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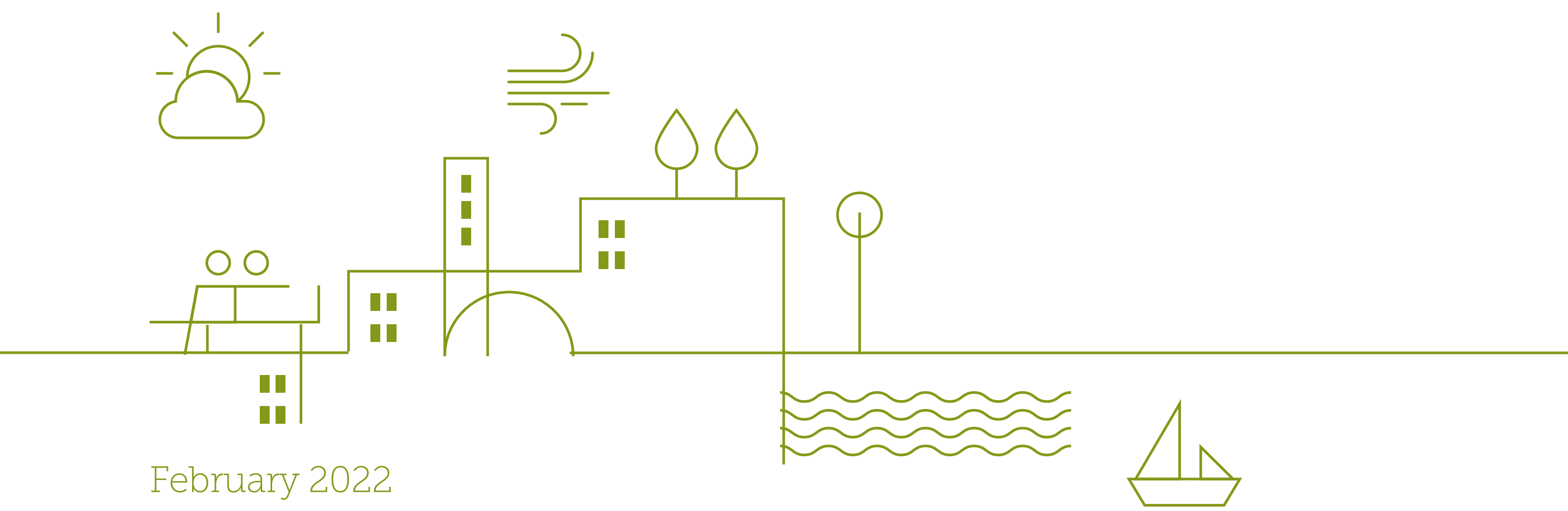
Institute of Environmental Management & Assessment (IEMA) Guide:

A New Perspective on Land and Soil in Environmental Impact Assessment



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Foreword

The aims of 'A New Perspective on Land and Soil in Environmental Impact Assessment' are ambitious, but also necessary and timely. The authors and reviewers have sought to address multiple issues in a complex area of practice to better assess and manage the effects of development on land and soils. Importantly, the guidance seeks to move practice away from a narrow focus on quantifying and financially compensating impacts on agricultural land and advocates a new and wider approach to assessing the soil functions, ecosystem services and natural capital provided by land and soils. The guide highlights and reinforces the importance of soil functions and ecosystems services to wider systems including but not limited to carbon and climate, hydrology, food production, biodiversity and ecology.

Part position paper, part educational resource, and part methodological guidance, the combined result is a handbook on the current state of land and soil in EIA and will be a valuable resource for practitioners seeking to assess and manage the effects of developments on land and soil.

I see this as the start, rather than the end, of IEMA's guidance on this important area and look forward to further innovations in methodological development and seeing future examples of good practice from EIA members and EIA Quality Mark organisations. I am hopeful that this publication will act as a catalyst for the strengthening of the consideration and protection of our vital and finite land and soil resources through impact assessment and planning.

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This guidance has been developed by an IEMA Impact Assessment Working Group on Land and Soils together with key EIA and Soil professionals from a wide range of organisations representing practitioners, regulators, academics and stakeholders from across the UK.

The project was led by **Chris Stapleton**, a soil scientist and member of the RTPI specialising in environmental planning, with experience in the use of soil information within the planning system. As lead author, Chris was supported by an editorial team comprising **Eleanor Reed** (Natural England), **Lynne Gemmell** (Wood) and **Kay Adams** (Enigma Technologies).

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75 YEARS 1947–2022 BRITISH SOCIETY OF SOIL SCIENCE

Soils are a highly diverse, living component of terrestrial ecosystems, which is reflected in the UK's wide variety of habitats, land use and landscape; with different soils exhibiting different capabilities and delivery of ecosystem services. Land and soil are finite in extent and a good understanding of soil function and soil capability is key to making optimal choices about sustainable use of land and soil resources. The Professional Practice Committee (PPC) welcome the publication of these Land and Soil in EIA Guidelines as an important step forward in the comprehensive consideration of both land and soils in planning.

PPC BSSS

Executive Summary

Land use changes arising from development are readily understood, but the effects of these changes on soils are largely unseen and unknown until they are damaged and/or displaced by the development, when it can be too late to make good use of what is effectively a non-renewable resource.

The Environmental Impact Assessment (EIA) Regulations[1] apply to development which is given planning permission under Part III of the Town and Country Planning Act 1990[2], and apply the amended EU Environmental Impact Assessment Directive '*on the assessment of the effects of certain public and private projects on the environment*'[3]. The Regulations do not apply to development given consent under other regimes and subject to separate EIA Regulations (e.g., forestry, oil and gas, etc.). Prior to this publication, the Institute of Environmental Management & Assessment (IEMA) did not have guidance on this subject, and there is no known guidance that specifically addresses how soils and soil functions are comprehensively addressed in EIA. Furthermore, there have been no changes in the emphasis of the assessment of development impacts on land and soils since well before the concept of soil functions was introduced in 2001[4].

Insufficient practitioners are confident in the use of soil information when carrying out EIAs, and there are relatively few soil specialists with the necessary planning skills available to advise them. There has been a long-term decline in the number of qualified and experienced soil specialists and soil surveyors available to enter the planning system, an issue occurring across numerous countries, not just the UK[5]. It is because of these skills and comprehension gaps that these guidelines have an educational role and contain explanatory text to provide a comprehensive source of advice for EIA practitioners, with supporting specialist information in the annexes.

Assessments of the effects of developments on soil in EIA have typically emphasised the soil function for biomass production, meaning that the loss of other important soil functions can be overlooked. It is also recognised by regulators and EIA professionals that although mitigation measures to prevent damage to soil during handling may be clearly set out in EIA reports, in practice, soil handling during site preparation, construction, decommissioning and restoration can be less than satisfactory. This can result in the downgrading of agricultural land quality[6], flooding, poor ground cover establishment, soil erosion, and impacts on surface water quality. Furthermore, soils are not typically considered early enough in the planning process to identify both the risks to soils and their function; or to inform the development design and sustainable reuse of the soils.

The evolution of new environmental perspectives also means that the practical implications of soil functions, soil biodiversity, soil health, ecosystem services and natural capital should be applied within the overarching framework of climate change, to incorporate them effectively into the EIA process.

1 The Town and Country Planning (Environmental Impact Assessment) Regulations (2017). These Regulations apply to England but for the purpose of this guidance could generally be interchanged with the Town and Country Planning (Environmental Impact Assessment) (Scotland) or (Wales) Regulations 2017, or the Planning (Environmental Impact Assessment) Regulations (Northern Ireland) 2015.

2 Town and Country Planning Act 1990, Part III. Similar to the application of the EIA Regulations, various Town and Country Planning legislation applies across the United Kingdom. For the purpose of this guidance, the English Act has been used for brevity. Section 4 provides key planning policy and legislation for land and soils for each part of the United Kingdom.

3 Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment (as amended by Directive 2014/52/EU).

4 DETR (2001) Draft Soil Strategy – a consultation paper, Department of the Environment, Transport and the Regions, London. Formal recognition of this concept is published in Defra (2004) First Soil Action Plan for England.

5 Brevik et al., 2020 Soil and Human Health: Current Status and Future Needs. Air, Soil and Water Research 13 1-23.

6 Welsh Government (2010) TAN 6 Planning for Sustainable Rural Communities.

It is because of these concerns about the use of soil information and the wide scope of the guidelines that they are not prescriptive, although it is anticipated that the soil functions evaluation methodology will be taken up by practitioners. The guidelines are designed to be a selective reference document, more in the nature of a land and soil 'handbook'. Soil specialists and EIA practitioners will focus on content relevant to their interests, perhaps in respect of specific development proposals. They will interpret and apply the guidelines as appropriate to the sensitivity of the environment at the development location, and the nature of the proposed development. Because of the soil skills gap, the guidelines set out both what to do and how to do it, and some of the annexes are intended to be a tutorial for soil specialists within EIA teams.

The guidelines and annexes seek to improve planning for the sustainable use of soils; as well as the delivery of soil handling mitigation measures to more fully conserve soils displaced by development, as this is currently a matter of some concern. The main purpose of this document is to develop, improve, and standardise the approach to soils and land use within a proportionate EIA, to ensure sustainable outcomes from development projects.

These guidelines will help practitioners understand and record the full environmental implications of development on land and soil, embedding sustainable soil management throughout EIA. It is anticipated that this is initial guidance that will be subject to review as ideas evolve, and this is most likely to apply to the soil functions-based EIA evaluation methodology, and to the assessment of cumulative effects.

Part I – Introduction and Context

1 Introduction

Our understanding of soil functions, notably in the wider contexts of climate change and biodiversity loss, is still evolving, and consequently so is soil policy and guidance. However, there is growing recognition at a UK Government level and at an international policy level of the need to protect soil functions and to value soil as natural capital and as an effectively non-renewable resource[7,8,9.]

This guidance sets out a new 'soil functions' approach to assess the effects on land and soil of developments likely to have a significant effect on the environment, due to their nature, size or location, and which fall under the Town and Country Planning (Environmental Impact Assessment) Regulations (2017). These guidelines seek to provide a comprehensive source of advice and information for EIA practitioners, land and soil specialists, regulatory agencies, Local Planning Authorities, developers and their agents, and contractors.

The guidance seeks to embed into EIA practice the concepts of soil functions, soil biodiversity, soil health, ecosystem services and natural capital, and to consider the influence of soil carbon on climate change. This is achieved through introducing a soil functions-based EIA evaluation methodology and improved mitigation measures for soil conservation, so to avoid and minimise detrimental impacts on soil resources and to ensure that all soils are sustainably managed. The guidelines also promote the consideration of natural, undisturbed soils (see Box 2 on page 13) which deliver the most important ecosystem services, and the loss of which are most likely to be significant.

This guidance is split into three main parts: Part I provides an introduction and background to the consideration of land and soils in EIA, including key soil science concepts and overarching soils policy; Part II provides practical assessment guidance on considering land and soils in EIA, including screening, scoping, baseline, assessment methodology, and determining significance; Part III focuses on mitigation, post-consent monitoring and environmental management during construction. A suite of 11 supporting annexes provide further detail and content on a range of aspects addressed within the guidance.

7 Soil formation depends on the parent material, climate, topography, biota, and time.

8 Planning Policy Wales (PPW11) https://gov.wales/planning-policy-wales

9 UK Government (2019) Implementing the Sustainable Development Goals.

2 An Overview of Environmental Impact Assessment

2.1 Defining Impact Assessment

Impact Assessment (IA) in its broadest definition means any technique or process that assesses the impact of a planned activity on the environment and society. In the majority of uses it usually refers to any process for considering the implications, for people and their environment, of proposed actions while there is still the opportunity to influence (or even, if appropriate, cancel) the proposals. It can be applied to all levels of decision-making, from policies to specific projects[10].

Environmental Impact Assessment (EIA) means the statutory process of identifying, predicting, evaluating, and mitigating the biophysical, social, and other relevant effects of proposed development proposals prior to major decisions being taken and commitments being made[11]. For the purposes of this guidance, this is taken to mean statutory EIA as required by UK legislation transposed from the original EIA Directive[12] and its amendments. An Environmental Statement (ES)[13] is the document that presents the applicant's assessment of likely significant effects from a proposed development and is used to inform the decision-makers' EIA process.

2.2 Impact Assessment as a Design Tool

Two key outcome-focussed concepts within IA are the application of environmentally led design and the application of the mitigation hierarchy (avoidance, reduction, compensation, and remediation[14]). Together, these two concepts seek to promote sustainability through embedding beneficial environmental and social outcomes from development at the earliest possible opportunity within the development planning cycle, at the pre-feasibility and concept stage onwards.

To seize opportunities for enhancement and net environmental gain, and to avoid design elements that lead to adverse environmental and social impacts, it is necessary to consider these issues from the outset of a project's conception. Many major adverse impacts are the result of early design decisions such as site selection, the consideration of alternatives, the consideration of the 'do-nothing' option, and decisions on technology, materials, siting, and the composition of developments.

The application of mitigation is often incorrectly considered a later stage with the EIA process, after impacts have been identified. However, in practice, the application of the mitigation hierarchy should begin at the project outset, with the most important first step being avoidance, which is best carried out at the concept development stage and during the consideration of early design decisions. For further detailed guidance on mitigation, see Part III of this guidance.

2.3 Intended Audience and Further Guidance on EIA

The intended audience for this guidance is EIA practitioners and stakeholders concerned with the management of land and soils within the environmental assessment process. This audience is assumed to have a working knowledge of EIA in the UK, and to be able to take into account any country-specific requirements.

It is recommended that, as part of applying this guidance, those who do not have a working knowledge of delivering EIAs, or who simply wish to refresh their understanding, undertake preliminary reading on the way in which the process is undertaken, particularly in relation

10 International Association for Impact Assessment (IAIA) Impact Assessment [online]. Available at: https://www.iaia.org/wiki-details.php?ID=4

11 IAIA (2009) What is impact assessment? Fargo, ND: IAIA.

12 Council Directive 85/337/EEC of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment.

13 EIA Report in Scotland. The remainder of the Primer uses the collective term ES, which can be read as Environmental Statement in England, Wales and Northern Ireland and EIA Report in Scotland.

14 IEMA (2004) Guidelines for Environmental Impact Assessment.

to the application of EIA within the design process and the use of Environmental Management Plans (EMP) or Construction Environmental Management Plans (CEMP) as a control mechanism. Useful information can be found in the following Institute of Environmental Management & Assessment (IEMA) documents:

- Guidelines for Environmental Impact Assessment;[15]
- Environmental Impact Assessment Guide to: Shaping Quality Development;[16]
- Environmental Impact Assessment Guide to: Delivering Quality Development;[17] and
- Delivering Proportionate EIA: A Collaborative Strategy for Enhancing UK Environmental Impact Assessment Practice[18].

These sources of information should be used in conjunction with this guidance, but their technical content is not duplicated.

2.4 The Use of Competent Experts in EIA

The UK Regulations require that:

> *'In order to ensure the completeness and quality of the Environmental Statement... (a) the developer must ensure that the Environmental Statement is prepared by competent experts; and (b) the Environmental Statement must be accompanied by a statement from the developer outlining the relevant expertise or qualifications of such experts.'*

Therefore, the Land and Soil Topic Lead is expected to be the primary competent expert for this subject matter; however, an EIA Coordinator would also be expected to have a working understanding of the definitions, terminology and principles.

The Land and Soil Topic Lead's level of understanding should include (but not be limited to):

- a relevant degree, other professional qualifications, or relevant experience relating to the built environment sector, land and soils, and sustainable resource management;
- a working knowledge and appreciation of UK land uses and soil types, their properties and features that render them able (or not) to be managed in accordance with the highest tiers of the mitigation hierarchy; and
- knowledge of the concepts, theories and application of soil functions, ecosystem services and natural capital pertaining to land and soils.

As well as a sound knowledge of the key principles concerning land and soils, the Topic Lead must have a good understanding of EIA principles, including the ability to:

- define the scope of an environmental assessment, including its temporal and spatial boundaries (to ensure a proportional approach);
- determine potential environmental impacts and effects (whether positive or negative);
- understand the mechanisms established by legislation, policy and accepted practice, to adequately reduce potential impacts; and
- define significant environmental effects for consideration within EIA.

Within all core environmental assessment documentation, it is the responsibility of the Land and Soil Topic Lead to ensure that their competence, and the competence of those supporting the production of content, is clearly evidenced.

15 IEMA (2004) Guidelines for Environmental Impact Assessment.

16 IEMA (2015) Environmental Impact Assessment Guide to: Shaping Quality Development **[link]**

17 IEMA (2016) Environmental Impact Assessment Guide to: Delivering Quality Development **[link]**

18 IEMA (2017) Delivering Proportionate EIA: A Collaborative Strategy for Enhancing UK Environmental Impact Assessment Practice **[link]**

3 Defining Land and Soil

Land and soil are often considered to be the same thing but there are important differences between them, as presented in Box 1. Similarly, land and soil quality definitions are presented in Box 2.

Soil is a natural resource, like air, water, land, and biodiversity, and plays a vital role within sustainable ecosystems. It is recognised by the UK Government as a key component of natural capital[19].

Section 6.2 sets out the soil functions that are components of terrestrial ecosystem services. Society relies on ecosystem services provided by land and soil and these services are central to social, economic and environmental sustainability.

Land is the terrestrial part of the earth's surface. Economists consider land to be one of the basic factors of production, along with labour and capital. From the human perspective, land is an area or location where we can live and carry out activities for subsistence or wealth-creating employment, leisure activities and other lifestyle choices. People need land for economic activity and to produce things, whether it is within an office or factory, or within parcels of agricultural land. The value placed on land is partly determined by its physical properties (climate, topography, and soil). Land also has social and economic dimensions, which are influenced by the different potential uses of land (including urban development) and also by its location in relation to settlements and environmental features.

Soil consists of particles of weathered rock, organic matter, air spaces and water. Soil is the topmost layer of the land, forming the interface between geology and the atmosphere, and is a component of terrestrial ecosystems, providing a medium for the transmission of carbon, water, nutrients, and the growth of plants.

Non-soil Materials

Given the importance of soil movements for mitigation, an explanation of the distinction between 'soils' and 'excavated materials' is a useful starting point (see Annex A, Definition of Terms). It should be noted that excavated natural rock (weathered or un-weathered) and other inert geological deposits are, by custom and practice within engineering disciplines, also incorrectly referred to as 'soil', with only the 'topsoil' being differentiated from all other 'engineering soils', including soil forming materials (e.g. compost) and 'wastes'.

Therefore, where Earthworks Design Specifications refer in conventional engineering terms to 'soils', these should be predominantly weathered and un-weathered geological materials. They should not include topsoils or subsoils. These distinctions between agricultural soils and engineering 'soils' (i.e. soils and non-soils), and between soils and other excavated materials, should be recognised by contractors in their handling of excavated materials and should be incorporated into Earthworks Design Specifications.

Box 1: Land and Soil Definitions (The integrated definition of these terms is set out in Annex A).

19 DEFRA (2011) The Natural Choice: securing the value of nature.

Land Quality

Within EIA, 'land quality' has two meanings:

- the value of land and soils to produce food, fibre, and timber; and
- the degree to which land and soils have been degraded by disturbance[20] and contamination.

Traditionally the first type of land quality has been determined by its productive capability and value for agriculture and forestry. Most of the soils on this land have been subject to some form of human influence, but they generally have soil profiles that are largely undisturbed and uncontaminated, and can be considered natural[21] for the purposes of EIA.

Topsoils and subsoils disturbed by excavation during construction can, if managed correctly, become reinstated natural soil profiles[22] following appropriate mitigation.

The second type of land quality is concerned with determining the need for the remediation of soil and soil-forming materials more severely disturbed and contaminated by industrial and commercial processes, which, due to their potential to significantly affect human health, property, or environmental receptors, falls under Part 2A of the Environmental Protection Act 1990.

These guidelines are concerned primarily with the first type of land quality, although contamination becomes a consideration where brownfield land is included (knowingly or not) within a proposed development where materials are excavated and available for reuse.

We are seeing a shift in the definition of the first type of land quality to encompass the provision of a wider range of terrestrial ecosystem services than solely biomass production from agricultural land. The overarching concept of sustainable development has introduced the need to protect the other functions of land and soils for a wider range of environmental objectives, and this should be reflected in EIAs.

Land Quality and Soil Quality

Land quality on largely undisturbed and uncontaminated land is determined by its capacity to support versatile and productive agricultural land; assessed though the Agricultural Land Classification (ALC)[23] and Land Capability for Agriculture (LCA)[24] systems in England and Wales, and Scotland, respectively. Agricultural land quality is determined based on the site-specific climatic, topographic and largely inherent soil parameters. Soil quality is determined from soil physical, chemical and biological parameters; some of which contribute to the (agricultural) land quality assessment.

20 Natural Capital Committee (2017) How to do it: a natural capital workbook.

21 Very few areas of land exist that have not been subject to some form of human disturbance; however, for the purposes of EIA, agricultural land which has both topsoils and subsoils in place can, from a soil resources perspective and for practical purposes, be considered to be largely natural and undisturbed, despite activities including cultivation and the application of fertilisers, herbicides, and sewage sludge etc. This is to distinguish soils on agricultural land from other less-favourable soil, and soil-forming materials, available from land that has been subject to a greater degree of disturbance, notably building/infrastructure construction and demolition, and including brownfield land that may be affected by contamination. Other land with soils considered to be natural could include ecological conservation sites, Ancient Woodland, peatlands, wetlands or wild land areas.

22 The clearing of trees inevitably causes disturbance and the mixing of topsoils and subsoils, with a potential downgrading effect on land quality. In such areas, topsoils and subsoils might have to be stripped as one material, depending on the density of tree cover and maturity of the trees removed.

23 MAFF (1988) Agricultural Land Classification of England and Wales: Revised criteria for grading the quality of agricultural land.

24 Bibby et al., (1991) Land Capability Classification for Agriculture. The Macaulay Land Use Research Institute.

Soil quality can also be assessed for materials on disturbed and contaminated land where it is also determined by contamination and engineering properties. On some development sites, such soil quality surveys (e.g., contaminated land, geotechnical assessments and peat surveys) may be carried out separately from land quality surveys by suitably qualified and experienced soil scientists or environmental specialists to inform an EIA.

The link between land quality and soil quality surveys is that the latter should be undertaken to inform the remediation of contaminated materials found to be present on a site. Following treatment, they can subsequently be used, together with the natural soils present, as a mitigation/enhancement measure. The need for the management of disturbed soils in urban areas subject to construction activities is being increasingly recognised[25]. See also Box 7 for a description of soil quality and its relevance with regards to soil health.

Box 2: Land and Soil Quality Definitions

25 For example, there is the initiative by the Sustainable Soils Alliance at https://sustainablesoils.org/our-work/projects/urban-and-development-soils

4 Policy and Legislation

This section provides a high-level summary of existing UK guidance, policy and legislative drivers on land and soil in EIA and evidence of progress towards a soil function, ecosystems services and natural capital approach to soil in EIAs.

A draft Soil Framework Directive was not ratified by the European Member states and was formally withdrawn in 2014[26], and, to date, the UK Government has not applied a unified and comprehensive approach to the protection of land and soils as natural resources and part of our natural capital[27]. However, relevant policies for individual planning regimes across the UK are set out below and there are some consistent policy principles that are applicable across the UK.

4.1 EIA Regulations

The regulatory regime for EIA across all parts of the UK differs in specifics but are all based on a common framework provided by the EIA Directive[28]. The various UK EIA Regulations are all based on the implementation of the core principles of EIA as set out in the EIA Directive and require that likely significant effects on the environment caused by relevant development projects are described and assessed, and where negative effects are identified that these are mitigated, and the final effects reported on in Environmental Statements (ES)[29].

The 'Environment' in the context of EIA is comprehensive and includes:

(a) population and human health;

(b) biodiversity, with particular attention to species and habitats protected under Directive 92/43/EEC(1) and Directive 2009/147/EC(2);

*(c) **land**, **soil**, water, air and climate;*

(d) material assets, cultural heritage and the landscape;

*(e) the **interaction between the factors** referred to in sub-paragraphs (a) to (d).*[30]

Therefore, land and soils are both explicitly included as factors in their own right, as well as required to be considered in the context of their functional relationships with other environmental factors. Land and soils are again explicitly referred to in Schedule 4 of the EIA Regulations which sets out the information required for inclusion in ES:

1. A description of the development, including in particular:

(a) a description of the location of the development;

*(b) a description of the physical characteristics of the whole development, including, where relevant, requisite demolition works, and the **land use requirements** during the construction and operational phases;*

*(c) a description of the main characteristics of the operational phase of the development (in particular any production process), for instance, energy demand and energy used, **nature and quantity of the materials and natural resources** (including water, **land, soil** and biodiversity) used;*

*(d) an estimate, by type and quantity, of expected residues and emissions (such as water, air, **soil and subsoil pollution**, noise, vibration, light, heat, radiation and **quantities and types of***

26 European Commission (2014) C153 https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:C:2014:153:FULL&from=EN

27 This type of approach is outlined in Defra (2020) Enabling a Natural Capital Approach: Guidance (available online at: https://www.gov.uk/government/publications/enabling-a-natural-capital-approach-enca-guidance).

28 Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment (as amended by Directive 2014/52/EU).

29 In Scotland, Environmental Reports (ER), where this document refers to ES, this can be read as ER for Scottish practitioners.

30 Section 4.2 of The Town and Country Planning (Environmental Impact Assessment) Regulations 2017, emphasis added.

***waste** produced during the construction and operation phases.*[31]

Schedule 4 also expands upon the environmental factors:

> *Schedule 4. A description of the factors specified in regulation 4(2) likely to be significantly affected by the development: population, human health, biodiversity (for example fauna and flora),* ***land (for example land-take), soil (for example organic matter, erosion, compaction, sealing),*** *water (for example hydromorphological changes, quantity and quality), air, climate (for example greenhouse gas emissions, impacts relevant to adaptation), material assets, cultural heritage, including architectural and archaeological aspects, and landscape.*[31]

Despite these legal requirements to consider land and soil as part of the EIA, currently, the wider planning system in England and Wales primarily focusses on protecting land and soils with reference to the ALC system (the only approved system for grading agricultural land for planning purposes in England and Wales), and in particular 'Best and Most Versatile (BMV)' agricultural land. BMV is defined within the planning system as Grades 1, 2 and Subgrade 3a. In Scotland, the Land Capability for Agriculture (LCA) is applied. The ALC and LCA are based on a similar range of the mainly physical properties of climate, topography and soil, and the degree to which long-term limitations affect the agricultural versatility, productivity, and workability of land (further information on ALC and LCA is provided in Annex B).

4.2 English Land and Soil Planning Policy

A revised version of the National Planning Policy Framework (NPPF)[32] was published in July 2021. This sets out general principles for spatial development across England. The policy context on soils includes:

Paragraph 174:

- protecting and enhancing valued landscapes, sites of biodiversity or geological value and soils (in a manner commensurate with their statutory status or identified quality in the development plan);
- recognising the intrinsic character and beauty of the countryside, and the wider benefits from natural capital and ecosystem services – including the economic and other benefits of the BMV agricultural land, and of trees and woodland;
- preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil pollution or land instability;
- remediating and mitigating despoiled, degraded, derelict, contaminated and unstable land, where appropriate;

Paragraph 175:

- plans should take a strategic approach to maintaining and enhancing networks of green infrastructure and plan for the enhancement of natural capital at a catchment or landscape scale across local authority boundaries;

Paragraph 210:

- not granting planning permission for peat extraction from new or extended sites;

31 Schedule 4 of The Town and Country Planning (Environmental Impact Assessment) Regulations 2017, emphasis added.

32 Ministry of Housing, Communities & Local Government (2021) The National Planning Policy Framework (NPPF).

- providing for restoration and aftercare at the earliest opportunity, to be carried out to high environmental standards, through the application of appropriate conditions, whereby characterising and protecting the soil resource is a key part of carrying out developments and restorations to high environmental standards.

Currently, in relation to guidance on soils and agricultural land, the '*Planning Practice Guidance for the Natural Environment*'[33], which accompanies the NPPF, states that:

> *'a local planning authority must consult Natural England before granting planning permission for large-scale non-agricultural development on best and most versatile land that is not in accord with the development plan.'*

The Planning Practice Guidance for the Natural Environment advocates use of the ALC to enable informed choices to be made about planning decisions on the future use of agricultural land. Therefore, the ALC of the site must be known, to determine whether the requirements of planning policy are being met.

Current guidance to assess the effects of development proposals on the capacity of soils to support productive agricultural use (i.e., BMV agricultural land) in England can be found in Natural England's '*Guide to Assessing Development Proposals on Agricultural Land*' (2021)[34].

The National Planning Practice Guidance for the Natural Environment recognises soil as an essential natural capital asset that provides important ecosystem services, for example as a growing medium for food, timber, and other crops; as a store for carbon and water; as a reservoir of biodiversity; and as a buffer against pollution, and recommends the use of Defra's 2009 '*Construction Code of Practice for the Sustainable Use of Soils on Construction Sites*'[35]. This code seeks to protect soil functions during and after construction, although it does not adequately address requirements for the maintenance of soil functions beyond guidance for the restoration of land primarily for agriculture. Due to its date of publishing, the Defra guidance also contains references to various pieces of legislation that are now out of date; however, it remains the most up-to-date and relevant guidance on the topic. It is understood that the Construction Code of Practice is currently under review by Defra.

On some development sites, soils are protected because they are situated on land with statutory ecological, geological, landscape or cultural heritage/archaeological designations, or they are classified as BMV agricultural land or safeguarded mineral sites. However, there is no guidance that covers all soil functions and resulting ecosystem services. The requirements for assessing environmental topics are set out in the Town and Country Planning (EIA) regulations and the Infrastructure Planning EIA Regulations (see Section 2).

The importance of soils has recently gained increased attention in England, including the announcement of the Soil Health Action Plan for England (SHAPE) in September 2021. This plan has the overarching aim to help restore the health of England's soils and contribute to the Government's targets on biodiversity, recognising that well-managed soils can result in increased biodiversity, improved water quality and reduced carbon emissions[36].

33 Ministry of Housing, Communities & Local Government (2019) The National Planning Practice Guidance (NPPG) for the Natural Environment

34 Natural England (2021) Guide to Assessing Development Proposals on Agricultural Land.

35 Defra (2009) Construction Code of Practice for the Sustainable Use of Soils on Construction Sites.

36 UK Parliament (2021) Soil Health Action Plan for England https://questions-statements.parliament.uk/written-statements/detail/2021-10-19/HCWS326.

4.3 Northern Irish Land and Soil Planning Policy

The Natural Environment Division in the Northern Ireland Environment Agency is one of the statutory consultees to the Department for Infrastructure (DfI) and Planning Authorities in Northern Ireland. The Regional Development Strategy 2035 (RDS) is prepared under the Strategic Planning (NI) Order 1999 and is a material consideration in planning decisions and appeals. The RDS recognises the need to manage soil, protect peat habitats, and safeguard soils. It places value on the ecosystem service of soils in reducing the risk of flooding, filtering inputs to underground water and capturing and storing carbon.

The Strategic Planning Policy Statement (SPPS) consolidates 20 separate policy publications into one document. The SPPS has a statutory basis under Part 1 of the Planning Act (Northern Ireland) 2011 which requires the Department to formulate and co-ordinate policy for securing the orderly and consistent development of land and the planning of that development. Planning Policy Statement (PPS) 18 relates to Renewable Energy Developments and sets out Northern Ireland's planning policy on soil impacts and handling in this context. The Natural Environment Division (NED) within the Department of Agriculture, Environment and Rural Affairs (DAERA) utilises elements of Guidance produced by Scottish Natural Heritage (SNH; now NatureScot) and Scottish Environmental Protection Agency (SEPA) in its assessment of impacts from windfarm development.

Each council area has responsibility for the development of their own Local Development Plan (LDP). The provisions of the SPPS apply to the whole of Northern Ireland. They, along with the RDS and existing PPSs, must be considered in the preparation of Local Development Plans and are material to all decisions on individual planning applications and appeals. LDPs for each council area are currently in development.

The DfI has published Development Control Advice Notes for a range of issues. Note 10 provides general guidance on the operation of the Planning (EIA) Regulations (Northern Ireland) 2017. It includes a list of requirements for inputs to Environmental Statements and sets out the requirement to provide an estimate, by type and quantity, of expected residues and emissions as well as a description of aspects of the environment likely to be significantly affected by the development including soil. NED is a statutory consultee to the DfI and the planning authorities in Northern Ireland.

DAERA has published '*The Code of Good Agricultural Practice*' (COGAP) for the Prevention of Pollution of Water, Air and Soil[37], which provides practical advice on management practices to encourage the sustainable use of natural resources by reducing any negative impacts on agriculture on water, air, and soil.

NED also recommends 'Guidelines for Ecological Impact Assessment in the UK and Ireland'[38] produced by the Chartered Institute of Ecology and Environmental Management (CIEEM). This provides best practice guidance for assessing the ecological impact of plans and projects including impacts to soils. A peatland policy is currently being drafted by DAERA with engagement at inter-departmental level.

37 DAERA (2008) 'The Code of Good Agricultural Practice' (COGAP) for the Prevention of Pollution of Water, Air and Soil https://www.daera-ni.gov.uk/publications/code-good-agricultural-practice-cogap

38 CIEEM (2019) Guidelines for Ecological Impact Assessment in the UK and Ireland https://cieem.net/wp-content/uploads/2018/08/ECIA-Guidelines-Sept-2019.pdf

4.4 Scottish Land and Soil Planning Policy

The Scottish National Planning Framework sets out a statutory long-term plan for spatial development across Scotland.

The current version of the Scottish Planning Policy (SPP) published in 2020 sits alongside the National Planning Framework (due to be updated). It is a non-statutory policy statement and a material consideration requiring planning applications to be determined in accordance with relevant development plans. The Scottish Planning Policy protects prime quality agricultural land defined as Classes 1, 2 and 3.1 in the LCA, and other valuable soil resources like peat soil.

Other key Scottish National Planning Policies include:

- avoiding over-development, protecting the amenity of new and existing development and considering the implications of development for water, air, and soil quality.
- in respect of windfarms, areas are given significant protection where there are nationally important mapped environmental interests, including areas of wild land as shown on the 2014 SNH map of wild land areas, carbon-rich soils, deep peat, and priority peatland habitats, using the carbon calculator[39,40].

Relevant SPP Principles include:

- Principle 80. Where it is necessary to use good-quality land for development, the layout and design should minimise the amount of such land that is required;
- Principle 194. The planning system should seek to protect soils from damage such as erosion or compaction; and
- Principle 205. Where peat and other carbon-rich soils are present, applicants should assess the likely effects of development on carbon dioxide (CO_2) emissions. Where peatland is drained or otherwise disturbed, and there is liable to be a release of CO_2 to the atmosphere, developments should aim to minimise this.

Development on prime quality agricultural land, or land of lesser quality that is locally important, should not be permitted except where it is essential:

- as a component[41] of the settlement strategy or necessary to meet an established need, for example for essential infrastructure, where no other suitable site is available; or
- for small-scale development directly linked to a rural business; or
- for the generation of energy from a renewable source or the extraction of minerals where this accords with other policy objectives and there is secure provision for restoration to return the land to its former status.

It should be noted that these principles in the SPP are likely to be reviewed in the forthcoming Scotland's Fourth National Planning Framework (NPF4). The NPF4 position statement, issued by Scottish Government in November 2020, considers what Scotland should look like in 2050 and sets out current thinking regarding national planning policies and where future development should take place in line with net zero emission targets. This will potentially strengthen consideration for the soil carbon resources and sustainable use of soil resources. This consideration extends to the protection of good-quality land through the design of developments, the restoration and aftercare of worked out at mineral sites, and the avoidance of pollution, CO_2 emissions, soil erosion, and soil compaction.

39 Scottish Government (2008) Calculating potential carbon losses and savings from wind farms on Scottish peatlands.

40 Scottish Government (2018) Carbon calculator for wind farms on Scottish peatlands: factsheet.

41 Scottish Natural Heritage (now NatureScot) (2018) Environmental Impact Assessment Handbook Guidance for competent authorities, consultation bodies, and others involved in the Environmental Impact Assessment process in Scotland.

The SNH EIA Handbook (2018) Version[42] includes useful guidance covering the assessment of impacts on soils. The introduction to Appendix 5 clearly identifies the issues which emphasise the need for a greater awareness of the topic:

> *'Soils occupy a unique position in earth heritage environmental assessment, because although explicitly listed as an environmental factor in the EIA Directive and Regulations, they are not explicitly and routinely covered by any of the existing designated area legislations in Britain. These designations are often used as the basis for protecting valued natural resources.'*

These designation protections are not available to soils. The Appendix continues: *'Because soils do not fit neatly into this site-based framework, they can be overlooked in EIA. The position of soils at the interface between the geosphere, biosphere, and hydrosphere further compounds this, as they cannot be easily compartmentalised. They also play an important part in biodiversity conservation so, it is vitally important that soils information is included as an integral part of the EIA process, as changes to soils can have subsequent effects on other parts of ecosystems, such as vegetation, freshwater and coastal habitats condition and composition. Also, key to natural heritage interests is the intrinsic value of the soil resource* [which] *has functional roles in the context of changing climate (e.g. as a carbon repository and source of greenhouse gases). The role of soils in delivering ecosystem services and environmental goods is now widely acknowledged.'*

4.5 Welsh Land and Soil Planning Policy

The Future Wales National Plan 2040[43] states that:

> *'Our Productive Land is a vital resource …' that 'we must continue to value and protect …'. Future Wales seeks to sustainably manage, maintain, and enhance our natural resources, (including soils) for their environmental, social, and cultural value, while economic benefits will be utilised sustainably and appropriately by promoting nature-based solutions within a circular economy.*

Planning Policy Wales (PPW)[44] sets out the land use planning policies of the Welsh Government. It is supplemented by a series of Technical Advice Notes (TANs), Welsh Government Circulars, and policy clarification letters, which together with PPW provide the National Planning Policy Framework for Wales.

