdivision practices convert greenspace with low to moderate runoff potential to high runoff potential by reducing the depth that water can permeate before reaching a water-impermeable layer.[60] Applying topsoil to a depth only sufficient for grass exacerbates stormwater runoff.[61]

Interventions taken by councils to mitigate the harmful effects of stormwater runoff vary. While some councils, including Hamilton City Council and Hutt City Council, use impervious coverage standards to mitigate the stormwater impacts of development, others such as Kāpiti Coast District Council rely on district-wide hydraulic neutrality requirements, meaning that the stormwater leaving a site must be no greater than a pre-development baseline.[62] Implementation of this principle is achieved through providing for water storage on scales ranging from on-site to sub-catchment level using devices such as engineered wetlands.

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58 Auckland Council, 2022b, p.17.

59 Thompson-Morrison et al., 2023, p.10.

60 Thompson-Morrison et al., 2023, p.11.

61 Thompson-Morrison et al., 2023, p.12.

62 PCE, 2023, p.113; Elkink, 2019.

In summary

Local authorities have some valuable tools at their disposal to protect the important services provided by urban soil within their jurisdictions. However, the ability to implement soil controls at any level is tempered by development pressures and other priorities, meaning the environmental services provided by existing urban soils may be in jeopardy.

Regional councils are responsible for soil conservation and exercise their role in large-scale earthworks consenting for urban development activity. Their focus appears to be oriented towards sediment and erosion control rather than limiting the extent of soil stripping.

When it comes to stormwater, regional councils are not always well-placed to anticipate and mitigate the effects of changing landform (including soil removal) on stormwater flows. This is because of the common use of permitted activity rules and the practice by developers of sequencing their consents, often seeking earthworks consents prior to stormwater (where required). While water-sensitive design is becoming more popular and will mitigate impacts to some extent, bioretention devices do not always permit trees.

Added to this, soil specifications used in landscaped areas in subdivisions vary considerably around the country. Some make clear provision for layers of soil of an appropriate composition, depth and volume to enable a wide range of vegetation including trees to thrive; others propose soil depths that are too shallow or neglect the important function of subsoil, thereby making it costly or impossible to plant trees or install other green infrastructure in the future. Finally, the provision of grass – a popular greenspace option – only provides a very thin layer of soil and therefore offers modest environmental services in comparison to garden bedding and trees.

The limitations outlined here will likely affect the capacity of newly developed areas to soak up excess rainwater and support the growth of large, shady trees – services that will be crucial in a changing climate.

5

Lastreopsis velutina

Recommendations

This review has found that soil supports a bundle of environmental services in cities. Urban soils absorb and filter stormwater and permit the growth of trees that provide vital shade and cooling, among other benefits. However, extensive earthworks are eroding the capacity of soil to provide these services.

National direction on urban soil and the use of integrated catchment management plans

Recommendation 1: The Minister for the Environment should consider providing national direction or guidance under the Resource Management Act 1991 addressing urban soil and the services it supports, including the matters detailed below (recommendations 1.1 to 1.3).

Ministry for the Environment (MfE) officials are best placed to provide advice on the specifics of any national direction and whether it is best to have standalone direction addressing urban soils or whether the matters in recommendations 1.1 to 1.3 are better addressed by amending existing national direction such as the National Policy Statement on Urban Development.

Recommendation 1.1: Developers should be required to submit a landscape plan to territorial authorities in relation to any major new development, which includes at a minimum:

- **information about the depth, volume, composition and profile of soils**
- **a planting plan, details of which should be informed by national guidance (see recommendation 2.1).**

Developers should be required to explain the reasons for any proposed deviation from the guidance.

The depth, volume and profile of the soil (including subsoil) supporting trees is crucial in determining their ability to provide shade and cooling in cities. If the opportunity is lost to incorporate shade-bearing trees supported by an adequate soil profile, it may not arise again in the foreseeable future.

The requirement for developers to submit a landscape plan would ensure that developers and local authorities have made genuine efforts to address the adequacy of soil resources with appropriate professional guidance, while allowing flexibility to enable these to be tailored to local conditions.

Recommendation 1.2: All territorial authorities should be required to undertake prior planning for stormwater management for urban growth, such as an integrated catchment management plan (ICMP). This plan should:

- **be developed *prior* to consenting further new development**
- **cover the hydrological scale of a catchment or sub-catchment**
- **include the role of soil.**

Local authorities currently experience some limitations in their ability to manage the effects of urban growth on the ability of soils to serve their stormwater functions. Specifically, in regional plans a certain level of stormwater discharge is often a permitted activity, meaning that the cumulative effects of piecemeal development can be overlooked. In addition, the sequence in which consents are applied for may limit the ability of environmental managers within regional councils to assess effects. In some regions, developers tend to apply for earthworks consents before their stormwater consents, which means that environmental managers cannot anticipate the full effects of changing landform in terms of stormwater until it may be too late to adequately mitigate them.

ICMPs, which consider land development at the hydrological scale of a catchment or sub-catchment, including the role of soils, can enable local authorities to front-foot the placement of urban development within a catchment. However, where ICMPs are not in place, or stormwater planning is linked to piecemeal individual developments, the value of urban soil may be overlooked.

While the development of ICMPs does involve time and money, the long-term nature of many urban areas suggests this a prior investment worthy of consideration. Their widespread use would help optimise the capacity of development within a growth cell to handle the more frequent and intense rainfall events anticipated under a changing climate. They would also provide developers with greater certainty about local authority expectations in a growth cell. Finally, if ICMPs were universally required, developers would also be operating on a more level playing field.

