Building on soil sustainability: Principles for soils in planning and construction

Soils in Planning and Construction Task Force

Sept **2022**

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Foreword

This report is short, simple, important, revealing, and ultimately, just simple common sense. Soil is something we don't understand, see, or value. This must change.

I think we all know that soil is a source of nutrients for growing plants and crops. I think we know that healthy soil is important, and that with a bit of added compost, it will deliver real benefits for our roses! But when it's on a construction site it simply becomes unwanted muck to be removed so building work can commence.

You'll be shocked by the horrifying truth of the level of ignorance there is toward soil. Every single teaspoon of soil contains around one billion bacteria; every cubic metre of healthy soil captures between 12kg and 35kg of carbon. In the construction sector we destroy and throw it into landfill at a rate of nearly 30 million tonnes each year, worth nearly £3 billion!

This report lays bare just how important soil is, and how much we undervalue the dirty brown stuff. It highlights the extent of soil waste in construction and the costs of failing to recognise soil as an asset worthy of preservation and use – including the huge carbon release and loss of biodiversity when we disturb or compact it.

The report starts by highlighting the multiple and complex benefits of soil, its health, and its capacity to harbour mycorrhizal activity essential for life on earth. It highlights how soil is abused in construction, setting out the guidance and legislation that we rarely follow, and concluding just how misunderstood soil is. Finally, it proposes guidance for the key sectors that need to collectively deliver realistic and achievable change.

This is a practical and timely report, which I invite you to read and disseminate. In highlighting the key issues that compromise responsible soil management and setting out how to address them, the report empowers the policies that do exist and provides the imperative for us to unite and advance cross-sector action.

Finally, I urge non-construction audiences to read this report – because we are all contributors. Paving over our garden areas and turning them into outdoor living rooms or car parking bays contributes significantly to both soil loss and associated localised flooding.

We can all do our bit to preserve and enhance soil at home, and this report provides the basis for the construction sector to reverse present practice and see soil for what it is: a fragile, fundamental, and valuable asset for the planet and for us all.

Noel Farrer PPLI FLI
Vice President of the Landscape Institute.
(Image © Clare Elliott)

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Executive Summary

Soil provides a multitude of important functions and ecosystem services for society, including climate change mitigation and adaptation opportunities and supporting biodiversity. Yet, at present, soil is routinely undervalued, damaged and disposed of during construction and urban development. It is crucial that we not only stem the damage done to these vital ecosystems, but also actively consider how better planning and management of soil can result in environmentally and socially beneficial development. This report, collaboratively formed in consultation with a wide range of scientists, policy and industry representatives, aims to raise awareness of the importance of soil. It provides a set of guiding principles to help improve how soil is planned for and managed during construction and urban development.

What can you do?

Use these guiding principles for soils in construction:

1. **Plan, design and construct for soil functions** – including soil carbon storage and reducing CO2 emissions, water infiltration and flood mitigation, soil biodiversity, and optimal support for above ground vegetation and trees
2. **Engage** local communities and stakeholders on soil issues and development during the consultation process
3. **Reuse or share soil** – maximise use of soil on site and share excess soil to ensure there is no loss to landfill
4. **Maximise permeability** – minimise soil sealed area and maximise permeable paving to allow water to infiltrate and soil to respire; manage draining on-site using SuDS rather than off-site
5. **Minimise compaction** – plan haul routes and materials storage and designate Soil Protection Zones (SPZs) where soil is protected from traffic, stripping and stockpiling
6. **Stockpile correctly** – minimise the duration of stockpiling and size of stockpiles, ensure this is undertaken according to soil texture, moisture and weather conditions, and ensure topsoil and subsoil are separated and do not become mixed or contaminated
7. **Minimise erosion** – prevent sediment loss by use of vegetation cover, seeding, mulching, silt fences or rolls, or geotextiles, particularly on slopes and stockpiles
8. **Learn through training** – engage with soil professionals to continually develop best practice

Local Authorities – use a standard planning clause for soil that includes consideration of soil functions, requirement of a soil survey and soil management plan, and a method statement for soil prior to commencement of works. Encourage the use of Soil Protection Zones (SPZs) to minimise vehicle compaction in areas for future green spaces and private gardens.

Clients and Developers – include the importance of soils in tender briefs. Bring in a soil specialist early and encourage their collaboration with other disciplines (ecology, landscape architecture, arboriculture and engineering). Undertake a soil survey as part of the EIA and use this to write a soil management plan, going beyond engineering or contamination surveys. Consider levels and earthworks early in the process to maximise cost benefits of reusing soils.

Design Teams – consider soil early on in a collaborative way and design based on soil functions and soil survey information. Maximise synergies across disciplines (landscape architecture, architecture, ecology, engineering) to create better schemes for soils, tree protection, habitats, biodiversity net gain, open spaces and private gardens.

Contractors – include soils in ECSR targets and raise with clients, undertake toolbox talks on good practice for soil management, and undertake soil handling according to methods in the latest Defra guidance: Construction Code of Practice for the Sustainable Use of Soils on Construction Sites.

Introduction

Soil provides a multitude of important functions and ecosystem services for society, including playing an important role in climate regulation and supporting biodiversity – two of the biggest existential threats to society. Yet, soil is routinely undervalued, damaged and disposed of during construction. The rising need for more homes and infrastructure to support growing populations and economies are putting increasing pressure on soils. It is vital that we better manage this non-renewable resource during construction so it can continue to provide its many crucial functions, and help us in our fight against climate change and biodiversity loss.

Currently in the United Kingdom, soils on construction sites fall within a gap in policy and legislation and large amounts of soil is being lost and damaged as a result. The key guidance document, the Defra Construction Code of Practice for the Sustainable Use of Soils on Construction Sites is not often followed, and good practice is rarely seen. Whilst the total cost of the soil lost and damaged during construction to society is currently unknown, the initial evidence gathered together here indicates that in any terms the cost is large, and likewise, the scale of responsibility and opportunity for improving practice and delivering positive change is substantial.