Paragraphs 3.58 and 3.59 of PPW provide the main guidance for protection of BMV land in Wales:

3.58 states that agricultural land of Grades 1, 2 and 3a of the Agricultural Land Classification system (ALC)[45] is the best and most versatile, and should be conserved as a finite resource for the future.

3.59 states that when considering the search sequence and in development plan policies and development management decisions, considerable weight should be given to protecting such land from development, because of its special importance. Land in Grades 1, 2 and 3a should only be developed if there is an overriding need for the development, and either previously developed land or land in lower agricultural grades

42 Scottish Natural Heritage (now NatureScot) (2018) Environmental Impact Assessment Handbook Guidance for competent authorities, consultation bodies, and others involved in the Environmental Impact Assessment process in Scotland.

43 Welsh Government (2021) Future Wales: The National Plan 2040.

44 Welsh Government (2021) Planning Policy Wales Edition 11 https://gov.wales/sites/default/files/publications/2021-02/planning-policy-wales-edition-11_0.pdf

45 Welsh Government. Agricultural Land Classification Guidance and Services available at: https://gov.wales/agricultural-land-classification

is unavailable, or available lower grade land has an environmental value recognised by a landscape, wildlife, historic or archaeological designation which outweighs the agricultural considerations. If land in Grades 1, 2 or 3a does need to be developed, and there is a choice between sites of different grades, development should be directed to land of the lowest grade.

TAN 6 'Planning for Sustainable Rural Communities' provides guidance on the implementation of PPW. Section 6.2 (Sustainable Agriculture, Development involving agricultural land) is most relevant in terms of agricultural land and ALC. Annex B of TAN 6 provides details on consultation arrangements.

Detailed policy advice on the mechanisms for aggregates and coal extraction are set out in *'Minerals Technical Advice Note (Wales) 1: Aggregates'*[46] and *'Minerals Technical Advice Note (MTAN) Wales 2: Coal'*[47].

The Environment (Wales) Act 2016[48] promotes the sustainable management of natural resources in Wales. Natural resources include (but are not limited to) —(a) animals, plants and other organisms; (b) air, water and soil; (c) minerals; (d) geological features and processes; (e) physiographical features; and (f) climatic features and processes. The objectives are to maintain and enhance the resilience of ecosystems and the benefits they provide, meet the needs of present generations without compromising the needs of future generations, and contribute to the well-being goals set out in Section 4 of the Well-being of Future Generations (Wales) Act 2015[49].

A requirement under the Environment (Wales) Act (2016) is to produce a natural resources policy[50], for the sustainable management of natural resources in Wales. For improved ecosystem resilience, it states that

> *'We must also better manage our soil and safeguard our best and most versatile agricultural land to improve soil quality, productive capacity and its resilience to degradation.'*

The 2016 Act also requires Natural Resources Wales (NRW) to produce an annual state of natural resources report (SoNaRR). Section 2 of the current SoNaRR report states

> *'Soil is a key component of the earth's critical zone and has a profound effect on health and well-being. Soil is a valuable and finite natural resource underpinning the delivery of ecosystem goods and services which support every aspect of the natural and built environment on which well-being depends. The way land and soils are used can deliver several functions or services at the same time and place, providing multiple benefits.'*[51]

To support PPW and The Environment (Wales) Act (2016), the Welsh Government has produced a new online predictive ALC map for Wales (see Annex B of these guidelines).

46 Welsh Government (2004) Minerals Technical Advice Note (Wales) 1: Aggregates.

47 Welsh Government (2009) Minerals Technical Advice Note (Wales) 2: Coal.

48 Environment (Wales) Act 2016 https://www.legislation.gov.uk/anaw/2016/3/contents/enacted

49 Well-being of Future Generations (Wales) Act 2015 https://www.legislation.gov.uk/anaw/2015/2/contents/enacted

50 Welsh Government (2018) Natural Resources Policy https://gov.wales/natural-resources-policy

51 Natural Resources Wales (2020) The Second State of Natural Resources Report (SoNaRR) Assessment of the achievement of sustainable management of natural resources: Land use and soils https://cdn.cyfoethnaturiol.cymru/media/693310/sonarr2020-theme-land-use-and-soils.pdf

5 A Critique on the Current State of Land and Soils Assessment

As set out above in the policy section, across the UK there is a requirement (which is applied differently in each of the nations) to consider soil throughout the EIA process. As stated in the Introduction, this policy guidance is intended to be used with the Town and Country Planning (Environmental Impact Assessment) Regulations (2017) only and does not provide direct guidance for development given consent under other regimes; these are subject to separate EIA Regulations (e.g. forestry, oil and gas, etc.). However, many of the recommendations will be applicable across different EIA regimes and sectors.

5.1 Screening

The process of screening determines whether a proposed project falls within the remit of the EIA Regulations, whether it is likely to have a significant effect on the environment and therefore requires an assessment.

Screening is broadly divided into two categories of development, set out in Schedule 1 and Schedule 2. Schedule 1 lists the types of major developments which will, by the nature of the development, likely result in significant environmental effects and therefore require an EIA to be carried out (for example, nuclear power stations and major airports). Schedule 2 sets out a second category of development projects that may require EIA depending on certain thresholds (set out in Schedule 2) and environmental criteria (set out in Schedule 3) which take account of the characteristics of the development, the location of the development, and the type and characteristics of the potential impacts. Therefore, to establish if a development listed in Schedule 2 requires an EIA, a screening assessment needs to be undertaken to review the thresholds and criteria to determine the need for an EIA.

Again, land and soil are specifically listed in Schedule 3 as criteria for screening:

Characteristics of development

1. *The characteristics of development must be considered with particular regard to:*
   - (a) *the size and design of the whole development;*
   - (b) *cumulation with other existing development and/or approved development;*
   - (c) *the use of natural resources, in particular* ***land, soil,*** *water and biodiversity;*
   - (d) *the production of waste;*
   - (e) *pollution and nuisances;*
   - (f) *the risk of major accidents and/or disasters relevant to the development concerned, including those caused by climate change, in accordance with scientific knowledge;*
   - (g) *the risks to human health (for example, due to water contamination or air pollution)*[52].

The second criteria also specifically refers to land and soils:

Location of development

2. *The environmental sensitivity of geographical areas likely to be affected by development must be considered, with particular regard, to:*
   - (a) *the existing and approved land use;*
   - (b) ***the relative abundance, availability, quality and regenerative capacity of natural resources*** *(****including soil, land,*** *water and biodiversity) in the area* ***and its underground****;*
   - (c) *the absorption capacity of the natural environment, paying particular attention to the following areas:*

52 Schedule 3 of The Town and Country Planning (Environmental Impact Assessment) Regulations 2017, emphasis added.

(i) wetlands, riparian areas, river mouths;

(ii) coastal zones and the marine environment;

(iii) mountain and forest areas;

(iv) nature reserves and parks;

(v) European sites and other areas classified or protected under national legislation;

(vi) areas in which there has already been a failure to meet the environmental quality standards, laid down in European Union legislation and relevant to the project, or in which it is considered that there is such a failure;

(vii) densely populated areas;

(viii) landscapes and sites of historical, cultural or archaeological significance.

Consideration should therefore be given during screening to determine whether a development could have significant effects on land and soil. As noted in Section 4 above, some high-value soils or scarce soils are specifically recognised in UK planning policy, including BMV agricultural land in England and Wales, statutory designated sites, prime quality agricultural land in Scotland, peat, and other carbon-rich soils in Scotland. The SNH Handbook (2018) Version 5[53] also highlights the need too consider the position of soils at the interface between the geosphere, biosphere and hydrosphere. Screening should recognise the important part played by soils in biodiversity conservation and other natural capital and ecosystem functions.

In all cases, in the first instance, developers should be seeking to avoid negative effects on land and soil through development location and design, particularly taking into account the factors set out in Schedule 3.[54] Where siting and location are constrained from other factors, then early consideration should be given to identifying the potential a proposed development has to result in loss of soil functions through significant soil loss or damage to soils. Where likely negative effects may occur, early consideration should then be given to following the mitigation hierarchy (avoid > prevent > reduce > offset)[55] starting with the avoidance of effects, and only seeking to offset when avoidance, prevention and reduction have been applied and are still inadequate to mitigate the adverse effects arising from the development. Adapting the generic mitigation hierarchy to soils could be to adopt: avoid > minimise > restore on-site > reuse off-site (see Part III of this guidance).

5.2 Scoping

Scoping is a formal stage of the EIA process and is designed to define the focus of the EIA by identifying key factors/issues that may result in significant adverse effects and agree the appropriate methodologies for carrying out the subsequent assessments.

The developer (and/or their agents/consultants) are responsible for putting together a scoping request and will often submit a Scoping Report setting out their proposed scope and methodology for the EIA. The relevant planning authority, normally the local planning authority (LPA), will then consult statutory stakeholders on the developer's Scoping Report. A formal Scoping Opinion setting out the LPA's and Statutory stakeholder's opinions on the scope and level of detail of the information to be provided by the Applicant in the ES accompanying the Planning Application will then be produced.

A few key points should be considered during scoping. Firstly, it is good practice to follow published EIA

53 Scottish Natural Heritage (now NatureScot) (2018) Environmental Impact Assessment Handbook Guidance for competent authorities, consultation bodies, and others involved in the Environmental Impact Assessment process in Scotland.

54 (Environmental Impact Assessment) Regulations 2017.

55 For more information on applying the mitigation hierarchy in EIA see IEMA 2015 EIA Guide to Shaping Better Quality Development and IEMA 2016 EIA Guide to Delivering Better Quality Development.

methodology and standards[56], furthermore developers should consult with the statutory stakeholders prior to submitting the Scoping Report, to ensure their views have been understood, and where possible, incorporated into the Scoping Report prior to its submission. Secondly, the Scoping Opinion is set by the LPA, not the developer, and supersedes the Scoping Report setting the final scope of the EIA. Thirdly, the Scoping Opinion is legally binding and any major subsequent departure from the methodologies and scope set out in the Scoping Opinion should be agreed in writing with the LPA.

Regarding the recommendation to follow published EIA methodologies and standards, this document constitutes IEMA's current guidance with regard to land and soils in EIA. However, prior to this publication, no existing guidance provides a complete evaluation methodology which considers all soil functions.

The Design Manual for Roads and Bridges (DMRB) EIA guidance sets out the assessment criteria and methodology for highway projects only; however, aspects of the DMRB guidance are sometimes applied to other project types such as linear energy infrastructure. The DMRB LA109 Guidance on Geology and Soils[57] sets out five questions designed to assist practitioners in deciding whether the assessment of effects on land and soil is required, these are shown in Box 3.

1) Is the project likely to affect designated geological sites (statutory or non-statutory)?
2) Is the project likely to affect the function or quality of soil as a resource?
3) Is the project likely to affect agricultural land classified as BMV or prime quality land?
4) Is the project likely to disturb historical contamination?
5) Is the project likely to introduce significant sources of contamination?

Box 3: DMRB LA109 Existing Guidance for Scoping Soils in EIA

The DMRB guidance requires scoping to determine whether a development project is likely to affect the functions of soil as a resource, e.g., due to the permanent loss or reduction of soil functions and of current or future land uses through soil 'sealing' (where sealing refers to built areas only, whilst land-take is the hard development plus associated urban green space such as parks and gardens etc). Consideration should also be given to effects on soil organic matter, compaction and loss of soil structure, or erosion of the soil resource, as well as effects on agricultural land. However, what is missing from the DMRB guidance is an evaluation methodology to assess the significance of development impacts on all soil functions.

The DMRB guidance, Institute of Civil Engineers (ICE) EIA Handbook[58] and also the SNH EIA Handbook[59] refer to soil quality and maintaining soil functions but offer no practical guidance on how to assess the effects of development on soil functions and how they should be reported in an ES. Yet, there is little evidence of independent approaches to the issue within EIAs which have received public examination.

56 For a list of IEMA EIA guidelines, see https://www.iema.net/knowledge/policy-horizon/impact-assessment/current-work

57 DMRB (2019) LA109 Geology and Soils https://www.standardsforhighways.co.uk/dmrb/search/adca4c7d-4037-4907-b633-76eaed30b9c0

58 Institute of Civil Engineering (2019) Environmental Impact Assessment Handbook.

59 SNH (2018) Environmental Impact Assessment Handbook: Guidance for competent authorities, consultation bodies, and others involved in the Environmental Impact Assessment process in Scotland.

The scoping of EIAs should consider potential impacts on the functional capabilities of soils, their sensitivity, vulnerability, and general condition. Soil data, in the form of a soil resource survey should be collected and collated for the wider range of soil ecosystem services than solely the agricultural land quality, and if needed, within the context of contaminated land assessments to determine the suitability of the land and soil for proposed end uses. The appropriate soil survey methodologies are set out in Annex C. However, integrating a consideration of all applicable soil functions into a proportionate EIA is not straightforward, due in part to complex interactions between soil functions and other environmental topics.

5.3 Assessment of Land and Soil

Current assessments of land and soils in EIA are often focussed solely on impacts on agricultural land quality, recognising the value of BMV land as a resource, and thus underpinning the principals of sustainable development. BMV and prime-quality agricultural land can support a wide variety of consistently high-yielding crops and is afforded a degree of protection in the NPPF and the Scottish Governments' National Planning Policy. In Wales, 'significant weight' is given to BMV[60]. For the soil biomass function, thresholds of between 1 and 20 ha of agricultural land loss (particularly in respect of BMV or prime quality agricultural land) may be considered significant in the context of a development site, but smaller areas may also be significant in terms of the loss of other soil functions. In Wales, more than 20 ha BMV loss is considered 'nationally significant'.

Thus, the current approach in assessing the effects of a development on land and soil is largely restricted to the protection of the biomass soil function for food, fibre and timber production. The structural resilience of soils to damage when they are moved and reused is also considered in the context of protecting the same soil function. However, soils have other functions, and ecosystem services such as nutrient cycling and water filtration.

Furthermore, soil is a finite natural resource, with little regard typically given to the conservation of this resource at construction sites (other than at surface mineral sites[61]), even when large volumes of soils are potentially lost. Therefore, an EIA evaluation methodology covering the effects of all types of development on all soil functions is required.

The secured beneficial reuse of displaced soil resources can ensure the continued delivery of a wide range of soil functions and ecosystem services which are addressed in the proposed EIA methodology. However, the loss of agricultural land (i.e. land-take) is considered a permanent loss which cannot be mitigated, which is why the assessment of agricultural land quality remains an important consideration in EIA.

5.4 Deficiencies in Current Guidance

Current published and widely used evaluation methodologies include DMRB LA104 (Environmental Assessment and Monitoring)[62] and LA109[63], and the ICE EIA Handbook[64]. The ICE guidance offers an alternative to the DMRB Guidance for assessments other than highway projects (see Box 5), although the DMRB guidance can be applied to other project types. DMRB LA104 sets out the approach to deriving impact

60 Welsh Government (2021) Planning Policy Wales Edition 11 https://gov.wales/sites/default/files/publications/2021-02/planning-policy-wales-edition-11_0.pdf

61 Defra (2004) Guidance for Successful Reclamation of Mineral and Waste Sites

62 DMRB (2020) LA104 Environmental Assessment and Monitoring https://www.standardsforhighways.co.uk/prod/attachments/0f6e0b6a-d08e-4673-8691-cab564d4a60a?inline=true

63 DMRB (2019) LA109 Geology and Soils https://www.standardsforhighways.co.uk/dmrb/search/adca4c7d-4037-4907-b633-76eaed30b9c0

64 ICE (2019) Environmental Impact Assessment Handbook.

significance from considering the value of the receptor (hereafter referred to as sensitivity) and the magnitude (change) of effects, and the mitigation hierarchy to be applied when using the DMRB LA109 Guidance to assess effects on geology and soils.

Within the DMRB LA109 Guidance, National Highways, Transport Scotland, the Welsh Government, and the Northern Ireland Department for Infrastructure have aligned guidance between England, Wales, and Scotland on the assessment of impacts on land quality.

However, as described above, LA109 provides incomplete guidance to cover the proposed soil functions methodology. The evaluation methodology in Tables 3.11 and 3.12 of LA109 relate mainly to the sensitivity, magnitude and significance of development effects on agricultural land quality (i.e. food production and the biomass soil function) and on soils supporting habitats of European, national and local value. Table 3.11 does not give 'sensitivity' values for the loss of soil volume or soil functions (or soil type). Table 3.12 gives only 'magnitude' values for the loss of soil volumes or the permanent or temporary loss of one or more soil functions.

The LA109 approach reflects the NPPF requirement that environmental resources, including soils, should be safeguarded, commensurate with their statutory status or identified quality and that the best agricultural land should be protected. However, in this approach, some important soil functions are not addressed.

Land and soil in EIA should consider geology and minerals, and the receptors are discussed briefly in Box 4. Within LA109, the sensitivity of the geology is considered in terms of its designation. In addition to potential soil sealing, the presence of a mineral resource needs to be considered during planning, to prevent the unnecessary sterilisation of minerals because of land sealing (see Box 4).

Regionally Important Geological and Geomorphological Site (RIGS)

RIGS are designated as important locations for geology, geomorphology and other earth science features. They are conserved and protected by the Town and Country Planning Act 1990, but they do not have the statutory management protection applied to Sites of Special Scientific Interest (SSSIs).

RIGS do not have national statutory protection, but they are regionally or locally representative sites where consideration of their importance should be an integral part of the planning process.

Minerals within Surface Deposits

These are minerals extracted by opencast methods (e.g. sand and gravel), and this method of working generally involves on-site soil conservation for land restoration. Prior to making a planning application, a developer should investigate the potential presence of such commercially viable mineral deposits within a proposed development site. This will avoid the sterilisation of mineral resources.

Planning applications for opencast mineral extraction should be supported by Soil Resource Plans (SRPs), possibly within a CEMP, for soil conservation and land restoration as a mitigation measure.

Box 4: Geology and Minerals

An alternative, yet also incomplete evaluation methodology in respect of soil functions is provided in the ICE EIA Handbook (see Box 5), which refers to soil type, in relation to some soils being more sensitive to handling than others, but it does not provide a means of determining a sensitivity value for the loss of soil volumes or soil functions.

The ICE EIA Handbook evaluation methodology assesses sensitivity with reference to the physical properties of soil, i.e., the mineral and organic content of topsoil and subsoil, and soil wetness (drainage) status. This values soil as a growing medium and places weight on its resilience to physical damage caused by soil handling during construction. Resilience to damage relates to the successful restoration of land, but the maintenance of a range of wider environmental soil functions is not made explicit. Reducing damage to the soil during handling and restoration enables the maintenance of soil health to deliver ecosystem services, but the ICE Handbook does not currently lend itself to assessing potential net environmental benefits or losses; nor does it demonstrate what the soil function trade-offs are when different parcels of land are developed. The ICE Handbook and DMRB LA109 follow a similar approach, but some of the criteria for assessing sensitivity, magnitude and significance of effects differ.

Box 5: ICE Environmental Impact Assessment Handbook Guidance for Soils

5.5 Required Improvements to the Assessment of Land and Soil

The DMRB LA109 Guidance determines the sensitivity of soils relative to their functions within international, national, or regionally designated sites of high nature conservation or landscape amenity value (this is related to soil's biodiversity function, though not specifically to soil biodiversity), and their sensitivity as an agricultural resource (the biomass function), assessed in accordance with the ALC/LCA.

However, this approach potentially ignores other soil functions that are important in the local and national context (such as soil's hydrological functions) and, in the context of soil organic carbon storage and potentially soil biodiversity, functions that are important in the global context of maintaining healthy ecosystems and mitigating climate change.

In practice, where development is to take place, soil sensitivity assessment should also relate to the ability of soils to withstand change whilst retaining their functions, as outlined in the ICE guidance.

Determining the magnitude of effects on soil or changes to soil should involve some quantification of the potential effects on soil, or changes to land (e.g., the areas of land use changes, volumes of soil involved, and the sensitivity of a soil type to handling). There are also materials/ waste management considerations arising from any soil surplus that may result from a proposed development that should be given early consideration in an EIA.
In summary, to complete a soil functions evaluation methodology requires further elaboration of the DMRB LA109 and ICE methodologies.

Part II – New Perspectives in Land and Soils

6 Towards a New Approach to Land and Soils Assessment

6.1 Introduction to New Perspectives

As set out in Section 5, the current EIA approach to land and soil is unable to respond adequately to evolving environmental perspectives (e.g., the response to climate change, biodiversity loss and sustainability etc). When soil is lost or damaged because of development, subsequent inappropriate land use or land management, the effects on some soil functions such as carbon cycling, biodiversity, water filtration and storage, and nutrient cycling are not widely or consistently recognised within the EIA process. The impacts of such changes to soil functions can often result in the increased incidence of flooding, poor ground cover establishment, soil erosion, effects on surface water quality and the downgrading of agricultural land quality (ALC/LCA).

To address this challenge within the current EIA framework, we must understand the relationships between the concepts of soil functions, soil biodiversity, soil health, ecosystem services and natural capital, and to consider the influence of soil organic carbon, a component of soil organic matter, on climate change.

Soil functions support biomass production, biodiversity, the carbon, nitrogen and hydrological cycles, and the preservation of cultural artefacts. Soil biodiversity relates to living organisms within soils and a healthy soil can achieve its potential level of such diversity. Soil health[65] supports ecosystem services, and it is determined by the physical, chemical, and biological properties of soil that determine its ability to fulfil the functions necessary to sustain ecosystem services. Of these properties, soil organic matter has positive effects on soil structure, drainage, water retention, nutrient supply and carbon storage etc, and the maintenance or enhancement of soil organic matter levels is crucial to sustain ecosystem services. Soil is a natural capital stock, and it also combines with other environmental factors to provide ecosystem services and other stocks of natural capital that are utilised by people to provide sustainable benefits to society. These concepts are discussed and addressed in more detail in the Annexes.

Changes to the physical, chemical, and biological properties of soils arising from disturbance because of development and their consequent effects on soil functions are readily understood by soil specialists involved in EIA. For example, soil organic matter content and soil structure are key parts of the carbon and hydrological cycles, and inherent soil textures are an important factor in determining the value of land for wildlife habitats. It is because of these readily understandable connections (see Figure 1: A Conceptual Diagram Linking Key Soil Properties to Ecosystem Services through Soil Functions) and the precedents set by the DMRB and ICE methodologies, that the proposed EIA evaluation methodology in this guidance is based on the link between soil properties and soil functions, rather than on the other related higher-level and less well-defined concepts of ecosystem services and natural capital. However, the implications of development for the latter can be inferred from the effects on soil functions.

6.2 Soil Functions, Land Use and Ecosystem Services

Soil provides us with a wide range of benefits and performs 'functions' that are important for our environment, society and economy. The following soil functions are components of terrestrial ecosystem services:

- biomass (food, fibre, fuel) production;
- ecological habitat and platform for soft infrastructure

65 Soil health can be interpreted in different ways. The definition adopted in this Guidance is presented in Annex D.

(i.e. green Infrastructure);

- interactions with the atmosphere: as a component of the carbon and nitrogen cycles;
- interactions between land and the atmosphere: as a component of the hydrological cycle (see Box 6: Soil Function and Hydrology);
- for the preservation of archaeology, cultural heritage, community benefits and geodiversity; and
- as a source of materials.

Mineral soils also act as a platform for hard development which seals off and largely isolates the soil from the rest of the terrestrial ecosystem. Land-take for hard development is considered a permanent land use change, as addressed in Sections 5.2, 7.2 and 7.3. A combination of hard and soft development and land uses determines the different physical and cultural environments experienced by people in urban and rural areas.

Frameworks for linking soil functions and soil ecosystem services have been produced across the UK with various degrees of success. Good soil health reflects the capacity of the soil to deliver certain soil functions (i.e., not all soils can provide all soil functions to the same extent).

Digital maps of ALC are available for England and Wales. Similarly, digital maps of LCA, Carbon Sequestration and Drinking Water Provision have been prepared by the James Hutton Institute for Scotland. However, the resolution of these models is not always suitable for site-specific assessments.

It is generally acknowledged in the UK that there are pressures on soil functions. The Environment Agency's 2019 *'State of the Environment Report for Soil in England and Wales'*[66] and Natural Scotland's 2011 *'The State of Scotland's Soils'*[67] reports set out the current understanding of these pressures, including the importance of soils as a natural capital resource, providing many essential services. Both reports identified climate change and changes in land use and land management practices as the most important pressures affecting soil in England, Wales and Scotland. The Soil Policy Evidence Programme[68] includes the assessment of Welsh soil issues in this context. In addition, the SoNaRR report[69] describes the state of natural resources in Wales.

There are ongoing attempts to prevent further degradation of soil health and loss of soil functions within the UK. There are three new schemes that will be rolled out in England that will reward Environmental Land Management (ELMS): Local Nature Recovery; Landscape Recovery; and the Sustainable Farming Initiative. These schemes will be piloted between 2021 and 2022 and launched between 2022 and 2024.[70] Whilst the Soil Health Nutrient Health Scheme (SHNS) was announced in October 2021 in Northern Ireland for agricultural land.

The soil functions described above support the delivery of ecosystem services, which can be categorised in one of four groups:

- provisioning services (direct or indirect food for humans, fresh water, wood, fibre, and fuel);

66 Environment Agency (2019) State of the Environment Report for Soil in England and Wales https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/805926/State_of_the_environment_soil_report.pdf

67 Natural Scotland (2011). The State of Scotland's Soils. https://www.sepa.org.uk/media/138741/state-of-soil-report-final.pdf

68 Welsh Government (2021) Soils Policy Evidence Programme https://gov.wales/soils-policy-evidence-programme

69 Natural Resources Wales (2020) The Second State of Natural Resources Report (SoNaRR) Assessment of the achievement of sustainable management of natural resources: Land use and soils https://cdn.cyfoethnaturiol.cymru/media/693310/sonarr2020-theme-land-use-and-soils.pdf

70 Defra (2021) Environmental Land Management scheme: overview https://www.gov.uk/government/publications/environmental-land-management-schemes-overview/environmental-land-management-scheme-overview

- regulating services (gas e.g., CO_2 and water, climate, flooding, erosion), and biological processes such as pollination;
- providing cultural services (aesthetic, spiritual, educational, and recreational); and
- supporting services (nutrient cycling, production, habitats, and biodiversity).

Figure 1: A Conceptual Diagram Linking Key Soil Properties to Ecosystem Services through Soil Functions *See section 9.1 for a more comprehensive list of soil properties illustrates the physical, chemical, and biological properties of soils and their connection with soil functions and ecosystem services. It is the changes to these soil properties arising from development and their effects on soil functions that should be covered by soil specialists involved in EIA.

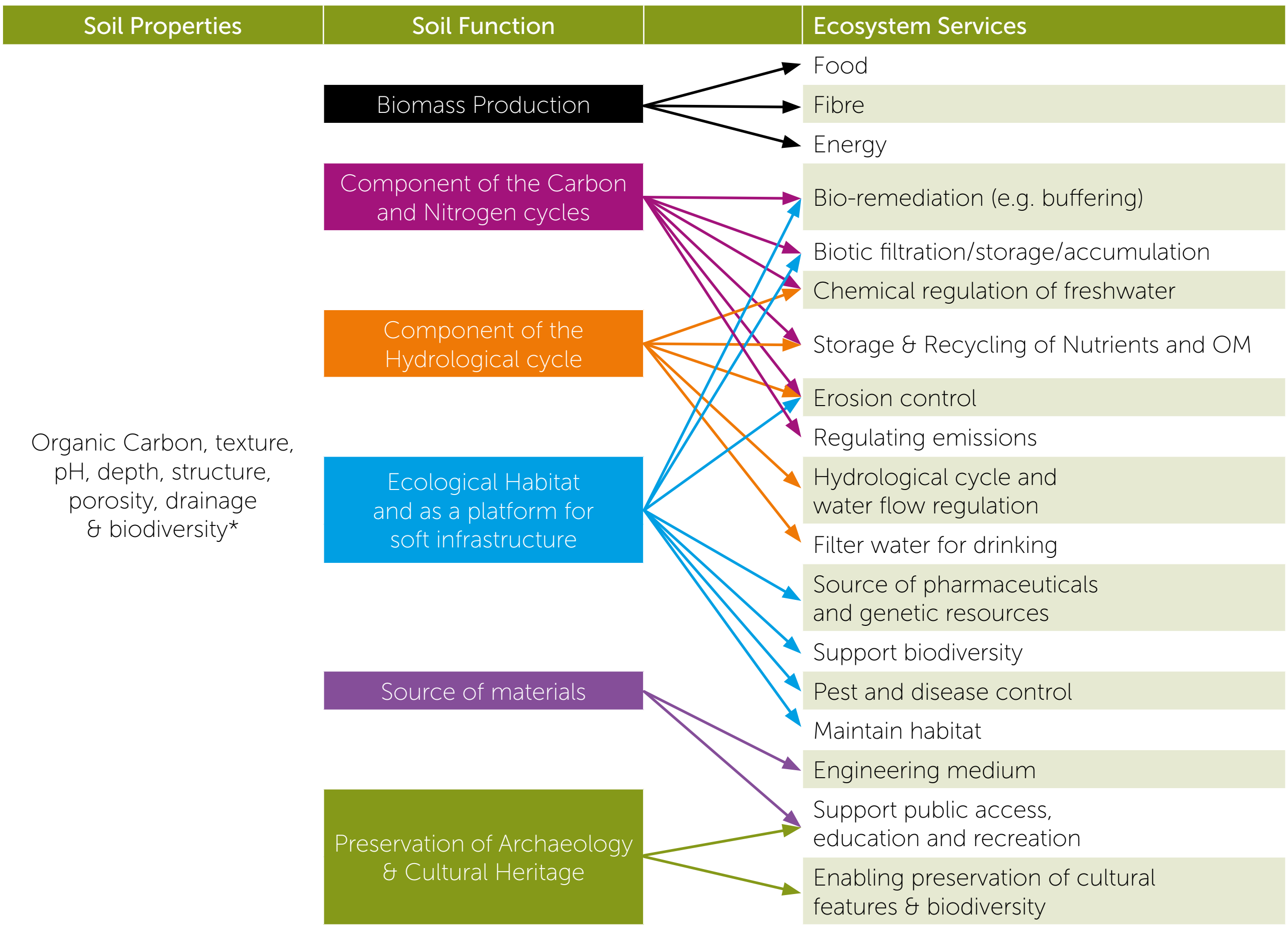


Figure 1: A Conceptual Diagram Linking Key Soil Properties to Ecosystem Services through Soil Functions

*See section 9.1 for a more comprehensive list of soil properties

Soils are finite and any loss or degradation of this resource reduces the national stock and the capacity to support ecosystem services, raising questions about the sustainable use and management of soil resource. Natural England has identified the following gaps in our understanding of ecosystem services[71]:

- how best to measure the long-term economic and other impacts of development on our national stock of soils so that these finite resources and their protection can be better quantified, monitored and addressed;
- how to determine the relative value of soils for potential and current ecosystem services and how this could be translated into practical tools for land use planning to support national planning guidance; and
- how best to maintain, develop and deploy existing [analytical] tools in a changing planning and environmental context.

The proposed evaluation methodology set out in these guidelines will help to address these questions.

Hydrology

Soil has an important role in the hydrological cycle. A proportion of precipitation reaching the ground surface will infiltrate the soil and move laterally and vertically through the soil profile; whilst some may flow over the soil surface as run-off. The lateral movement goes downslope to enter streams and rivers, and open water bodies, and the vertical movement percolates into the groundwater within rocks under the soil. This, together with the evaporation and transpiration of water back into the atmosphere, is the terrestrial part of the hydrological cycle before water from rivers and groundwater enters the sea and oceans and then returns to the atmosphere by evaporation.

Development that disturbs and/or displaces soils can have significant effects on soil functions within the hydrological cycle. It can reduce infiltration rates and the water storage capacity of soils and increase surface run-off rates. This can have the effect of increasing erosion risk; downstream flood risk within river catchments and changing water table levels on lower-lying areas and receiving sites. Vulnerable receptors include residents in urban areas and species within habitats sensitive to hydrological changes.

The soil is also a pathway for the transmission of water-borne contamination that may be generated by development with downstream and other water transmission effects. This can be in the form of chemical and particulate contamination arising from increased surface run-off. Examples are the nitrogen and phosphate enrichment and eutrophication of watercourses and an increase in suspended solids like silt. SUDS are a means of using the hydrological function of soils to reduce the effects of urban development on greenfield and brownfield sites. The removal of the soil-water pathway can be an important part of the remediation of contamination present on brownfield sites. Detailed guidance on SUDS design, construction, and operation and maintenance is available from the Construction Industry Research and Information Association (CIRIA) publications C609 ('Sustainable Drainage Systems'), C697 ('The SUDS Manual'), and C698 ('Site Handbook for the Construction of SUDS').

Box 6: Soil Function and Hydrology

71 Natural England (2015) Access to Evidence Information Note EIN012 Summary of Evidence: Soils.

6.3 Soil Biodiversity and Soil Health

6.3.1 Soil Biodiversity

The planning system should seek to protect and enhance soil biodiversity which is an indicator of soil health. EIA practitioners should note that although there is no statutory protection for soil biota, soil is home to a quarter of all living species[72].

A soil biodiversity baseline is unlikely to be easily encompassed within a single framework, or quantifiable. There is a current lack of data and monitoring can be complex. However, some qualitative discussion and small-scale focussed monitoring of soil biota may be practicable within a development project to determine changes and verify the effectiveness of mitigation measures.

Further information on soil health and biodiversity is given in Annex D, which sets out potential approaches to collecting relevant data on soil health and applying this information in EIA. The collection of this information can be integrated into the soil survey methodologies described in Annex C.

6.3.2 Soil Health

Soil health is defined as the ability of a soil to function and provide ecosystem services and it can be separated into inherent and manageable properties. Healthy soils perform multiple functions within the natural environment, as described above. These are threatened by soil sealing and the associated displacement of soil, together with wider-scale compaction, soil erosion, loss of soil carbon and their unsuitable reuse[73]. Land use changes due to development are likely to result in changes to soil health, soil functions and the delivery of ecosystem services that the soil can support.

The 2020 Defra guidance, *'Enabling Natural Capital Approach Guidance',* identifies the beneficial contributions of healthy soils towards the reduction of greenhouse gas emissions, water treatment costs, flood risk, and increased crop yields.

Soil Health and Soil Quality

'Soil health' and 'soil quality' are two distinct concepts. Soil health refers to self-regulation, stability, resilience, and lack of stress symptoms in a soil as part of an ecosystem and it is the integrity of the natural balance between soil organisms and their environment. Whereas soil quality describes the physical attributes of soil, including soil organic matter, nutrient levels, soil structure, etc., which contribute to soil health. These attributes can be influenced by land use and management practices to enhance or diminish soil health.

Box 7: Soil Health and Soil Quality

The UK has a wide range of different soil types, which function in differing ways to support different land uses and habitats, and a nationwide assessment of soil health and soil functions would have to encompass this natural variability. Currently, there is no established process for developers or their consultants to carry out baseline studies for soil health or a single standard against which soil health can be measured. The ALC/LCA systems indicate the capability and potential intensity of agricultural use taking into consideration the location-specific, soil, site and climatic conditions, but they do not provide an indication of soil health. Condition assessments of Sites of Special Scientific Interest (SSSIs) consider whether the habitats and features of these sites are in a healthy state and are being conserved by appropriate management, but these assessments do not specifically assess soil health against a baseline.

72 Natural England Commissioned Report (2012) NECR100 Managing Soil Biota to deliver ecosystem services.

73 Defra (2020) Enabling a Natural Capital Approach: Guidance.

Soil contamination reduces soil health and soil functionality, but soil health in the context of ecosystem services is not currently considered in a contaminated land assessment, though the assessment will take into account the basic characteristics of a soil type (e.g. clay, silty clay, silty clay loam, sandy loam, sand and so on) in order to assess the prospects for remediation. Instead, a contamination assessment will focus on whether exposure to the soil would have a negative impact on the health of site users for a particular land use (such as residential gardens, public open spaces, allotments, or commercial premises), or whether the effects of pollutants in the soil would have a negative effect on the condition/health of other receptors (such as groundwater, surface water, flora and fauna).

Further information on soil health is given in Annex D, which highlights the complexity of determining soil health, based on the natural variability of soil and land uses.

6.4 Natural Capital

Our soils are a natural capital stock or asset that help to provide a 'flow' of ecosystem services that should be maintained into the future. The natural capital approach emphasises the importance of natural assets like soils. It provides a framework, guidance, and tools for appreciating the multiple ecosystem services benefits they deliver and the contribution of these services towards economic activity, social objectives, and human well-being, and ensuring that these are considered in decision-making. This framework can be used to support planning decisions which make the necessary environmental investments to establish long-term resilience, to ensure that future generations can enjoy the full range of benefits from soils that are necessary for their well-being.

The UK planning regime is moving towards a natural capital approach (see Section 4.2 on NPPF) and the Natural Capital Committee (NCC) defines the soil natural asset type as '*the combination of weathered minerals, organic materials, and living organisms and the interactions between these*'.