Recommendation 1.3: The roles and responsibilities of regional councils with respect to soil conservation should be clarified.

Regional councils are charged with *soil conservation* but take a relatively narrow interpretation that is largely confined to the management of sediment and soil erosion. They do not appear to have a strong focus on soil quality *per se* and its capacity to support vegetation and attenuate stormwater. This needs to be addressed to ensure that net soil loss and degradation of soil profile in cities does not become an unintended consequence of current policy initiatives. Current policies are targeted at concentrating growth in urban-zoned land while avoiding rural productive soil and wetlands.

This national direction should be developed alongside Manaaki Whenua – Landcare Research's recently delivered recommendations on surplus soils,[1] which aim to prevent waste soil and encourage beneficial reuse.

[1] Cavanagh et al., 2023.

Guidance to support councils' management of urban soils

Recommendation 2: MfE should develop national guidance to support councils' management of urban soils and the implementation of any national direction on urban soils and ICMPs.

Recommendation 2.1: Guidance, including detailed specifications, should be provided on:

- **the recommended depth of topsoil underlying grass and other green areas**
- **the recommended volume of topsoil and subsoil to support shade-bearing trees over a long lifespan, and the desirable canopy coverage contained within urban developments**
- **the recommended soil profile to address the above, incorporating both subsoil and topsoil**
- **recommended practices regarding soil decompaction.**

This review has found that soil specifications, such as those found in subdivision engineering codes of practice, are highly variable around the country and in some cases inadequate. National-level guidance should aim to improve clarity on best practice and consistency in subdivision engineering practice. This guidance should include quantitative specifications around minimum parameters.

Often the greatest proportion of green space incorporated into urban developments is made up of grass lawns. Many **topsoil depth** specifications for these areas allow for only 100 millimetres of topsoil. Consideration should be given to increasing these depths. For example, if a depth of 300 millimetres of topsoil underlying grass were provided, it would enable triple the volume of water storage available in a large rainfall event. Such a volume also would allow for greater flexibility to incorporate trees or other plantings in future.

The **depth and volume of both topsoil and subsoil for trees** is equally important. Large trees require a minimum volume of soil that their roots can penetrate to support growth and provide nutrients to the maturing tree. A soil profile incorporating both appropriate topsoil *and* subsoil is important because it allows a diversity of vegetation to thrive and also offers drainage and stormwater benefits. As soil compaction can also affect the quality of subsoil, de-compaction measures should be outlined where applicable.

Recommendation 2.2: MfE should provide guidance on details regarding the development of ICMPs, specifying responsibilities and the scope of matters to be included.

This would capture any detail that would be needed to support the widespread adoption of ICMPs as recommended in 1.2.

Recommendation 2.3: MfE and local authorities should provide guidance on bioretention devices for stormwater with a view to evaluating the merits of including trees, noting their value in managing stormwater.

Current stormwater guidance does not allow for trees to be planted in raingardens and swales. Given the benefits of vegetation – including trees – in managing stormwater, guidance should be reviewed to ensure that appropriate recognition is given to the role of trees.

Incentives for developers

Recommendation 3: Regional councils, territorial authorities and other relevant agencies should encourage developers to:

- **conserve and protect soil**
- **submit all consents for a given development – including stormwater and earthworks – at the same time**
- **reuse soils on-site instead of disposing of them off-site when the soil in question poses a low level of risk to people and the environment.**

Are we building harder, hotter cities? recommended that relevant agencies review the incentives available to developers. One way forward is the use of green-score techniques, such as those being implemented in overseas cities such as Seattle, Berlin and London.[2] These recognise the role of soil in green spaces. For example, in London an Urban Greening Factor is used to evaluate the "quality and quantity of urban greening".[3] This approach gives a greater level of credit to developments where the "minimum soil volume is equivalent to at least two thirds of the projected canopy area of the mature tree".[4] Closer to home, the *Waikato stormwater management guideline* includes a scoring approach that encourages developers to take a low impact design approach, which includes a range of factors – for example, reducing the extent of impervious surfaces on a site.[5]

Incentives for developers that could be explored in association with green-score approaches could include reduced processing times, development contribution rebates, or a 'credit' that could be redeemed against other planning obligations.

It is also worth noting that the raising and extension of the waste levy is providing an increasingly pressing incentive to manage a greater proportion of soils excavated during land development, on site.

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[2] PCE, 2023, p.147.

[3] Greater London Authority, 2023, p.15.

[4] Mayor of London, 2021, Table 8.2.

[5] Waikato Regional Council, 2020a, pp.75–83.

Professional guidance

Recommendation 4: When New Zealand Standard (NZS) 4404:2010 *Land development and subdivision infrastructure* is next updated, it should provide more explicit reference to the environmental services provided by soil.

Developers, in consultation with geotechnical engineers, consult this New Zealand standard, which details considerations on landform selection. While the standard looks at impacts on water resources to some extent, it does not give sufficiently explicit consideration to low impact design relating to soil. The standard should guide professionals to identify areas of deep, freely drained topsoil and subsoil on a site. It should further encourage efforts to protect this soil *in situ* where possible, and where that is not possible, encourage the stockpiling of soil for later reuse, providing it is not contaminated.

Hypolepis dicksonioides

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This report has been produced pursuant to subsections 16(1)(a) to (c) of the Environment Act 1986. The Parliamentary Commissioner for the Environment is an independent Officer of Parliament, with functions and powers set out in the Environment Act 1986. His role allows an opportunity to provide Members of Parliament with independent advice in their consideration of matters that may have impacts on the environment.

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