This report aims to raise awareness of the importance of soil and why it needs to be better managed during construction. It has been developed by a cross-sector team of scientists and practitioners in consultation with a wide range of representatives from planning and construction industries. In developing and sharing this document, we hope to provide a valuable case for taking soils seriously in planning and construction, and a set of high-level useful principles for practice. The report is for anyone working in planning, development, design and construction, and focuses on the UK context. It provides a set of guiding principles to improve how soil is planned for and managed, and there are dedicated sections with specific actions for each industry to support project teams to manage soils more sustainably.

Why is soil important?

Soil is a mixture of minerals, organic matter, living animals and micro-organisms, water and gas. It takes hundreds, thousands or even tens of thousands of years for soil to form – this means **it is a non renewable resource** and it is vital we look after it.

Soil provides many important functions and, as such, it is a valuable resource that we rely on for life on Earth. Soil provides nutrients for plants and crops to grow, it holds water and prevents flooding, it's an important store of carbon, is a cornerstone of biodiversity and habitats, and it filters pollution and contaminants from water.

Soil is a living system. **One teaspoon of topsoil contains around one billion bacteria**[1]. In urban parks, soil biodiversity can be very high. For example, in Central Park in New York, the breadth of soil microbes was similar to that found across the world in arctic, tropical and desert soils[2]. These soil micro organisms, along with soil insects and worms, decompose organic matter and recycle it into nutrients. In parks, gardens and new developments, these nutrients **support the growth of trees and green infrastructure**. Soil animals also burrow through the soil and help maintain the soil structure, creating pore spaces where oxygen is stored and water can infiltrate. Water movement and storage in the soil is key to mitigating flooding, so looking after soil helps to prevent waterlogging and reduce flood risk.

Soil also plays an important role in mitigating climate change. It is the largest store of carbon on land, storing nearly twice as much carbon as all the plants and atmosphere combined[3]. **When soil is disturbed, carbon is emitted to the atmosphere as CO2 – this means we need to manage soils carefully so that carbon remains stored in the soil**.

Why does soil in planning and construction matter?

Whilst only a small fraction of our total global soil resource is built upon (around 1% of habitable land supports human settlements and infrastructure[4]) towns and cities are the fastest growing use of land and a major driver of soil change. Whilst this is only a small land area, the scale of soil degradation that currently occurs in this small fraction of land is astounding. We are only just beginning to learn about the scale and costs of soil degradation from construction, but from the initial insights presented in what follows, it is clear to see that the current approach to soils in planning and construction presents a major threat to national prosperity.

It is also important to note that these soils also matter because of their proximity to where the majority of people live and work. Soil's ability to function, for example by infiltrating water and reducing flood risk or supporting high quality green spaces, has direct effects on our daily lives. The opportunity is there to better plan and build for soil functioning and create positive benefits for communities and economies being developed.

[1] Needelman (2013) What Are Soils? Nature Education Knowledge, 4(3)(2).

[2] Ramirez et al. (2014) Biogeographic patterns in below-ground diversity in New York City's Central Park are similar to those observed globally.
Proceedings of the royal society B: biological sciences, 281(1795).

[3] Ontl and Schulte (2012) Soil Carbon Storage. Nature Education Knowledge, 3(10)(35).

[4] https://ourworldindata.org/land-use

29.5 million tonnes of soil from construction sites was sent to landfill in 2018: ten times that lost due to soil erosion across the whole of England and Wales

Once compacted, soil structure is damaged and the soil can no longer function – the best approach is to prevent compaction in the first place

Soil loss from construction sites

Topsoils can become mixed with subsoils, and both can be mixed with construction rubble or stones. If these soils no longer meet specifications following mixing or damage during construction, they will be disposed of to landfill. Soils need to be designated as a resource rather than a waste material and should be retained or reused on site as much as possible.

In 2018, **29.5 million tonnes** of soil from construction sites were disposed of in landfill in the UK[5]. Only 0.6 % of this was hazardous, which means a huge amount of this vital resource is being lost during construction. **This is 10 times greater than the 2.9 million tonnes of soil lost due to soil erosion each year in England and Wales**[6]. This soil has value and its loss constitutes a substantial material impact for schemes. The economic value at its most basic level is large. Topsoil has a sale value of between £80 – 100 a tonne bag, and even if only 10% of the soil lost to landfill was usable topsoil, this would equate to approximately £300m per year. However, when the broader functional value of this soil is considered, the cost of soil loss to landfill alone to the UK could be estimated to be in the order of £1.5bn per year.

In addition to soil lost to landfill, **soil erosion on construction sites can be 100 times greater than on agricultural soils** due to the removal of vegetation, disturbance of soil and alteration of topography through stockpiling[7,8].

Take action: Designate soil materials early through a soil survey, soil management plan and a materials management plan using the **CL:AIRE Definition of Waste Code of Practice** (DoW CoP)[9]. *The Routemap for Zero Avoidable Waste in Construction*[10] may also be useful. These actions, when combined with good erosion control, will help prevent the loss of valuable soil from construction sites. This will significantly enhance the sustainability credentials of projects and generate cost benefits if soil reuse can be maximised and earthworks minimised.

Soil compaction

Soil compaction occurs due to trafficking of heavy vehicles, laydown of materials and poor soil stockpiling. This can occur in both topsoils and subsoils on construction sites. When soil is compacted the structure is damaged and the pore spaces are lost, meaning water and oxygen can no longer get into the soil, plants will not grow, and micro-organisms will not survive.

Compaction can reduce water infiltration by 70-99%, and heavily compacted soil starts to resemble the infiltration characteristics of an impervious surface[11]. This leads to poor drainage, waterlogged sites and issues with flooding. Compacted soils also cause problems for plant establishment and growth due to a restricted rooting area, particularly for woody plants and trees[12]. Restoration of soil structure is very difficult, takes many years, and is dependent on soil texture and the damage caused[13]. Remediation of compacted soil adds costs and time to a project and will not immediately return the soil to its former state. Recovery will only occur with time and a lack of disturbance.