Defra's '25 Year Environment Plan' (25 YEP) (2018),[74] illustrates clearly that soils are a critical component of natural capital, and the plan defines natural capital as 'the sum of our ecosystems, species, freshwater, land, soils, minerals, our air and our seas. These are all elements of nature that either directly or indirectly bring value to people and the country at large. They do this in many ways but chiefly by providing us with food, clean air and water, wildlife, energy, wood, recreation and protection from hazards'. The plan will use a 'natural capital' approach as a tool to help make better choices and long-term decisions which help support environmental enhancement and deliver benefits such as reduced flood risk, increases in wildlife, and a boost to long-term prosperity, and quality of life.

To safeguard soil and their benefits, we need to understand the current state of soils, their functions and the ecosystem services (i.e., 'benefits') they provide and anticipate how these may be threatened, sustained or enhanced by land use planning and management choices.

The NCC has advised the UK Government that an environmental baseline census of natural capital stocks is an essential foundation for the 25 YEP. The Committee also noted the lack of baseline environmental data against which changes can be assessed for the 25 YEP Indicator Framework, describing the soil as a critical asset, which based on the data available is described as '*deteriorating*'. The NCC attempted to assess soil health baseline nationally based on existing data, but acknowledged that the data was insufficient to produce

74 Defra (2018) A Green Future: Our 25 Year Plan to Improve the Environment https://www.gov.uk/government/publications/25-year-environment-plan

an assessment[75]. Furthermore, the UK Net Zero Strategy[76] highlighted that '*We do not currently have the required data to include these habitats [referring to soils or blue carbon habitats] in the UK GHG Inventory or to accurately quantify their potential contribution to net zero but are doing further work to close these evidence gaps*'.

6.5 Climate Change, Soil Organic Matter and Soil Carbon

The UK has given a commitment to achieve a target of net zero carbon emissions by 2050, with the Net Zero Strategy setting out how the UK will deliver on this commitment[77].

The Net Zero Strategy acknowledges that protecting, restoring, and sustainably managing natural resources including soils, can provide benefits for biodiversity and climate adaptation, as well as for carbon sequestration, including nature-based strategies for Greenhouse Gas Removal (GGR) approaches such as soil carbon sequestration.[78]

Soils are a vitally important part of the carbon cycle because they are a substantial reservoir of terrestrial organic carbon, with plants, fauna (macro, meso and micro) and organic deposits principal components of soil organic carbon. One of the key ecosystem services provided by soils is their regulation of CO_2 in the atmosphere, thorough the storage and recycling of organic matter. Soils are also important for their regulation of other greenhouse gas emissions, including nitrous oxide and methane.

The balance between soil carbon sequestration and greenhouse gas emissions can be disturbed by the damage to soil properties, health and functions, caused by development. Within the UK, it is important to retain (as well as sequester) carbon in peats and other carbon-rich soils.

6.5.1 Climate Change

Changes to weather patterns associated with climate change will have different effects across the UK. Overall, there will be an increase in extreme events, shifts in temperature and variations in rainfall. This could directly affect many soil properties including drainage, soil moisture content, nutrient cycling rates, carbon sequestration and emission rates, and changes in soil leaching, erosion, and run-off. It could also affect soil biodiversity and stability through clay shrinking. There will also be indirect effects due to land use changes, together with socio-economic consequences.[79]

Initial thoughts on potential climate change and climate-related development impacts, and measures to enhance climate change resilience are set out in Table 1: Climate Change Impacts on Soils and Resilience Measures (The Main Issues). The table sets out measures that could be considered, as a scheme design evolves during the EIA process, to achieve sustainable development. The measures can be adjusted for local circumstances.

75 Natural Capital Committee (2020) Final Response to the 25 Year Environment Plan Progress Report.

76 BEIS (2021) Net Zero Strategy https://www.gov.uk/government/publications/net-zero-strategy

77 BEIS (2021) Net Zero Strategy https://www.gov.uk/government/publications/net-zero-strategy

78 BEIS (2021) Net Zero Strategy https://www.gov.uk/government/publications/net-zero-strategy

79 IEMA (2020) IEMA EIA Guide to: Climate Change Resilience and Adaptation.

Table 1: Climate Change Impacts on Soils and Resilience Measures (The Main Issues)

Potential development Impacts on resources/receptors	Potential independent climate change impacts on resources/receptors	Measures required to enhance the climate change resilience of land and soil significantly affected by development
Soil Disturbance Soils temporarily and permanently displaced by the construction of the scheme and potential compaction and damage to soil structure during stripping, storage, and the reinstatement of soil profiles	For natural and undisturbed agricultural soils, drier conditions could affect their quality and capability, with currently droughty soils being downgraded but wet soils potentially upgraded (with respect to ALC/LCA)*. For restored soils, these effects could be exacerbated by compaction and damage to soil structures during soil handling. Wetter conditions could increase the area of lower quality and marginal land on reinstatement, where the soils have heavier textures. Seasonality changes to rainfall/ temperature could also be important.	This is generally addressed by good practice in soil handling guidelines, but potentially droughty soils could be reinstated to greater thicknesses to increase the volume of moisture retention. The creation of well-drained landforms with shallow gradients in reinstated areas is an option; together with the installation of field drains, as necessary, and possibly extending the 5-year aftercare period following land restoration.
Loss of agricultural soils	More extreme weather events (e.g. localised high-intensity rainfall), particularly on moderately steep to steep gradients, and where the soils have heavier textures with deep cracking. Dry topsoils exposed to more-frequent high winds by ploughing and cultivation. Increased loss of soils because of flooding.	The creation of suitable well-drained landforms with shallow gradients in reinstated areas is an option, together with the installation of field drains, as necessary. Controlled by dry farming techniques, e.g., minimum cultivation.
Loss of woodland	Loss of trees because of drought, and consequent exposure of soils to surface water erosion.	Plant drought-resistant species with suitable provenances.
	Longer growing season could benefit tree growth.	Plant species suited to warmer and drier conditions.
	Increased risk of tree loss due to greater frequency of storms/high winds, and consequent exposure of soils to surface water erosion.	Reinstating land for woodland with suitable soils which facilitate deep rooting. Plant deeper-rooting species resistant to storms and windy conditions.

Potential development Impacts on resources/receptors	Potential independent climate change impacts on resources/receptors	Measures required to enhance the climate change resilience of land and soil significantly affected by development
Disruption to reinstated drainage/ water supply systems	Damage to drainage/water supply systems where the soils have heavier textures with deep cracking.	Adjust design of drainage/ water supply systems e.g., support drains within a trench of flexible permeable fill. Installation of SUDS within and adjacent to developments.
	Increased need to drain lower-lying areas of land within receiving sites during wetter winters and during periods of intense heavy rainfall. Failure of drainage system could lead to the flooding of agricultural land.	Consider installation of a network of drains with greater capacity and avoiding potential increased rapid discharge downstream leading to greater flood risk.
Loss of woodland soils	Loss of woodland biodiversity because of drought, and consequent exposure of soils to surface water erosion.	Reinstating land for woodland with suitable soils. Plant suitable tree species, according to location (i.e., micro-climate, topography, and soil type).
Spread of invasive species and injurious weeds following translocation of soils	The potential spread of invasive species and injurious weeds along linear transport and energy infrastructure could be exacerbated by climate change.	
Run-off	Increased run-off in winter due to wetter conditions. Also, in summer with intense localised rainfall events with potential rapid penetration of soils through deep cracks in heavy soils.	Consider capacity of drainage system to be installed on reinstated land. Installation of SUDS within and adjacent to developments.
	Could see reduced run-off and infiltration rates during drought conditions.	No additional measures identified.
Loss of peatland	It is uncertain how climate change will impact peatlands, but restoration of degraded (e.g., drained or eroding) peatlands could be designed to increase their resilience to drought, wildfire and other effects of climate change.	Peatland restoration.

Further commentary is available from '*London-West Midlands Environmental Statement, Volume 5 Technical Appendices, Preliminary Consideration of Potential Climate Change Impacts, CT-009-000*', on the HS2 website.
*The CSCP outputs detail these impacts for Wales for suitability and capability (https://gov.wales/soils-policy-evidence-programme)

6.5.2 Soil Organic Matter and Soil Carbon

Soil carbon is a proportion of soil organic matter, and it is the carbon component of soil organic matter that is of primary interest in respect of the relationship between soils and climate change.

For most soil types, the higher concentration of soil organic carbon will be found in the topsoil, and there can be significant difference in total soil organic carbon between different soil types, under different land uses and under differing land management.

Organic (peat) soils are deemed important as carbon storing habitats, with organo-mineral soils important as a shallow store of soil carbon. However, it is not just topsoil which can contain organic carbon, global research indicates that podzols are second only to peats in their ability to store carbon, due to their capacity to lock carbon up in the subsoil as part of the podsolisation process.

Increasing soil carbon is considered by the NCC to be the primary key metric to target in the process of improving soils. Accordingly, the NCC has identified the possibility of undertaking an England-wide measurement of soil carbon. The Scottish and Welsh Governments are using soil carbon as ecosystem health and well-being indicators, respectively.[80,81] However, it should be noted that there is no standard approach for calculating the soil component of carbon balance for a proposed development.

Soils have an important role to play in climate change mitigation, because they are a large reservoir of organic carbon and the potential conversion of this to CO_2 when soils are disturbed by construction activities has significant implications for climate change. Whilst CO_2 is not the only greenhouse gas (GHG) relevant to soils and soil health, soil carbon is an important component of methodologies for the assessment of GHG emissions arising from a development project.

The British Society of Soil Science (BSSS) has published a Soil Carbon Science Note, which sets out opportunities to improve soil health and assist with efforts to mitigate and adapt to climate change through increasing soil organic carbon levels.[82]

The design of soil handling operations should seek to avoid significant avoidable losses of carbon from soils to the atmosphere during construction. For example, alternative soil handling methods should be considered to reduce the distances over which soils are transported to reduce fuel consumption; topsoil and subsoil stockpiles should be seeded with grass to reduce potential CO_2 emissions arising from the increased oxidation of exposed organic carbon. Peat soils are particularly important with regards to their carbon storage potential and role in mitigating climate change, as described in detail within Lindsay (2010).[83]

Peat has a biodiversity value, and many peatland areas are protected by legislation (e.g., the Habitats Directive and the Water Framework Directive) and by planning designations. The protection of peatland is particularly strong in Scotland, possibly reflecting the greater proportion of land with peat and peaty soils subject to development pressures. In some places, peats have been subject to agricultural improvements (e.g., drainage) to become high-quality agricultural land.

80 Welsh Government (2019) Wellbeing of Wales: national indicators.

81 Scottish Government (2019) Scotland's Wellbeing – Delivering the National Outcomes

82 BSSS (2021) Science Note on Soil Carbon https://soils.org.uk/wp-content/uploads/2021/11/Long_BSSS_Science-Note_FOR-DIGITAL.pdf

83 Lindsay (2010) Peatbogs and Carbon: A Critical Synthesis

6.5.3 Handling Peat and Peaty Soils

Where peat disturbance by construction activities cannot be avoided, special measures are required for their handling. As with mineral soils, where peats and peaty soils are disturbed by development, they must also be conserved by stripping and storing for subsequent reinstatement and beneficial use following construction, but by applying special techniques.

Where the disturbance of peat cannot be avoided, SEPA has set out good practice guidance on the handling of peat for upland blanket peats, which might also be applicable for lowland peats.[84] Construction contractors should be required to demonstrate competence in the handling of peat and peaty soils, excavated from both wet and dry locations, and when handling peat and peaty soils they should follow the specific guidance on handling set out in Annex E.

It should be noted that peat soils do not function as a platform for building without substantial geoengineering works, which can result in detrimental environmental impacts and loss of peat function.

84 SEPA (2011) Restoration Techniques Using Peat Spoil from Construction Works

7 Introduction to a Soil Functions Approach

In addressing a 'soil functions approach', this section first provides as context a summary of the soil topic within EIA. This includes the importance of soil type, typical land use changes and development impacts, and discussion of the changes needed to ES/EIA report chapters.

The cross-cutting nature of the soil topic within the EIA process requires a multidisciplinary approach, and effective cooperation between environmental disciplines in the evolution of the design of schemes from an early stage in an EIA. This should be done with reference to the baseline soil data commissioned for the EIA and follow the initial identification of potential impacts by soil practitioners. Collection of site-specific baseline data should begin at an early stage in the EIA process and be developed as needed as the EIA progresses. The consideration of topic interactions needs to be maintained throughout the EIA to ensure that mitigation measures are effectively framed and implemented. A comprehensive approach to the soil topic in EIA will require a new way of looking at land use changes, impacts and mitigation.

The proposed EIA evaluation methodology for assessing development effects on land and soil is soil functions-based, and it recognises the cross-cutting nature of the soil topic.[85]

7.1 The Importance of Soil Types

The nature of soil types present within a development site will have a strong influence on their soil functions. The direct and indirect impacts of development on these functions will determine the options available for the delivery of ecosystem services with their maintenance on restoration if displaced. Understanding the initial distribution and condition of soil types on-site prior to development is the key to avoiding and mitigating the impacts of development. For example, and in respect of the ecology function, Annex F shows how ecologically valuable habitats and ground cover have naturally developed in a range of soil parent materials in certain topographic and hydrological situations.

The reuse of available soils to replicate these combinations of soil types, topographic locations and ground cover will optimise prospects for the successful establishment of ground cover for landscaping and habitat creation and transfer, with significant implications for net biodiversity gain (see Box 8 and Box 9). This is matching soil types with the suitable reuse of soils for the maintenance and enhancement of soil functions and ecosystem services.

Biodiversity Net Gain

Biodiversity Net Gain has been introduced into the planning system through the NPPF, with the Environment Act 2021 formalising this element. From 2023, developers in England will be required to provide a 10% biodiversity (and associated environmental) net gain in respect of a new development that results in habitat loss or degradation. To secure a planning consent, developers will need to submit a biodiversity net gain plan to the local planning authority for approval. The local planning authority can only approve the Plan if the 'biodiversity value' attributable to the development is greater than the 'pre-development biodiversity value' of any on-site habitats by at least 10%, using the 'Biodiversity Metric 3.0'[86].

On-site or local gains are encouraged by the metric, but if no local sites are available developers can contribute towards nationally strategic habitats and wider Environmental Improvement Plans (EIPs) on a landscape scale through 'statutory biodiversity units', with the 25-Year Environment Plan becoming the first EIP and will be reviewed by January 2023 (see also Box 9: Mechanisms to Enhance the Reuse of Soil).

Box 8: Soil as a Pathway for Biodiversity Net Gain

85 A worked example is set out in Section 9.3

86 Natural England (2021) Biodiversity Metric 3 http://nepubprod.appspot.com/publication/6049804846366720

Biodiversity Net Gain (BNG)

The measurement of BNG is technically complex and evolving; however, there are opportunities within EIA to consider the reuse of available soils within a site to optimise prospects for the successful establishment of the required ground cover for landscape planting and habitat creation and transfer, with significant implications for net environmental and biodiversity gain.

Off-site contributions towards nationally strategic habitats and wider Environmental Improvement Plans could include the off-site use of surplus soils where the soil types are suitable for the establishment of ground conditions that will support net environmental and biodiversity gain. Impacts on soil biodiversity should be considered in assessing the effects of development in terms of soil health.

Biodiversity Opportunity Areas (BOAs) and the Nature Recovery Network (NRN)

Action to enhance biodiversity is focusing on BOAs and the conservation priorities for biodiversity within each area. This is to ensure that habitat enhancement, restoration and recreation projects make the most of opportunities to establish more extensive areas and networks of wildlife habitats. Other BOA objectives are to improve habitat management and enhance connectivity for the recovery of Priority Species in a fragmented landscape.

The NRN is a major commitment in the 25 YEP. It will be a national network of wildlife-rich places, both designated and undesignated. The aim is to expand, improve and connect these places within corridors across urban areas and countryside to address biodiversity loss. Wider objectives are to improve public amenity and resilience to climate change on a landscape scale, providing natural solutions to reduce carbon and manage flood risk, and sustaining vital ecosystems such as improved soil, clean water, and air. The importance of soils in achieving the objectives BOAs and the NRN highlights the need to provide detailed survey information on soil types; the soil volumes within a development site; and the potential reuse of soils.

Box 9: Mechanisms to Enhance the Reuse of Soil

7.2 Land Use Change

Land use changes can be described as 'hard' or 'soft' development, depending on the degree to which soils are displaced and whether they can be retained for beneficial uses on-site.

This is where it is necessary to apply the distinction more fully between 'land' and 'soil' at construction sites. Whereas land can be lost (i.e., land use change), the soils displaced both temporarily and permanently must be conserved and reinstated to achieve sustainable development. Good practice for the restoration of surface mineral working sites and landfills is documented in government guidance[87]; however, the same level of detailed soil planning is not commonly applied to soils temporarily or permanently displaced by other types of development. Where soils are permanently displaced by hard development, a beneficial use should be found for these soils (preferably within a site) and where such soils are reused for soft development, the soils must be able to support the proposed soft use (i.e., the sustainable use of soil resources).

Linear developments for transport and energy infrastructure can cause impacts on soil resources that are more difficult to resolve than ring-fenced developments (e.g., for residential and mixed-use developments, and for mineral extraction). These difficulties include too much land being stripped at one time, and insufficient storage space within red lines that are too tightly drawn, resulting in surplus soil being taken off-site and not reused sustainably.

It is because of evolving environmental perspectives and regulations that soft development now includes such a wide range of potential sustainable land uses. Where land use change and soil disturbance are unavoidable, mitigation options for the reinstatement of soils within a development site now include the creation of Green Infrastructure (GI), that includes SANGS (Suitable Alternative Natural Green Spaces), wildlife habitats and community woodlands etc. In addition, SUDS can be created to offset the increased amount of sealed land surface which would otherwise increase the risk of surface flooding. This is an important point because the greater range of soft development introduces more options for the beneficial use of displaced soils, when the disturbance of soil is unavoidable. While planning conditions regularly include detailed planting specifications and requirements for SANGS etc., it is rarely recognised that the success of these schemes is highly dependent on matching the available soil type to an appropriate land use (as described above) and maintaining the appropriate condition of that soil, through good soil management.

Remediation of contaminated soil is usually carried out to make land suitable for a new intended use; however, restoration of otherwise degraded (but not contaminated) natural soil (such as drained peatland or fenland) may require a land use or management change in order for the scheme to be successful (e.g., to limit access to an area to the restoration management team only). In some instances, soil restoration will be possible within a development red line boundary; however, off-site restoration schemes are also becoming more common as compensatory measures.

In addition, temporary development on agricultural land and soils (e.g., solar developments), which may be in operation more than 40 years, presents a risk of damage to soils not only during construction but also at decommissioning.

7.3 Development Impacts

Land and soils are perhaps amongst the most direct environmental receptors of development impacts, given that we set out with the intention of taking land and changing land uses, rather than avoiding these natural resources. Land-take and the consequent displacement of soils by development are the primary impacts, particularly in the change from agriculture to urban uses.

87 Natural England (2021) Guidance: Planning and aftercare advice for reclaiming land to agricultural use

Although in some cases other types of land use change occur, perhaps in association with urban development, where soils are not necessarily displaced, such as tree planting for landscaping, and the creation of wildlife habitats on agricultural land. Urban and brownfield soil and soil-forming resources also need to be considered for their existing and potential biodiversity, including soil biodiversity benefits.

Whilst it is not possible to entirely mitigate the loss of agricultural land to a development, it is possible to mitigate the displacement of soils. Land with natural soils may be lost to hard development, but for sustainable development the soils displaced (both permanently and temporarily) must be conserved for beneficial use. This is an important difference in the consideration of land and soils within EIA.

8 Screening, Scoping and Baseline Conditions

8.1 Soil Survey

Land and soil information required for EIA baseline studies is obtained from available sources and by carrying out soil surveys. Where a significant impact on land or soils is anticipated, detailed ALC/LCA and soil surveys should be carried out as part of the EIA baseline studies (within Wales, a soil resources and physical characteristics report is also requested to accompany the ALC for all minerals' EIAs). These surveys will inform the agricultural land quality based on the soil, site and climatic conditions. These surveys can be supplemented to provide a statement of site physical characteristics that inform site-specific management plans relating to soil and associated waste materials (i.e., SRPs, Soil Management Plans (SMPs), Land Management Plans (LMPs), and Site Waste Management Plans (SWMPs)). The SRPs identify the volumes and different types of topsoil and subsoil that will be impacted by development, and which should be conserved for beneficial uses.

The UK sources of baseline information are set out in Annex B, and the soil survey methodologies for all soil functions (including ALC/LCA for biomass, ecology, landscape design and hydrology etc) are set out in Annex C. Table 1 in Annex D (Soil Health) can also be used at scoping to help identify where development effects on soil health are likely to occur. These methodologies can (with modifications) be applied in England, Wales, Northern Ireland, and Scotland.

Relevant guidance indicates that ALC/LCA surveys should be carried out for baseline studies, and that soil survey should be carried out (usually at the same time) to provide the information necessary to assess the effects of development on all soil functions. However, at present, where ALC/LCA survey information determines that soils are not associated with higher-quality agricultural land, there is often an incomplete consideration of the effects of a development on displaced or impacted soil resources and soil functions. To achieve wider environmental objectives, therefore, baseline data on soil properties (included in Annex C) additional to those recorded by ALC/LCA surveys should be acquired to determine the potential impacts of development on soil functions. This will allow any significant changes to be related to soil health, ecosystem services, and natural capital.

The collection of soil data should allow the magnitude of potential impacts relating to the site-specific temporary or permanent displacement of soils to be qualitatively and, to some extent, quantitatively assessed.

Many projects also generate other effects such as airborne or water emissions, physical pressures on land surfaces from recreation, or geomorphological effects like erosion, which have on-site and off-site consequences for the physical and chemical status of soils. By improving our understanding of off-site baseline conditions (where appropriate) it will be possible to identify the wider cumulative effects of development.

The types of surveys required to support an EIA will depend on circumstances at the site and surrounding land, and in many instances more than one survey type will have to be carried out by specialist consultants or contractors (see Box 2).

8.2 Soil Skills and Competencies

The shortage of soil specialists with the necessary skills and experience to carry out ALC/LCA and soil surveys to an acceptable standard can lead to soil inputs to EIAs of variable quality. Non-specialists may attempt to rely on published reconnaissance-level data and inadequate surveys when detailed site-specific ALC/LCA and soil surveys are required. This can become evident when the validation of soil inputs, especially agricultural land quality assessments, has been required by statutory agencies. This has led to the rejection of reports and requests from agencies for compliant surveys to be carried out by competent practitioners. The BSSS has published advice on how to assess an ALC report; written predominantly for development planning and control professionals.[88] Annex C sets out the required soil survey methodologies. In Wales, the Land Quality Advice Service (LQAS) provides a free validation service of ALC reports to LPAs and developers.[89]

The lack of soil specialists with the necessary skills and experience to carry out ALC/LCA and soil surveys to an acceptable standard is a serious skills gap. Many environmental consultancies and EIA teams do not permanently employ a soil specialist; therefore, it is necessary to indicate when such a specialist should be engaged during the EIA process. The BSSS provides '*Working with Soil'* training, which includes describing a soil profile and ALC modules; and has a website which lists qualified soil practitioners,[90] some with expertise in land use planning relevant to EIA.

ALC/LCA, soil resource and soil functions/soil health surveys, on-site supervision of soil handling operations and the monitoring of soil conditions should be carried out by suitably qualified and experienced soil scientists or environmental scientists in closely related disciplines with the necessary training. Other suitably qualified soil practitioners have studied soil and land management modules at universities and colleges, and other environmental practitioners within EIA teams may have acquired sufficient expertise during professional practice to use soil information provided by these qualified soil and environmental scientists. The BSSS[91] sets out the recognised professional soil competencies, which sets out the minimum qualifications, skills, and knowledge, which the BSSS considers necessary for scientists and engineers working on various aspects of soil science.

8.3 Screening, Scoping and Chapter Structure

8.3.1 Screening

Effective screening by LPAs, regulatory agencies and other practitioners depends on the identification of potential significant impacts on high-value soil functions. With reference to Figure 2: EIA Scoping and Proportionality, desk-based baseline studies on air, water, and land quality (including soil and ALC / LCA surveys) and contaminated land assessments, together with selective initial reconnaissance site surveys are carried out at increasing levels of detail in the transition from Strategic Environmental Assessment (SEA) through Sustainability Appraisal to EIA. The results of these investigations are combined with published information to determine the sensitivity of the local environment in relation to the nature of the proposed development, to screen for the need to carry out an EIA, and to determine the scope.

As previously described, some high-value soils or scarce soils are specifically recognised in UK planning policy, including BMV agricultural land in England and Wales, statutory designated sites, peat and other carbon-rich soils, and prime quality agricultural land in Scotland. However, considering ongoing biodiversity loss, the need for climate change resilience and food security, there is increasing appreciation of soil as a natural capital asset that provides these important ecosystem services. Therefore, potential for significant development effects on the function of *all other soils should be covered in EIA.*

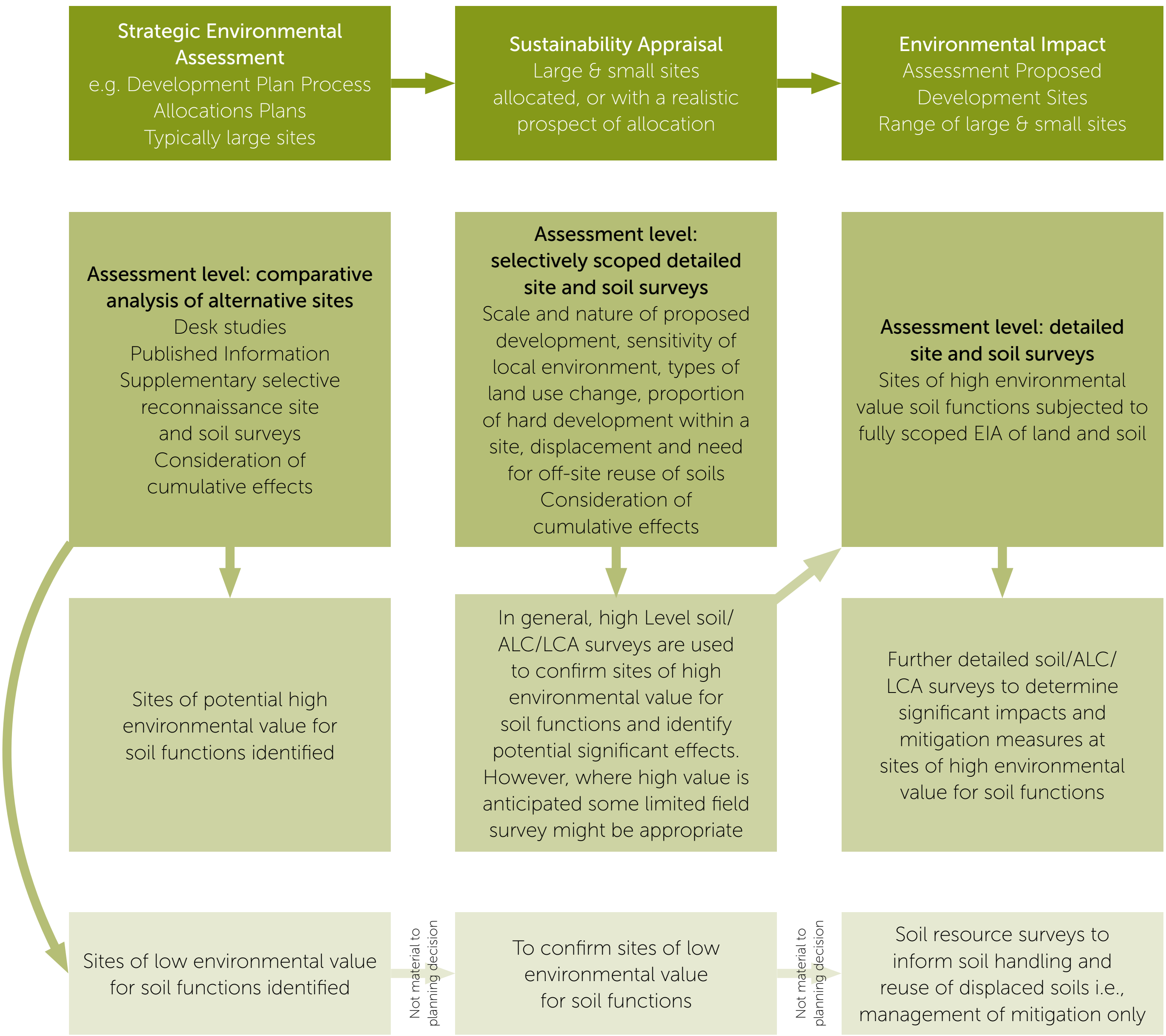
88 BSSS (2022) Working with Soil Guidance Note on Assessing Agricultural Land Classification Surveys in England and Wales https://soils.org.uk/wp-content/uploads/2022/01/Assessing-Agricultural-Land-Jan-2022.pdf

89 Welsh Government (2016) ALC Reports https://gov.wales/sites/default/files/publications/2018-11/agricultural-land-classification-reports.pdf Agricultural land classification: predictive map guidance (gov.wales).

90 https://www.soils.org.uk/find-an-expert

91 BSSS (2018) Working with Soil – Professional Competency in Soil Science https://soils.org.uk/wp-content/uploads/2021/01/WWS-Complete-Competencies.pdf

Figure 2: EIA Scoping and Proportionality



In the first instance, developers should be following the mitigation hierarchy (see Section 2.2), avoiding negative effects on soil through development location and design, particularly the high-value soils (however defined). However, if this is not possible then early consideration should be given to identifying what potential the development has to result in significant soil loss or damage. Where significant negative effects may occur, early consideration can then be given to avoiding these, mitigating them through prevention and reduction of impacts within the development, or, if necessary, through providing off-site compensation.

Potential for positive effects on existing degraded soils should also be considered from screening onwards. This includes soils affected by pollution or waste disposal, which can potentially be improved by remediation during a development. For large developments there may be opportunities for remediation involving soil restoration to be integrated into the design. There are also losses of soil function arising from intensive agriculture and commercial forestry that have caused soil compaction, loss of soil carbon, erosion, loss of soil biodiversity (which in turn affects soil health), and changes to hydrological cycling and nutrient balance. Soil functions can be improved and there are examples of successful peatland and fenland restoration and more experimental ongoing projects such as the Knepp Wildland rewilding project[92]. These examples can inform mitigation and compensation decisions on development projects (see Box 8 and Box 9.).

8.3.2 Scoping

Scoping is informed by the aims of the planning system with regard to land and soils. The 25 YEP[93] (applicable only in part to the whole of the UK) has set out the following aims in relation to soil:

- protect the best agricultural land;
- put a value on soils as part of our natural capital;
- manage soils in a sustainable way by 2030; and
- restore and protect peatland.

Assessing the impacts of development on all soil functions, and the cumulative effects of land losses at the local and national levels should be considered at the scoping stage. This will depend on the scale and nature of a proposed development and the sensitivity of the local environment at a development site.

To cover the loss of soil resources and soil functions, further elaboration of DMRB LA109 (Tables 3.11 and 3.12) can consider 'Sensitivity', 'Magnitude' and 'Significance' values and thresholds for soil volumes and soil functions lost, to provide a more complete evaluation methodology. In this process, more emphasis should be placed on types of land use changes, proportion of hard development within a site, displacement of soil and need for on – and off-site reuse of soils.

In terms of proportionality, site-specific work would be carried out when:

- sites have a realistic prospect of being allocated for development according to the development plan process and in the judgement of developers; and
- initial studies at the higher level indicate that the environmental value of the land from an all soil function perspective (i.e., not just land quality in terms of ALC or LCA) will trigger more-detailed site-specific surveys at the Sustainability Appraisal and EIA levels.

Figure 2: EIA Scoping and Proportionality illustrates in a generalised way the stages at which assessments are carried out, the appropriate level of detail at each stage and where the environmental value of soil functions is likely to have a material influence on planning decisions.

Following this proportionate approach, where sites of high environmental value soil functions have been identified as being likely impacted by a development, the EIA Scoping Report should clearly set out the proposed methodology for the consideration of land and soils and should reference the use of these IEMA Land and Soil Guidelines[94]. Prior to submitting the scoping request to the LPA to agree the scope of the land and soils assessment, discussion will also be required between the

92 Knepp: Soil Restoration https://knepp.co.uk/soil-restoration

93 Defra (2018) A Green Future: Our 25 Year Plan to Improve the Environment https://www.gov.uk/government/publications/25-year-environment-plan

94 Stapleton, C., Reed, E., Gemmell, L., Adams, K. (eds) (2022) IEMA Guide: A New Perspective on Land and Soil in Environmental Impact Assessment.

competent expert for land and soils, other topic leads and the EIA Coordinator on the overarching ES chapter structure and the treatment of the interaction of effects across different environmental factors.

8.3.3 Chapter Structure

Within EIA reports, chapter headings and content can be tailored to improve the assessment of effects on land and soil. The current focus on agricultural land and soils in EIAs is often reported on in an ES section or chapter, setting out the areas of ALC grades/subgrades and LCA classes of land taken by the proposed development, possibly with soil handling proposals for the conservation and reinstatement of displaced soils. Protecting our BMV/ prime quality agricultural land remains an important planning consideration. However, the broadening of focus within the planning system from agricultural land and biomass production to a wider range of land uses and soil functions should be reflected in a generic ES section or chapter entitled 'Land and Soils'. This would help in understanding the full environmental significance of land-take, soil disturbance, changes of land use (in terms of mixes of hard and soft land uses, including temporary uses), and effects on soil functions.

This ES chapter could also set out the proposed areas of agricultural land (in hectares) transferred to different types of hard and soft development within a scheme, together with an account of what is proposed to be done with the soils displaced both permanently and temporarily. In this way, opportunities for the use of permanently displaced soils to establish ground cover on brownfield land intentionally included within a study area, for example, could be more clearly presented and understood as a sustainability benefit of a proposed development.

In respect of impacts on farming, land-take might also be accompanied by a consequential restructuring of ownership, tenure, and changes to agricultural infrastructure. These are the social and economic dimensions of impacts on agriculture, and the important considerations are:

- land use changes;
- the proportion of a holding affected by land-take;
- the effect on land management; access to land severed (particularly by linear infrastructure development); and
- the loss of farm buildings and infrastructure.

Depending on the structure of the ES, these impacts, if present, could be reported in an ES chapter entitled 'Land and Soils', alternatively these matters may be appropriately addressed in existing ES chapters on social and economic impacts.

Evolving environmental perspectives have introduced the need to assess new types of development impacts on soil functions, including indirect impacts on other receptors through soil pathways. Annex G provides an insight into soils as a receptor and pathway for air pollution; a focus of the Environment Act.

9 Assessing Impacts on Land and Soil

9.1 Considering the Sensitivity of Receptor and Magnitude of Effect

Existing sources of guidance do not provide a complete evaluation methodology for the assessment of impacts on land and soil. In addition to the current methodologies focussed on assessing the significance of developments on the biomass soil function, this guidance extends the assessment to consider the effects of development on all soil functions. Where appropriate, the proposed methodology incorporates current evaluation methodologies.

According to the DMRB guidance (see Box 3) the relevant questions are whether:

- the project is likely to affect the function or quality of soil as a resource; and
- the project is likely to affect agricultural land classified as BMV or prime quality land;

The second question is already largely covered by the DMRB and ICE guidance, but the first question can be more fully addressed by supplementing the existing guidance within a wider soil function-based methodology. Tables 3.11 and 3.12 in DMRB LA109 can be supplemented and used with Tables 3.7 and 3.8.1 in LA104, and ICE Table 7.2 to support such a methodology. The process is set out in Tables 2 to 6.

The sensitivity of soil functions to development impacts following mitigation is determined with reference to effects of proposed land uses, as determined by changes in soil properties including:

Physical Properties
Soil depth, texture, structure, porosity, drainage, infiltration, water retention, storage capacity, stone content and hydraulic conductivity etc

Chemical Properties
Soil organic matter, stored carbon, nutrient, and pH levels

Biological Properties
Soil biota diversity and population.

The gradation of sensitivities from very high to negligible is not necessarily one of discrete categories for all of the soil functions, and it is not possible to anticipate all possible permutations of soil resources and soil functions in Table 2. Therefore, this process involves an element of professional judgement.

Within the UK nations, different circumstances and priorities may be recognised and have a bearing on the criteria set out in Table 2. For example, in Wales, the Predictive ALC maps indicate a small proportion of BMV agricultural land nationwide, and because of this the policy guidance requires Grades 1, 2 and Subgrade 3a to be considered a receptor of 'Very High Sensitivity'.