Take action: The best approach is to prevent soil compaction in the first place rather than mitigate afterwards. Soils that are protected from vehicle traffic and are stockpiled appropriately will be less likely to suffer from compaction and will continue to function as healthy soils.

[5] Defra (2021) ENV23 - UK statistics on waste data.

[6] Graves et al. (2015) The total costs of soil degradation in England and Wales. Ecological Economics, 119, 399-413.

[7] Hani Ismail and Yee (2012) MUSLE Evaluation of Soil Loss on a Construction Site by Using Gauging Weirs. Advanced Materials Research, 446-449, 2718-2721.

[8] Weil and Brady (2017) The nature and properties of soils. 15th edition.

[9] CL:AIRE (2011) The Definition of Waste: Development Industry Code of Practice.

[10] Green Construction Board (2021) The Routemap for Zero Avoidable Waste in Construction.

[11] Gregory et al. (2006) Effect of urban soil compaction on infiltration rate. Journal of Soil and Water Conservation, 61(3), 117.

[12] Day and Bassuk (1994) A Review of the effects of soil compaction and amelioration treatments on landscape trees. Journal of Arboriculture, 20(1), 9-17.

[13] Horn et al. (2021) Consequences of gas pipeline hauling on changes in soil properties over 3 years. Soil and Tillage Research, 211, 105002.

Soil biodiversity is harmed by compaction from stockpiling or heavy vehicle traffic because it leads to a lack of oxygen

Soil carbon storage

Typical construction soil management, where topsoil is stockpiled and then replaced onto compacted subsoil, leads to losses of carbon as CO2 emissions from the soil[14]. Earthworks disrupt soil aggregates, and the carbon stored in these aggregates and attached to soil minerals becomes more accessible to soil micro-organisms[14,15,16]. This makes the carbon more vulnerable to decomposition and it can then be lost as CO2.

Soil carbon stocks vary greatly depending on soil type, texture, climate, land use and management, and vegetation cover. In the UK, the top 1 metre of soil has been estimated to contain an average of 18 kg carbon per m2 soil (or 180 tonnes per hectare); in semi-natural habitats this is 32 kg per m2 soil, in woodlands it is 25 kg per m2 soil, and in arable land it is 12 kg m2 soil[17].

In 2013, **soil carbon losses due to development were estimated at 6.1 million tonnes of CO2**; this is greater than losses of greenhouse gases from other big emitting industries such as concrete production (6 million tonnes CO2 equivalent) and the chemical industry (5.2 million tonnes CO2 equivalent)[18].

Take action: To keep carbon in the soil there needs to be minimal disturbance, and ideally 'Soil Protection Zones' (SPZs) should be left completely undisturbed to maintain soil carbon storage. These SPZs could be combined with tree root protection areas and areas set aside for biodiversity net gain, where appropriate. Where movement and stockpiling is necessary, this should be done appropriately for the soil texture, water content and weather conditions.

Soil biodiversity

Soil animals and micro-organisms are affected by soil stockpiling, compaction, damage to soil structure and contamination. Most harm to soil biodiversity occurs due to the creation of anaerobic conditions, where soil oxygen is depleted due to compaction during stockpiling or vehicle movement. Anaerobic conditions can develop soon after stockpiling and persist at depths below 1 metre in large stockpiles, though smaller stockpiles can also become anaerobic over time[19]. Anaerobic stockpiles can lead to a reduction in mycorrhizal fungi and earthworm populations[20], and a reduction in the diversity of mycorrhizal species[21]. Compaction can also alter the community structure of soil invertebrates[22].

Take action: To maintain healthy soil life and biodiversity, reduce disturbances to soil structure and chemistry (i.e. avoid physical disturbance and contamination), and ensure that soil is kept oxygenated and is not compacted. This will allow soil insects, worms, bacteria and fungi to continue their ecological processes, helping to recycle nutrients, support vegetation growth, and store carbon in the soil.

[14] Chen et al. (2013) Changes in soil carbon pools and microbial biomass from urban land development and subsequent post-development soil rehabilitation. Soil Biology and Biochemistry, 66, 38-44.

[15] Wick et al. (2009) Soil aggregation and organic carbon in short-term stockpiles. Soil Use and Management, 25(3), 311-319.

[16] Wilson and Karakouzian (2012) Assessing Soil CO2 at Project Sites in the Desert Southwest, United States. SEBUA-12 ICHMT International Symposium on Sustainable Energy in Buildings and Urban Areas. Turkey. 323-328.

[17] Bradley et al. (2005) A soil carbon and land use database for the United Kingdom. Soil Use and Management, 21(4), 363-369.

[18] Committee on Climate Change (2016) Environmental Audit Committee – Inquiry into Soil Health, Written Submission.

[19] Mackenzie and Naeth (2019) Native seed, soil and atmosphere respond to boreal forest topsoil (LFH) storage. PLOS ONE, 14(9).

[20] Abdul-Kareem and Mcrae (1984) The effects on topsoil of long-term storage in stockpiles. Plant and Soil, 76(1), 357-363.

[21] Fadaei et al. (2021) Impact of soil stockpiling on ericoid mycorrhizal colonization and growth of velvetleaf blueberry (Vaccinium myrtilloides) and Labrador tea (Ledum groenlandicum). Restoration Ecology, 29(1).

[22] Devigne et al. (2016) Impact of soil compaction on soil biodiversity – does it matter in urban context? Urban Ecosystems, 19(3), 1163-1178.