Table 2: Guidance on Proposed Receptor Sensitivity and Typical Soil Resource/Functions Descriptions (Developed from Table 3.11 in DMRB LA109)

Receptor Sensitivity (in-situ soils)	Soil Resource and Soil Functions
Very High	**Biomass production:** ALC Grades 1 & 2 or LCA Classes 1 & 2 (for Wales all BMV (Grade 1, 2 and 3a) is considered Very High*) **Ecological habitat, soil biodiversity and platform for landscape**: Soils supporting protected features within a European site (e.g., SAC, SPA, Ramsar); Peat soils; Soils supporting a National Park, or Ancient Woodland **Soil carbon:** Peat soils Soils with potential for ecological/landscape restoration **Soil hydrology:** Very important catchment pathway** for water flows and flood risk management **Archaeology, Cultural heritage, Community benefits and Geodiversity:** SAMs and adjacent areas; World Heritage and European designated sites; Soils with known archaeological interest; Soils supporting community/recreational/educational access to land covered by National Park designation **Source of materials**: Important surface mineral reserves that would be sterilised (i.e., without future access)
High	**Biomass production:** ALC Grade 3a (for Wales all BMV is considered as Very high*), or LCA Grade 3.1. **Ecological habitat, soil biodiversity and platform for landscape:** Soils supporting protected features within a UK designated site (e.g., UNESCO Geoparks, SSSI or AONB, Special Landscape Area, and Geological Conservation Review sites); Native Forest and woodland soils; Unaltered soils supporting semi-natural vegetation (including UKBAP Priority habitats or Section 6 habitats in Wales) **Soil carbon:** Organo-mineral soils (e.g., peaty soils) **Soil hydrology:** Important catchment pathway** for water flows and flood risk management **Archaeology, Cultural heritage, Community benefits and Geodiversity:** Soils with probable but as yet unproven (prior to being revealed by construction) archaeological interest; Historic parks and gardens; RIGS; Soils supporting community/recreational/educational access to RIGS and AONBs **Source of materials:** Surface mineral reserves that would be sterilised (i.e. without future access)
Medium	**Biomass production:** ALC Grade 3b or LCA Grade 3.2 **Ecological habitat, soil biodiversity and platform for landscape:** Soils supporting protected or valued features within non-statutory designated sites (e.g. Local Nature Reserves (LNR), Local Geological Sites (LGSs), Sites of Nature Conservation Importance (SNCIs), Special Landscape Areas; Non-Native Forest and woodland soils **Soil carbon:** Mineral soils **Soil hydrology:** Important minor catchment pathway** for water flows and flood risk management **Archaeology, Cultural heritage, Community benefits and Geodiversity:** Soils with possible but as yet unproven (prior to being revealed by construction) archaeological interest; Soils supporting community/recreational/educational access to land **Source of materials:** surface mineral reserves that would remain accessible for extraction

Low	**Biomass production:** ALC Grades 4 & 5 or LCA Grades 4.1 to 7 or Urban soils **Ecological habitat, soil biodiversity and platform for landscape:** Soils supporting valued features within non-designated notable or priority habitats/landscapes. Agricultural soils **Soil carbon:** Mineral soils **Soil hydrology:** Pathway** for local water flows and flood risk management **Archaeology, Cultural heritage, Community benefits and Geodiversity:** Soils supporting no notable cultural heritage, geodiversity nor community benefits; Soils supporting limited community/recreational/ educational access to land **Source of materials:** Surface mineral reserves that would remain accessible for extraction
Negligible	As for low sensitivity, but with only indirect, tenuous, and unproven links between sources of impact and soil functions
All BMV in Wales is considered 'Very High' sensitivity due to the PPW wording '...significant weight to protect [BMV] from development*'. Only if a development can demonstrate 'overriding need' would BMV grades need to be considered for the sequential test. **As defined by the site and catchment characteristics according to the professional judgement of a catchment hydrologist	

Guidance on identifying the magnitude of impacts following mitigation is set out in Table 3.

Table 3: Guidance on Identifying Magnitude of Impact on Soil Resource and Soil Function (Developed from Table 3.12 in DMRB LA109)

Magnitude of Impact (Change)	Description of Impacts Restricting Proposed Land Use
soil functions or soil volumes	Permanent, irreversible loss of one or more soil functions or soil volumes (including permanent sealing or land quality downgrading), over an area of more than 20ha or loss of soil-related features set out in Table 2 above, as advised by other topic specialists in EIA team (including effects from 'temporary developments'*) or Potential for permanent improvement in one or more soil functions or soil volumes due to remediation or restoration over an area of more than 20ha, or gain in soil-related features set out in Table 2 above, as advised by other topic specialists in EIA team (including effects from 'temporary developments'*)
Moderate	Permanent, irreversible loss of one or more soil functions or soil volumes, over an area of between 5 and 20ha or loss of soil-related features set out in Table 2 above, as advised by other topic specialists in EIA team (including effects from 'Temporary Developments'*) or Potential for improvement in one or more soil functions or soil volumes due to remediation or restoration over an area of between 5 and 20ha, or gain in soil-related features set out in Table 2 above, as advised by other topic specialists in EIA team
Minor	Permanent, irreversible loss over less than 5ha or a temporary, reversible loss of one or more soil functions or soil volumes), or temporary, reversible loss of soil-related features set out in Table 2 above, as advised by other topic specialists in EIA team or Potential for permanent improvement in one or more soil functions or soil volumes due to remediation or restoration over an area of less than 5ha or a temporary improvement in one or more soil functions due to remediation or restoration or off-site improvement, or temporary gain in soil-related features set out in Table 2 above, as advised by other topic specialists in EIA team

Magnitude of Impact (Change)	Description of Impacts Restricting Proposed Land Use
Negligible	No discernible loss or reduction or improvement of soil functions or soil volumes that restrict current or proposed land use

* Temporary developments can result in a permanent impact if resulting disturbance or land use change causes permanent damage to soils

Table 3 has been supplemented by adapting the ICE EIA Handbook, paragraph 7.11.4, on magnitude which states that the permanent loss, or reduction in quality, of more than 20ha of agricultural land due to development is of very high magnitude, 5 to 20ha is of high magnitude, and low magnitude is for the permanent loss of less than 5ha of agricultural land. The derivation of these definitions is related to previous guidance in England and Wales that referred to 20ha as a single magnitude threshold. Currently in Wales 20ha or more is considered a nationally significant loss, with less than 20ha usually considered a local matter for the LPA to consider on a case-by-case basis.

Having determined the sensitivity of land and soil to development impacts in the wider environmental context in Table 2, it is also recognised that some soils are more sensitive to damage when handled during construction than others. This impact occurs during the implementation of mitigation and Table 4 provides a summary of broad soil types and their sensitivity to structural damage, as set out in the ICE guidance.

Table 4: Sensitivity of Soil Receptors (Table 7.2 Reproduced from the ICE Environmental Impact Assessment Handbook – A Practical Guide for Planners, Developers and Communities (3rd Edition).

Sensitivity of Topsoil and Subsoil	Soil Texture, Field Capacity Days and Wetness Class
High sensitivity (low resilience to structural damage)	Soils with high clay and silt fractions (clays, silty clays, sandy clays, heavy silty clay loams and heavy clay loams) and organo-mineral and peaty soils where the Field Capacity Days (FCD) are 150 or greater. Medium-textured soils (silt loams, medium silty clay loams, medium clay loams and sandy clay loams) where the FCDs are 225 or greater. All soils in wetness class (WCV or WCVI).
Medium sensitivity (medium resilience to structural damage)	Clays, silty clays, sandy clays, heavy silty clay loams, heavy clay loams, silty loams and organo-mineral and peaty soils where the FCDs are fewer than 150. Medium-textured soils (silt loams, medium silty clay loams, medium clay loams and sandy clay loams) where FCDs are fewer than 225. Sands, loamy sands, sandy loams and sandy silt loams where the FCDs are 225 or greater or are in wetness classes WCIII and WCIV.
Low sensitivity (high resilience to structural damage)	Soils with a high sand fraction (sands, loamy sands, sandy loams and sandy silt loams) where the FCDs are fewer than 225 and are in wetness classes WCI to WCII.

9.2 Understanding and Communicating Significance

Impact significance for loss of soil functions/volumes and soil-related features following mitigation can be assisted using a significance matrix such as the one provided in Table 5. However, many situations may not neatly fall within the definitions provided in Tables 2, 3, 4 and 5, and in all cases these tables should not replace professional judgement by experienced professionals based on the specifics and context of the EIA being undertaken.

Table 5: Significance Matrix (Adapted from Table 3.8.1 in LA104 and Figure 3.2 in ICE EIA Handbook)

		Nature of impact (magnitude/probability/reversibility)				
		No Change	Negligible	Minor	Moderate	Major
Nature of Receptor (sensitivity/ value/ importance)	**Very high**	Neutral	Slight	Moderate or large	Large or very large	Very large
	High	Neutral	Slight	Slight or moderate	Moderate or large	Large or very large
	Medium	Neutral	Neutral or slight	Slight	Moderate	Moderate or large
	Low	Neutral	Neutral or slight	Neutral or slight	Slight	Slight or moderate
	Negligible	Neutral	Slight	Neutral or slight	Neutral or slight	Slight

Furthermore, when using the above matrices within an ES, the terminology of the tables may need to be adapted to align with a wider EIA reporting terminology framework used within a specific ES. Noting that different EIAs may apply different terminologies regarding the description of effects, for example adverse/beneficial or negative/positive. Likewise, EIAs may refer to impact or effects[95] within ranges using different descriptive scales for example:

- no change/neutral/none
- insignificant/negligible/slight
- low/minor
- moderate/medium
- large/very large/high/major.

95 Some EIAs define effects and impacts as separate terms, others use one term or the other exclusively or use them interchangeably. Each EIA should seek to define their use and strive for consistency in language. For the purpose of this guide, effects and impacts are used interchangeably.

One of the key focuses of EIA is on the identification and mitigation of 'significant' effects. Some EIAs define significant effects/impacts as those effects identified as moderate/medium and above. However, all effects, even those identified as minor and below should still be mitigated where possible and may also contribute to cumulative effects and, through interactions with other factors, may result in additional significant effects or contribute to the magnitude of other identified effects.

Significance can be described as a judgement based on the[96]:

- context in which the impact is likely to occur (inc. the nature of the sensitivity/value/importance of the receptor)
- intensity or severity of the impact (inc. taking account of magnitude/probability/reversibility of the impact)
- reference to published standards (inc. thresholds), case law and expert judgement.

Table 6 (derived from Table 3.7 from LA104) sets out further the theoretical relationship between EIA 'significance' and 'material considerations' in planning terms. A material consideration is a matter that should be taken into account in deciding a planning application or on an appeal against a planning decision. However, it is important not to confuse significance or materiality with 'acceptability'. Acceptability is a separate concept to significance and can include public opinion, political decisions and decisions made 'on balance' of a wide range of planning policy considerations.

Table 6: Significance Categories and Typical Description (Table 3.7 in LA104)

Significance Category	Typical Description
Very Large	Effects at this level are material in the decision-making progress
Large	Effects at this level are likely to be material in the decision-making progress
Moderate	Effects at this level can be considered to be material in the decision-making process
Slight	Effects at this level are not material in the decision-making process
Neutral	No effects or those that are beneath levels of perception, within normal bounds of variation or within the margin of forecasting error

Note 1 Where relevant, individual environmental factors can set out variations in significance description requirements.

Note 2 The approach to assigning significance to effect relies on reasoned argument, the professional judgement of competent experts and using effective consultation to ensure the advice and views of relevant stakeholders are taken into account.

96 Adapted from the ICE (2020) EIA Handbook, page 46, paragraph 3.4.2.

9.3 Proposed Methodology – A Worked Example

In *'Gaining Ground'* (Stapleton. Transform[97] June 2020) an assessment of development impacts on land and soil was presented in outline as a matrix approach that is in general use in EIA and ES documents. The approach draws together baseline data on soil resources for all soil functions affected by a proposed development. In the matrix format, the quantities of soils to be displaced and/or disposed of or reused off-site can be tracked, as can the extent to which soil functions are impaired, retained or enhanced by development proposals. This is an approach which would concentrate all key elements of the soil topic, which are at best currently dispersed in a fragmented manner throughout the EIA process. Where potentially significant effects on soils are identified in the assessment, this approach can demonstrate how the development proposal's design and embedded mitigation measures can be optimised to achieve the best outcome for soil resources, and to arrive at the balance of adverse and positive effects.

Annex I builds upon the example published in *'Gaining Ground',* of a soil functions approach, which identifies potential opportunities to reduce soil surplus. Within an EIA team, soil practitioners will work with other related topic leads (e.g., climate change, ecology, hydrology, etc) to identify the key soil functions on a proposed development site. With reference to Tables 2 to 6 above, professional judgement would be applied by the EIA team to select the sensitivity, magnitude, and significance categories of residual impacts, following mitigation. There may be a range of significant residual impacts across several topics, depending on the nature of the proposed development and the sensitivity of the local environment.

Specialists within EIA teams would contribute towards this analysis and commentary to determine the balance of sustainability achieved in respect of soil functions and land use changes, set against the perceived positive social and economic benefits of a proposed development.

The worked example has been selected to demonstrate the sustainable development benefits of incorporating brownfield land with no existing soil or soil-forming resource and determined to have low potential for both above – and below-ground biodiversity into the proposed development site. It is recognised, however, that this option is more likely to be available in some parts of the UK than others. It is important to note that brownfield and urban land, some with soil and soil-forming resources present, will have varying degrees of above – and below-ground biodiversity (actual or potential) which will need to be considered fully as part of an EIA.

The methodology would combine a degree of quantification commensurate with our understanding of the relevant EIA topics, together with objective analysis by specialists. The commentary within the ES would explain how the categories of impact significance are arrived at for each soil function. In particular for the biodiversity soil function, there would be scope for ecologists to determine any biodiversity net gain and offsetting.

9.4 Quantifying the Soil Balance of a Proposed Development

The waste hierarchy, as introduced in Part I and expanded in Part III of this guidance, supports the reuse of soil on-site in preference to off-site. A simple graphic can illustrate the balance between soil volumes reinstated on-site, and the surplus volumes taken off-site for reuse. This is shown for a worked example in Annex I. This surplus can be minimised through the implementation of mitigation measures set out in Part III. There are limits to what can be achieved in terms of soil conservation, given the current lack of sustainable opportunities for the off-site use of displaced soils.

97 Transform is IEMA's membership magazine and the title for Environment and Sustainability Professionals worldwide (https://www.iema.net/transform-magazine).

However, this soil balance approach would begin to quantify the scale of the loss of this finite resource and demonstrate the positive effects of early design measures for soil conservation.

Similar tables to those in Annex I can be produced for other types of development proposals with a different mix of land use changes, where there is scope for the sustainable use of displaced soils. This approach represents a useful assessment framework with a comprehensive checklist of considerations, and it provides a better understanding of the effects of development on land and soils than current practice.

Some topics (e.g., ecology and landscape) have formally recognised evaluation methodologies. In developing a more comprehensive approach to land and soil, and with more effective interactions between environmental disciplines, these methodologies may require adjustment to accommodate a more comprehensive consideration of soil resource effects.

9.5 Cumulative Effects

An agreed methodology for the cumulative effects assessment (CEA) on land and soils has yet to be established, although guidance contained in the Planning Inspectorate's advice note for cumulative effects for Nationally Significant Infrastructure Projects (NSIPs) has become a de facto framework for the assessment of cumulative effects[98] (see also Developments of National Significance in Wales[99]). Alternative approaches are discussed in Annex H. The proposals have been drafted with reference to IEMA's *'State of Environmental Impact Assessment Practice in the UK' (2011) report, and the notes from the IEMA webinar 'Demystifying Cumulative Effects' based on the Impact Assessment Outlook Journal Volume 7, July 2020,* of the same title. Although there is much discussion and uncertainty around methodology and terminology of cumulative assessment, and variability in how it is approached, there are some commonalties that have been identified in Annex H.

The CEA provides a means of achieving some key desirable outcomes, including:

- the early factoring of land and soil conservation into site boundaries and design to avoid impacts that cannot otherwise be mitigated; and
- an insight into the effectiveness of local policies for land and soil conservation.

An outline methodology is set out in Annex H for the assessment of the cumulative effects of land loss for undeveloped and agricultural land at the national and local levels. The local outline methodology requires a means of adjusting results for the proportion of developed and undeveloped/agricultural land within a local authority area. This could otherwise strongly influence the significance of cumulative effects at the local level and a means has to be found to adjust for this. This would be resolved by using land use change statistics broken down by local authority area.

A further adjustment may be required at the local level due to regional differences in the spatial distribution of agricultural land and BMV, because the significance of BMV land loss may be influenced by the administrative boundary used as a baseline. For most rural areas, county boundaries might be the most appropriate level and results for more urbanised areas might be less meaningful. This point does not apply in Wales because of the clearly stated policy in the PPW.

Given that land losses cannot be mitigated, cumulative national and local land losses relative to the total area of the land resource (undeveloped or agricultural land) at any given time has less meaning than the change in the rate of annual average land losses. The proposed methodology refers to five-year average land losses. This

98 The Planning Inspectorate (2019) Advice Note: Cumulative Effects Assessment.

99 Welsh Government (2019) Developments of national significance (DNS): guidance.

indicates whether the loss of these finite resources is increasing or decreasing, providing a useful measure of the influence of policies for land and soil conservation.

The assessment of cumulative effects indicates that where high quality land is anticipated, some limited soil/ALC/LCA field surveys might be appropriate at the sustainability appraisal stage. This is the current requirement in Wales, where recent iterations of PPW have brought such surveys forward to the start of the development process. The predictive map for Wales is available as an evidence base for development plans to inform spatial strategy and sustainability appraisal.

The proposed national and local outline CEA methodologies also require a means of determining the significance of these cumulative effects.

Part III – Mitigation, Management and Monitoring

10 Implementing Mitigation

10.1 The Mitigation Hierarchy

As introduced in Part I, Section 2, the 'Mitigation Hierarchy' should be employed to mitigate potential negative impacts on soil caused by development: Avoid, Minimise, Restore on-site, or Reuse off-site. The early consideration of soil will maximise the appropriate implementation of the mitigation hierarchy and inform project design.

10.2 Avoiding Impacts

The first consideration within the mitigation hierarchy is to avoid impacts. For example, where development might disturb peat, the guidance states that detailed surveys should be carried out to identify the peat resource, and the focus is on the avoidance of deep peat and the modification of scheme design to avoid excavation and prevent the generation of peat spoil. Where peat and peaty soils cannot be avoided, Annex F sets out in general terms appropriate methods of soil handling and Annex E focusses on handling peat and peaty soils.

Through the design of schemes, it is possible to ensure that the smallest area of land is lost, consistent with the sustainable construction and operation (and potentially decommissioning) of the proposed development, and to avoid more highly valued/more sensitive land and soil resources, where practicable. Red line site boundaries and the corridors of land affected by linear developments should be adjusted during the acquisition of land at the beginning of a project to allow sufficient space for soil movements and storage, as it can be difficult to achieve this at a later stage. Layouts can also be configured to locate hard development on less-valued land and soils, and to maintain the physical viability of residual agricultural land. If land-take is minimised then the emphasis of mitigation measures will be on soil conservation and soil handling.

In this context, DMRB LA109 refers to the identification of study areas. It states that project boundaries, construction footprints and study areas should be adjusted to avoid or mitigate impacts on soil and enable beneficial impacts on soil, such as the remediation of contamination, peat land restoration and wildlife habitat restoration, creation, and translocation.

With reference to the scoping flow chart (Figure 2), a soil survey should be undertaken as early as possible, in line with the methodology set out in Annex C, to identify the soil types across the study area; inform the infrastructure footprint and micro-siting; identify beneficial soil reuse opportunities, and determine appropriate soil handling methodologies.

10.3 Minimise Disturbance and Damage

Where soils are disturbed by development, soil handling is the main form of mitigation and this is addressed in more detail below.

The restoration of agricultural land to its original quality is the main mitigation objective where it is temporarily disturbed by development, and this can potentially be achieved through the reinstatement of temporarily displaced soil resources that are put back where they came from using appropriate soil handling methodologies, as determined from a soil and ALC/LCA Survey undertaken prior to the start of construction works.

If surplus soil is generated, a greater challenge is to find a suitable location and beneficial reuse elsewhere (preferably within the red line of a development site, if possible, for effective development control) for permanently displaced soils to retain their natural functions. This often requires the delineation of wider red line boundaries to facilitate handling of the greater soil volumes temporarily generated. Although this does not necessarily increase the hard development footprint, it may increase the soft development footprint and this could have a positive residual effect in terms of sustainability. It is in this context that a comprehensive review is required of opportunities for the on-site and off-site use of soils to maintain soil functions.

Much of the good practice guidance on soil handling has been derived from guidance on the restoration of surface mineral working sites and the refinement of methods for the restoration of agricultural land. Good practice guidance is presented predominantly in three documents; the Defra (2009) *'Construction Code of Practice for the Sustainable Use of Soils on Construction Sites';*[100] the Institute of Quarrying (2021) *'Good Practice Guide for Handling Soils in Mineral Workings'*[101], and Defra's (2004) *'Guidance for Successful Reclamation of Mineral and Waste Sites'.*

This good practice guidance is applicable in many development contexts beyond mineral sites and agricultural land restoration; however, there is little evidence, that the guidance extended to construction sites in Defra's *'Construction Code of Practice for the Sustainable Use of Soils on Construction Sites' is being applied on the ground in a consistent and effective manner on construction sites. The recent 2021 publication of the 'Good Practice Guide for Handling Soils in Mineral Workings' by the Institute of Quarrying, which succeeds MAFF's 2000 'Good Practice Guide for Handling Soils',* reflects the growing interest in conserving soils.

100 Defra (2009) Construction Code of Practice for the Sustainable Use of Soils on Construction Sites https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/716510/pb13298-code-of-practice-090910.pdf

101 IQ (2021) Good Practice Guide for Handling Soils in Mineral Workings: https://www.quarrying.org/soils-guidance

11 Soil Management, Construction EMPs and Land Restoration

Central to the application of the Defra 'Construction Code of Practice for the Sustainable Use of Soils on Construction Sites' is the collection of soil survey information required for a statement of on-site physical characteristics at the outset of a project, and the incorporation of this information into a Soil Resources Plan (SRP). As stated above, ALC or LCA surveys of study areas can be supplemented with additional soil information obtained at the same time as the ALC / LCA survey, to provide statements of site physical characteristics and soil resources, requiring minimal additional resource or time during the survey.

Mitigation measures identified during the EIA process are often collated within a CEMP. Such plans address a range of issues for several environmental topics (e.g., soil, ecology, landscape, land, air, and water quality, etc). The statement of site physical characteristics identifies the volumes and different types of topsoil and subsoil that will be displaced by development. This information informs SRPs, which can form part of a CEMP or a site-specific SMP.

SRPs should be produced on all construction sites where topsoil and subsoil have been identified by soil survey and they can form part of a Materials Management Plan (MMP) produced in accordance with CL:AIRE '*The Definition of Waste: Development Industry Code of Practice' (DoWCoP)*[102], or an equivalent plan. SRPs should include remediated and reusable contaminated soils and available soil-forming materials.

SRPs within CEMPs set out location-specific requirements for the separate stripping, storage, and reinstatement of soils for the restoration of land to a range of specified residual end uses. Proposals generally extend beyond the construction phase to cover an aftercare period of land management to reinstate soil health and functions. Soils should be reinstated to establish the preferred soil functions. The better-quality topsoils and subsoils (in traditional terms) tend to be used for the restoration of land to agriculture (often to restore BMV agricultural land), whilst poorer-quality soils are used for forestry, landscaping, and wildlife habitat creation and translocation.

It is essential that there is regular auditing, segregation and clear labelling of different soil stockpiles and that buffer zones prevent their toes from overlapping and mixing. In addition, whilst maximum stockpile heights are suggested in the Defra 'Construction Code of Practice for the Sustainable Use of Soils on Construction Sites' to prevent structural damage, stockpile heights should consider potential windshear and wind erosion, prior to the establishment of a vegetation cover. To prevent this, and in addition to the dampening of soil stockpiles in dry weather, stockpile heights can be kept below the height of site hoarding (typically 2.2m).

In respect of planning ground works and at the ground investigation stage prior to enabling works for development, unstripped soils should be protected where possible by minimising the working footprint. To avoid compaction of soils it may also be necessary to use measures such as suitable track matting and the use of tracked vehicles rather than wheeled. Consideration should also be given to the careful timing of works to allow use to be made of temporary access roads required for other elements of the development. Under wet conditions this avoids difficulties for site contractors in the use of heavy (drilling, other excavation and associated) equipment on soft and unstable soils and soils which quickly become waterlogged.

There is well-established good practice guidance on soil handling for the restoration of land to agriculture. However, with increased environmental awareness and the requirement to achieve sustainability, soft development within construction sites now includes a wide range of land uses, providing more options for the sustainable use of displaced soils. There is no widely available practical guidance for soil practitioners

102 CL:AIRE (2020) The Definition of Waste: Development Industry Code of Practice.

advising ecologists and landscape designers on the most important properties of soils and general principles of soil handling for effective habitat creation and translocation and establishing ground cover. This can result in the preparation of substrates that are unsuitable for the successful establishment of habitats and ground cover, and explains why mitigation or enhancement commitments in some ecology and landscape reports fail to be delivered. Annex F provides further practical guidance on soil handling to fill this gap.

Land restoration plans should show soil stripping, storage, and reinstatement areas, together with haulage routes. They should also identify the areas of proposed residual end uses. These requirements and the machinery/equipment to be used should be specified in procurement contracts relating to the movement and use of soils.

Good project design and well-managed construction operations must ensure the handling of topsoils and subsoils separately from the bulk movement of other excavated materials, to conform to the good practice guidelines for soil handling referred to in documents published by DoE, IQ and Defra. It should be noted that the natural rock underlying soils (particularly when it is a soft or weathered) is a common form of excavated material, often incorrectly referred to as 'soil' (see definitions for soil, topsoil and subsoil in Annex A and Box 1).

Proposals for the management of other (non-soil) excavated materials in EIA baseline studies should also be incorporated into a CEMP, which can be a vehicle for the integration of SRPs, MMPs and SWMPs.

The second consideration of land quality as the degree to which land and soils have been disturbed and contaminated also comes into play at this stage of an EIA in respect of materials classified as waste. Soils considered to be waste must be managed via appropriate Environmental Permits, exemption or through use of recognised processes like those set out in the CL:AIRE DoWCoP.[103] Care must be taken to avoid natural and uncontaminated soil being classified as waste at the point of excavation. This is achieved through the clear definition of 'clean' soils and soil-forming materials, the correct characterisation and documentation of on-site materials and appropriate proposals for their handling and use within a SWMP or MMP. There must be certainty over the use of such materials and the volumes restricted to those appropriate for the need, e.g., for the proposed land uses (see the reference to the Waste Framework Directive (WFD)). This process must be supported by the necessary Environmental Permits and other documentation.

It should be noted that waste issues need to consider an array of indicators, and this means that there can be a degree of uncertainty in respect of waste management. Therefore, decisions need to be taken in the light of all circumstances, especially the waste holder's behaviour and intentions.

The EIA process must assemble any necessary formal documentation, based on evidence from baseline studies and analysis in support of materials and waste management proposals, where these are likely to result in significant effects on the environment.[104] It should also be noted that if there is an excess of materials on-site, and no definite plans for the use of this material (often referred to as 'certainty of use'), then it is likely to be designated as waste.

11.1 On-site Reuse

The waste hierarchy supports the beneficial reuse of soil on-site in preference to off-site and seeks to avoid the classification of soil as waste if it is to be used off-site. Furthermore, the recent BSSS Guidance Note 'Benefitting from Soil Management in Development and Construction' has been prepared to promote the

103 CL:AIRE (2020) The Definition of Waste: Development Industry Code of Practice.

104 IEMA (2020) Materials and Waste in Environmental Impact Assessment.

protection of soils and the important functions they support within the planning system and the development of individual sites.[105]

11.2 Off-site Reuse

Development schemes often comprise a high proportion of hard development and this generates permanently displaced soil resources. If there is insufficient storage space and no space for mitigation measures within red lines that are too tightly drawn, this can result in surplus soil having to be taken off-site. Whilst this material should be sustainably reused off-site, materials described as 'soils' are noted to form a large component of landfills, with the disposal of over 28 million tonnes in 2016 in the UK (55% of the tonnage received).[106,107]

No doubt a proportion of these materials sent to landfill are incorrectly described as 'soils', being predominantly weathered and un-weathered geological materials. They will, however, inappropriately include some soil resources.

If largely natural and uncontaminated soil resources (and suitable soil-forming materials) surplus to requirements within a site are identified at an early stage, and it is not possible to adjust site boundaries, these soils should be highlighted for inclusion within the MMP (as part of the SWMP) to begin the process of establishing sustainable off-site uses for the soil.

11.3 Mitigation Post-Consent

Mitigation measures for soil handling identified during the EIA process are implemented during the post-consent construction phase of a development. However, some mitigation commitments set out in the CEMP (for example, in more topic-focussed and detailed Landscape and Ecology Management Plans) may extend beyond the construction phase, as aftercare management. Aftercare also applies to the management of restored soils. Given the nature of the local environment, the statement of site physical characteristics and the proposed development, soil practitioners will be aware of what should be contained within CEMPs, MMPs and SWMPs, based on SRPs. The implementation of mitigation should be evidenced through monitoring as appropriate.

These various management plans are prepared for different EIA topics, and possibly overlapping purposes, by different teams of specialists. As a result, they may not be well integrated, and this can become evident during their implementation. Developers and their agents, EIA managers, consultants and their sub-consultants must ensure the coordinated planning and delivery of mitigation measures throughout the construction phase and beyond.

Annex J sets out a flow chart for the sustainable use of soil resources and other excavated materials. It shows the process of integrating an SRP, MMP and SWMP within a CEMP to achieve the successful implementation of mitigation measures for the movement of excavated materials and soils. This integration is key to soil conservation: minimising damage to soils and successful soil and land restoration during the construction phase of a development in line with the pre-consent documents.

105 BSSS (2022) Working with Soil Guidance Note on Benefitting from Soil Management in Development and Construction https://soils.org.uk/wp-content/uploads/2022/01/WWS3-Benefitting-from-Soil-Management-in-Development-and-Construction-Jan-2022.pdf

106 Environment Agency (2019) The State of the Environment – Soil.

107 DEFRA (2020) UK Statistics on Waste.

There are two stages to the process. The first stage involves the EIA baseline studies, site investigations, analysis and formulation of proposed mitigation measures (i.e., the pre-consent planning by the EIA team) within SRPs, MMPs and SWMPs, as necessary. This stage is theoretical, and it is carried out by environmental specialists in the EIA team with reference to the sensitivity of receptors (see Section 9.1), recognising that some soils are more sensitive to damage when handled during construction than other soils.

Important considerations include:

- Has a competent expert been appointed to advise on land and soils?
- Is the EIA team sufficiently informed about soils on the site?
- Have all potential significant negative effects on soil resources been considered?
- Have all opportunities for beneficial effects on soils been considered?

The second stage of the process, following the acquisition of documentation, certification and licences is post-consent and practical. It involves the organised, supervised, and controlled movements of materials on the ground. This part is carried out by contractors, their subcontractors and other suppliers of services employing mainly non-technical operatives.

EIAs involving the movement of excavated materials and soils often fail to deliver fully on commitments beyond the first (pre-consent) stage of this process, even when developers are formally required to discharge conditions on soil handling attached to planning consents. This is known to regulatory authorities like the Environment Agency (EA) and LPAs, but in practice it is also widely known that most authorities do not appear to have the resources to effectively monitor or enforce compliance. Furthermore, there does not appear to be a centralised overview of the scale of non-compliance, which is anecdotally considered to be widespread.

Responsible developers and scheme promoters should ensure that all Environmental Management Plans (CEMP, SRP, MMP and SWMP), informed via the EIA process, are incorporated into the procurement of construction and post-consent delivery contracts. Furthermore, it is recommended that separate provision for independent monitoring of compliance is provided from the client side to ensure contractor (and sub-contractor) compliance with planning consent conditions.

For planning permission granted following an EIA, and based upon mitigations measures set out within the EIA, it is the responsibility of the LPA to ensure these are carried out via appropriate monitoring.[108] In practice, this means securing these mitigation and monitoring measures through planning conditions. Approval of a CEMP is often included as a planning condition; however, monitoring of the implementation of the CEMP, its effectiveness, and the outcomes arising from its implementation are often not monitored or enforced by the LPA, which could lead an LPA to be in breach of their responsibilities under the EIA Regulations (see Section 14).

108 See Section 26 of The Town and Country Planning (Environmental Impact Assessment) Regulations (2017).

12 Contaminated Materials

'Contaminated land' is determined according to Part 2A of the Environmental Protection Act 1990 (Part 2A EPA), and on designated contaminated land and other land affected by contamination (but not meeting the Part 2A EPA legal definition of contaminated land), the presence of contaminants reduces soil health and soil function. Most sites affected by contamination are dealt with through the planning system and the requirement for applicants to demonstrate through land quality assessments (and potentially remedial works) that the site is suitable for the proposed end use.

For potentially contaminated sites, the information derived from soil survey and contaminated land assessment should be exchanged between topic disciplines at the scoping stage of an EIA. Initially, this would involve the identification of areas of potential or known contamination. If remediation is required within the study area, then the interaction at scoping stage could be more complex. The sampling and inspection are carried out for contaminated land studies at development sites, according to BS10175, and Environment Agency LCRM96 requirements etc.

Contaminated soils and other materials are often suitable for use within developments (subject to their geotechnical properties meeting the design requirements) where it can be demonstrated that they will not pose a significant risk to receptors following site development. The soils/materials on the site may be suitable for the intended use without treatment or they may require remediation (in-situ or ex-situ) to enable them to be used at the same location or elsewhere on the site (or off-site as discussed above in relation to the DoWCoP). The MMP (or equivalent documents such as a SWMP) is the tool used to define these materials and their locations and quantities, and provide certainty of use (i.e. demonstrate that the material will be used and that use is not just a probability, because stockpiles of material with no known destination are 'waste').

It should be noted that the assessment of baseline 'land quality' in the context of a contaminated land or geo-environmental report is not about soil health (see Box 2). It is an assessment of whether contaminants in the soil can affect the health of human site users on and off-site, property (including the built environment and crops or livestock), and environmental receptors.

12.1 Contaminated Land Site Investigation and Risk Management

For land contamination assessment, there is an established initial desk-based process for collating and reviewing available site data and then conducting a site reconnaissance investigation to build a conceptual site model to assess the risks to human and environmental receptors. The results of this desk study are used to plan further targeted site investigation, the scope and criteria of which would include soil sampling and testing. In EIA, this assessment and any further investigation/remediation then informs the description of the baseline conditions, analysis of impacts and proposals for mitigation measures and residual land uses.

In respect of planning ground works, even at the ground investigation stage prior to enabling works for development, unstripped soils should be protected from damage, as outlined in Section 11.

Clearly, the presence of contaminants in displaced excavated materials is a constraint to their movement from one development site to another. However, as stated above, in England and Wales, following the voluntary code of practice set out in the DoWCoP, can provide an alternative to Environmental Permits or Waste Exemptions, as this code sets out a means of transferring such soils displaced permanently from one site to another, subject to appropriate verification measures, and contingency plans etc.

In the UK planning system, the safe development of sites is the responsibility of the developer. Methods for assessing and managing risks arising from land contamination are well established in the UK, and the Specialist in Land Condition (SiLC) Register scheme provides a recognition of competence in land condition assessment. A registered SiLC is a senior practitioner who has a broad awareness, knowledge and understanding of land condition issues, and can provide impartial and professional advice in their field of expertise.

13 Movement of Materials

13.1 Soil Handling

There are often significant failures in soil handling and the maintenance of soil functions. Early planning for the sustainable use of displaced soils and the effective transmission of the soil conservation message throughout the life of a project are key requirements. This depends on effective communications between environmental specialists and those responsible for construction activities. It also depends on a procurement process that clearly defines responsibilities for protecting soil resources. This is a procedural gap between EIA theory and practice.

Early engagement with a consultant is required to complete an MMP and Declaration by a Qualified Person to CL:AIRE (acting as an informal regulator for EA and NRW) or SEPA in Scotland (which has a different approach). The soil resource may only be reused as a material, if the Declaration has been made prior to excavation commencing. If 'certainty of reuse' is gained prior to planning approval or planning/design before works begin, DoWCoP applies. If not, soil is by default waste (U1 exemption could allow up to 1000t reuse on-site).

EIA (or Environment/Sustainability[109]) managers must ensure that specialists with suitable skills and experience in soils provide the necessary technical support during soil handling. This includes on-site supervision to ensure continuity in the delivery of mitigation commitments set out in the EIA. For example, it is understood that Clerks of Works (e.g., for archaeological excavations or ecological mitigations) will often have limited understanding of soil handling mitigation measures within CEMPs, and they need the support of soil specialists to ensure delivery and compliance.

Close liaison should be maintained between developers and their agents, EIA managers, consultants and their sub-consultants, contractors, and other suppliers of services, particularly during the post-consent phase. This is necessary to ensure that the specifications for soil handling and subsequent management set out in the SRP are implemented on the ground during construction works, and beyond as aftercare management. Non-compliance by contractors and subcontractors has unfortunately been a frequent occurrence.

The successful movement of materials also depends upon the provision of the necessary documentation arising from the EIA process and planning requirements, e.g., Site Investigation (BS5930, BS10175), Risk Assessment (Environment Agency Land Contamination Risk Management (LCRM)[110]; and the NRW in Wales).

With the exceptions of surface mineral workings and some waste operations, planning consents granted for construction projects often fail to include planning conditions for soil handling. For construction sites, there is, therefore, a planning gap that fails to require soil handling mitigation measures for soil conservation.

At the EIA stage, environmental specialists have developed increasingly scientific and technical methods for the mitigation of impacts. The development of more complex mitigation measures has widened a comprehension gap between those who propose mitigation measures at the planning stage and those who must put them into effect on the ground during construction works.

The gaps referred to above are the focus of cooperation between the IEMA Land and Soil, and Post-Consent Working Groups. Annex K (Soil Handling Guidance for Contractors) sets out two examples of good practice guidance for soil handling in non-technical terms suitable for an on-site induction procedure that can be readily understood by contractors, their subcontractors, and other suppliers of services. The advice in this annex is

109 Depending on the developer, geography, sector or industry, the title and role of the person responsible for environment mitigation and monitoring may differ.