Soil sealing

Urban development seals the soil with impermeable surfaces such as road asphalt, paving and concrete. In England, an average of 15,800 hectares (158 square km) of undeveloped land was developed each year between 2013-2018[23]. This is a large increase from an average of 4,500 hectares per year in the 2000s[24], with a percentage increase of over 250 %. As soils are increasingly sealed over there is less water and gas exchange between the soil and atmosphere, and this prevents the soil providing its many functions[25].

Sealing also leads to increased surface run-off, risk of flooding, and pollution to surface water from roads. In urban areas, the proportion of front gardens in England that are paved over increased from 28% in 2001 to 48% in 2011[26], further exacerbating the problem of sealed surfaces in urban areas and putting pressure on urban drainage systems.

Take action: To reduce surface run-off and waterlogging on sites, green spaces and permeable paving should be maximised to enable water to infiltrate. SuDS and water management should be dealt with on-site.

Soil contamination

Contamination in soil can occur during construction through the misuse and spillage of materials or chemicals on site. Notable examples of this are the pollution of soil with hydrocarbons during storage of fuel, and asbestos fibres through the demolition or reuse of rubble materials. Historically, waste materials and rubble were used as fill and there may be legacy contamination in some urban soils and construction sites. Once soil is contaminated or earthworks expose older contaminated soils, rainfall and groundwater can move the contaminated soils and sediments across the site and to adjacent areas spreading the problem further.

Soil that is considered to be lightly contaminated may be reused for some purposes if it does not pose a risk. However, the uncertainty of environmental risk related to soil reuse can lead to resistance, and often new materials are sought as a preference[27].

Take action: Ensure all risk assessments and method statements are adhered to for materials and chemicals on site to prevent spillage and contamination. Be aware of the location of materials laydown and rubble storage in relation to soil stockpiling, water courses and the future landscape design to minimise contamination to both soil and water. Undertake toolbox talks on the importance of soils, good soil management techniques and prevention of contamination.

Soil sealing increased from 4,500 hectares per year in the 2000s to 15,800 hectares per year between 2013-2018

[23] Department for Levelling Up, Housing and Communities and Ministry of Housing, Communities & Local Government (2020) 2017 to 2018 land use based change tables Live Tables.

[24] Environment Agency (2019) The state of the environment: soil.

25 FAO (2022) Urbanisation and soil sealing. Soil Letters no 5. Intergovernmental Technical Panel on Soils.

[26] Harley and Jenkins (2014) Research to ascertain the proportion of block paving sales in England that are permeable. Report for the Adaptation Sub-Committee of the Committee on Climate Change.

[27] Hale et al. (2021) The Reuse of Excavated Soils from Construction and Demolition Projects: Limitations and Possibilities. Sustainability, 13(11), 6083.

Current state of UK policy and guidance or soils in construction

There are a number of relevant existing policies, reports and guidance documents that address soils in construction, as summarised in Table 1. These policies and documents contain a great deal of useful advice. However, the current state of soils in planning and construction is evidence that, to date, these have not gone far enough or have not been effectively implemented.

Defra Construction Code of Practice for the Sustainable Use of Soils on Construction Sites

The Defra Code of Practice (2009) sets out the importance of soil functions and the issues that arise through poor management of soils on construction sites. The key messages in the Code of Practice are the need for a **soil resource survey** which can feed into a materials management plan, and a **soil resource plan**, which sets out how soil will be stripped, hauled and stockpiled.

The guidance sets out methods for soil handling including topsoil and subsoil stripping, stockpiling, reinstatement, and remediation of compaction. **This guidance is due to be updated in 2022/2023 – the most up-to-date version of the guidance should be used when making soil management plans and construction method statements**.

Working with Soil Guidance Note on Benefitting from Soil Management in Development and Construction – British Society of Soil Science (2022)

This BSSS (2022) guidance note sets out recommendations for **soil resource surveys** and **soil management plans**. It states that a soil resource survey should be conducted by a professional soil scientist with the appropriate competencies as set out in BSSS *Working with Soil Professional Competency in Soil Science* Documents. It also highlights some key recommendations around surface flooding, planting in relation to soil conditions, and soil biodiversity.

British Standards

The following British Standards are relevant when working with soils in construction:

- **BS 3882:2015 Specification for topsoil** – this specifies requirements for natural or manufactured topsoil brought in to a site rather than topsoils remaining in situ.
- **BS 5837:2012 Trees in relation to design, demolition and construction** – provides recommendations relating to tree care and Root Protection Areas. It recommends that there should no excavation, no changes of soil level and no compaction within the root protection area.
- **BS 8683:2021 Process for designing and implementing Biodiversity Net Gain** – sets out a process for implementing biodiversity net gain to ensure that development and land management leaves biodiversity in a measurably better state than before.
- **PAS 100:2018 Specification for composted materials** – provides a compost quality standard for the organics recycling sector.

National Planning Policy

The National Planning Policy Framework (NPPF) for England (DLUHC, 2021) recognises the need for local planning policies that relate to the protection and enhancement of soils. Through the NPPF, mitigation and remediation of despoiled, degraded, contaminated and unstable land, where appropriate, is recommended. In relation to green field sites, the NPPF advocates that the best agricultural land is preserved from development and poorer quality agricultural land be used preferentially.

Soils in Environmental Impact Assessment

Depending on the type of development and statutory importance of the site, soils may be considered in Environmental Impact Assessment (EIA). The recent IEMA guidance: A New Perspective on Land and Soil in Environmental Impact Assessment (2022), provides a comprehensive methodology to assess the effects of developments on soil functions. Soil specialists in EIA teams should use it to assess the significance of development impacts on selected soil properties and the consequent changes in soil functions.

Local Planning Guidance

Soil in local planning is routinely dealt with through Agricultural Land Classification (ALC), however ALC data alone is not sufficient for assessment of a development site, as confirmed by Natural England[28]. Specific soil policies in local plan documents are not common, though two examples of local soil guidance and policy follow.