110 Environment Agency (2021) Land Contaminated Risk Management (LCRM).

derived from an interpretation of published good practice guidelines, adjusted specifically in the first example for the translocation of Ancient Woodland topsoils, and in the second example for land temporarily disturbed by development. The actual approach should be adjusted for the soil types present, the nature of the site and the proposed development and the detailed objectives of the soil handling operation. Soil handling should also be supported by on-site supervision by a suitably qualified soil practitioner.

13.2 The Off-site Reuse of Surplus Soils and Regulatory Controls

If displaced soils are managed sustainably in accordance with best practice guidance, they can be reused on other schemes. If soils are sampled, tested, and handled in accordance with British Standards *'BS 3882:2015 Specification for topsoil' and 'BS 8601:2013 Specification for subsoil and requirements for use'* and meet the necessary criteria they can be sold for use off-site as such.

Soils that are poorly managed would lose value, requiring costly remedial action and, in the worst case, be dealt with as waste, entailing unnecessary expense to a project. However, the fact the material is benchmarked against a relevant quality standard is not the critical issue when considering waste status. A material can be of value in terms of quality yet still be considered waste. It is the holder's conduct and intent which counts.

There are two main Codes of Practice that support soil and contaminated land management. The Defra (2009) '*Construction Code of Practice for the Sustainable use of soils on Construction Sites'* is used to protect soils and ensure adequate soil function during and after construction. The CL:AIRE DoWCoP provides a clear and concise process to determine whether material excavated on a development site needs to be managed as a waste, and to identity at the same point when materials require treatment.

CL:AIRE does not apply in Scotland, where guidance on the reuse of soils and waste guidance is available from: *'Is it waste? – Understanding the definition of waste – SEPA Guidance', 'On-site management of Japanese Knotweed and associated contaminated soils', and 'Developments on peat and off-site uses of waste peat'.*[111]

The DoWCoP for the reuse of excavated materials on-site, or their movement between sites, can provide an alternative to Environmental Permits or Waste Exemptions. This code of practice provides a process to help the Environment Agency or NRW to determine whether excavated materials on a development site are unlikely to be waste and provides an alternative framework for managing materials without the need for traditional waste management methods. It enables:

- the direct transfer and reuse of clean naturally occurring soil materials between sites;
- the conditions to support the establishment/ operation of fixed soil treatment facilities; and
- the reuse of both contaminated/uncontaminated materials on their site of origin and between sites within a defined cluster (several remediation and development sites that are in relatively close proximity and share a decontamination/treatment facility located at a single 'hub' site).

The WFD has an exclusion which means that natural and uncontaminated soils are not considered a waste, so long as they have certainty of use, are suitable, and appropriate volumes are involved, etc. The DoWCoP can apply to all materials, and it is often used when the WFD exclusion might otherwise apply, as projects prefer the assurance of higher-quality material and the certainty this can provide. The DoWCoP requires an MMP that incorporates a remediation strategy (or Design Statement) based on an appropriate risk assessment, and this ensures materials are reused against a site-specific specification. In this way, the MMP can also form part of a SWMP for a development site.

111 These references may be found at: https://www.sepa.org.uk/regulations/waste/guidance

Alternatively, soil materials could be reused under a Recovery Permit. According to the definition of 'Recovery' in the WFD 3(15), and the explanation given in Defra's Guidance on the legal definition of waste and its application 2012 (g3.68), *'The principal objective of a recovery operation is to ensure that the waste serves a purpose by replacing other substances which would otherwise have had to be used for that purpose, thereby conserving natural resources'.* This is known as the 'substitution principle'. It follows that if you cannot prove that substitution of the material is most likely, then the operation could be considered disposal rather than recovery. Further text and explanation are in the EC's Guidance on the interpretation of key provisions of Directive 2008/98/EC (WFD) on waste (para 1.4.5). Some projects can struggle to show recovery due to the financial context of the projects, and this this can make them disposal operations where the material remains a waste.

13.3 Further Developments in Soil Handling and Reuse

Launched in September 2008 and updated in 2011, the DoWCoP has significantly increased the conservation of displaced soil resources and the sustainability of land remediation and development projects. In setting out a means of transferring soils displaced permanently from one site to another, this challenges the widely held view that such transfers are prevented by waste management and other pollution control regulations. For example, the SEPA 2010 Regulatory Guidance *'Promoting the Sustainable Reuse of Greenfield Soils in Construction'* explicitly excludes the *'storage of greenfield soil on third party sites pending use'.*

However, there is a need to establish a denser network of soil treatment facilities because the current estimate is that 30–40km is the maximum distance for the commercial transfer of soil resources.

For the successful off-site use of permanently displaced soils, individual projects are required to anticipate at an early stage and flag up surplus soils in their MMP remediation strategy (or Design Statement). This would help CL:AIRE to build up their Register of Materials (including suitable soil-forming materials) available to use at other sites.[112] It is understood that some organisations across several sectors are beginning to recognise the commercial and reputational benefits of this approach in their development strategies. This can involve securing the ownership and control of potential off-site locations and extending red line boundaries to include brownfield sites and introducing increased opportunities for Biodiversity Net Gain (see Box 8 and Box 9).

CIRIA has commissioned a research project to provide up-to-date, interactive guidance on the surplus soil management process, which will help users to make informed decisions on surplus soil management.[113] There could be exchanges between sites, such that permanently displaced clean soils can be exported to remediated contaminated areas, brownfield sites or even long-term neglected vacant land and inaccessible greenfield areas, and this could be managed in compliance with waste legislation. The objective is to avoid soils being classified as waste wherever possible (e.g. through use of an MMP, or SWMP), so that they can be put to sustainable use.

In general terms, the use of permanently displaced soil on brownfield sites or other soil-related mitigations could include the improvement or creation of wildlife habitats and corridors, tree planting areas, peatland restoration, the creation of allotments and raised beds for communities to grow produce, even local composting schemes which could increase the supply of peat-free compost. Significant legal issues may arise from proposals for the reuse of materials on projects for some new land uses, however. Projects are also recommended

112 CL:AIRE. Register of Materials: https://www.claire.co.uk/projects-and-initiatives/cl-aire-register-of-materials

113 Information on this initiative is available at: https://www.ciria.org/News/CIRIA_news2/New_Community_of_Practice_for_construction_soil_management.aspx

to prove the financial viability of proposals to ensure the long-term management of a habitat, and to pass the substitution test, or proposals will be deemed waste disposal rather than materials recovery.

The Scottish Government has a database of Vacant and Derelict Land, and local authorities may have sites in their ownership where there is potential for permanently displaced soil to be relocated to low-value sites that are not viable for commercial development but may require environmental improvement.

14 Monitoring and Enforcement

Planning approval is a pre-requisite to all development proposals and consideration of the impact on soil is an integral part of the environmental assessment process. However, there is no specific direct planning control on the sustainable use and management of soil resources on construction sites or a requirement for the monitoring of soil protection and sustainable reuse.

Section 26 of the EIA Regulations explicitly allows for the imposition of monitoring measures:

(3) When considering whether to impose a monitoring measure under paragraph (1)(d), the relevant planning authority, the Secretary of State or inspector, as appropriate, must:

(a) if monitoring is considered to be appropriate, consider whether to make provision for potential remedial action;

(b) take steps to ensure that the type of parameters to be monitored and the duration of the monitoring are proportionate to the nature, location and size of the proposed development and the significance of its effects on the environment; and

(c) consider, in order to avoid duplication of monitoring, whether any existing monitoring arrangements carried out in accordance with an obligation under the law of any part of the United Kingdom, other than under the Directive, are more appropriate than imposing a monitoring measure.[114]

Note above, under paragraph (a) of Section 26, the possibility to include provision for remedial action as a result of monitoring. Planning conditions can therefore require the monitoring of appropriate standards of site works, restoration and translocation, and enforcement if operations are not carried out to the appropriate standard.

Furthermore, landscaping aspects of developments often enter a 5-year monitoring period, often on a 'defects liability' arrangement. The maintenance of all areas that reuse soils on-site should include monitoring of the soil conditions to maintain soil health and soil function. This can be achieved by hand digging small trial pits or taking auger samples at representative locations two to three times during each year and particularly a few weeks after planting or turfing.

Verification of restoration standards should be carried out to determine whether potential significant impacts have been successfully addressed by mitigation measures. The monitoring, verification and enforcement of restored soil conditions should be carried out by suitably qualified and experienced persons. The survey techniques used to collect baseline data can potentially be replicated for monitoring and validation purposes, so that the soil condition can be checked before and after development to see if it has deteriorated, remained the same or improved.

In practice, there is often inadequate monitoring and a failure of enforcement of appropriate site works and land restoration standards. Therefore, planning conditions should require ongoing monitoring, and enforcement of non-compliance and remedial action needs to be more effective.

114 See Section 26 of The Town and Country Planning (Environmental Impact Assessment) Regulations (2017).

Annexe A Land and Soil Guidance Definition of Terms

Agricultural Soils

For the purposes of EIA and given the objectives of soil handling mitigation measures (i.e., the separate movement, storage and reinstatement of topsoils and subsoils), agricultural soils which have both topsoils and subsoils in place can, from a soil resources perspective and for practical purposes, be considered to be largely natural and undisturbed, in spite of cultivation and the application of fertilisers, herbicides and sewage sludge etc. This is to distinguish them from other less favourable soil and soil-forming materials available from land that has been subject to a greater degree of disturbance.

In respect of forestry/woodland, it should be noted that the clearing of trees from a development site inevitably causes disturbance of the soils; the mixing of topsoils and subsoils has a downgrading effect on the quality of the soils. In such areas, topsoils and subsoils might have to be stripped as one material, depending on the density of tree cover and maturity of the trees.

Agricultural Land Classification

England, Wales & Northern Ireland

The system devised and introduced by the Ministry of Agriculture, Fisheries and Food (MAFF) to classify agricultural land according to the extent to which its physical or chemical characteristics (climate, topography and soil) impose long-term limitations on agricultural use. Land is graded from 1 (excellent quality) to 5 (very poor quality), with grade 3 subdivided into agricultural subgrades 3a and 3b. See 'Best and Most Versatile'.[115]

See Land Capability for Agriculture for Scotland.

Best and Most Versatile

England, Wales & Northern Ireland

The National Planning Policy Framework (NPPF) (Department for Communities and Local Government, 2021) defines best and most versatile (BMV) land as land of excellent (ALC Grade 1), very good (Grade 2) and good (Subgrade 3a) agricultural quality. BMV land is afforded a degree of protection against development within planning policy. Lower-quality Subgrade 3b and Grades 4 and 5 land is restricted to a narrower range of agricultural uses.

See Prime Quality Agricultural Land for Scotland.

Brownfield Land

Brownfield land has generally been subject to disturbance and may be potentially affected by contamination. In some instances, this may meet the definition of contaminated land as set out in Part 2A of the Environmental Protection Act 1990. The presence of contaminants will not necessarily limit development; however, a suitable assessment must be carried out to confirm whether the land is suitable for the proposed end use (*see 'Contaminated Land'*). Where contamination is present, the substrate may become suitable for some uses following remedial measures. Where there are abandoned structures, brownfield land may also be referred to as derelict land.

Compaction

Compaction of the topsoil or subsoil as a result of trafficking or handling causes soil structures to be compressed together and the closure of soil pores, restricting the movement of water and air within the soil. This inhibits vegetation growth and can result in an anaerobic soil.

115 MAFF, 1988. Agricultural Land Classification of England and Wales: Revised criteria for grading the quality of agricultural land – ALC011

Contaminated Land

England, Wales & Scotland

Part 2A of the Environmental Protection Act 1990 and the associated Statutory Guidance (Defra, 2012[116] and Scottish Executive, 2006[117]) describe the Contaminated Land Regime, which is primarily aimed at dealing with the legacy of contamination. In order to determine a site as 'contaminated land' under Part 2A of the EPA 1990 there has to be 'significant possibility of significant harm' (SPOSH).

Land contamination is a material planning consideration for new developments, because it can potentially harm human health, drinking water supplies, groundwater and surface water, soils, ecosystems and property. If a proposed development site or adjacent land have been in industrial use, used for the disposal or treatment of wastes, used for mining or another land use that may have caused pollution through leakage or spills or inadvertent spreading, or if the site has been subject to deposits of pollutants from the air, then there is the potential for the land (including soil and groundwater), to be contaminated. In the UK planning system, the onus is on the developer to demonstrate that the proposed development site is suitable for the proposed end use. Development that complies with the relevant planning guidance[118] and industry good practice guidance for assessing contaminated land will 'as a minimum' ensure that the land is not capable of 'determination' as contaminated land under Part 2A of the Environmental Protection Act.

Northern Ireland

The Contaminated Land Regime, which is set out in Part III of the Waste and Contaminated Land (Northern Ireland) Order 1997 has been enacted but is not yet in force. This regime is very similar to that provided in Part 2A of the Environmental Protection Act 1990 in England and Scotland since 2000 and in Wales since 2001. A timetable for implementation of the regime in Northern Ireland has not been agreed.

Department for Environment, Food & Rural Affairs (Defra)

The UK Government department responsible for policy and regulations on environmental, food and rural issues. The department's priorities are to grow the rural economy, improve the environment and safeguard animal and plant health.

Droughtiness

A physical limitation to the agricultural use of soils. It is defined by a calculation set out in the Agricultural Land Classification guidelines, which uses soil and climatic parameters to provide an estimate of likely moisture stress in 'standard' crops due to the crop's requirements for water exceeding the available water capacity of the soil.

Excavated Material

This comprises natural rock material and soil (and, on previously developed land or land used for waste disposal, may include anthropogenic materials) removed from the ground during construction. Natural rock and other geological deposits, which may be hard or soft,

116 Defra (2012). Environmental Protection Act 1990: Part 2A Contaminated Land Statutory Guidance. Available online at: https://www.gov.uk/government/publications/contaminated-land-statutory-guidance

117 Scottish Executive (2206) Environmental Protection Act 1990: Part IIA Contaminated Land Statutory Guidance: Edition 2. Available online at: https://www.gov.scot/publications/environmental-protection-act-1990-part-iia-contaminated-land-statutory-guidance

118 e.g. UK Government (2019) Guidance: Land affected by contamination. Available online at: https://www.gov.uk/guidance/land-affected-by-contamination and Scottish Government (2000) Planning Advice Note PAN 33 Development of Contaminated Land. Available online at: https://www.gov.scot/publications/pan-33-development-of-contaminated-land

weathered or un-weathered, often constitute the largest proportion of excavated materials on development sites. Soils overlie the rock and deposits, and the transition from soil to rock occurs below the subsoil, where soil-forming processes and the creation of soil structures largely cease. In general terms, subsoil is the weathered layer of soil between the natural topsoil at the ground surface and the un-weathered geological parent material below. Generally, these distinctions are applied only to the uppermost 1.2m in soil stripping areas (see Soil Profile), but peats should generally be considered to the full depth of this resource.

The use of displaced soil to maintain soil functions has priority over their use for civil engineering purposes. Largely natural and undisturbed soils on agricultural land, forestry/woodland and ecologically valuable areas that are to be disturbed by development are a distinct and important subset of excavated materials. Their separate handling (required for the maintenance of soil functions) is subject to different and higher standards of management than other excavated material to reflect and retain their greater environmental value and potential. As such, they must be handled with more care than other excavated materials. In sustainable placement locations, separately stored topsoils and subsoils displaced during the construction shall be reinstated on top of excavated material.

It should be noted that notwithstanding the above distinctions, excavated natural rock (weathered or un-weathered) and other inert geological deposits are by custom and practice within engineering disciplines also incorrectly referred to as 'soil', with only the 'topsoil' element of soil being differentiated from all other 'engineering soils'.

Field Capacity

The hydrological state of soil, which describes the amount of water held in the soil after rainfall has saturated the soil, and the excess gravitational water has drained away and the downward movement of water has largely ceased.

Green Belt

Green Belt is largely Greenfield land, but it is formally designated by planning authorities in development plans, mainly for the protection of visual amenity and openness.

Greenfield Land

Greenfield land tends to be undeveloped agricultural land in rural and urban fringe areas with largely undisturbed natural soils. In some places this land may be affected by contamination. This could include agricultural contaminants such as pesticides and herbicides, heavy metals derived from sewage sludge (also emerging contaminants such as pharmaceuticals, microplastics and perfluorinated and polyfluorinated alkyl substances) or contaminants from other sources such as shooting ranges, or unauthorised waste disposal; but typically not to the extent that it is considered to be contaminated, according to Part 2A of the Environmental Protection Act 1990.

Hard Development

Land where natural soils have been displaced or sealed (covered) by built structures and manufactured impermeable surfaces.

Land

Land is the terrestrial part of the earth's surface, and people think of land in terms of what they can do with it. Economists consider land to be one of the basic factors of production, along with labour and capital. From the human perspective, land is an area or location where we can live and carry out activities for subsistence or wealth-creating employment, leisure activities and other lifestyle choices. People need land for economic activity and to produce things, whether it is within an office or factory, or within parcels of agricultural land. The value placed on land is partly determined by its physical properties (climate, topography and soil). Land also has social and economic dimensions, which are influenced by the different potential uses of land (including urban development) and also by its location in relation to settlements.

[*Adapted from 'Methods of Environmental and Social Impact Assessment', Oxford Brookes (2018)*].

Land Capability for Agriculture

Scotland

The classification of land for agricultural purposes in Scotland detailing information on soil, climate and relief in a form which will be of value to land use planners, agricultural advisers, farmers and others involved in optimising the use of land resources. The classification comprises 12 classes. Land suited to arable uses is included in Classes 1–4, and that not suited to arable use in Classes 5–7. There are no divisions within Class 1 and 2; Classes 3 and 4 each have two divisions and Classes 5 and 6 three divisions. *See Prime Quality Agricultural Land.*[119]

See Agricultural Land Classification for England, Wales & N. Ireland.

Natural Capital

The global stock of natural resources, comprising geology, soils, air, water and all living organisms. Some natural capital assets provide ecosystem services. Two of these resources (clean water and fertile soil) underpin our economy and society, and thus make human life possible.

Organo-mineral Soil

A generic definition of organo-mineral soils is that they have a surface horizon or topsoil which is relatively rich in organic matter or peat but which is <40cm thick. They include rankers, rendzinas, podzolic and gleyed soils. These are further defined to three types of organo-mineral soils: (1) Humose topsoil greater than 15cm thick; (2) Peaty loam or peaty sand topsoil greater than 15cm thick; or (3) Peat less than 40cm thick starting at or near the surface, or less than 30cm thick where the peat lies directly on bedrock. (Soil Survey of England and Wales (SSEW))

Peat

These are predominantly organic soils derived from partially decomposed plant remains that accumulate under waterlogged conditions.

England and Wales: >40cm deep (or >30cm if directly over rock) and greater than 20% organic matter by dry weight (SSEW).

Scotland: >50cm deep and greater than 60% of organic matter.

119 Bibby J S et al, 1991. Land Capability Classification for Agriculture. The Macaulay Land Use Research Institute, Aberdeen. ISBN 0 7084 0508 8

Prime Quality Agricultural Land

Scotland

The Scottish Government's National Planning Policy protects prime quality agricultural land defined as Classes 1, 2 and 3.1 in the Land Capability for Agriculture.

See BMV for England, Wales & N. Ireland.

Soft Development

Soft development retains the soils within a development site. The soils may be temporarily disturbed or remain in-situ during the construction phase of the development. It is because of evolving environmental perspectives and regulations that soft development now includes a wide range of land uses like open spaces, sustainable drainage systems (SUDS), suitable alternative natural greenspaces (SANGS), other wildlife habitats and community woodlands etc.

Soil

Where soil occurs, it is the topmost layer of the land, forming the interface between the underlying geology and the atmosphere and is a component of terrestrial ecosystems, providing a medium for the transmission of carbon, water, nutrients, and the growth of plants. People rely on ecosystem services provided by land and soil, most notably for biomass production, including, but not limited to, food, fibre, and timber; and these services are central to social, economic and environmental sustainability.

[*Adapted from 'Methods of Environmental and Social Impact Assessment', Oxford Brookes (2018)*].

Soil consists of particles of weathered rock, organic matter, air spaces, and water. Descriptions usually identify the main physical characteristics of its layers or horizons of topsoil and subsoil (usually to a depth of 1.2m – see 'Subsoil') in terms of significance for the growth of plants. It should be noted that the British Standards '*BS 3882:2015 Specification for topsoil*' and '*BS 8601:2013 Specification for subsoil and requirements for use*' relate mainly to material traded between sites (e.g., for land restoration purposes).

Soil Profile

A vertical column of soil comprising soil layers or horizons. The sequences of horizons are used to help classify soils and are given letters, O, A, E, B, C and R. O horizons are composed of organic material; A horizons are near the surface with organic matter incorporated; E show evidence of removal of organic material, iron or clay; B show evidence of accumulation of these materials and is altered from the parent material C, which shows little alteration. Soils may also form directly over hard or weathered rock. Soil profiles can contain a range of horizon sequences, but for simplicity in EIA, the soil profile is typically broken down into three general horizons: the topsoil (horizon A); the upper subsoil (horizon B); and the lower subsoil (horizon C). Agricultural practitioners generally consider a soil profile to be about 1.2m in depth[120], unless an impenetrable layer (e.g., rock) occurs at shallower depths. For land restoration, topsoils require a reinstated subsoil to perform and maintain their natural functions.

It is important to note that engineering definitions utilise a different set of definitions of the soil horizons. Engineers consider the 'A' and 'B' horizons to be 'topsoil' and the 'C' horizon as 'subsoil', whereas in agricultural terms the 'B' horizon is normally considered to be the upper subsoil and the 'C' horizon is the lower subsoil.[121] The engineering or the agricultural terminology and handling is applied, depending on the proposed use of the soils.

120 Natural England (2021) Guidance Guide to assessing development proposals on agricultural land https://www.gov.uk/government/publications/agricultural-land-assess-proposals-for-development/guide-to-assessing-development-proposals-on-agricultural-land#new-surveys

121 Design Manual for Roads and Bridges (DMRB), Volume 4, Section 1, PRT 1 HA 44/91, April 1995

Soil Resource

The textures, structures and volumes of different soil types (topsoil and subsoil) that occur on the ground surface in areas of natural undisturbed land, which have a potential for beneficial reuse.

Soil Resource Plans

A SRP is informed by Agricultural Land Classification, Land Classification for Agriculture and soil surveys. The SRPs are based on the soil types present in any given area and can be used to inform their restoration and sustainable reuse.

Soil Sealing

Covering the soil surface with an impermeable material, or urban development on areas of natural undisturbed land, i.e., hard development on greenfield sites.

Soil Structure

The combination or aggregation of soil particles into larger compound units (or peds) with pore spaces and channels between that allow the flow of air and water and the penetration of roots. They are characterised and classified based on size, shape, and degree of development.

Soil Texture

The relative proportion of the soil particle size fractions in the mineral component of a soil, comprising sand, silt, and clay. The soil texture classes (e.g., sandy loams, clay loams, sandy clay loams etc) are precisely defined in terms of the percentages of sand, silt, and clay in the Agricultural Land Classification of England and Wales: Revised Guidelines and Criteria for Grading the Quality of Agricultural land, Defra Publications, 1988.

Subsoil

In general terms, subsoil is the weathered layer of soil between the natural topsoil at the ground surface and the un-weathered geological parent material below. Subsoil has a lower organic matter and plant nutrient content than topsoil. In some places there is an upper subsoil layer or horizon, which is transitional in texture between the topsoil and a lower subsoil.

The transition from soil to rock occurs where soil-forming processes and the creation of soil structures largely cease. The nature of the rock has a considerable influence. Hard rocks (e.g., sandstones and limestones) limit the depth of soils, but in soft rocks like clays and loose geological deposits, agricultural practitioners generally consider subsoil to become rock at 1.2m. This is a notional depth for practical purposes because weathered rock often extends to greater depths than 1.2m (*see Soil Profile*).

Agricultural subsoils (i.e., within 1.2m depth) usually represent the more weathered and granular (structured) materials are often suitable for use in certain aspects of the engineering earthworks construction, such as stable slopes (particularly in respect of embankments and cuttings). Therefore, a proportion of these agricultural subsoils may be used for civil engineering purposes. Agriculture, ecology and landscape would generally have priority for topsoil and upper subsoil and engineering might have priority for lower subsoil, thus reducing potential conflict over soil resources.

Topsoil

Upper 'A' layer of a soil profile, usually darker in colour (because of its higher organic matter content) and more fertile than the upper subsoil 'B' layer, and which is a product of natural biological and environmental processes.

It should be noted that engineers consider the 'A' and 'B' horizons combined to be 'topsoil'. The DMRB state a minimum default requirement for the depth of reinstated topsoil (i.e., the 'A' and 'B' horizons combined) is 300mm, unless stated otherwise in engineering specifications.[122]

This is too thin for a combined 'A' and 'B' horizon of a reinstated agricultural soil. Defra does not permit this mixing of horizons for agriculture,[123] therefore, the engineering or the agricultural terminology and handling will be applied, depending on the proposed use of the soils.

Translocation

Transporting and release of species, habitats, or soils from one location to another. For example, if an area of land is required permanently for a new development, species, habitats, and soils can be moved from that site to a suitable alternative location.

Upper Subsoil

Soil profiles on higher-quality land (e.g., ALC Grades 1, 2 and 3a, and LCA Classes 1, 2 and 3:1) tend to have sequences of three separate or gradually merging texture layers or horizons (i.e., loamy topsoils and favourable loamy upper subsoils over less favourable clayey, silty or sandy lower subsoils). Soil profiles on lower-quality land (ALC Grades 3b, 4 and 5, and LCA Classes 3:2, 4, 5 and 6) tend to have only two texture layers or horizons (i.e., loamy topsoils directly over less favourable clayey, silty or sandy lower subsoils).

Wetness Limitation

A soil wetness limitation exists where the soil water regime adversely affects plant growth or imposes restrictions on cultivations or grazing by livestock.

List of Abbreviations

ALC	Agricultural Land Classification
AONB	Area of Outstanding Natural Beauty
BMV	Best and Most Versatile
BNG	Biodiversity Net Gain
BSSS	British Society of Soil Science
BOA	Biodiversity Opportunity Areas
CEA	Cumulative Effects Assessment
CEMP	Construction and Environmental Management Plan
CIEEM	Chartered Institute of Ecology and Environmental Management
CIRIA	Construction Industry Research and Information Association
COGAP	Code of Good Agricultural Practice
CO_2	Carbon Dioxide
DAERA	Department of Agriculture, Environment and Rural Affairs (Northern Ireland)
DfI	Department for Infrastructure (Northern Ireland)
DoE	Department of the Environment (Northern Ireland)
DoWCoP	Definition of Waste: Code of Practice
DEFRA	Department for Environment, Food & Rural Affairs
DMRB	Design Manual for Roads and Bridges
EA	Environment Agency
EIA	Environmental Impact Assessment
ELMS	Environmental Land Management Schemes

122 Design Manual for Roads and Bridges (DMRB), Volume 4, Section 1, PRT 1 HA 44/91, April 1995

123 'Good Practice Guide for Handling Soils in Mineral Workings', IQ 2021; 'Construction Code of Practice for the Sustainable Use of Soils on Construction Sites', Defra 2009

ICE	Institute of Civil Engineers
IEMA	Institute of Environmental Management & Assessment
IQ	Institute of Quarrying
ES	Environmental Statement
FCD	Field Capacity Days
LCA	Land Capability for Agriculture
LDP	Local Development Plan
LMP	Land Management Plan
LNR	Local Nature Reserve
LPA	Local Planning Authorities
LQAS	Land Quality Advice Service
MAFF	Ministry of Agriculture Food & Fisheries (Now Defra)
MMP	Materials Management Plan
MTAN	Minerals Technical Advice Note
NCC	Natural Capital Committee
NED	Natural Environment Division
NPF4	Fourth National Planning Framework
NPPF	National Planning Policy Framework
NRN	Nature Recovery Network
NRP	Natural Resources Policy
NRW	Natural Resources Wales
PPS	Planning Policy Statement
PPW	Planning Policy Wales
RDS	Regional Development Strategy
RIGS	Regionally Important Geological and Geomorphological Sites
SAC	Special Area of Conservation
SANG	Suitable Alternative Natural Green Spaces
SEA	Strategic Environmental Assessment
SEPA	Scottish Environment Protection Agency
SMNR	Sustainable Management of Natural Resources
SNCI	Sites of Nature Conservation Importance
SNH	Scottish Natural Heritage (now NatureScot)
SPA	Special Protection Area
SPP	Scottish Planning Policy
SoNaRR	State of Natural Resources Report
SPPS	Strategic Planning Policy Statement
SRP	Soil Resource Plans
SSSI	Sites of Special Scientific Interest
SWC	Soil Wetness Class
SUDS	Sustainable Urban Drainage Systems
SWMP	Site Waste Management Plan
TAN	Technical advice note
UNESCO	United Nations Educational, Scientific and Cultural Organisation
WFD	Waste Framework Directive
25 YEP	25 Year Environment Plan

Annexe B Sources of Land and Soil Information

Introduction

Extensive records of land and soil information have been collected by environmental survey organisations in each of the UK nations, and in recent decades significant progress has been made to provide access to historical and new data. In particular, digitisation and online map viewer platforms provide access to soil and land classification data covering large parts of the UK. However, differences in open data access policies remain between nations with restriction on the accessibility of some specialist datasets.

The range of information relevant to EIA includes:

- Soil Type maps for England, Wales, Northern Ireland and Scotland;
- Agricultural Land Classification (ALC) maps for England, Wales and Northern Ireland;
- Land Classification for Agriculture (LCA) maps for Scotland;
- Soil Risk maps for erosion and compaction;
- Interpretative or Thematic maps on Nitrate Vulnerable Zones, Soil Carbon and Peatland;
- Models and Toolkits – such as land suitability for habitat restoration.

Sources of Information for England and Wales

Soil Information

England and Wales are covered by six regional soil maps at a scale of 1:250,000, showing the distribution of generalised soil types called Soil Associations, each containing several component Soil Series, which are described in more detail.

These small-scale maps are accompanied by six regional memoirs (Soil Survey of England and Wales (SSEW) Bulletins 10 to 15) describing Soil Series profiles. The regional memoirs include a map index showing the relatively small proportion of England and Wales covered by more-detailed published Soil Series maps at scales of 1:63,360, 1:50,000 and 1:25,000. These soil maps are also accompanied by memoirs describing the soil types in each survey area.

Most soil information is derived from what was the Soil Survey of England and Wales and it is now held by the Cranfield Soil & AgriFood Institute (CSAI). The Cranfield soil information includes a national soil map at *https://www.cranfield.ac.uk/case-studies/research-case-studies/national-soil-map, which maps the Soil Associations.*

Repeated patterns of broad soil types related to geology, drainage patterns and landforms form the basis to what are described by the Cranfield Institute as 'Soilscapes', and these are shown at *http://www.landis.org.uk/soilscapes/*. Soilscapes are based largely on a reconnaissance level of information. Further information available for purchase from the Cranfield Institute includes digitised soil data sets, which are largely derived from the above maps at scales of 1:25,000 to 1:250,000.

Limitations of Available soil Information

Much of the soil information held by the Cranfield Institute is based on a classification of soil types called Soil Series, based on the soil parent material (geology) and the different soil forming processes that lead to the development of soil profiles. This approach to soil classification has often proved to be more academic than is necessary for the practical application of soil information within the planning system. Furthermore, there is limited coverage of available larger-scale (1:25,000) detailed Soil Series maps, the production of which has been discontinued. This limitation applies to the digitised soil data sets.

In most cases, therefore, detailed soil surveys should be carried out to provide quantified information on a limited number of selected soil properties for specific land use planning purposes, like ALC surveys and soil resource surveys reporting on site physical characteristics for soil handling. For these purposes, it is not necessary to identify named Soil Series. The soil properties that are necessary for soil surveys carried out to inform ALC, LCA and soil handling for the restoration of land to agriculture, habitat creation and translocation, and landscape design are set out in Annex C.

It should be noted that where soil baseline GIS data is available, in most instances this does not provide 100% coverage of the UK. Mapping layers can become outdated and may be based on models and projections using limited field data derived from reconnaissance surveys. Therefore, they are unlikely to be suitable for use for site-specific determinations at a development site scale, and site-surveys, walkovers and intrusive ground investigation will typically still be needed.

Agricultural Land Classification Information

The Agricultural Land Classification (ALC) system (MAFF) was introduced in the 1960s and is based on the severity of long-term climatic[124], topographic[125], and soil limitations to the agricultural use of land. The purpose was to map the distribution of agricultural land quality, across England and Wales, to a common standard. This was to ensure scarce high-quality land could be protected from development, through the planning system. Land is graded on a scale of 1 to 5 (Grade 1 being best quality and Grade 5 being poorest). The principle of 'most limiting factor' (Liebig's law of the minimum) is used to determine grade.

Half of England and Wales was assessed as Grade 3 land; therefore, in the mid-1970s, Grade 3 was initially subdivided into Subgrades 3a, 3b and 3c. Introduced in 1987, Grade 1, Grade 2 and Subgrade 3a land is termed Best and Most Versatile (BMV). In 1988, the ALC was comprehensively revised, which included the amalgamation of Subgrade 3b with 3c.

A Provisional series of reconnaissance 1:63,360 scale maps showing the distribution of five grades of agricultural land in England and Wales was published by MAFF in the period up to the mid-1970s. Following the update of the ALC methodology in 1988, these maps were subsequently republished as regional maps covering the whole of England and Wales at a scale of 1:250,000. These maps are known as the 'Provisional ALC Maps' and are available on Natural England's '*Access to Evidence*' website.[126] These Provisional maps do not show the subdivision of Grade 3 and they are based on an outdated ALC methodology. Furthermore, they are a reconnaissance level of information and their scale is not suitable or accurate for the assessment of individual fields or sites.

In Wales, the Provisional 1:250,000 maps were withdrawn on 27th November 2017 and should not be used to support any planning proposal or as an evidence base for Local Development Plans (LDP). They have been replaced by the Predictive ALC Map for Wales.

England

Detailed ALC surveys using the updated 1988 guidance including the subdivision of Grade 3 were carried out by MAFF and subsequently by Defra in the period from 1988 to 1999 for areas in England that have been the subject of planning consultations, and they are referred to as 'post-1988 ALC surveys'. The results of these surveys have been made available by Defra on the MAGIC website managed by Natural England[127] largely at a detailed scale of 1:10,000. Some survey reports and soil profile descriptions are also made available. Such surveys are no longer carried out by Defra. Instead they are carried out by specialist consultants, largely for developers and are available through individual local authority planning portals.

124 Climatic information for the ALC was prepared by the Meteorological Office in 1989, and in view of climate change it is considered by Defra to be valid until 2030. The current ALC climate dataset is available on Natural England's publications pages at http://publications.naturalengland.org.uk/publication/6493605842649088?category=5954148537204736

125 Topographic information includes flood risk and ground surface gradients. The flood risk information is available from the Environment Agency website and gradients are measured in the field using a clinometer.

126 http://publications.naturalengland.org.uk/category/5954148537204736

127 https://magic.defra.gov.uk/Magic Map.aspx

Post-1988 ALC survey results, the Cranfield Soilscapes, details of agri-environment, forestry, woodland and other schemes, statutory and non-statutory habitats and species designations, have been digitised and have been made available by Defra on the MAGIC website.

Natural England has also produced indicative '*Likelihood of Best and Most Versatile Land*' maps at a scale of 1:250,000, which predict the likelihood of ALC Grades 1, 2, and 3a (BMV) being present within broad areas, for strategic planning purposes.[128]

In England, the Provisional and Likelihood maps should be used as a first sieve only in determining the approximate distribution of BMV agricultural land. If there is no recent post-1988 ALC data available for a site, a new detailed survey is then likely required to determine the actual grade of land within a development study area.

Wales

The Welsh Government has produced '*The Predictive ALC Map for Wales*' version 2[129] supported by the 'Agricultural land classification: predictive map guidance'[130]. This mapping uses the MAFF 1988 ALC, published soil information, and climatic and topographic information to predict ALC Grades.

Where more-detailed soil maps are available from field survey work (largely for the lowland parts of Wales), they replace the Cranfield Institute 1:250,000 soil map of Wales. Soil and ALC surveys commissioned, validated, and accepted by the Welsh Government since 2017 have been added to the database. The Predictive ALC map has also been updated to include the results of earlier surveys commissioned between 1988 and 2017.

In Wales, the Predictive ALC map should be used as a first sieve only in determining the approximate distribution of BMV agricultural land. A detailed field survey is then required to determine the actual grade of land within a development study area.

Sources of Information for Northern Ireland

The Northern Ireland Environment Agency (NIEA) Natural Environment Map Viewer provides environmental data at: https://appsd.daera-ni.gov.uk and this can be downloaded from: *https://www.daera-ni.gov.uk/articles/daera-digital-datasets-available-download* but this does not include soil information.

Soil maps and layers can be viewed on the UK Soil Observatory (UKSO) online browser (using the World Based Reference system only) or they are available as paper copy from the Agri-Food and Biosciences Institute of Northern Ireland (AFBNI).[131]

The Scottish National Heritage (SNH), now Nature Scotland (NS) Commissioned Report No.325 '*Climate Change, Land Management and Erosion in the Organic and Organo-mineral Soils in Scotland and Northern Ireland*' reports on soil erosion and carbon loss and shows a number of small-scale soil type and topsoil organic carbon maps[132].