Worcestershire County Council set out the importance of soil and the implications of poor management during development in a technical research paper[29]. West Lothian Council provide a more recent example of local policy and guidance adopted in 2021. They set out a policy requirement for developers to provide a soil sustainability plan and to use their planning guidance document: *Soil Management & After Use of Soils on Development Sites*[30], which will be applied when making planning decisions. The aim of the guidance is to reduce flooding, water logging and failed landscaping due to poor soil handling.

Table 1 – UK Policy and Guidance

Strategies, Plans & Legislation

Document Type	Date	How is soil considered?
Safeguarding our Soils: A strategy for England (Defra)	2009	The vision of the strategy is that by 2030 all England's soils will be managed sustainably and degradation threats tackled successfully. This includes soils in urban areas being valued during development and construction practices that ensure that vital soil functions are maintained.
25 Year Plan to Improve the Environment (Defra)	2018	The plan identifies actions to protect and improve soils with a focus on agricultural soils. The risks to soils from construction and subsequent loss of soil functions are not addressed in the plan.
The Environment Act (UK Parliament)	2021	The Act does not set specific soil targets. However, a Soil Health Action Plan for England (SHAPE) is expected to be produced which will provide soil targets.
The Scottish Soil Framework	2009	The aim of the Framework is to promote the sustainable management and protection of soils in relation to the economic, social and environmental needs of Scotland. It does this by identifying 13 soil outcomes.
EU Soil Strategy for 2030: Reaping the benefits of healthy soils for people, food, nature and climate (European Commission)	2021	The strategy provides a framework to protect and restore soils. It sets out a vision and objectives to achieve healthy soils by 2050, with actions by 2030; and announces a Soil Health Law to ensure a high level of protection.

National Planning Policy

Document Type	Date	How is soil considered?
National Planning Policy Framework (NPPF)	Updated 2021	The NPPF focuses on valued landscapes and sites of biodiversity, geological value or soils with a statutory status or identified quality. Soils are not valued or given statutory status unless they are peat soils or considered through Agricultural Land Classification (ALC).

National Planning Guidance

Document Type	Date	How is soil considered?
Code of practice for the sustainable use of soils on construction sites (Defra)	2009 – update in 2022	This voluntary code sets out the importance of soil functions, gives guidance on best practice, and highlights issues that arise through poor management of soils on construction sites. Key messages are the need for a soil resource survey which can feed into a materials management plan, and a soil resource plan, which sets out how soil will be stripped, hauled and stockpiled.
Planning Practice Guidance for the Natural Environment	2019	This guidance suggests planning can safeguard soils by referring to the Defra Code of practice.
Guide to assessing development proposals on agricultural land (Natural England)	Updated 2021	This sets out how the NPPF and 25 Year Environment Plan aim to protect agricultural land and soils, with a focus on using ALC to inform planning decisions.
A New Perspective on Land and Soil in Environmental Impact Assessment (IEMA)	2022	This provides guidance for soils and land in Environmental Impact Assessment. It provides an approach to assess the impacts of a development proposal on soil properties and soil functions and sets out how soils should be considered more substantially in EIA.
SEPA Position Statement on Planning and Soils	/	Sets out SEPA's role in relation to land use planning and the Scottish Soil Framework.

Local Planning Guidance

Document Type	Date	How is soil considered?
Technical research paper: Planning for Soils in Worcestershire (Worcestershire County Council)	2011	Highlights the importance of soil and the implications of not managing it well through development.
Planning Guidance: Soil Management & After Use of Soils on Development Sites (West Lothian Council)	2021	The local development plan sets out a policy requirement for developments to have a Soil Sustainability Plan and to use this planning guidance. The guidance aims to reduce flooding on development sites and failed landscaping due to unsuitable soil handling.

Other Resources

Document Type	Date	How is soil considered?
The Definition of Waste: Development Industry Code of Practice (CL:AIRE)	2011	This voluntary code describes good practice for assessing whether excavated materials are classified as waste or not, and determine whether treated material can be re-used.
Policy Position Statement: Protecting and Enhancing Soils (CIWEM)	2019	Highlights the multi-functional and non-renewable nature of soils. It calls for actions to reflect this, including increased legislation to protect soils, implementation of the 25 Year Environment Plan, and improvements to the evidence base for policy decisions about soils
Position Statement: Sustainable Urban Soils Health Initiative (SUSHI) (Sustainable Soils Alliance)	2020	The position statement sets out where policy and guidance is lacking, where current issues are arising, and makes the case for an update to the Defra Code of practice.
Guidance Note: Benefitting from soil management in development and construction (British Society of Soil Science)	2022	This note makes recommendations based on soil resource surveys and soil management plans. It also highlights key recommendations around surface flooding, planting in relation to soil conditions, and soil biodiversity.
Soils and Stones Report (Society for the Environment)	2021	This report recognises soil as a valuable resource and material, and aims to prevent it ending up in landfill by promoting its re-use in construction projects.

Three barriers to improving integration of soil sustainability into planning and construction

Consultation with policy, industry and academic experts presented three major barriers to better treatment of soils in planning and construction.

1 **Soil is not understood or valued – earthworks are seen as something to be completed to get to the 'real work', and soil is seen as 'muck' to be removed. Project teams (including clients, designers and contractors) are often unaware of the importance of soils and how to design with soils in mind. Soil specialists are often brought into a project too late, leaving little opportunity to make useful plans for soil management and prevent soil damage.**

2 **Soil data availability – site-scale soil data is not always available and desk-based studies or ALC data is not sufficient to understand the soil resource, in particular for soil carbon storage. A full soil survey should always be done for EIA or during early stages of the project and the soil data shared throughout the design and construction stages.**

3 **Time and space constraints – project timelines can mean that topsoil stripping and stockpiling go ahead even in poor weather. Once the soil is damaged in this way it cannot be restored easily. Space limitations can also lead to poor stockpiling, where topsoils and subsoils become mixed. This means soil will be replaced incorrectly and will cause damage to the soil ecosystem, biodiversity and soil structure.**

What would help?