The first full survey of Northern Ireland soils was carried out over the period from 1988 to 1997, using a Soil Series classification. Soil profiles were observed on a 5km grid across Northern Ireland for each major Soil Series identified in the agriculturally important areas (generally below 200m) and their physical and chemical properties determined. In 2004/05, the grid was extended to include all Northern Ireland (i.e., uplands and urban soils).

128 http://publications.naturalEngland.org.uk/category/5208993007403008

129 http://lle.gov.wales/catalogue/item/PredictiveAgriculturalLandClassificationALCMap2/?lang=en

130 https://gov.wales/agricultural-land-classification-predictive-map-guidance

131 https://www.afbini.gov.uk/articles/soil-maps-and-soil-survey#toc-2

132 https://soils.environment.gov.scot/media/1470/2009_climate-change-land-management-and-erosion-in-the-organo-mineral-soils-in-scotland-and-northern-ireland_research-report-no-325.pdf

Of the 583 soil profiles identified, 81 were classified as peat. This constitutes the National Soils Inventory for Northern Ireland. Erosion features were recorded at only one peat site, although active or historical peat cutting may have masked erosion features at numerous peat sites.

Site-specific ALC surveys for planning purposes are carried out with reference to published soil maps, which cover Northern Ireland at scales of 1:250,000 and 1:50,000. The Agri-Food and Biosciences Institute (AFBI) are the IP holders of the 1:50,000 Soil Series Map of Northern Ireland. The soil map is available as a series of 17 paper maps or under licence as a digital product, contact: *Info@afbini.gov.uk*

Sources of Information for Scotland

Soil Information

Scotland is covered by regional soil maps at a scale of 1:250,000, showing the distribution of generalised soil types called Soil Associations, each containing several component soil types called Map Units, based on parent material and soil forming processes. More-detailed 1:63,360, 1:50:000 and 1:25:000 scale maps have also been produced for a relatively small proportion of Scotland for specific land use planning and land management practices (e.g., Forest Estate maps by Forest Research). These soil maps are also accompanied by memoirs describing the soil types in each survey area.

The Scottish Environment website (SEweb[133]) contains links to all environmental data for Scotland. Scottish Soil (SS) as part of Scotland's Environment, also has a website (Ssweb[134]), which is the dedicated section of SEweb concerned with soil information. These websites are information hubs which do not hold maps or data. Instead, both are managed by the Scottish Environmental Protection Agency (SEPA) with data inputs from the James Hutton Institute (JHI), Nature Scotland (NS), and Scottish Forestry (SF). JHI is the main data custodian for soil information, but Ssweb should be the initial source for digital datasets and reports. All new soil information produced in Scotland with public funding should ultimately end up on Ssweb.

In addition, all dataset and metadata information are available on the Scotland spatial data catalogue portal[135].

The joint SEPA, JHI, NS, SF and SS website provides links to soil maps, thematic maps, capability maps, risk maps and point data including parent material, topsoil lead and zinc concentration and peat depth.

Soil maps and layers can also be viewed on the UK Soil Observatory (UKSO) online browser at *UKSO*[136] using the World Based Reference system.

Land Capability for Agriculture (LCA) Information

The LCA is based on the severity of long-term climatic[137], topographic[138], and soil limitations to the agricultural use of land, and also on the agricultural use of the land. However, whereas the LCA was devised for both land management and land use planning purposes, the ALC was never intended to be anything other than a planning tool for the protection of BMV agricultural land.

133 https://www.environment.gov.scot

134 https://soils.environment.gov.scot

135 https://spatialdata.gov.scot/geonetwork/srv/eng/catalog.search#/home

136 http://www.ukso.org

137 Climatic information for the LCA was prepared by the Macauley Institute (now the James Hutton Institute). It is available at https://soils.environment.gov.scot

138 Topographic information includes flood risk and ground surface gradients. The flood risk information is available from the Environment Agency website and gradients are measured in the field using a clinometer.

The LCA maps classify agricultural land into seven classes according to the types of crops that may be grown depending on environmental and soil characteristics. The LCA Classes range from Class 1 (land capable of producing a wide range of crops) to Class 7 (land of very little agricultural value). Land within Class 3 is subdivided to provide further information on potential yields; Classes 4 and 5 are divided to provide information on grassland; and Class 6 is subdivided on the quality of the natural vegetation for grazing. LCA is also used for planning purposes and Classes 1 to 3.1 are known as 'prime quality agricultural land'[139].

The LCA assessment was carried out in 1981 using data collected between 1978 and 1981. The national scale LCA map was then created in 1983 at a scale of 1:250,000.

The LCA was originally mapped at 1:50,000 in some parts of Scotland, and at this scale it provided greater detail on the types of crops that may be grown, and on the distribution of "prime quality agricultural land".

Paper copies of LCA maps can be purchased from the data custodian JHI at *https://www.huttonsoils.com/maps/category13* for 1:250,000 scale maps and at *https://www.huttonsoils.com/maps/category12* for 1:50,000 scale maps.

Online versions are available from the Scottish Government's SE website[140]. A large part of eastern and lowland Scotland is covered by these online maps at a scale of 1:50,000.

Other Available Information

Further details on available soil and ALC/LCA information can be derived from the 2022 British Society of Soil Science (BSSS) guidance note 'Soils and Land Quality'.[141] This guidance overlaps with other sources of information in this annex.

Geology and Soil Parent Materials

Drift geology maps give a good indication of ground surface deposits and the parent materials that soils are likely to have developed within a study area. The natural variability of soils can be difficult to summarise on a map because of our complex geology and geomorphological history of glacial and fluvial erosion and deposition. However, in many places there are repeated patterns of soil types around landforms which reflect the underlying geological parent materials, and this is the basis to the 'Soilscapes' in England and Wales, described above.

The British Geological Survey's Geochemical Baseline Survey of the Environment (G-BASE) is a high-resolution geochemical mapping project that covers the UK. It was originally designed to assist geological mapping but now has a range of environmental applications and includes soils[142]. In addition, the Geological Survey of Northern Ireland (GSNI) carried out a regional geochemical survey of Northern Ireland's soils between 2004 and 2006 as part of the Tellus Survey[143].

Maps showing underlying geology, ground surface deposits, and scanned borehole records are published as the 'British Geological Survey Open Geoscience Geology Map'[144]. The *BGS GeoIndex*[145] also provides details on

139 https://www.hutton.ac.uk/sites/default/files/files/soils/lca_leaflet_hutton.pdf

140 https://soils.environment.gov.scot/maps/capability-maps/national-scale-land-capability-for-agriculture

141 BSSS (2022) Soils and Land Quality https://soils.org.uk/wp-content/uploads/2022/01/Soils-and-Land-Quality-Jan-2022.pdf

142 https://www.bgs.ac.uk/geology-projects/applied-geochemistry/g-base

143 https://www2.bgs.ac.uk/gsni/tellus/data_licensing/index.html

144 http://mapapps.bgs.ac.uk/geologyofbritain/home.html

145 https://mapapps2.bgs.ac.uk/geoindex/home.html

a range of onshore local datasets and survey results. The *GSNI GeoIndex*[146] provides bedrock and superficial geological information at a range of scales and includes the locations of boreholes and site investigation reports as well as a number of other data sets.

Carbon and Peatland Maps

Detailed site-specific information on the location of carbon-rich soils, deep peat and peatland habitats is likely to become more important and figure more prominently in the EIA process.

In response to the planning policy requirement to identify carbon-rich soils, deep peat and 'priority peatland habitat' as a nationally important interest, Nature Scotland and the James Hutton Institute have developed a Carbon and Peatland Map, published by Natural Scotland. This shows the extent of these soils and habitats across Scotland, recognising that areas thus mapped as Classes 1 and 2 according to this methodology are of national importance. This map is designed for use as a strategic tool for spatial planning. Site-specific surveys are required to determine the precise location and extent of such areas, and to determine the potential impacts of developments in these areas. The map and supporting information are available on the Scotland's soil website[147].

Habitat Mapping

At present there is a variety of published UK soil data related to soils and habitats, most of which is now available digitally. Some data is modelled, some based on field surveys (which may be decades old and possibly not representative of current conditions) and some on remote sensing data. It is an evolving picture but there is a lot of freely available information.

With increased use of GIS-based data in EIA, the UK Centre for Ecology and Hydrology (UK CEH) is undertaking research into the exploitation and integration of technologies and modelling to assess the role of land use and climate change on soils and habitats, and their interaction over time and space from local to national and global scales. This is with a view to recording these changes and applying a natural capital approach to understand the impacts on social and economic benefits. The UK CEH use land cover classes for the UK are similar to the UK Biodiversity Action Plan broad habitats. Looking at soil in this way would potentially facilitate an understanding of the interactions between soils and biodiversity in an EIA. These land cover classes can be related to Annex F in respect of soils on ecologically important habitats. The UK CEH map has the benefit of being relatively current.

146 http://mapapps2.bgs.ac.uk/GSNI_Geoindex/home.html

147 https://soils.environment.gov.scot/maps/thematic-maps/carbon-and-peatland-2016-map

Table 1 – UK CEH Land Cover Classes and Associated Soils

UK CEH Aggregate Class	UK BAP Broad Habitat	UKCEH Land Cover Class	Soils
Broadleaf woodland	Broadleaved mixed and yew woodland	Deciduous woodland	Forest soils – variable
Coniferous woodland	Coniferous woodland	Coniferous woodland	Forest soils – variable (more likely to be acidic and nutrient-poor), note some planted on peatlands
Arable	Arable and horticulture	Arable	Agricultural soils – variable, fertile, acid to neutral (some calcareous) soils
Improved grassland	Improved grassland	Improved grassland	Agricultural soils – variable, fertile, acid to neutral (some calcareous) soils, distinguished from semi-natural grasslands by higher productivity
Semi-natural grassland	Neutral grassland	Neutral grassland	Soil with pH 5 to 7, often less well-drained soils, includes semi-improved grasslands, may be managed for silage, hay or pasture
	Calcareous grassland	Calcareous grassland	Typically, thin soils derived from lime-rich bedrock with pH generally >6
	Acid grassland	Acid grassland	Soils with pH <5.5 derived from acidic bedrock or from superficial deposits such as sands and gravels, free-draining, nutrient-poor such as gravels
	Fen marsh and swamp	Fen	Variable – may include peat or peaty soils, organo-mineral or mineral soils, groundwater-fed and permanently or periodically waterlogged
Mountain, heath and bog	Dwarf shrub and heath	Heather	Typically, well-drained nutrient-poor acid soils
		Heather grassland	
	Bog	Bog	Peat, peaty soils in wetlands that support peat-forming vegetation
	Inland rock	Inland rock	Acid soils, alkaline soils, gravelly soils, note that inland rock includes quarried areas which may have been infilled with imported materials/contaminants (landfill)
Saltwater	–	Saltwater	Soil mismanagement and soil erosion can negatively affect water quality
Freshwater	Standing open water and canals	Freshwater	Soil mismanagement and soil erosion can negatively affect water quality
	Rivers and streams		

UK CEH Aggregate Class	UK BAP Broad Habitat	UKCEH Land Cover Class	Soils
Coastal	Supralittoral rock	Supralittoral rock	Rock above the high-water mark, features that may be present include vertical rock, boulders, gullies, ledges and pools
	Supralittoral sediment	Supralittoral sediment	Shingle beaches, sand dunes, machair
	Littoral rock	Littoral rock	Vertical rock, shore platforms, boulder shores, or rocky reefs surrounded by areas of sediment
	Littoral sediment	Saltmarsh	Includes beaches, sand banks, intertidal mudflats, deep peat and mud
Built-up areas and gardens*	Built-up areas and gardens	Urban Suburban	Variable – may include natural in situ soils and high likelihood of imported materials being present including imported topsoil, engineered fill materials (soil, rock or man-made), waste materials (construction/demolition wastes/spoil heaps etc.).

*Note, this category includes domestic gardens, allotments, urban parkland (but not amenity grassland which would be included in the 'Improved grassland' category). Former mineral extraction and mining areas could fall into this category and resulting spoil heaps may be present above soils on the original ground surface. A problem for sustainable soil and development is that, frequently, soil from the arable or grassland categories is moved to the built-up areas and gardens, where it is likely to require ongoing management.

Other Risk and Thematic Maps

The Scotland's Soils website provides a viewing platform for a range of soil-derived and thematic maps, together with advice on how to use the maps and download the data underlying the maps.[148] This includes the following:

- thematic maps showing the distribution of specific soil properties such as soil organic matter content, and soil texture within Nitrate Vulnerable Zones;
- risk maps showing areas of soil at risk of erosion, leaching and compaction; and
- point data on soils at specific locations.

Environment, Natural Capital, Soil Health and Biodiversity Information

The Scottish Environment website (SEweb[149]) contains links to all environmental data for Scotland, and this includes information on the Scottish National Parks, crofts and other land-related issues.

The charity Buglife Invertebrate Conservation Trust has produced B-line maps (albeit at the small scale of 1:1,000,000) of insect pathways and Important Invertebrate Areas (IIAs) which are informed by monitoring data from various sources and include organisms living in soil such as earthworms[150].

Some data on aspects of soil health are published through the Global Soil Biodiversity Atlas.

148 https://soils.environment.gov.scot

149 https://www.environment.gov.scot

150 https://www.buglife.org.uk/resources

The Joint Research Centre, European Soil Data Centre (ESDAC): Global Soil Biodiversity Atlas is available at: *https://esdac.jrc.ec.europa.eu/content/global-soil-biodiversity-atlas.*

Soil Pollution

The Environment Agency (2007): UK soil and herbage pollutant survey (UKSHS) is available at: *https://www.gov.uk/government/publications/uk-soil-and-herbage-pollutant-survey.* Some data are available from this survey and from contaminated land records held by local authorities.

The UK Air Pollution Information System (APIS) provides a searchable database and information on pollutants and their impacts on habitats and species, including site-relevant critical loads and source of attributions[151]. Soil as a receptor and pathway for air pollution is addressed in Annex G.

Soil Monitoring

There are currently no active baseline soil monitoring schemes. Previous nationwide soil monitoring efforts include the Countryside Survey Monitoring Scheme; the National Soil Inventory England and Wales; and the National Soil Inventory Scotland (see Table 2). More recent developments on soil monitoring have been developed at national levels. This includes partial resampling of national soil information, the development of digital mapping and remote sensing techniques to assess the changing state of soil conditions.

In addition to the three soil monitoring programmes listed in Table 2, Natural England regularly assesses, as a rolling programme, twenty soil plots each year across four national nature reserves (or similar sites) for a range of biological, chemical, and physical parameters, with monitoring repeated every nine years, approximately. This is part of the Natural England Long-term Monitoring Network (LTMN).

151 http://www.apis.ac.uk

Table 2: Previous Soil Monitoring Schemes (taken from EA, 2008*)

Monitoring Scheme	Sample Dates	Sample Design	Soil Properties Tested and Recorded	Area Covered	Scheme Comments
Countryside Survey	1978, 1998, 2007	Stratified random sample from 15km grid intersections	Topsoil depth 0–15cm for most properties. 1978: pH and LOI. CS2000: pH, LOI, Total C and N, Olsen-P, Total Cd, Cr, Cu, Ni, Pb, V, Zn, Hg, As, bacterial counts, BIOLOG, invertebrate taxa, Range of PAHs and PCBs on subset of samples. CS2007 bulk density, pH, LOI, Total C and N, Olsen-P, mineralisable N, Total Cd, Cr, Cu, Ni, Pb, V, Zn, Hg, As, invertebrate taxa, microbial biodiversity (tRFLP).	England, Scotland Wales	Scheme based on representative sampling of ITE land classes. 1978 survey = 256 1km squares x 5 soil sampling locations (max. 1,280 samples). For 1998 (CS2000) reporting was by environmental zones and JNCC broad habitats for UK, England and Wales combined and separately for Scotland (Black et al., 2000). Sampling in 2007 increased to ~600 1km squares (max. ~ 3000 samples).
National Soil Inventory (NSI) England & Wales	c.1978 – 1983. Repeat sampling for SOC on subset during 94, 95 and 2003	5km square intersections	Horizon: colour, texture, structure, moisture, porosity, roots, stones (shape, number and size) carbonates, nodules. Topsoil depth 0–15cm; soil pH in water, SOC, particle size distribution, available K and Mg, available P, extractable Cd, Co, Cu, Pb, Ni, Zn, total Al, Ba, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Ni, P, K, Na, Sr and Zn.	England, Wales	Not designed to be used for the individual countries, but since it is a grid-based design it can be divided easily between the two countries. Any reporting classification can be applied showing the flexibility of a grid-based design.
National Soil Inventory Scotland	1978 –1987	10km grid intersects with additional morphological information at 5km intersections	Depth to top of sample; Depth to base of sample; LOI; % International sand, silt clay; % of USDA or BSTC sand and silt; Ca; Mg Na; K; Exch acidity; Sum of cations; Base saturation; pH in water; pH in Calcium chloride; Total C; Total N; C/N ratio; Organic matter; Total P; Sample Batch Identification; In addition to soil parameters measured for NSIS 1, topsoil horizons were later analysed for Ca; Na; K; Mg; Cu; Zn; Fe; Mn; Al; P; Ni; Cd; Cr; Co; Pb; Sr; Mo; Ti; Bi. NSIS_2 (2006-2008) includes top horizon and topsoil (0–15cm) analyses.	Scotland	As for NSI England and Wales, any reporting classification can be applied since it is a grid-based design. Some classes, however, may not be represented.

* Black et al., (2008) Design and operation of a UK soil monitoring network Science Report – SC060073

Annexe C Soil Survey Methodology

This Annex sets out the soil survey methodology for in situ natural soils, covering all soil functions (including ALC/LCA for biomass, ecology, landscape design and hydrology), that can (with some modifications) be applied in England, Wales, Northern Ireland, and Scotland.

The Agricultural Land Classification (ALC) system used in England, Wales and Northern Ireland[152], and the Land Classification for Agriculture (LCA)[153] require some different approaches to a broadly similar survey methodology; however, this is mainly in respect of climatic, topographic, and land use assessments.

Existing soil information available from other sources (see Annex B) for land within a proposed development site should be collated in a desk study, and then combined with the results of detailed field survey work undertaken for the proposed development.

Detailed soil surveys are carried out using OS base maps at scales of 1:10,000 or larger, with soil auger samples taken at an appropriate density to map variations in soil types (usually at a density of one sample per hectare on a 100m grid). Depending on the variability of the soil and site characteristics, supplementary auger and soil pits are investigated within this grid to fine-tune the boundaries between different soil types. This, for example, is considered by Defra and Natural England to be a definitive level of detail for ALC and soil resource surveys for the restoration of surface mineral sites, and in broad terms, it might be considered applicable to the rest of the UK. However, this density of sampling should be significantly increased for the planning of soil handling for habitat creation and translocation, and the actual density will depend on the physical properties of the study areas.

Following an initial desk-based review of existing soil maps, soil augers are used to determine the distribution of different soil types within a study area, and soil pits are dug to describe the subsoil structures and drainage status of the soil profiles for each of the soil types, which cannot otherwise be seen from an auger sample.

ALC/LCA, soil resource and soil functions/soil health surveys, on-site supervision of soil handling operations and the monitoring of soil conditions should be carried out by suitably qualified and experienced soil scientists or environmental scientists in closely related disciplines with the necessary training. Other suitably qualified soil practitioners have studied soil and land management modules at universities and colleges, and other environmental practitioners within EIA teams may have acquired sufficient expertise during professional practice to use soil information provided by these soil and environmental scientists. The British Society of Soil Science[154] sets out the recognised professional soil competencies.

The ALC/LCA and advice on soil handling will rely principally on identifying and recording the physical characteristics of the soil profile, particularly the depth and texture of each soil horizon (topsoil, upper subsoil, where present, and lower subsoil) and presence or absence of diagnostic horizons (e.g., slowly permeable layers for assessing wetness limitations), together with some chemical characteristics. Topographic and climatic information is also required alongside the soil characteristics to inform the ALC/LCA grade/class.

The soil information is compiled and used to determine the quality of agricultural land, the soil resources present and to identify the implications of the proposed development for all soil functions. The output of this work will generally comprise a master spreadsheet of

152 MAFF (1988) Agricultural Land Classification of England and Wales: Revised criteria for grading the quality of agricultural land – ALC011 (naturalengland.org.uk)

153 Bibby J S et al, 1991. Land Capability Classification for Agriculture. The Macaulay Land Use Research Institute, Aberdeen. ISBN 0 7084 0508 8

154 https://soils.org.uk/wp-content/uploads/2021/01/WWS-Complete-Competencies.pdf

soil observations, GIS mapping identifying the location of observations and the properties of soils at each sample point and an accompanying report.

Site Conditions

Prior to the survey, the site-specific climatic and flood risk characteristics should be determined.

The soil survey shall include a description of the local topographic features (local relief, slope, aspect, micro-relief), current land use and groundcover.

For hydrological studies dip wells, piezometers and other suitable ground and surface water level measurement equipment may be installed in a pattern determined by the main soil types and topographical locations within a study area. This may be relevant when carrying out soil surveys in peatland and wetland areas, and for habitat creation and translocation.

Detailed Specifications

The soil survey shall observe, describe, and record the characteristics of the site and soil profile using the established terminology set out in the *Soil Survey Field Handbook*[155] to describe the soils. The ALC methodology is set out in MAFF's 1988 *'Agricultural Land Classification of England and Wales: Revised criteria for grading the quality of agricultural land'*[1].

Prior to work commencing, buried service plans should be obtained and checked, and each survey point should be scanned for presence of utilities and services using a Cable Avoidance Tool (e.g. CAT scanner) and/or other suitable service location equipment by suitably trained personnel to comply with the Health and Safety Executive's guidance document HSG47[156]. If services are detected, the survey point should be relocated at a safe distance, with the alternative location also being scanned.

The soil survey shall be carried out using a soil auger to a depth of 1.2m (unless the ground is impenetrable at a shallower depth) at a density of one auger per hectare, to determine the physical properties and collect soil samples for the main soil types present in the survey area.

The core is taken in stages down to 1.2m, with approximately 200mm increments removed at a time, so that the soils are removed in sequence down the profile, with no mixing. Following assessment, soils are replaced in sequence to maintain the soil profile and thoroughly tamped down so no 'hole' or divot is left behind.

During the soil survey, a soil pit shall be dug in each of the main soil types present in a survey area to observe and describe the whole soil profile in more detail, particularly in respect of subsoil structure, stone content and rooting development. It should be assumed that at least one soil pit will be required per mapped soil type.

The profile pit is excavated to remove material and examine each profile horizon present in sequence. The excavation should be stepped, with the number of steps dependent upon depth. Once the profile has been investigated, the soils are replaced on a horizon by horizon basis to replicate the soil profile. Soils are tamped down so no 'hole', divot or mound is left behind. Turves are replaced in their original orientation, to minimise gaps between turves, and tamped down.

Alternative sources of published soil information will be needed where it is not possible to dig soil pits (e.g. where landowners have not given permission). The default should be to refer to local pit data for the soil type in question from relevant MAFF/Defra or other survey, or available detailed soil mapping on or close to the survey area, or local NSI (National Soil Inventory) mapping (i.e., from the individual 5km NSI points on or close to the route in the locality for the relevant soil types). Only if this quality of information is not available will information

155 Hodgson (1974) Soil Survey Field Handbook: Describing and Sampling Soil Profiles

156 HSE (2014) HSG47 'Avoiding danger from underground services'

from the standard published profile (e.g., the LandIS Soils Guide, and the Soil Information for Scotland soil apps) be considered. In practice, experienced soil surveyors will consider a range of sources.

For ecological translocation purposes in respect of a wide range of habitat types the soils at both donor and receptor sites will need to be surveyed. This applies in particular to the translocation of Ancient Woodland soils. Ecological site investigations (particularly for translocations) will require a higher density of sampling and may also require additional information, with reference to the CIRIA '*C600 Habitat Translocation Best Practice guidelines*' (2003). This level of site investigation goes beyond the scope of soil survey for ALC/LCA and agricultural restoration.

When imported waste material is intended to be mixed on-site with soils, information on the properties of the material and the mixing ratio should also be provided.

Soil Characteristics

At each auger sample point, the following characteristics shall be recorded, with reference to the Soil Survey Field Handbook:

- site characteristics (slope, aspect, micro-relief), flood risk, land use and groundcover;
- presence/absence of a litter layer;
- depth of the topsoil, upper subsoil (where present) and lower subsoil horizons;
- soil textures;
- Munsell colours;
- stone content;
- signs of impeded drainage and presence of slowly permeable layers by extrapolation from horizons in representative pits;
- presence of calcium carbonate in each soil horizon shall be tested using dilute (10%) hydrochloric acid; and
- the ALC/LCA grade/class for each auger sample and soil pit, in accordance with the MAFF Agricultural Land Classification of England and Wales or the Bibby et al., Land Capability for Agriculture, respectively.

For each of the main soil types within a survey area, the following characteristics shall be recorded at a soil pit (including with photographs) in addition to those described above and collected from augering:

- the soil profile;
- topsoil and subsoil structures, consistency and porosity;
- stone content (type, size and hardness); and
- plant root development.

Soil Sampling and Laboratory Analysis

Analysis for particle size distribution (using the traditional sieving/settlement methods which underpin the soil texture classes required for the ALC) may, on occasion, be required to confirm or calibrate hand texturing.

Where sampled soils are of a clay loam and silty clay loam texture, additional laboratory testing is required to determine the soils' clay content for the accurate determination of ALC. In this case and typically, one 500g composite sample is taken to represent each distinct topsoil or subsoil type identified within the site.

In addition to sampling for particle size distribution, composite samples can be taken within each soil type to obtain information on the soil chemical characteristics. To compile a composite homogenous sample for chemical analysis, an appropriate sampling protocol should be followed. For example, four incremental sub-samples shall be taken by auger (at a density of one composite bulked sample per hectare) separately from each of the upper two soil layers (i.e. topsoil, and subsoil or upper subsoil where present) at 10m distances to the north, south, east and west of the original auger sub-sample point and mixed together to create one 'composite sample' (minimum 500g) for topsoil, and another for subsoil/upper subsoil.

The depth of subsoil and topsoil may vary across sites. Hence, the location and depth of subsoil and topsoil should be clearly recorded. The definition of topsoil and subsoil shown under 'Soil Profile' in Annex A can vary depending on the proposed use of displaced soils and the aims of the survey. Soil samples for restoration purpose should consider topsoil as 'A' horizon only, not the combined 'A' and 'B' definition used by engineers when referring to excavated materials. The 'B' horizon should be considered as the upper subsoil.

To compile a composite sample for habitat creation and translocations each soil layer (i.e., topsoil, and subsoil or upper subsoil where present) shall be collected (as described above) from 4 contiguous sample locations and combined to form 1 composite sample for laboratory analysis, at a density of 5 composite, bulked samples per hectare.

Each composite sample of topsoil and subsoil (or upper subsoil where present) shall be submitted for laboratory analysis, using a quality assured laboratory (UKAS and GLP accredited), which should use the appropriate methods for the intended purposes of the analysis.

The soil chemical specifications are required in all cases to inform the landscape design and ecology mitigation, and are dependent on the laboratory analysis of the following:

- pH (1:2.5 soil/water extract, and pH in CaCL2);
- major nutrients (extractable Phosphorus, Potassium & Magnesium (mg/l – RB427 Method));
- organic matter content (% Loss on Ignition); and
- total Nitrogen (mg/l) (for habitat translocations).

Monitoring and Validation

The survey techniques used to collect baseline data can potentially be replicated for monitoring and validation purposes, so that the soil condition can be checked before, during and after development to see if it has deteriorated, remained the same or improved.

Annexe D Soil Health

What is Soil Health?

Soil health is the ability or potential to fulfil the functions and sustain the ecosystem services that are expected of soil. Soil in good health can perform its expected functions (potentially including growing food and timber, controlling the quality and quantity of water flow, supporting plant and animal habitats and species, and storing carbon), whereas soil in poor health or that has been damaged will have impaired functions or will have lost the ability to perform certain functions.

In some instances, soil health for some functions (e.g., food production) is poor due to natural factors (e.g., very sandy soil has poor structure, poor fertility and cannot hold water), and moorland peat can be wet, with high organic matter contents, and acidic pH values). However, these soils perform other ecosystem services very well (supporting lowland heathland, rare wetland habitats, and carbon storage). Clearly, soil health is a relative term, depending on the preferred use of the land, and a key consideration should be the maintenance of the expected soil functions for a given soil type.

The presence of certain elements or contaminants at elevated concentrations due to natural or other processes (pollution) can also reduce expected functions (e.g., heavy metals in soil inhibiting plant growth). Soil structure drainage channels and pore spaces are key to soil health as they influence water retention and movement, root penetration, carbon storage, susceptibility to erosion, and fertility. They underpin many of the natural capital benefits soil provides[157]. There is no common set of soil health indicators, but key indicators are likely to include soil structure, bulk density, pH, organic carbon, nutrients, and soil biota.

Soil Biodiversity

Most healthy soils have high levels of biodiversity, but this is a poorly understood subject. Living organisms within soils include micro-organisms (e.g., bacteria, fungi, protozoa, and nematodes) and meso-fauna (e.g., acari and springtails), as well as the more familiar macro-fauna like earthworms. Plant roots are also soil organisms.

Within a soil, organisms interact with one another and with the various plants and animals in other parts of ecosystems to form a complex web of biological activity. Soil organisms contribute a wide range of essential services to the sustainability of all ecosystems. They act as the primary agents of nutrient cycling, regulating the incorporation of soil organic matter, soil carbon sequestration and greenhouse gas emission, modifying soil physical structures and water regimes, enhancing nutrient acquisition by plants, and supporting plant health. These services are not only essential to the functioning of natural ecosystems but constitute an important resource for the sustainable management of agricultural systems.

The Natural Capital Committee's *'Enabling a Natural Capital Approach: Guidance'*[158] suggests that, at the national level, consideration should be given to a measurement of soil invertebrates that are known to be essential for good soil health. This could then be potentially applied on a targeted project scale.

There are many possible approaches to measuring elements of soil biodiversity (e.g., root density, earthworms and other species, microbial, and DNA arrays), but few provide a direct assessment of how measured biodiversity indicators relate to the health and fitness of soil to deliver specific functions or indicate the management options that will improve soil health and

157 The Royal Society (2020). Soil structure and its benefits, An evidence synthesis. Available online at: https://royalsociety.org/-/media/policy/projects/soil-structures/soil-structure-evidence-synthesis-report.pdf?la=en-GB&hash=72F445B55A767AB4894238472B684B30

158 Defra (2020) *Enabling a Natural Capital Approach: Guidance* https://www.gov.uk/government/publications/enabling-a-natural-capital-approach-enca-guidance

functions. Current approaches can indicate the status of soil biodiversity, health, and functions, but they provide little information on the impacts that development can have on these soil properties. However, the soil health concept is gaining traction as a holistic measure of the way in which the physical, biological, and chemical status of soil changes in response to a range of social, development and environmental pressures.

The UK Crop Microbiome Cryobank (UK-CMCB) has been set up to record the results of future research and facilitate the sustainable improvement of yields for the UK's six major food crops: barley, oats, oilseed rape, potato, sugar beet, and wheat. The Cryobank will develop a 'Noah's Ark' of UK microbes associated with crop systems that will form the first publicly available resource of its kind anywhere in the world. The project will use advanced DNA sequencing techniques to discover what microbes are present, their function in the microbiome and their role in enhancing crop growth.

Microbiomes are all the microbes present in any one terrestrial ecosystem (of which soil is a part), in this case those associated with the crop plants, whether they are present in the leaves, seeds and stems or in the bulk soil around the roots. A beneficial microbiome results in a healthy plant and improved crop yield and better-quality food.

Assessing Soil Health

On land where development is proposed, it is necessary to understand the soil health baseline and the likely effects of the development on this baseline. Due to the natural variability of soil and the range of pre-development land uses, there is no single method that can be applied to measure effects on soil health. However, there are established and emerging approaches to considering soil health in the round, both qualitatively and quantitatively, and in certain contexts. These include:

Surveys of agricultural land

Land capability mapping and risk mapping including Agricultural Land Classification (ALC) surveys undertaken in England, Wales and Northern Ireland, and Land Capability for Agriculture (LCA)[159] surveys in Scotland.

Assessment of soil properties

A range of soil assessment approaches for farmers and growers is provided in the Agriculture and Horticulture Development Board (AHDB) *'GREATSOILS Soil Assessment Methods factsheet'*[160]. In 2016, AHDB and the British Beet Research Organisation (BBRO) funded a five-year Soil Biology and Soil Health Partnership to focus on soil health, which aims to produce a toolkit to assist with its measurement and management. A *'Soil Health Scorecard'*[161] has been developed which considers the physical, chemical, and biological properties of soil. The AHDB is also looking at common indicators: pH, routine nutrients, bulk density and penetrometer resistance. Less-common indicators include the visual evaluation of soil structure (VESS), soil organic matter and loss on ignition (LOI), respiration and earthworms; and new indicators like total nitrogen, microbial biomass carbon, potentially mineralisable nitrogen (PMN), and DNA measures of pathogens, like nematodes and microarthropods.

A quick soil structure score card based on the SRUC (Scotland's Rural College) Visual Evaluation of Soil

159 https://www.hutton.ac.uk/sites/default/files/files/soils/lca_leaflet_hutton.pdf

160 AHDB, GREATSOILS Soil Assessment Methods Factsheet. Available online at: https://projectblue.blob.core.windows.net/media/Default/Programmes/GREATSoils/GREATsoils_SoilAssess_2018-06-29_WEB.pdf

161 AHDB, GREATSOILS Soil Biology and Soil Health Partnership Research Case Study, Testing the soil health scorecard (On-farm soil monitoring 2018–2019). Available online at: https://projectblue.blob.core.windows.net/media/Default/Imported%20Publication%20Docs/AHDB/Soil%20Health%20SCard.pdf

Structure (VESS) system[162] is available from the Soil Association[163]. A quality score is given together with suggested management options to maintain or improve soil health.

The Royal Society *'Recommendations for assessing soil structure'*[164] include the use of visual field assessments and scorecards, soil compaction and soil water assessments, use of soil remote sensing data, and modelling. There are also moves to develop a new generation of soil models based on a systemic approach comprising relevant physical, chemical, and biological processes to address critical knowledge gaps in our understanding of soil processes and their interactions.

Data on aspects of soil health are published through the Global Soil Biodiversity Atlas, the UK Soil and Herbage Pollutant Survey, and from contaminated land records held by local authorities.

More recently, SRUC has developed a soil health test[165] which provides an integrated measure of the condition of a soil, allowing for informed management to improve underlying soil properties rather than responding to crop symptoms. It provides options for optimising soil health, to maximise crop yield with fewer inputs. The Scottish database enables quantifiable comparison of changes over time to determine the effects of specific management practices.

Peatland

Guides to peat depth and peatland condition surveys[166] and peatland condition assessment[167] are available from NatureScot for the restoration of upland peatland habitats.

Topsoil

The '*BS 3882:2015 Specification for topsoil*' sets out composition requirements for the classification of material as topsoil, where natural and manufactured topsoils are moved or traded between sites (i.e., not topsoil in situ), specifying characteristics such as texture, acidity and permitted levels of contaminants. This is relevant in assessing the quality of imported topsoil, where it is required for a development, or where topsoil displaced by development must be relocated off-site.

Subsoil

The '*BS 8601:2013 Specification for subsoil and requirements for use*' sets out composition requirements for the classification of material as subsoil and specifies the use of subsoils which are moved or traded between sites to create soil profiles intended to support plant growth. It specifies requirements for multipurpose subsoil, which is fit for most needs, and also specific-purpose subsoils that are for specialist use where acidic or calcareous soil profiles are required. It also specifies requirements for sampling and analysing subsoil.

162 www.sruc.ac.uk/vess

163 Soil Association. Healthy Grassland Soils – Four quick steps to assess soil structure. https://www.soilassociation.org/media/6472/healthy-grassland-soils-2_sider.pdf

164 The Royal Society (2020). Soil structure and its benefits, An evidence synthesis. Available online at https://royalsociety.org/-/media/policy/projects/soil-structures/soil-structure-evidence-synthesis-report.pdf?la=en-GB&hash=72F445B55A767AB4894238472B684B30

165 https://www.sruc.ac.uk/business-services/help-in-your-sector/agricultural-production/soils/soil-health-testing-kit

166 NatureScot. Peatland Action – Peat depth and peatland condition survey guidance (2020-21). Available online at: https://www.nature.scot/peatland-action-peat-depth-and-peat-condition-survey-guidance-and-recording-form-guidance

167 NatureScot. A guide to peatland condition assessment. Available online at: https://www.nature.scot/sites/default/files/2017-10/Guidance-Peatland-Action-Peatland-Condition-Assessment-Guide-A1916874.pdf

The Future of soil health metrics

The Natural Capital Committee[168] suggests that in developing and adding to soil metrics proposed in the UK Government's 25 Year Environmental Plan (YEP) indicator framework, consideration should be given to the following metrics to form a baseline data for soil:

- bulk density as a measure of soil structural development and stability, compaction, water storage capacity in respect of flood risk, and risk of nitrous oxide production (an important greenhouse gas);
- soil pH, which is important for biomass production, water quality and biodiversity;
- soil organic carbon measured to a depth of 15cm, which is important for carbon sequestration, crop nutrition and soil structural stability;
- soil nitrogen, which is important for biomass/crop production and potential risk to water quality, nitrous oxide production and plant biodiversity; and
- soil phosphorous, which is important for biomass/ crop production and potential risk to water quality.

Soil Health Interactions

Other surveys and assessments undertaken for the purposes of an EIA may also provide information on soil health, despite soil health not being their focus. The interactive, cross-cutting use of the findings from these surveys with those carried out specifically to assess soil health should be considered in EIA. Such surveys and assessments may include, but are not limited to: land contamination; flood risk assessment; climate change and sustainability; ecology; health and wellbeing.

Soil Health in the Context Of Planning

Development can have an immediate and significant negative effect on soil health (e.g., a productive agricultural soil being sealed; topsoil being compacted by the use of heavy machinery during construction or left at risk of erosion when stored in high mounds with steep slopes, no vegetation/ground cover and exposed to wind and rain). More subtle effects on soil health may occur due to changes in land use as a result of development (e.g., increased public access and footfall could lead to the removal of vegetation, soil compaction, and increased soil erosion etc). Development can also have a positive effect on soil through the remediation of contaminated land, peatland restoration, and changes in land management practices. However, such positive effects on soil health will rely on effective management measures and monitoring, so the default position is to protect healthy soils wherever possible.

Applying Soil Health in EIA

It is necessary to understand at an early stage in the EIA process the negative effects of a proposed development on the soil properties that define soil health and determine soil functions, as described in Section 6 of the main text of the guidelines. It is then necessary to determine whether these can be avoided or mitigated or compensated for, and whether there are any potential positive effects.

The tools set out above can be applied or adapted (with specialist inputs from soil scientists, ecologists, etc) to provide qualitative and quantitative soil health data to establish baseline conditions. These tools can be used to determine the effects of a proposed development on the soil properties that define soil health. They can also be used during and after development to determine the soil health outcomes a proposed development.

168 Natural Capital Committee (2019). The Natural Capital Committee's advice on an environmental baseline census of natural capital stocks: an essential foundation for the government's 25 Year Environment Plan, September. Available online at: https://www.gov.uk/government/publications/natural-capital-committee-advice-on-developing-an-environmental-baseline-census

Table 1 can be used at scoping to help identify where development effects on soil health are likely to occur.

Table 1: Effects of Development on Soil Health

Does the proposed development include:	If yes, actions required include:
A change in land use or land management that will permanently and significantly affect soil health (including soil functions)? Consider whether the proposed development will result in changes to soil health indicators: e.g., soil sealing, drainage, bulk density, porosity, pH, organic carbon, nutrients and biota.	Carry out a qualitative assessment of baseline soil health. Use quantitative data on soil health where possible so that this can inform the design process early on to avoid unexpected problems later in the EIA process when there may be less flexibility (e.g., over the red line boundary). Quantify areas and volumes of soil affected by change (permanent or temporary). If negative effects are likely then look for opportunities to avoid, mitigate or compensate for these. Consider the subtler (negative) impacts of changes to land use and land management practices that will result from the development on soil health (e.g., increased public access in an area previously not frequently accessed) and how these can be avoided/limited. Consider whether improvements to soil health are possible through contaminated land remediation, removal of invasive species (alien plant species [e.g., rhododendron] which replace native vegetation and can have potential knock-on consequences for soil biodiversity[169].
Construction activities that could affect soil health (e.g., use of heavy machinery on temporary access routes)?	Soil survey, site-specific Soil Resource Plan, and applicable guidance (e.g., Defra Construction Code (2009)) to avoid/reduce impacts.
Temporary displacement of soil (i.e., soil will be handled and returned to the site of origin, so measures are needed to prevent the soil becoming damaged)?	Soil survey, site-specific Soil Resource Plan, and applicable guidance (e.g., Defra Construction Code (2009)) to avoid/reduce impacts. Consider soil sensitivity to handling and adjusting the site boundary to ensure adequate space to allow good practice for soil handling.
Permanent displacement of soil (i.e., there is a need to avoid soil becoming a waste and ideally to identify a suitable receiving site)?	Soil Resource Plan (SRP) to tie in with the Materials Management Plan (MMP) or Site Waste Management Plan (SWMP) if contaminated land is an issue. Consider soil sensitivity to handling and adjusting the site boundary to ensure adequate space to allow good practice for soil handling and identifying possible on-site receiving areas. If soil cannot be used on-site, note the potential for clean naturally occurring soil (and suitable soil-forming excavated materials) to be used off-site without waste legislation needing to be applied[170].

169 Natural Scotland (2011). The State of Scotland's Soils. Available online at: https://www.sepa.org.uk/media/138741/state-of-soil-report-final.pdf

170 The DoWCoP allows direct transfer and reuse of clean naturally occurring soil materials between sites. See: CL:AIRE (2011) The Definition of Waste: Development Industry Code of Practice, Version 2. https://www.claire.co.uk/projects-and-initiatives/dow-cop/28-framework-and-guidance/111-dow-cop-main-document

Annexe E Soil Handling for Peat and Peaty Soils

Peat disturbance and removal are particularly damaging as this disrupts the structure of the peat and changes its hydraulic characteristics perhaps irreversibly, as well as resulting in the release of carbon and the destruction of any associated paleo-environmental archive. Therefore, development on peat soils should be avoided where possible.

SEPA and the windfarm industry have worked together to produce guidance on the assessment of peat volumes, reuse of excavated peat and minimisation of waste. Much of this is applicable to any development on peat and this needs to be referred to and drawn from. It is somewhat dated but still relevant. It is available at: *https://www.gov.scot/publications/assessment-of-peat-volumes-reuse-of-excavated-peat-and-minimisation-of-waste-guidance/*

Good practice regarding restoration of peatland is also available from the NatureScot website at: *https://www.nature.scot/climate-change/nature-based-solutions/peatland-action-project*

The peatland survey guidance published by the Scottish Government updated in 2017 is essential reading: *https://www.gov.scot/publications/peatland-survey-guidance/* and Nature Scotland has links to best practice for development on peat.

According to SEPA: '*Restoration Techniques Using Peat Spoil from Construction Works*', 2011, such handling should aim to:

- maintain or enhance peatland ecosystem services (such as carbon sequestration);
- minimise risks to ecosystem services (such as loss of habitat, water quality, storage, or ground stability; and
- retain excavated peat in storage as close to the point of disturbance as practicable.

To this list should be added minimising the time excavated peat is stockpiled and ensuring adequate irrigation of stored peat, preferably with water derived from local rainfall. Peat has several attributes which determine the approach to be taken when it is handled, and the SEPA guidance sets out the main considerations:

- the greatest biological activity within peat takes place at variable depths near the ground surface, but generally within the top 30cm;
- there are two main types of peat (amorphous and fibrous); and
- in many locations water will be present (at least for part of the year) within peats and peaty soils disturbed by development. and it will be necessary to dewater them prior to their excavation in a relatively dry state.

These considerations will have a significant influence on the method of excavating, storing, and reinstating the peat.

Water can be derived from surrounding drift or bedrock, or otherwise present within the peat. In general, excavation should try to avoid groundwater-fed areas of peat and the widespread dewatering over the whole of a development site for peat excavation should be avoided if possible, and alternatives should be explored as dewatering poses a significant hydrological impact extending beyond the immediate physical footprint of the development.

Localised alternatives might include reducing the time excavations are left open and dewatered, thus also reducing the risk of slumping. Sheet piling can be used around deeper and more prolonged excavations. Shallow restoration piling around open excavations should be considered as most of the water movement within peat (except for around peat pipes) is likely to occur within the uppermost 1m or so of the peat profile.

Control measures should be considered prior to construction and set out in a Peat Management Plan (PMP) or equivalent, to include mitigation measures around naturally occurring peat pipes, which can carry significant volumes of water and are known to be widespread features across blanket mires. Land restored using peat should include provision for the long-term control of groundwater.

There may be peats or peaty soils which become strongly acidic when oxidised (i.e., drained or exposed to the atmosphere), which can give rise to acidic water runoff. This will require specific identification and separate stripping and storage of these sulphidic peats. The soil survey and Soil Resources Plan (SRP) or (PMP) should be used to identify any potentially sulphidic peats. Amorphous and fibrous peat should be stripped and stored separately from each other and separately from materials from the top 30cm. These materials and mineral substrates (i.e., lower subsoils and weathering rock) should not be mixed. The volumes of the different types of peat should be set out in an SRP or PMP, based on detailed soil surveys carried out according to the most-appropriate methodology.

Amorphous peat becomes liquefied if moved whilst wet, and mobile if placed on ground with a surface gradient. Because of this, storage might have to be within confined areas (e.g. in cells temporarily excavated, preferably within mineral soils for this purpose) to support both the retention of peat within its designated storage area and its adequate irrigation, preferably with water derived from local rainfall. It is essential, to keep peat wet during storage to minimise its further degradation and carbon emissions, though complete replication/maintenance of the conditions under which it formed is unlikely to be realised. This treatment would also benefit sulphidic peats, reducing the potential for the development of acidic conditions.

Peats and peaty soils should be handled only if, under moderate pressure between the hands, water is not squeezed out. Peats and peaty soils should not be handled if disturbance causes wind blow. The reinstatement of peats and peaty soils should be carried out when they are moist, and this might require a degree of dewatering of the stored peats and peaty soils prior to their reinstatement.

Peats and peaty soils should be reinstated at a location with shallow surface gradients, and within a wider landform where it will be possible to control the groundwater and maintain water table levels appropriate to the proposed land use. A ground cover suitable for the proposed land use should be introduced shortly after the reinstatement of the peat to protect the ground surface from rainfall and to stabilise the peat. The restoration of semi-natural peatland vegetation is highly desirable.

The handling of peaty soils (i.e., those with a mineral content derived from weathered rock) is generally covered by the general guidance available for soil handling. Where peaty soils have a significant depth of peat topsoils over mineral subsoils, however, the handling of the peat topsoils during stripping, storage, and reinstatement should follow the specific guidance set out above for peats.

The ‘floating haulage route’ method should be used for the movement of vehicles used for peat handling. On shallow gradients, the SEPA guidance on haulage routes indicates the use of crushed stone laid to a depth of 700–800mm on geotextile. Other low-impact measures should be used for handling peats, such as the use of low ground pressure vehicles and other equipment.

Provision should be made for the long-term management of land to maintain its value for the intended use with a peat or peaty substrate.

Annexe F Soil Handling for Restoration to Agriculture, Ecology and Landscape Design

Introduction

This Annex is derived from an interpretation of the good practice guidance on soil handling in the Defra (2009) '*Construction Code of Practice for the Sustainable Use of Soils on Construction Sites*'; the IQ (2021) Good Practice Guide for Handling Soils in Mineral Workings, and Defra's (2004) '*Guidance for Successful Reclamation of Mineral and Waste Sites*'. It sets out practical guidance for soil practitioners advising specialists in agriculture, ecology, and landscape design on the most important properties of soils, together with some general principles of soil handling for effective land restoration, habitat creation and translocation, and landscape design. Peatland restoration is addressed in Annex E.

The Most Important Soil Properties

The most important soil properties for soil handling are soil texture, structure, drainage, and soil chemistry. Protecting and restoring a range of soil properties will maintain the ability of soil to support soil functions: healthy habitats, crop production, and the establishment of landscape planting.

Soil Texture and Soil Structure

Soil texture[171] describes the size and shape of the mineral component of soil derived from weathering rock. Soil textures combine with organic matter and cements like iron oxides to form porous structural aggregates separated by drainage channels. The development of soil structures is highly dependent on the presence of soil organic matter. Together, soil texture and structure determine many of the inherent stability and drainage properties of soils.

Soils are composed of weathered rock, organic matter including microorganisms (concentrated mainly in the topsoil), air and water. The mineral component of the soil is a continuum of particle sizes, but in practice, particles are classified into three size ranges (sand, silt, and clay). Organic soils and peats have little or no mineral content, and they form separate textural classes.

Soil texture and soil structure vary with depth. Organic matter is usually concentrated in the top part of the soil profile. This is referred to as the 'topsoil', which often has loamy textures and develops loose and open crumb structures, which combine with relatively high levels of nutrients to provide a favourable substrate for the initiation of plant growth.

Lower down the profile, subsoils have a significantly lower organic matter content and are closer in texture to their parent material or underlying geological substrate. Hence, they have often a more compacted nature less suitable for root penetration and development, with lower nutrient levels.

Obviously, clay rocks weather to clays, sandstones to sand and siltstones to silt. But there are several geological mixing effects which create loamy textures (i.e., soils with proportions of sand, silt, and clay). Some rocks are made up of different minerals which can weather to sands, silts and clays to form loams. Some strata contain alternating lithologies (e.g. layers of sand within siltstones), which also weather to loams.

Over geomorphological periods of time (thousands to hundreds of thousands of years) fluvial, colluvial and glacial processes have eroded, deposited and mixed different types of material to cover underlying rocks with superficial deposits of alluvial terraces and floodplains, together with glacial till and head deposits, as shown on geology drift maps. These superficial deposits often weather to form loams.

171 Natural England Technical Information Note TIN037 – Soil texture.

These processes create soil parent materials with different proportions of sand, silt and clay, and they are classified into soil texture classes, as shown in the texture triangle below. This example is derived from the Soil Survey of England and Wales Field Handbook[172] and it is used in the ALC system.

Soil texture influences many soil properties largely driven by the surface area of particles. For example, a large surface area (i.e., clay) typically results in a higher capacity for holding water, nutrients and other chemicals, a greater propensity for soil particles to aggregate, and increased area for microorganisms to colonise; however, due to the small size, flat shape and packing of clay particles, pore space can be low, resulting in poor drainage.

The yellow zone in the texture triangle shows the most favourable texture classes for plant growth from an agricultural perspective, for both topsoils and upper subsoils. This is because these loamy textures develop optimum soil characteristics, including smaller structures with good pore spaces, which can be exploited by plant roots for the extraction of moisture and nutrients, whilst also exhibiting good aeration and drainage. These smaller structures also generally mean more drainage channels and better drainage.

In our cool temperate climate, soil structures have developed over long periods of time because of repeated cycles of wetting, drying, freezing, and thawing; combined with the cementing and binding effects of iron oxides, calcium carbonate (where present) and organic matter. The different types of structures (blocky, prismatic, and platy, etc.) are described in the '*Soil Survey of England and Wales Field Handbook (Hodgson, 1975)*'.

Without well-developed subsoil structures, soils would not be able to drain, and plants would not have sufficient rooting depth to extract sufficient moisture and nutrients. Soil handling should seek to avoid damage to these structures, and soil translocations should seek to replicate donor site structures within receptor sites, following an aftercare period.

Soil profiles on higher quality agricultural land (e.g., ALC Grades 1, 2 and 3a, and LCA Classes 1, 2 and 3:1) tend to have sequences of three separate or gradually merging texture layers or horizons, with loamy topsoils and favourable (from an agricultural perspective) loamy upper subsoils over clayey, silty and sandy lower subsoils. Soil profiles on lower quality land (ALC Grades 3b/4, and LCA Classes 3:2, 4, 5 and 6) tend to have only two texture layers or horizons, with topsoils directly over clayey, silty and sandy subsoils. These are a more favourable substrate from an ecological perspective..

Where they occur, the upper subsoils vary in thickness from one place to another. The deeper the combined thickness of the loamy topsoil and upper subsoil textures (and their associated structures) the better the quality of the land, the higher the ALC/LCA Grade/Class, and the higher the levels of nutrients. These are generalisations, but they are helpful in planning the alternative uses of soil resources displaced by development. This becomes clearer when focusing on objectives at a particular site.

Proposed land uses, restoration objectives and methods should be based on the properties of soils present within a study area, as determined by a soil survey. From an agricultural perspective, the better-quality soils with the loamy upper subsoils are likely to have greater accumulated relatively high nutrient levels from their more intensive agricultural use and fertiliser applications. For the restoration of semi-natural habitats, however, this may prove detrimental to species that thrive on low nutrient or specific pH levels. So, for ecological purposes, the aim of a soil survey is to identify and secure the soils from the lower-quality (for agriculture) land with the two texture layers or horizons, with subsoil textures outside of the yellow zone.

172 Hodgson (1974) Soil Survey Field Handbook: Describing and Sampling Soil Profiles.

In applying this approach, soil surveys and statements of site physical characteristics should describe soil profiles in terms of the sequence and thickness of soil texture horizons, as within a Soil Resource Plan (SRP) this readily facilitates method statements for the separate stripping of topsoils and different subsoil horizons, and the allocation of soil resources to land uses for agriculture, ecology or landscaping.

Chemical Properties

Ecologically valuable habitats are associated with low nutrient and high pH (alkaline/calcareous) or low pH (acidic) soils. Soil organic matter content and its status will also be critical factors. Soil with a high organic content, if not handled and stored properly, can be prone to desiccation and the subsequent re-wetting of the material may prove to be difficult, and this is addressed in Annex E.

To ensure the sustainable management of soil (a 25 YEP target), the proposed habitat should be selected to match the characteristics of available soils, rather than altering the soil to suit a habitat. To achieve this, it is necessary to determine the chemical characteristics of the available soil. Broadly speaking, soil samples should be collected and tested prior to use for pH value, extractable phosphorus, potassium, and magnesium, and organic matter content. Soil samples should also be tested for total nitrogen to inform habitat translocations, following standard methods of soil analysis. Separate analysis should be carried out on topsoil, subsoil and soil-forming material of different origins especially when importing or mixing with imported material. Further details are given in Annex C.

Good Practice for Soil Handling

Much of the good practice guidance on soil handling (for example, *'Good Practice Guide for Handling Soils in Mineral Workings'* (IQ 2021), and *'Guidance for Successful Reclamation of Mineral and Waste Sites'* (Defra, 2004)) is derived from the field of surface mineral working and the restoration of agricultural land. This guidance was extended to cover construction sites and restoration for other purposes in *'Construction Code of Practice for the Sustainable Use of Soils on Construction Sites'* (Defra, 2009).

The main requirements of the good practice guidance on soil handling are to protect soils to avoid:

- the loss of topsoil/subsoil volumes;
- mixing topsoils, subsoils and waste building materials;
- the loss of soil nutrients and soil biota and/or reduction of its activity; and
- damaging (e.g. compacting) soil structures and loss of drainage channels in reinstated soils. as a result of compaction from using the wrong machinery for soil handling under wet soil conditions.

These impacts can be avoided by:

- using the most appropriate machinery and method of soil handling for the soil type present;
- the handling of soil resources only when sufficiently dry to prevent compaction and damage to soil structure, this is determined by the relationship between soil texture, moisture content, and the soil resilience to structure damage;
- using wheeled vehicles with wide low-pressure tyres; and
- using protected temporary tracks to limit the extent of vehicle traffic and compaction.

Further remedial mitigation measures include:

- decompacting the subsoil;
- installing drainage; and
- aftercare management of the restored land.

A site should be cleared of vegetation before soils are stripped. Standing crops or any other bulky vegetation should be cut and removed before soil stripping commences.

In view of the above considerations, good practice for soil handling on relatively large sites is to use excavators to strip topsoils and subsoils successively in parallel strips, the width of the strip being determined by the reach of the excavators. The minimum thickness of the strip that can be achieved is likely to be between 5 and 10cm, depending on the nature of the soil being stripped, and the visual distinctiveness of the separate soil horizons. The soils are loaded onto dumper trucks which run on the subsoil layer for topsoil stripping, and the layer beneath the subsoil for subsoil stripping. The dumper trucks follow designated haulage routes to storage mounds. On reinstatement, the process is broadly reversed. Further details are set out in the Defra Construction Code of Practice.

This method maximises the volumes of topsoil and subsoil that can be separately stripped and minimises the mixing of topsoils and subsoils. It reduces damage to soil structures and helps to retain drainage in reinstated soils. It also allows for varying stripping depths in a controlled manner as the parallel strips cross the boundaries of different soil types identified by a soil survey.

For smaller habitat creation and translocation sites this preferred approach might have to be adjusted to suit the physical characteristics of the donor and receptor sites.

The alternative of using bulldozers to strip and re-spread soils on reinstatement (together with excavators to lift the soil onto dumper trucks) may be quicker and cheaper in the short term, but it causes more damage to the soil resource even under suitable weather conditions. Furthermore, it is a less disciplined method of soil conservation that is difficult to control on a construction site and it often results in a significant loss of soil function.

Land Use Planning Context

Different planning systems apply across the UK. The information should be used in accordance with national policies and guidance set out in Part I of the main text of this guidance, and the relevant annexes. The actual approach to restoration should be adjusted for the soil types present, the nature of the site and the proposed development, and the detailed objectives of the soil handling operation.

Soil information is used by ecologists in different situations within the planning system, and this guidance helps to provide context for their work. The main soil resource implications of moving soils in these different situations are set out below.

Greenfield Sites

Outside of built-up areas and on greenfield sites, urban development generally involves the loss of agricultural land, together with the permanent and temporary disturbance, storage and reinstatement of natural and previously undisturbed soils.

Habitat creation (i.e., by conversion of agricultural land) is often associated with urban development projects as a proposed land use, and this involves the preparation and management of what was previously agricultural land. The biodiversity potential of some greenfield sites is reduced by fertiliser applications. Where deep ploughing has been carried out to reduce nutrient levels by mixing topsoil and subsoils, this can lose valuable seedbanks and reduce valuable soil variability.

Soil survey should be used to locate areas with loamy upper subsoils, and if possible, these should not be used within a development site for habitat creation.

Brownfield Sites

The existing biodiversity value of brownfield sites should be determined. The objectives are then to determine the quality and quantity of the soil resource on-site; including the presence of any contamination, which then needs to be assessed (in accordance with the UK contaminated land guidance) to determine whether remediation is needed, and if so, what remediation option is appropriate (by agreement with the regulator) to make the land suitable for the proposed end uses, including habitats. Habitat creation on these sites can involve the use of available nutrient-poor subsoils (without topsoil), suitable for a species-rich habitat. Brownfield site restoration can also involve the identification and use of soil-forming materials as alternatives to natural soils and importing soils from other parts of a development site, or (if possible) from other locations as a growing medium in place of the absent natural soils.

Surface Mineral and Landfill Sites

On these sites, the largely natural undisturbed soils are temporarily disturbed, stored, and reinstated for agriculture and other beneficial end uses, including woodland and habitats.

The identification of the different soil textures and structures in the upper and lower subsoils (where both horizons are present) relates mainly to the need to restore agricultural land temporarily disturbed by opencast/surface mining and landfill back to its original quality (particularly Best and Most Versatile Land and prime quality agricultural land), and to meet a condition attached to a planning consent. In this case, it is necessary to separately strip and store the more faourable (from an agricultural perspective) topsoils and upper subsoils to concentrate their reinstatement in coherent blocks of higher grades/classes of agricultural land that can be used for arable farming.

The opposite generally applies to habitat creation where upper subsoils present within a development should not be used for the conversion of what was originally agricultural land to habitat, because they have textures, structures, drainage characteristics and higher nutrient levels which will make it more difficult to create a low nutrient substrate and establish the preferred ground cover.

The less favourable soils (from an agricultural perspective) displaced by development can be more successfully used for ecological purposes. The soils available should inform the habitat to be created. If a proposed habitat requires removal of part of the original soil profile, this is not a sustainable reuse of the soil resource. If topsoil is not present, then it is possible to plant directly into subsoils. However, planting directly into subsoils where topsoils have been stripped is not recommended. An element of translocation can also occur for existing habitats within development sites.

Renewable Industry

The location of onshore wind farm installations is such that they can have an effect on organic soils and peats. Annex E describes soil handling for peat and peaty soils. Good practice regarding restoration of peatland is also available from the NatureScot website at: *https://www.nature.scot/climate-change/nature-based-solutions/peatland-action-project*.

Restoration of Land for Agriculture

This is covered by the good practice guidance in respect of surface mineral working and the restoration of agricultural land referred to above, and the guidance was extended to construction sites in '*Construction Code of Practice for the Sustainable Use of Soils on Construction Sites*' (Defra, 2009).

Soils on Ecologically Important Habitats

Ecologically valuable habitats and ground cover have largely developed naturally in a range of parent materials in certain topographic and hydrological situations, and they tend to be associated with low nutrient levels, high pH (alkaline/calcareous) or low pH (acidic) value soils; and in some cases high water tables. For example:

- high-altitude peats with a semi-natural ground cover where there is impeded drainage due to high altitude and rainfall, heavy soils, and/or shallow gradients over wide interfluves;
- lowland peats, calcareous fens, acidic bogs and other wetlands in poorly drained receiving sites over clays and silts with high water tables (e.g., on floodplains);
- lowland heathland and acidic grasslands on freely draining sandy and gravelly parent materials. Displaced sandy arable soils have considerable potential for conversion to such habitats because nutrients leach more rapidly from them. Over time, they become the type of soils (known as podzols) associated with existing lowland heathland;
- chalk rock, or chalky boulder clay and limestone rocks have alkaline soils with high pH values which form a suitable substrate for calcareous grassland; and
- soils with loamy topsoils and upper subsoils can support mesotrophic (neutral) grassland, but they tend to be associated with higher quality agricultural land with moderate to high levels of nutrients from fertiliser applications, and neutral pH levels. The higher the clay content of the loams, the more enduring the retention of nutrients.

These examples of ecologically valuable habitats demonstrate how geological parent materials and soils have a major influence in determining the potential for ecologically valuable habitats. These combinations of site physical characteristics are likely to be those that have to be replicated with habitat creation and translocation.

Habitat Creation and Translocation

Habitat Creation

This tends to be the conversion of previously managed land (agriculture or forestry) to habitats on sites where existing soils must be used and the nutrient levels (N, P, K and Mg) have to be reduced to establish a semi-natural ground cover. The partial or complete displacement of nutrient-rich topsoils (where subsoils remain in-situ) is not recommended, and habitats should be identified which can be supported by the existing soil profile, or a natural nutrient-stripping technique employed. The mixing of topsoils and subsoils to reduce ground surface nutrient levels is considered a loss of soil resource and not sustainable. Soil information derived from surveys helps to plan soil handling in Soil Resource Plans and an appropriate management regime for reducing soil nutrient levels.

When considering the establishment of a habitat on undisturbed agricultural land, many sites will have 'middle of the road soils' with slightly acid pH values of 5 to 6, and the focus will be on reducing nutrient levels. This can be achieved by the removal of nutrients in harvested crops (like nutrient-hungry barley) and their residues and over time through the leaching of nutrients to watercourses and groundwater. Where soils have favourable (for agriculture) upper subsoils with higher clay contents (e.g., clay loams, sandy clay loams and silty clay loams), this will prolong the process, because the clays retain nutrients.

Habitat Translocation

Habitat translocation often involves the disturbance of soils at both donor and receptor sites. The soils being moved from the donor site bring with them the soil textures and structures, pH and nutrient levels that are an intrinsic component of the habitat being translocated. However, it is necessary to replicate the donor site landform and hydrology (e.g., surface water drainage and ground water levels) prior to the placement of soils at the receptor site. Translocation method statements within Soil Resource Plans should be adjusted according to the site physical characteristics of both donor and receptor sites.

It will be necessary to match the donor and receptor site soil profiles in terms of their physical properties, in respect of both topsoils and subsoils, if possible. If achieved, this will require the translocation of topsoils only, and this is an important objective of the soil survey. Following translocation of the donor site topsoils, the chemical properties of the undisturbed subsoils which remain in-situ at the receptor site can then be gradually changed through longer-term management.

If it is not possible to match the receptor and donor site soil profiles, it might be necessary to move both topsoils and subsoils from the receptor site and import both topsoils and subsoils from the donor site. However, when subsoils are disturbed, they increase in volume, and the relationship between different subsoil textures and bulking rates is not well understood. Therefore, the translocation of both topsoils and subsoils introduces a greater degree of uncertainty over the bulking up of the translocated soils when they are spread at the receptor site. The on-site management of soil handling must therefore ensure that receptor site ground surface levels match those of adjacent land on completion of soil reinstatement. This is to avoid creating a different hydrological regime at the receptor site.

An aftercare period may be required for the recovery of soil structures and hydrology/drainage. It will be necessary to avoid traffic over wet soils with machinery, and to use appropriate livestock for conservation grazing, only when soils are sufficiently dry.

Restoration of Land for Specific Ecological Objectives

The approach to soil survey and soil handling for habitat translocation (and Ancient Woodland soil translocation in particular) can be markedly different to the approach to soil handling for the restoration of land for agriculture and landscape planting.

The scope of information required from soil surveys carried out for ecology is set out in Annex C. For example, a particular requirement for Ancient Woodland soil translocation is a comparison of the soil types at the donor and identified receptor sites, and a statement of the suitability of the proposed receptor site for translocation, together with advice on any location-specific provisions for soil handling.

The method of re-spreading soils for agriculture can also be applied to ecological habitats, where access permits and on land with shallow to moderate gradients generally in the range from 1:8 to 1:5.

On slopes steeper than 1:5, alternative methods can be used to prepare the substrates for ecology, particular in respect of engineering works for cuttings and embankments. In such circumstances, tracked excavators and other 'civil engineering' equipment is often required, with bespoke attachments, to achieve the same result as agricultural machinery and tillage equipment. In some cases, and by prior agreement between planning authority, developer and contractors, the 'peninsular' method of soil replacement can be used for the preparation of a substrate for ecology. This method utilises one access point to loose tip the soil and spread the topsoil over the subsoil. The re-spread topsoil will gradually 'fan out' with each subsequent topsoil load tipped at the edge of the newly created peninsular until the required area is covered with the topsoil.

Methods of soil decompaction and tillage, and the machinery for cultivating agricultural land, should also be suitable for the reinstatement of land to be returned to ecological habitats where access permits, on land with shallower gradients. However, alternative methods and machinery should be used for ecology areas where access is restricted, or the slopes are too steep for tractor-drawn equipment.

It is understood that the Chartered Institute of Ecology and Environmental Management (CIEEM) is seeking to create a special interest group to develop good practice guidance on ecological restoration and habitat creation.

Restoration of Land for Landscape Planting

The scope of information required from soil surveys for landscape planting is set out in Annex C.

Earthworks should be designed in conjunction with reinstated land uses and planting proposals to reflect the Landscape Design Approach. Landscaping proposals should make use of soils present within a site. The specification of topsoil and subsoil properties (with reference to BS3882 and BS8601 respectively) should relate only to material that has to be imported onto site to meet restoration objectives.

The methodology for re-spreading soils for agriculture can also be applied to land to be reinstated for landscaping where access permits and on land with shallow to moderate gradients; the latter defined as generally in the range from 1:8 to 1:5.

Alternative methods will be applicable for the preparation of substrates for landscaping on areas with steeper slopes, particularly in respect of engineering works for cuttings and embankments. In such circumstances, tracked excavators and other 'civil engineering' equipment is often required, with bespoke attachments, to achieve the same result as agricultural machinery and tillage equipment.

In some cases, and by prior agreement between developer and contractors, the peninsular method of soil replacement can be used for the preparation of a substrate for landscape planting.

The reinstated soil profile and quality of the soil should ensure the establishment and long-term health of the planting. Other local factors, such as slope stability, the characteristics of the specific soil type, site hydrology and topography, should also be considered. The depths to which topsoil and subsoil are to be re-spread should consider the anticipated rooting depth of the plants to be established. The table provides general guidance on the minimum soil depths required over placed excavated materials for different habitats/planting, as applied by landscape planting practitioners. This should be reviewed and modified as necessary by contractors/designers to suit specific locations and other design criteria and should also depend on the availability of soil resources and any other requirements for agricultural and ecological restoration within a development scheme.

Generalised Soil Profiles for Landscape Planting (i.e., Not Site Specific)

Habitat/ Planting Type	Minimum Topsoil Depth (mm)	Minimum Subsoil Depth (mm)
Woodland	300	700
Hedgerow	300	300
Grassland	150	150
Heathland	150	150

Trees and shrubs require a greater rooting depth than grasses and heathers, and hence a deeper soil profile. Therefore, it is necessary to select tree, shrub, and grass species to match site and soil conditions. The soil profile should be made up with a combination of topsoil and subsoil above placed excavated materials. Where excavated materials lie at depths greater than 1.2m, they should not, therefore, require ripping. The deeper profiles should not be made up entirely of topsoil. Replaced topsoil in particular does not normally perform well at thicknesses greater than 300–400mm (depending on topsoil composition and condition), where there is an increased risk of self-compaction due to loss of soil structure, and where the biochemical oxygen demand (BOD) often exceeds the rate of aeration. This often results in the development of anaerobic conditions that are detrimental to plant root health and function. Subsoil, which has a lower BOD, should therefore be used to create rooting depths of more than 300–400mm.

If surplus topsoil is likely to be present, there may be scope to increase the depth of topsoil in shallower rooting environments (e.g., grassland and heathland) up to 300–400mm provided it has acceptable chemical and physical properties for the intended habitat. Where there is surplus subsoil, it may be possible to increase the depth of subsoil reinstatement above the placed excavated material, and this would have the beneficial effect of increasing the available water capacity of the soil.

The soil fertility requirements for transport and energy infrastructure embankments should be Soil Index 3 or lower for extractable phosphorus, potassium, and magnesium to establish the appropriate ground cover and reduce management. Contractors should achieve the soil fertility requirements specified for each type of habitat.

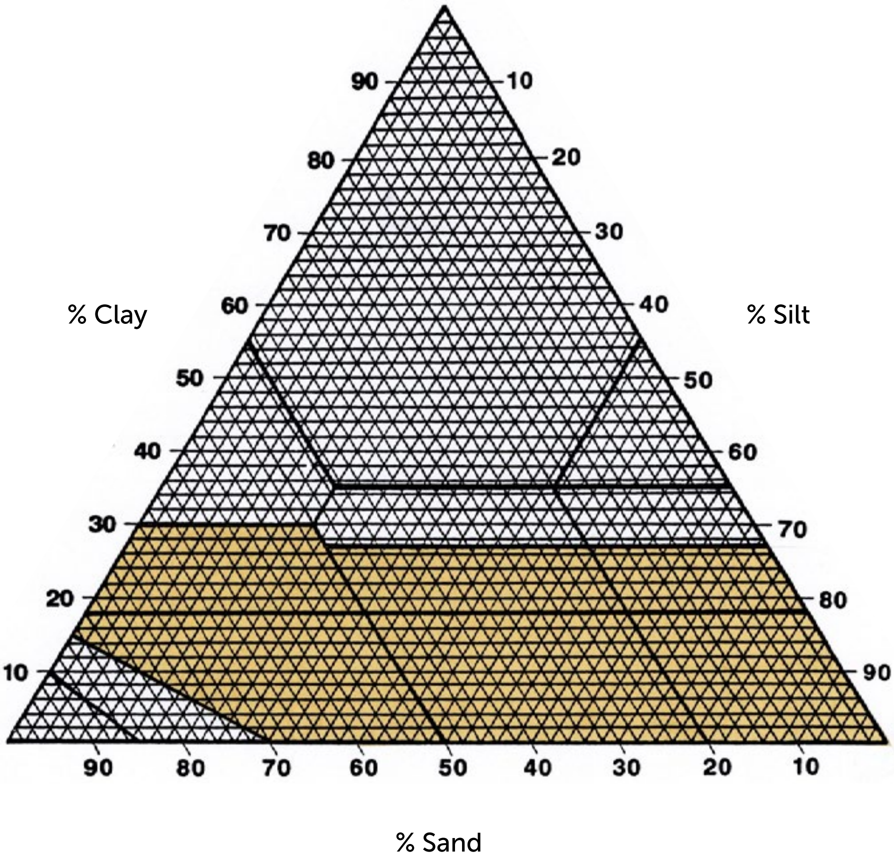
Habitats that are intended to be biodiverse (e.g., species-rich grassland, and heathland) should have soils with low extractable phosphorus concentrations (<16 mg/l, i.e., Soil Index 0 or 1) to reduce competition from aggressive broad-leaved species or the dominance of grasses. A Soil Index of 3 or lower for extractable potassium and magnesium is acceptable for such biodiverse habitats.

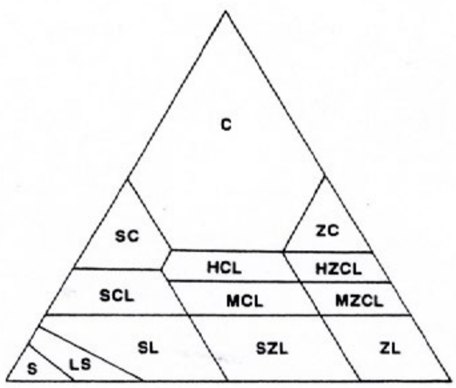
Minimum requirements for soil fertility levels should be specified for woodland, hedgerows and amenity grass in order to ensure that ample nutrients are available for the establishment period. Where soil fertility is too low, soil amelioration using compost and/or fertilisers will be required. Any fertilisers that are used should be 'slow-release' rather than 'soluble' to promote a slow, steady establishment and good root growth and to avoid too much top growth.

Methods of soil decompaction and soil tillage, and the machinery for cultivating agricultural land, should also be suitable for the reinstatement of land to be returned to landscape planting where access permits, and to land with shallow gradients.

However, alternative methods and machinery should be used for landscaping where access is restricted, or the slopes are too steep for tractor-drawn equipment. In such circumstances and on such slopes, the reinstated soil profile (topsoil and subsoil) should be suitably decompacted and cultivated using a 360° tracked excavator. Soil decompaction should be undertaken using a 'single ripper tine' attachment (not a toothed bucket) pulled through the soil profile at 600mm centres to a depth of 600mm (for tree and scrub planting) or 300mm (for groundcover, grass, heathland). The number and direction of passes being determined by soil conditions. The soils must be dry and the best time for subsoiling is in the late summer to early autumn. The topsoil layer should receive further cultivation as necessary using a 'landscape rake' attachment (not a toothed bucket) to achieve a suitable tilth for planting or seeding.