Think about soil early on – this applies to all those involved in a project: developers, EIA consultants, masterplanners, designers and contractors.

Understand the soil resource on site – a soil survey (see appendix 1) will tell you what type of soil you have and help you understand the functions it provides. This must go beyond geotechnical or contamination properties and should include soil texture, water holding, nutrients and carbon storage capabilities.

Design for soil retention and reuse – consider levels and construction methods from the outset – aim to minimise cut and fill, locate road access on areas of lower soil quality, prioritise greater topsoil depth in gardens and open spaces, work with the existing soils and landscape.

Write a soil management plan (see appendix 2) – use the soil survey to plan how best to use the soil resource, including how and when to move, store, and respread the soil, and how to avoid contamination. Proper planning and management of the soil on site means it can be reused, reducing the need to buy in new topsoil and leading to cost savings. Functioning soil at project completion with minimum compaction or disposal should be the outcome.

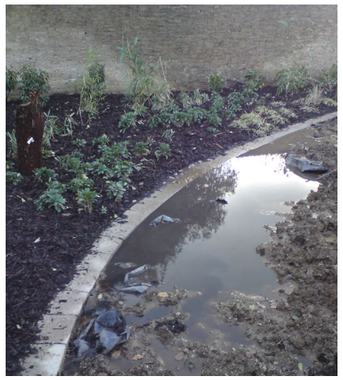
Soil Protection Zones (SPZs) – fence off areas in a similar way to tree Root Protection Areas (as per BS 5837) to prevent disruption to soil in those areas – this will enable soil to continue to function and retain soil biodiversity, soil carbon storage and water storage capability in those areas.

Include soil in accreditation schemes – soil, its biodiversity, and carbon storage properties should be taken account of in sustainability, nature and carbon accreditation schemes and targets.

Education and training – this would be useful for contractors moving and storing soil on site, planners making planning decisions, and landscape architects writing soil specifications.

Integrate soil with existing regulations – biodiversity net gain could provide an opportunity to protect soil through protection of older trees and habitats.

Monitoring of soil at completion – the aim is to have a functioning soil following project completion, with minimum compaction and good soil structure which will benefit water infiltration, soil biodiversity, plant growth and carbon sequestration. Monitoring the soil after it is respread or topsoil is brought in, and subsequent compaction is avoided, would ensure soil is able to provide these functions.



Guiding Principles for Soils in Planning & Construction

1. Plan, design and construct for soil functions – including soil carbon storage and reducing CO2 emissions, water infiltration and flood mitigation, soil biodiversity, and optimal support for above ground vegetation and trees
2. Engage local communities and stakeholders on soil issues and development during the consultation process
3. Reuse or share soil – maximise use of soil on site and share excess soil to ensure there is no loss to landfill
4. Maximise permeability – minimise soil sealed area and maximise permeable paving to allow water to infiltrate and soil to respire; manage draining on-site using SuDS rather than off-site
5. Minimise compaction – plan haul routes and materials storage and designate Soil Protection Zones (SPZs) where soil is protected from traffic, stripping and stockpiling
6. Stockpile correctly – minimise the duration of stockpiling and size of stockpiles, ensure this is undertaken according to soil texture, moisture and weather conditions, and ensure topsoil and subsoil are separated and do not become mixed or contaminated
7. Minimise erosion – and prevent sediment loss by use of vegetation cover, seeding, mulching, silt fences or rolls, or geotextiles, particularly on slopes and stockpiles
8. Learn through training – engage with soil professionals to continually develop best practice

What you can do

Local Authorities

- Include a specific soil policy in new local development plan documents – highlight the importance of soil functions and ensure soil is valued and protected in construction.
- Use a standard planning condition for soil that includes – consideration of soil functions, requirement of a soil survey and soil management plan, and a method statement for soil prior to commencement of works. It should also require evidence of good practice for soil management in construction, and monitoring of the soil following project completion. See West Lothian Council planning guidance for an example (see resources below).
- The construction method statement should include soil as a resource – ensure the order of work and project timings take account of soil management and that measures will be taken to minimise damage. Methods should be informed by the latest Defra Construction Code of Practice for the Sustainable Use of Soils on Construction Sites
- Use Soil Protection Zones (SPZs) to minimise vehicle compaction in areas for future green spaces and private gardens
- Ask for details on how a scheme has considered and optimised synergies for soils, trees and biodiversity
- Request sustainable drainage (SuDS) and that permeable paving is maximised to enable soil to function, allowing water to infiltrate and enable flood mitigation.

What to look for in a soil survey

- Ensure that site-based data is included that is based on soil sampling from the site and laboratory analysis.
- Look at the soil texture, water content, pH, carbon content and any contamination – this will tell you about the soil's permeability, biology and chemistry and will give an indication of its functioning (see Appendix 1: What should a soil survey contain?)
- Look for evidence of liaison with the project ecologist, landscape architect and arboricultural consultant to ensure the soil survey provides data they require to inform their work.

What to look for in the soil management plan

- The soil management plan should be based on information in the soil survey.
- It should set out plans for: soil protection, soil handling, soil use and any soil remediation needed (see Appendix 2: What should a soil management plan contain?)

Resources:

- Example of planning guidance for soils in construction – West Lothian Council – Planning Guidance: Soil Management & After Use of Soils on Development Sites (adopted 2021).
- Defra – Construction Code of Practice for the Sustainable Use of Soils on Construction Sites (2009) – due to be updated

Clients and Developers

- Include the importance of soil functions in tender briefs to consultants and contractors
- Bring a soil specialist in early before the scheme is set and ensure their liaison with the ecologist, arboricultural consultant and landscape architect at early project stages to achieve collaborative working and maximising synergies
- Consider levels and earthworks quantities early in the process and involve Quantity Surveyors to maximise cost benefits of retaining and re-using soils, feeding into the overall project viability analysis
- Undertake a soil survey for EIA and use the IEMA guidance for land and soil in EIA. Use the soil survey to write a soil management plan and construction method statement, going beyond engineering or contamination surveys (see Appendix 1: What should a soil survey contain? And Appendix 2: What should a soil management plan contain?).
- Use the latest Defra Construction Code of Practice for the Sustainable Use of Soils on Construction Sites to inform the soil management plan and appropriate method for soil stockpiling.
- Make EIA soil data available to all consultants and contractors for all project stages
- Provide the design team with levels data from the outset and ask them to design to minimize cut and fill
- Write a materials management plan before work starts on site – retain the valuable soil resource and reuse it appropriately
- Plan for the use of excess soils across the site; share with another site if it can't be reused
- Consider carbon calculations for projects that take account of soil carbon, and use such data to feed into project viability and sustainability credentials. Monitoring of soils following project completion can provide evidence of good soil management and the maintenance of soil carbon stores.
- Plan for rubble management – ensure it is not disposed of in gardens and green space areas
- Promote the understanding and importance of soil to contractors e.g. through training, and demand careful management of soil from contractors on site.

Benefits to clients and developers

- Shows you are taking environmental and climate change issues seriously – this could reduce planning uncertainty
- High standard private gardens and green spaces are a selling point for future home owners
- Involving a soil specialist early will help you get it right first time – this leads to reduced project time
- Careful management of existing soil resources will lead to less landfill tax and smaller topsoil import costs.
- Lower transport and fuel costs – less need to move soil to and from the site
- Fewer complaints and claims, for example, from home owners when private garden soils fail, are waterlogged, the structure is damaged, large amounts of rubble is found etc.
- Help with ECSR targets

Resources

- Defra – Construction Code of Practice for the Sustainable Use of Soils on Construction Sites (2009) – due to be updated
- CL:AIRE – DoW CoP – The Definition of Waste: Development Industry Code of Practice (2011)
- IEMA guidance – A New Perspective on Land and Soil in Environmental Impact Assessment (2022)
- Green Construction Board & Construction Leadership Council – The Routemap for Zero Avoidable Waste in Construction (2021)
- British Society of Soil Science – Working with Soil Guidance Note on Benefitting from Soil Management in Development and Construction (2022)
- Farm Carbon Toolkit – Monitoring Soil Carbon: a Practical Field, Farm and Lab Guide (2021) – though this is based on agricultural soil it provides a useful resource to understand monitoring for soil carbon.

Design Teams

- Consider soil early on in a collaborative way – design based on soil functions and soil survey information.
- Key disciplines to collaborate and advise on soil functions: soil specialist, ecology, arboriculture and landscape architecture.
- Key disciplines to design with soil in mind: landscape architects, architects and engineers. The lead designer must coordinate collaboration.
- Maximise synergies to create better schemes for soils, tree protection, habitats, biodiversity net gain, open spaces and private gardens
- Use these collaborations to inform the masterplan – plan to reuse the existing soil resource
- Design with levels in mind from the outset – explore options to minimise cut and fill, consider construction solutions, such as foundations, early to inform design solutions, ensure greater topsoil depths in private gardens and green spaces
- Maximise permeable paving in the design
- Soil specification – provide sufficient detail to allow soil to be stockpiled carefully, reused appropriately, and soil condition to be able to function to support the design.

Benefits to Design Teams

- Better and more sustainable masterplans that take advantage of the existing soil resource
- Show greater value for money to clients
- Greater sustainability credentials of schemes
- ECSR benefits

Resources

- Landscape Institute – Technical Information Note: Soils and Soil-forming Material (2017)
- Landscape Institute – Technical Information Note: Carbon and Landscapes (2018)
- Defra – Construction Code of Practice for the Sustainable Use of Soils on Construction Sites (2009) – due to be updated
- British Society of Soil Science – Working with Soil Guidance Note on Benefitting from Soil Management in Development and Construction (2022)

Contractors

- Include soils in ECSR targets and raise with clients
- Undertake toolbox talks on the importance of soils and good practice for soil management
- Work to the soil management plan, construction method statement and planning recommendations
- Refer to the latest Defra Construction Code of Practice for the Sustainable Use of Soils on Construction Sites to inform methods for soil stockpiling
- Keep topsoil and subsoil stockpiles separate and label clearly
- Undertake stockpiling appropriately according to soil texture and weather conditions
- Consider soil compaction when planning haul routes and materials laydown – minimise subsoil compaction rather than remediating afterwards
- Stick to planned haul routes, and minimise soil compaction or damage in Root Protection Areas or Soil Protection Zones
- Work to rubble management plans – ensure it is not disposed of in private garden and green space areas.

Benefits to contractors

- Good soil management from the start will enable better functioning soils at completion – less risk, and less cost for remediation or replacement afterwards
- Help with ECSR targets

Resources

- Defra – Construction Code of Practice for the Sustainable Use of Soils on Construction Sites (2009) – due to be updated
- CL:AIRE – DoW CoP – The Definition of Waste: Development Industry Code of Practice (2011)

Soils in Planning and Construction Task Force

Who we are

The Soils in Planning and Construction Task Force is made up of professionals from across soil science, local authorities, urban design and landscape architecture. The task force have come together to drive better management of soils through the planning and construction stages of development projects. Their aim is to protect and improve our vital soil resources, enabling soils in the built environment to function and provide crucial ecosystem services that support thriving places to live and work.

Task Force members

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- Professor Jess Davies, Lancaster University
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The project has been supported by a Lancaster University EPSRC Impact Acceleration Account, Lancaster City Council and Cornwall Council, as well as the EPSRC project Soil-Value and the UKRI project Interdisciplinary Circular Economy Centre For Mineral-based Construction Materials.

The report authors were Roisin O'Riordan, John Quinton and Jess Davies at Lancaster University, with support from all Task Force members.

www.lancaster.ac.uk/soilstaskforce

Network of Experts

A network of professionals and experts in planning, development, design and construction were consulted to inform and guide this document. The Task Force wishes to thank all those that provided expert advice and feedback in the development of this report.

Those that provided guidance were:

- Bruce Lascelles – British Society of Soil Science, Arcadis
- Clare Bower – RIBA
- Emma Askew – Earth Minutes
- Gemma Jerome – Building with Nature
- Helen Brookes – Atelier Helen Brooks, RIBA Cornwall
- Jess Hrivnak – RIBA
- Jessica Lewis – St James Group / St William Homes, Berkeley Group
- Joanne Kwan – CIRIA
- Julia Thrift – TCPA and Green Infrastructure Partnership
- Luke Engleback – Studio Engleback
- Martin Ballard – Willmott Dixon, Soil & Stones Group at SocEnv
- Nicholas Invernizzi – St James Group / St William Homes, Berkeley Group
- Olivia Dear – Countryside Properties
- Rob Askew – Askew Land and Soil
- Robert MacDiarmid – Countryside Properties
- Robin Nicholson – Cullinan Studio, Chair of Cambridgeshire Quality Panel
- Sue James, Trees & Design Action Group

Glossary

- **Organic matter** – is the organic material that comes from dead plant matter, including roots, leaves and stems, and dead organisms in the soil that all contribute organic compounds to the soil as they decompose.
- **Permeability** – is a measure of the ability of soil to allow water to infiltrate and pass through it.
- **Soil biology** – this encompasses all the insects, worms, fungi, bacteria and all micro-organisms that live in the soil and are important for key soil processes.
- **Soil carbon** – this is the carbon stored in soils globally. It includes soil organic matter and inorganic carbon as carbonate minerals.
- **Soil functions** – these are the important processes and services that soil provides, for example, the ability of the soil to hold water, provide nutrients to plants, and to enable food crops to grow.
- **Soil organic carbon** – this is the organic carbon that is stored in soils and originates from the ecological processes in soils, through plants, roots and organisms.
- **Soil processes** – this include all the biological, chemical and physical processes that occur in soil, for example, nutrient cycling, water cycling, organic matter storage and carbon sequestration.
- **Soil sealing** – this is the covering of soil with impermeable surfaces in urban areas, such as asphalt, concrete, stone or paving.
- **Soil structure** – the arrangement of pore spaces and solids within soil.

Photography courtesy of **Birgit Hontzsch** and **John Quinton**

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Appendix 1:
What should a soil survey contain?

A soil survey provides information about soil properties and functions beyond the information given in a geotechnical survey, contamination survey or agricultural land classification. It enables an understanding of how the soil functions, including the texture and structure, nutrient availability, water holding capacity, ability to store carbon and support vegetation growth.

The soil survey should

- Be based on representative site sampling and laboratory analysis
- Include a description of the soil types on site, their thickness and properties including soil texture, pH, water content, nutrient content, carbon content / stock, and any heavy metal or contamination issues.
- Include a map displaying areas of different soil types
- Include a report that describes the different soils on site and their suitability for future uses in the designed scheme.

What the soil survey data tells you

- **Soil texture and water content** – this will tell you about the soil's permeability, clay / sand content and ability for water to infiltrate and be stored in the soil.
- **Soil thickness** – gives an indication of the volume of soil resource available and will determine how earthworks will be undertaken.
- **pH** – this will tell you about the chemistry of the soil which controls nutrient availability, biological processes such as micro-organism and fungi activity, and the behaviour of contaminants or heavy metals.
- **Nutrient content** – provides information on how fertile the soil is. This should be used to determine the type of habitat and planting scheme that will be used in the design of the scheme.
- **Carbon content / carbon stock** – this gives an indication of the soil carbon storage of each type of soil at the time of the survey. It is often referred to as soil organic carbon (SOC). It should be used to consider which areas could be protected from soil handling and compaction to maintain the carbon in the soil and prevent its loss to the atmosphere. It could also be used to plan for planting and soil management to increase soil carbon storage.
- **Heavy metals and contamination** – this information will highlight risks from the soil which will need to remediated.

The British Society of Soil Science document: *Working with Soil Guidance Note on Benefitting from Soil Management in Development and Construction* (BSSS, 2022) makes similar recommendations for soil surveys and soil management plans. It states that a survey should be conducted by a professional soil scientist with the appropriate competencies as set out in BSSS *Working with Soil Professional Competency in Soil Science* Documents. See the guidance note for more details.

Appendix 2:
What should a soil management plan contain?

A soil management plan sets out how the soil will be planned for, handled, and managed so that the soil is able to function on completion of the project. The soil management plan will use data from the soil survey to inform plans for the site. It should include plans for:

Soil Protection

Plans for haul routes and laydown areas to minimise the extent of soil compaction across the site and ensure clear signage to prevent additional damage and compaction outside of these areas

The potential use of Soil Protection Zones (SPZs) where soil will be fenced off and protected from all disturbance or compaction from vehicle traffic. These will be clearly signposted.

Soil handling

- The location, size and duration of stockpiles that are appropriate for soil texture, moisture and weather conditions
- Methods of stripping and stockpiling
- The separation of stockpiles for topsoil and subsoils and clear labelling
- The prevention of mixing of soils with rubble or waste materials
- Haul routes and materials laydown to minimise soil compaction

Soil use

- How soil will be reused across the site, the volume that will be reused, and plans for any excess soil.
- Soil reinstatement that is appropriate in depth, nutrients and texture for future planting and green spaces, private gardens, and SuDs features.

Soil remediation

- How any damaged or compacted soil will be remediated.
- The plan should also state who will be responsible for supervising soil management on site.

Soil management plans should always refer to the latest Defra *Construction Code of Practice for the Sustainable Use of Soils on Construction Sites*. This provides detailed soil handling guidance for soil stripping, stockpiling, reinstatement and remediation of compaction. See more in the Defra Code of Practice.

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