Soil Texture Classes





S	–	Sand
LS	–	Loamy Sand
SL	–	Sandy Loam
SZL	–	Sandy Silt Loam
ZL	–	Silt Loam
SCL	–	Sandy Clay Loam
MCL	–	Medium Clay Loam
HCL	–	Heavy Clay Loam
MZCL	–	Medium Silty Clay Loam
HZCL	–	Heavy Silty Clay Loam
C	–	Clay
ZC	–	Silty Clay
SC	–	Sandy Clay

Annexe G Soil as a Receptor and Pathway for Air Pollution

Introduction

Sources of air pollution that can have implications for soil health and functions include 'point source' emission projects (such as industrial processes, construction projects, farming activities, or energy generation) or long-range imported emissions and linear emission sources such as road traffic.

Assessing the impacts of air pollution on soils and soil-based systems requires a multi-disciplinary approach by practitioners. The role of a soil specialist is likely to be one of determining:

- the extent to which the soil(s) in question have already been impacted by air pollution (for example by testing soil pH levels);
- the vulnerability of soil to future impacts from air pollution;
- indirect impacts on other receptors through soil pathways;
- the likely duration and reversibility of any impacts; and
- options for mitigation, remediation, or compensation.

The likely duration, dispersibility and reversibility of air pollution related impacts may be influenced by soil properties like texture and pH. For example, highly calcareous soils may have better buffering capacity and be more resilient to acid deposition, and neutral loamy soils may be more vulnerable, with consequences for the soil microbiota and vegetation.

The two most common impact mechanisms are pH modification and eutrophication.

Lowering pH (Acidification)

The most common pH modification is the acidification (lowering of pH) of soils by substances carried in air pollution. Sulphur Dioxide (SO_2) is an acidic gas that can directly affect plant life (particularly sensitive species) but it can also be deposited to the ground (e.g., as 'acid rain'), where it can lower soil pH and affect the soil microbiota, plant life, and vegetation composition.

Common sources of SO_2 include energy generation projects, marine shipping, and industrial and domestic fuel combustion. Background concentrations of SO_2 in the UK have fallen so significantly in the UK that this pollutant now rarely poses an extensive direct threat, but localised impacts can still occur.

The UK Air Pollution Information System (APIS) advises that acidification may be exacerbated in areas of high rainfall and can lead to various impacts on soils including chemical changes leading to reduced fertility and nutrient deficiencies, release of toxic metals and changes in microbial activity. Additionally, many habitats and ecosystems require a particular pH and they will be damaged or destroyed (for example, losing important, rare, or characteristic plants) if the pH changes beyond the tolerable range.

Raising pH

The raising of soil pH (i.e., making it more alkaline) is not as common as acidification, but it can occur in certain circumstances, for example, where alkaline dust is being generated through the crushing of concrete and other construction aggregates, or where alkaline materials such as limestone are being quarried and processed.

Eutrophication

The long-term implications of eutrophication caused by air pollution may also be heavily influenced by soil. Nutrients form chemical bonds with the surfaces of clay particles, and it may take decades for deposited nutrients to be removed from a soil with high clay content. Whereas nutrients will be leached more rapidly to groundwater and watercourses from freely draining sandy and gravelly soils.

Nitrogen deposition is the key driver of the eutrophication (nutrient enrichment) of soils and, by extension, the habitats and vegetation that they support. Nitrogen-containing compounds act as plant nutrients and, in otherwise Nitrogen-limited systems can cause the rapid growth of plants. This can result in elevated crop yields in agricultural systems, but in semi-natural systems results in the vigorous growth of aggressive nitrophilous species that then out-compete other, more delicate native species, leading to a precipitous loss of biodiversity.

Where excess soil nutrients leach into groundwater or surface water, they can be carried into watercourses or the sea. Freshwater ecosystems are usually phosphate-limited and therefore are less likely to be affected by the deposition of Nitrogen from air pollution alone, but marine ecosystems are more often Nitrate-limited, and could therefore be affected.

The deposition of oxidised forms of Nitrogen (NOx) emitted from sources such as motor vehicles can contribute towards and cause eutrophication problems, but reduced forms of Nitrogen such as ammonia are proportionately significantly more damaging. The principal source of reduced Nitrogen is agriculture (fertiliser spraying and slurry lagoons, etc) but Selective Catalytic Reduction (SCR) technology in motor vehicles also converts NOx into ammonia for human health protection reasons, so traffic can also contribute towards ammonia deposition (this may also increase as the vehicle fleet transitions away from diesel engines and to petrol hybrid vehicles).

The APIS supported by the UK environmental regulatory agencies has established a database and interactive tool for calculating the exceedance of the critical load for soil acidity. This, and an explanation of the methodology is available at: http://www.apis.ac.uk/critical-load-function-tool.

Key Assessment Principles and Parameters

The contribution to air pollution made by any development project is known as the "Process Contribution" (PC). When added to the predicted background concentration of that type of air pollution at a particular point in time through modelling, this becomes the 'Predicted Environmental Concentration' (PEC).

Generally, air pollution impact assessment processes involve measuring the PEC that the subject PC will lead to, either alone or in combination with other projects, against a specified environmental threshold or 'Environmental Limit Value' (ELV) that represents (by proxy) the sensitivity of that receptor to that type of air pollution.

For ecosystems, the environmental thresholds concerned are called the 'Critical Level' (for ambient concentrations of pollution) or 'Critical Load' or (CL) (for pollution deposition). In assessing impacts on soils, Critical Loads are most relevant as they relate to the amount of pollution that has 'come to ground' (i.e., accumulated in the soil) and which could therefore alter soil chemistry or other properties of soil.

The term 'Critical Load' is defined on the Air Pollution Information System (APIS) (www.apis.ac.uk) as:

> *'a quantitative estimate of exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge.'*

Critical Loads are typically measured in units of kg/ha/year, and for ecosystems are normally expressed as a range to communicate the varying response of habitats in different circumstances, with the lower (CLmin) and upper (CLmax) Critical Loads defining the range within which different examples of a habitat type might expect to start experiencing negative changes. For ecosystems, APIS provides guidance on the circumstances in which the lower or upper end of the Critical Load range should be used for the assessment.

Nitrogen deposition rates are influenced by the types of habitats affected. 'Tall' habitats like woodland present a greater surface area that is subject to deposition and so the deposition velocity in these habitats is greater than in 'short' habitats like heathland or grassland.

For acid deposition, because both Nitrogen and Sulphur can contribute to acidification (with Sulphur compounds being more acidifying), a Critical Load Function (CLF) is used to determine the combined acidifying effects of all pollution. Acid deposition is usually measured in kilograms equivalent (keq/ha/year) which allows the combined acidifying effects (i.e. availability of H+ ions) of different substances to be expressed using a common measure of acidity.

Factors that Influence Impact Significance

Anticipated air quality changes and the air pollution modelling stage of the assessment are related to the location and sensitivity of potential impact receptors. This will determine the significance of direct impacts on soil health and functions, and indirect impacts on other receptors through the soil pathway. This part of the assessment process will require the inputs of a soil scientist or ecologist (or both), depending on the nature of the sensitive receptor.

When levels of pollution exceed the CL, CLF or ELV, the sensitive receptor in question is said to be in exceedance. Harm is more likely to occur if the exceedance is significant or if the duration of exceedance will be long-term. For example, once the level of Nitrogen deposition within a habitat exceeds the 'integration threshold', when deposition exceeds the rate at which Nitrogen is metabolised or lost from the system. Similarly, long-term exposure to levels of acid deposition that are in exceedance of the CLF may also lead cumulatively to changes in the pH and other chemical properties of the soil. Habitats that have been, or are predicted to be, in exceedance for a longer time are therefore more likely to be significantly impacted. Background trends in pollution are an important consideration in relation to the above.

It is important therefore to consider whether:

- an exceedance will occur for the first time because of the project alone or in combination with other plans and projects;
- the background trend is improving or getting worse;
- an exceedance is already occurring that will be made worse;
- a project will prevent or significantly delay a site from getting back below its CLs (i.e., is the project going to cancel out an improving trend).

Options for Mitigation

The most effective forms of mitigation generally act on the source of pollution to reduce it such that exceedances of CLs are no longer expected to occur or be significant.

A dedicated 'menu' of mitigation options for some industrial/combustion and agricultural operations is available from Defra's '*Identification of Potential Remedies for Air Pollution Impacts on Designated Sites (RAPIDS) Project*' (Dragosits et al, 2015) and for agriculture specifically, also the preceding '*Inventory of Mitigation Methods and Guide to Their Effects on Water Pollution, Greenhouse Gas Emissions and Ammonia Emissions from Agriculture*' (The 'Defra User Manual') (2011).

Related to the above, Natural England has already begun work under their '*Improvement Programme for England's Natura 2000 Sites*' (IPENS) to develop strategic approaches to addressing the main sources of air pollution around Internationally designated sites. Such approaches, for example, take the form of '*Site Nitrogen Action Plans*' (SNAPS) that prescribe the measures needed at the National, Regional and Local levels to enable an affected site to recover.

Where soils have been polluted, soil specialists may be able to assist with remediation efforts. For example, where oligotrophic conditions are required for semi-natural habitat creation/restoration, techniques such as soil inversion or soil translocation may enable available soils from one or more locations to be favourably redistributed to achieve the desired objective. For example, nutrient-poor soils could be placed uppermost (within rooting depth), with more nutrient-rich soils buried at depth.

Annexe H The Cumulative Effects Assessment (CEA)

The requirement for Cumulative Effects Assessment (CEA) is set out in the Environmental Impact Assessment (EIA) Directive (EIA Directive 2014/52/EU, which amends EIA Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment).

An agreed methodology for the CEA on land and soils has yet to be established. Alternative approaches are discussed, and the outline proposals are a work in progress that might rely on the development of new databases at the local level (which can be combined to give the national picture) for a more informative understanding of the significance of changes in the rate of land losses.

Guidance on cumulative effects is set out in the Institute of Environmental Management and Assessment (IEMA) '*State of Environmental Impact Assessment Practice in the UK*' (2011) report. Although there is much discussion and uncertainty around methodology and terminology of cumulative assessment, and variability in how it is approached[173], there are some commonalties that have been identified.

To enable an assessment of cumulative effects, it is necessary to:

- set out the impact sources and pathways to land and soil receptors;
- determine the potential cumulative effects at the national and local levels;
- rely on reasonably clear relationships in determining impacts on each soil function; and
- set out clear criteria to determine the magnitude, sensitivity, and significance of impacts.
- EIA practitioners should use their professional judgement in applying this approach to the outline proposals to arrive at an assessment of the cumulative effects of a development project at the local and national levels. The assessment should be mainly qualitative with some quantitative analysis, to the extent that the information is available.

There are two types of cumulative effect, and these can be described as:

- all environmental effects arising from a proposed development; and
- these effects in combination with other developments at the national and local levels.

The first type is encompassed by the second, which gives the full significance of cumulative losses on land and soil.

Regarding soil as a finite resource, there are also historical cumulative effects to consider. These effects include the permanent loss of soil resources/functions due to previous development (mainly through soil sealing and earthworks), and other impacts such as soil erosion, loss of soil organic matter and loss of soil biodiversity. Conversely, peatland and brownfield restorations (for example) can count as gains. Currently, these effects are likely to be unquantifiable either at a local or national scale due to the lack of, or incomplete, baseline data for comparison with the present situation. However, historical effects should be considered within CEA, where possible, as our understanding of thresholds for the protection of soil functions evolves.

173 See IEMA webinar '*Demystifying Cumulative effects, Impact Assessment Outlook Journal Volume 7*, July 2020'.

Effects Arising from a Proposed Development

This covers direct and indirect effects on soil functions and ecosystem services and related environmental topics within and adjacent to a proposed development boundary. The multidisciplinary EIA team will consider the sensitivity of the local environment and the nature of the proposed development, to screen for cumulative effects. Table 1 sets out some examples of the potential cumulative effects that can occur within and around an EIA study area. The soil functions in Table 1 are all part of the biosphere and cumulative effects on them are often inter-related.

Some impacts are assessed in other environmental topic area CEAs and do not need to be considered further. Other impacts can be mitigated through the application of good practice (e.g., Defra's *'Construction Code of Practice, 2009'*[174]).

Effects in Combination with Other Developments

This covers the direct and indirect effects of reasonably foreseeable developments on soil functions and ecosystem services over wider areas at the national and local levels.

In assessing this category of cumulative impacts, it is necessary to clearly define spatial and temporal parameters for a development project, together with other 'reasonably foreseeable' developments that can include:

- development under construction;
- permitted applications (full or outline), not yet implemented;
- submitted application(s) not yet determined;
- projects on the Planning Inspectorate's Programme of Projects;
- allocations identified in the Local Development Framework (and emerging Core Strategies and Allocations Plan) and their equivalents in Wales, Scotland and Northern Ireland – with appropriate weight being given as they move closer to adoption;
- developments identified in other plans and programmes which set the overall framework;
- other future development consents/approvals, where such development is reasonably likely to come forward, to include:
    - amendments to planning consents;
    - reserved matters; and
    - discharge of conditions.

174 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/716510/pb13298-code-of-practice-090910.pdf

Table 1: Example of Land and Soil Impacts which affect other Environmental Topic Areas

	Climate change	Hydrology	Biodiversity	Air Quality	Cultural Heritage	Landscape
Soil and land loss	Reduced carbon storage capacity and climate change	Effects on catchment pathways for water flow, flood risk and water quality (e.g., soil filtration and attenuation of flow/ contamination)	Reduced habitat for above and below ground biota	Generation of dust and air quality impacts	Land and soils as a material for preservation of archaeology and understanding/ appreciating our historic/ cultural features	Land and soil as a platform for landscape. Effects on landform, ground cover, landscape features, character, green infrastructure and visual amenity
Soil compaction		Increased surface run-off leading to flooding and erosion of soils	Poor vegetation growth			
Soil disturbance	Increase in carbon losses, reduced carbon storage capacity and climate change	Increased erosion and water quality impacts from particulate or chemical contamination, leading to suspended solids like silt and eutrophication	Excessive removal of vegetation leading to soil exposure, erosion, silting and loss of stored carbon			

The CEA should establish the land and soils baseline at the local level using an administrative local authority boundary and Local Plan (where appropriate) to provide the necessary context to assess the local effects of planning policies. With this approach it is possible to go on to arrive at an outline methodology that also broadly approximates to an assessment of the total national cumulative effects of all development projects in respect of land loss.

CEA from a Soil Loss Perspective

This approach applies a generalised link between soil types and soil functions. 'Good' agricultural soils with deeper loamy and well-drained profiles tend to be associated with the biomass (i.e., food provisioning) soil function. Heavier textured, less-well-drained and lighter-textured droughty soils in the lower grades and classes are also important for agriculture and food production, but they are more likely to be associated with other land uses (particularly ecologically valuable habitats) and soil functions. This simplistic division of soil types can be used in an evaluation methodology that assesses the cumulative effects of soil losses.

Soils Associated with the Biomass Soil Functions

The ALC and LCA systems set out the main characteristics of soils that are most important for agriculture and food production (i.e., the biomass soil function). The soils associated with higher-quality agricultural land generally have loamy topsoils and upper subsoils with good soil profile drainage, moderate to high nutrient levels, and neutral pH levels. In England and Wales, these soils are associated with ALC Grades 1, 2 and Subgrade 3a, and in Scotland they are associated with LCA Classes 1, 2 and the upper part of Class 3.

Soils Associated With the Other Soil Functions

Non-agricultural ground cover and ecologically valuable habitats have developed in a range of parent materials in certain topographic and hydrological situations, and they are associated with low nutrient levels, high pH (alkaline/calcareous) or low pH (acidic) values, and in some cases poor drainage and high water tables. These situations are set out in Annex F

There are exceptions, such as lowland peats drained for agricultural production, but at the level of generalisation appropriate to the assessment of cumulative effects, the soils developed on these parent materials have a high level of performance for functions other than biomass production, through organic matter storage and biodiversity.

Soil information collected by the Soil Survey of England and Wales before the cessation of its work is now held by the Cranfield Soil & AgriFood Institute (CSAI). To arrive at the national stock of topsoils and subsoil volumes, the starting point would be the legend for the Soil Survey 1:250,000 Regional Soil Maps of England and Wales (1983) which identifies 296 Soil Associations (generalised soil descriptions) and gives for each Association the estimated percentage coverage of the total surface area of England and Wales. Unfortunately, (according to the footnote on page 5 of the legend) this includes urban, infrastructure and open water, so these percentages and the following approach would have this built-in inaccuracy.

The LandIS website, accessible at *http://www.landis.org.uk/services/soilsguide/#soilseries* sets out the proportion of the constituent soil series (more detailed soil descriptions) in each of the higher category (i.e. more generalised) Soil Associations shown on the Soil Survey 1:250,000 Regional Soil Maps of England and Wales. Typical soil profiles are described for each of the soil series giving the thickness of the topsoils, and it is also possible for a soil specialist to infer the approximate thickness of the subsoil. These are the basic parameters (together with the total surface area of England and Wales) necessary to calculate (at a strategic level) the total volumes of topsoil and subsoil potentially under threat of development.

Using site-specific soil survey information on soil types produced in support of planning applications, it is then a matter of deducting annual losses from the total topsoil and subsoil volumes for the soil types within a development study area to quantify the cumulative effect of development on the national stock of soil volumes. The worked example in Annex I shows how site-specific soil volumes can be considered.

A similar approach could be applied to Scotland and Northern Ireland, using the regional soil maps and memoirs published by the Macauley Institute (1982), now the James Hutton Institute, and the regional soil maps held by the Agri-Food and Biosciences Institute (AFBI) (see Annex B).

In Scotland, soil classification is based on the soil properties you can see in the field (for example, colour, texture) and on the arrangement and nature of the different horizons (layers) within the soil. The National Soil Map of Scotland shows the distribution of Soil Mapping Units, which are identified by a unique combination of parent material, component soil types (called soil series) and associated landforms. Over 580 combinations are found in Scotland.

The Scotland Soil website, accessible at https://soils.environment.gov.scot/ provides access to national and regional digital soil maps and derived information. It also provides detail on individual soil series and their typical properties (thickness, carbon content) that could be used to calculate estimates of total volumes of topsoil, subsoil and soil organic matter that can be under threat from development. Further information on the wider environment relevant to EIA is also provided for Scotland in SEWeb, accessible at https://www.environment.gov.scot/ and this includes a land information search.

This information could also be related to the generalised descriptions of the 'Soils of Agricultural Importance' (i.e., the biomass soil function), and 'Soils Associated with the Other Soil Functions' set out above, to calculate the proportions of this simple two-fold split in soil functions that are subject to cumulative loss. However, even this simplistic two-fold split may be too ambitious, and a more practical approach to cumulative effects might consider development losses of all soils as one category only.

A soil loss approach would provide useful context to a national database of surplus soils, their location, and characteristics, which would help to facilitate soil reuse off-site. However, this approach to manipulation of the LandIS database and calculating approximate national soil volumes based on the standard soil descriptions would require considerable resources and a major effort to provide the necessary baseline and would only be applicable for England and Wales.

CEA from a Land Loss Perspective

A more practicable alternative is a land loss approach to an assessment of cumulative effects. The land resource is the current total area of undeveloped land or agricultural land excluding urban, infrastructure and open water.

The quantification of undeveloped land loss will have the advantage of including all land with largely 'natural and undisturbed' soil profiles with both topsoils and subsoils. This land loss relative to the total average land loss over a defined period (e.g. 5 years) can provide a meaningful metric for the significance of cumulative land losses of development on all soil resources and their functions, which is the focus of the main guidelines.

This can be further refined for agricultural land loss and specifically the associated soil biomass function. It is estimated by Natural England that around 42% of agricultural land in England and Wales is Best and Most Versatile (BMV), based on previous studies[175]. Therefore, the agricultural land loss figures can distinguish between losses of higher and lower grades/classes, and this helps to determine the significance of cumulative land losses for the soil biomass function. At a local level, where BMV land is likely to be concentrated, or predicted to be largely absent, a further refinement to distinguish between BMV and lower-quality land may be worthwhile in the context of cumulative biomass function loss.

Outline Worked Example for England

The worked example shows how the cumulative effects of a proposed development can be assessed in combination with other development projects, relative to 5-year average land loss figures:

- for the loss of undeveloped land, to indicate the national significance of the loss of all soil functions;
- for the loss of agricultural land to indicate the national significance of the loss of the soil biomass function.

In addition, the assessment can be undertaken relative to the local 5-year average land loss, using a local authority boundary and the provisions of a Local Plan, where appropriate.

A similar approach to the assessment of national and local CEA from a land loss perspective could be applied to Wales, Scotland, and Northern Ireland.

Section 9.2 of the main guidelines sets out supplements to the DMRB and ICE EIA Handbook evaluation methodologies. For land loss, these methodologies do not need to address the significance of cumulative effects. These effects are all significant because land is a finite resource and land loss cannot be mitigated. Therefore, cumulative land losses relative to the total area of the land resource (undeveloped or agricultural land) at any given time has less meaning than the change in the rate of annual average land losses. This indicates whether the loss of this finite resource is increasing or decreasing, and is a more meaningful measure of the influence of policies for land and soil conservation.

The most recent land use statistics for England, published in July 2020, cover land use in England as of April 2018[176]. In April 2018, just over 12.12Mha (91.5%) of land in England was considered undeveloped (agriculture, forest, open land and water, outdoor recreation, undeveloped land, and vacant land). With the exception of open water, it is assumed that most of this land will have a soil resource.

Within England, the 5-year average land loss for 2013 to 2018 was 11,639ha per annum of undeveloped land to development[177] (corrected for any reverse land use

175 MAFF press notice (1996), based on analysis undertaken in 1994 by ADAS *'Revised statistics for the proportion of ALC grades'*, for the revised (1988) ALC system.

176 Land_Use_in_England__2018_-_Statistical_Release.pdf (publishing.service.gov.uk)

177 Table p360 Live tables on land use change statistics – GOV.UK (www.gov.uk)

change from developed to undeveloped, although the soils were unlikely to have been retained). For a proposed development, the CEA should calculate its proportionate contribution towards this annual land loss. Where a development will be phased over several years, the proposed land loss should be appropriately split over the duration of construction.

For undeveloped land, a contribution of more than say 1% of the 5-year average land loss could be deemed potentially significant at a national scale, but because the loss of land cannot be mitigated, it is the rate of change in this figure that is significant. However, determining the rate of change requires the comparison of a rolling sequence of 5-year averages, and this database is not yet available.

A similar approach could be applied to the loss of agricultural land only. As of 2018, 8.32Mha (62.8%) of the undeveloped land was agricultural. Within England, the 5-year average land loss for 2013 to 2018 was 6,791 ha per annum of agricultural land to development[178] (correcting for any subsequent return of land with retained soils to agricultural use). The cumulative assessment should calculate the proportionate contribution of the proposed development to this 5-year average agricultural land loss. Again, more than say 1% could be deemed potentially significant at the national scale.

If 42% of this land loss is BMV, the total loss of BMV land per annum is approximately 2,852ha, and this loss cannot be mitigated. Assessing the potential BMV agricultural land loss relative to an assumed national BMV total area may not reflect the significance of land loss. A further consideration is that due to differences in the spatial distribution of agricultural land and BMV (referred to above), it is necessary to adjust the approach at the local level. The significance of BMV land loss (or its subsets) is influenced by the proportion of such land within the administrative boundary used as a baseline. For most rural areas, county boundaries might be the most appropriate level and results for more urbanised areas might be less meaningful.

The Ministry of Housing, Communities and Local Government (MHCLG) Interactive dashboard[179] provides land use summary data per local authority and region per land use. This information can be used to establish the proportion of undeveloped land which is proposed for development in any given local authority, which can also be assessed for potential agricultural land loss. A loss of more than say 1% of the total land loss could be deemed potentially significant at a local scale, but again, it is the change in the rate of the 5-year average land loss that is significant.

Example at the National Level (England)

Table 2 sets out the land loss for a notional proposed development of 50ha, comprising 22ha of BMV and 20ha non-BMV agricultural land, and 8ha natural non-agricultural open land, located within the Newcastle upon Tyne local authority area, in which the full site will be developed. The land loss is related to the national cumulative losses of undeveloped, agricultural and BMV land on a 5-year average basis.

This example assumes no reuse of soils on-site. However, if the land were utilised for housing development, there would be a certain degree of soil reuse within gardens, open space, and SUDS, for example. The inclusion of an element of open spaces and soft development like woodland and habitat creation would retain more soils on-site.

178 Table p361 Live tables on land use change statistics – GOV.UK (www.gov.uk)

179 Microsoft Power BI

Table 2: National Cumulative Losses of Undeveloped and Agricultural Land (5-year average basis)

Type Of Land Loss	England*			Proposed Development			
	5-yr average undeveloped land loss in England (ha)	5-yr average Agricultural land loss in England (ha)	5-yr average BMV land loss in England (ha)	Area (ha)	Proportion of 5-yr average undeveloped land loss in England (%)	Proportion of 5-yr average agricultural land loss in England (%)	Proportion of 5-yr average BMV land loss in England (%)
Developed							
Undeveloped	11,639			50	0.43		
Agricultural		6,791		42		0.62	
BMV			2,852	22			0.77

* data from https://www.gov.uk/government/statistical-data-sets/live-tables-on-land-use-change-statistics Table 361

At the national scale for England, the proposed undeveloped land loss is less than say 1% of the total undeveloped, agricultural, and BMV land loss, and this could be deemed non-significant.

However, in all cases, it is the change in the rate of annual average land losses that is the most significant consideration. From 2018 onwards, these figures can be used to compile a database of 5-year averages, to facilitate a more informed assessment of the significance of changes in the rate of land losses, and an insight into the effectiveness of national policies for land and soil conservation.

Example at the Local Level (Newcastle upon Tyne)

For the same proposed development, the local cumulative losses of undeveloped, agricultural and BMV land are set out in Table 3.

As the 5-year average land loss data are not currently available for individual local planning areas in England, the proposed land loss in this example is compared to the total undeveloped and agricultural areas within the local authority area. This method can show whether the proposed land losses are greater than, or less than, the 5-year averages for England, indicating whether development is occurring at a faster or slower rate locally.

Table 3: Local Cumulative Losses of Undeveloped and Agricultural Land

Type of Land	Newcastle upon Tyne* Total Area (ha)	5-yr Average Land Loss In Newcastle Upon Tyne (Ha)	Proposed Land Loss	
			Area (ha)	Proportion of Type of Land in Newcastle upon Tyne (%)
Undeveloped	7,583	Not currently available	50	0.66
Agricultural	3,219	Not currently available	42	1.30

* Data from tab 3 of the Land Use in England interactive dashboard https://app.powerbi.com/view?r=eyJrljoiMDY2N2QxNDltZTg0YS00NWYxLThkNmMtOWI1MWMwNzEwMjExliwidCI6ImJmMzQ2ODEwLTljN2QtNDNkZS1hODcyLTI0YTJlZjM5OTVhOCJ9

The 'Land Use in England interactive dashboard' differs from Table 361 'Land Use Change: Land changing use by all previous uses' in that the 'Land Use Change' statistics are not broken down by each LPA; only the current land use is presented in the dashboard. Therefore, Table 2 presents the national land use change as a result of development over time; whilst Table 3 presents the current land use of a local area.

At the local level, the proposed undeveloped land loss is less than say 1% of the total undeveloped, and this could be deemed non-significant. However, the proportion of total undeveloped land take within Newcastle upon Tyne (0.66%) is greater than the national 5-year average undeveloped land take (0.43%), suggesting this development is impacting a disproportionately high area of undeveloped land.

The agricultural land loss exceeds 1% of the total and could be deemed significant. Furthermore, the proportion of total agricultural land take within Newcastle upon Tyne (1.30%) is greater than the national 5-year average agricultural land take (0.62%), suggesting this development is impacting a disproportionately high area of agricultural land.

However, in all cases, it is the change in the rate of annual average land losses (not currently available) rather than the change in the total developed and agricultural land within the local authority area that is the most significant consideration. Where these figures become available, they can be used to compile a database of 5-year averages, to provide a more informative understanding of the significance of changes in the rate of land losses.

Significance at the local level would be strongly influenced by the size and ratio of developed to undeveloped land within a local authority area, and a means would have to be found to adjust for this. This would be resolved if we could use land use change statistics broken down by local authority area. Also, rural LPAs, such as Northumberland have a very low proportion of agricultural land take, therefore, the rural or urban nature of the LPA should be taken into consideration when discussing these results.

With the available data, it is not possible to ascertain the proportion of Subgrade 3a and 3b within individual LPA areas. Thus, it cannot be determined whether the proportion of total BMV land take within Newcastle upon Tyne is greater or less than the national 5-year average agricultural land take. However, from the available ALC mapping, it can be stated that there is a relatively low proportion of BMV land in the Newcastle upon Tyne area. The 22ha of BMV land in the proposed development is 52.4% of the agricultural land loss, which is higher than the national estimated 42% of agricultural land. This implies that from a sustainability appraisal perspective, a better location might have been selected for the proposed development. Therefore, some limited soil/ALC/LCA field survey might be carried out at the sustainability appraisal stage to avoid the disproportionate loss of BMV land.

The CEA provides a means of demonstrating and achieving some other key desirable outcomes, including:

- the early factoring of land and soil conservation into site boundaries and design to avoid impacts that cannot otherwise be mitigated; and
- an insight into the effectiveness of local policies for land and soil conservation.

Further Considerations

Peat soils can support designated habitats, assessed under the heading of Ecology, in an assessment which may apply a methodology like that set out in LA108 '*Biodiversity Highways England, Transport Scotland, the Welsh Government and the Northern Ireland Department for Infrastructure (2019)*'. This has a biodiversity impact methodology which considers such soils as habitats.

'*LA108 Biodiversity*' has a significance of effects matrix that will inform the assessment of cumulative effects on peat. This may consider designated peat soils sufficiently for most of England; however, non designated peat soils and the larger extent of peat soils in Scotland might require a more focussed approach.

The above account only discusses adverse impacts (i.e., land loss). Potential benefits/gains could include the restoration of brownfield land, peatland and other restoration, and making use of displaced soil resources for SANGS, SUDS, and gardens and peatland or other habitat restoration.

The land use change statistics were reviewed in July 2020 and published responses state that the estimates of change (in hectares) will be published at three-yearly intervals, and that the number of land use classifications will be broadened to include ALC. This has the potential to alter the methodology presented here.

Annexe I Soil Functions Methodology Worked Example

An assessment of development impacts on land and soil was presented in outline in '*Gaining Ground*' (Stapleton, Transform, June 2020), as a matrix approach that is in general use in EIA and ES documents. The notional example presented builds on the '*Gaining Ground*' example, introducing further opportunities and benefits of a soil function-based methodology. It is set in England and thus applies English regulations and terminology.

Residential development often involves a change from agricultural land to hard development, resulting in a large amount of land sealing, and with limited opportunities for the reinstatement of some soils on-site in residual green spaces alongside roads and between the houses (i.e. soft development areas). It is often the case that these soils will undergo a degree of disturbance, as they typically require stripping and storage during the main construction works, when they may be compacted if handled inappropriately. This traditional approach often results in a large amount of surplus soil resource, which is taken off-site. Its subsequent reuse or disposal is unknown.

Currently, there is no requirement and few opportunities within the planning system to secure off-site the sustainable reuse of soils displaced by hard development. Finding off-site uses has implications for transport costs and other impacts, but we must question where these valuable and finite natural resources are currently going, as they seem to disappear without trace. The early consideration of soils in the planning process can provide opportunities to conserve them and increase their sustainable use, potentially introducing benefits for ecology, hydrology, and local communities.

The Matrix Table 1 at the end of this annex shows how land use changes and potential impacts arising from a proposed residential development can be addressed from a soil functions perspective. The significance of these land use changes should be assessed with reference to the need to maintain and enhance soil functions for the provision of terrestrial ecosystem services.

Current evaluation methodologies can be incorporated into the proposed soil functions methodology. The assessment of development impacts on soil functions in Table 1 should be carried out with reference to the DMRB soils in EIA guidance and ICE EIA Handbook, as described in the main text of the guidelines.

The Site and Proposed Development

In this relatively simple example, the proposed 48ha development site is a suburban extension that comprises 40ha of agricultural land with largely undisturbed natural soils[180], which will undergo development, and 8ha of adjacent brownfield land (shown by ground investigation and appropriate assessment to be uncontaminated) with no soil materials present, which is included within the development site to provide on-site opportunities for the sustainable use of displaced soils.

An ALC and soil resource survey undertaken at an early stage of the planning process has established the quality of the agricultural land and the soil resources present across the site, to help inform masterplanning and subsequent reuse of displaced soils.

In this example, the ALC and soil survey identified one soil type with a 25cm deep, nutrient-rich topsoil, and a slightly variable subsoil extending to a depth of 1.2m across the 40ha agricultural field. Due to the soil variability, 15ha are classified as Subgrade 3a and 25ha Subgrade 3b. As there are no soil resources on the brownfield land, the soil volumes available comprise approximately 100,000m^3 of topsoil and 380,000m^3 of subsoil. The first opportunity for mitigation is at the planning stage following the soil and ALC survey of the

180 For the purposes of EIA and given the objectives of soil handling mitigation measures (i.e., the separate mass movement of topsoils and subsoils), agricultural soils can, for practical purposes, be considered to be largely natural and undisturbed, this is in spite of cultivation and the application of fertilisers and herbicides etc. This is to distinguish them from other less favourable soil and soil-forming materials.

site, in which the footprint of the development should be minimised as far as practicable so to reduce the land take and soil disturbance; and secondly to microsite the development away from BMV land as far as practicable.

The soil resource survey has shown that the topsoil and subsoil are suitable for reuse within the development in the open space and gardens, and for the proposed land uses on the brownfield land.

As a rule of thumb, approximately half of a housing development site is likely to remain open space (gardens, open space, SUDS, etc). These areas tend to be initially stripped of soils to create the correct levels for house building, but the soil profile can be reinstated within these areas for mitigation, reducing the volume of surplus soil. In this example, the topsoil and subsoil could be restored as per the original soil profile (i.e., 25cm topsoil over 95cm subsoil). This introduces the second opportunity in the mitigation. To reduce the surplus topsoil, the depth of topsoil could be increased to 30cm over 90cm subsoil over approximately 20ha, reusing 60,000m3 topsoil and 180,000m^3 subsoil. If no further mitigation was put in place, this would result in a surplus of 40,000 and 200,000m^3 of topsoil and subsoil (see Figure 1), which would need to be transported for use off-site. Whilst this opportunity does not reduce overall soil resource surplus, it does preferentially utilise the valuable topsoil resource.

The waste hierarchy supports the reuse of soil on-site in preference to off-site and seeks to avoid the classification of soil as waste if it is to be used off-site. Part III of the guidance explains how this can be achieved.

Having established that the brownfield land is of limited existing biodiversity value, there is an opportunity to reduce the quantity of surplus topsoils and subsoils from the development site, by using the brownfield land within the development site to create a suitable habitat or habitats with the soil resource available. For example, half of the brownfield land could be utilised to create broadleaved community woodland with public access, and benefits to the local community. The remaining half of the brownfield land could be utilised to create grassland, with species reflecting the soil characteristics[181] (pH and nutrient status), with benefits for ecology landscape and hydrology.

The proposed development would therefore comprise, 40ha new houses, including soft development areas, 4ha of broadleaved community woodland with public access and 4ha of grassland with restricted public access.

To optimise the reuse of the topsoil resource, the proposed restored soil profile across the brownfield habitat creation areas could comprise 30cm topsoil and 90cm of subsoil across the 8ha of woodland and grassland. This habitat creation would use a further 24,000m^3 of the displaced topsoil, and 72,000m^3 of the subsoil on-site.

With the proposed soil reuse presented after mitigation by means of habitat creation, the soil balance indicates a surplus of 16,000m^3 and 128,000m^3 of topsoil and subsoil respectively that would otherwise have to be transported and reused off-site (Figure 2). Table 2 shows the balance of on-site and off-site uses of the soil resources following mitigation.

There may be further opportunities to use additional subsoil to create bunding, either for noise attenuation or landscape screening, reducing the surplus of subsoil. Additionally, a greater depth of the subsoil could be placed over the 8ha brownfield land, with some topographic landscaping where appropriate. The impact on the soil balance would need to be calculated in collaboration with the design team.

The beneficial off-site reuse of the surplus topsoil and subsoil should be secured, to ensure this resource will be used and sustainably managed. Depending on the

181 This may not always be the most 'biodiverse' seed or vegetation mix; however, by matching seed mix/vegetation species with the soil characteristics, there is an increased likelihood of successful restoration.

actual use of soils off-site, the quantities of soils lost from individual projects could provide inputs to the assessment of the cumulative effects of development on soil resources.

Table 2: Soil Balance Following Identification of Mitigation (i.e., Habitat Creation)

Existing Land Use	New Land Use & Mitigation	Soils Used On-Site		Soils Used Off-Site	
		Topsoil Volume m3	Subsoil Volume m3	Topsoil Volume m3	Subsoil Volume m3
Agriculture		100,000	380,000		
	Residential	~60,000*	180,000*		
	Mitigation				
	Community Woodland	12,000	36,000		
	Grassland	12,000	36,000		
	Unknown			16,000	128,000

* As a rule of thumb, approximately 50% of a housing development site is likely to remain open space (gardens, open space, SUDS, etc)

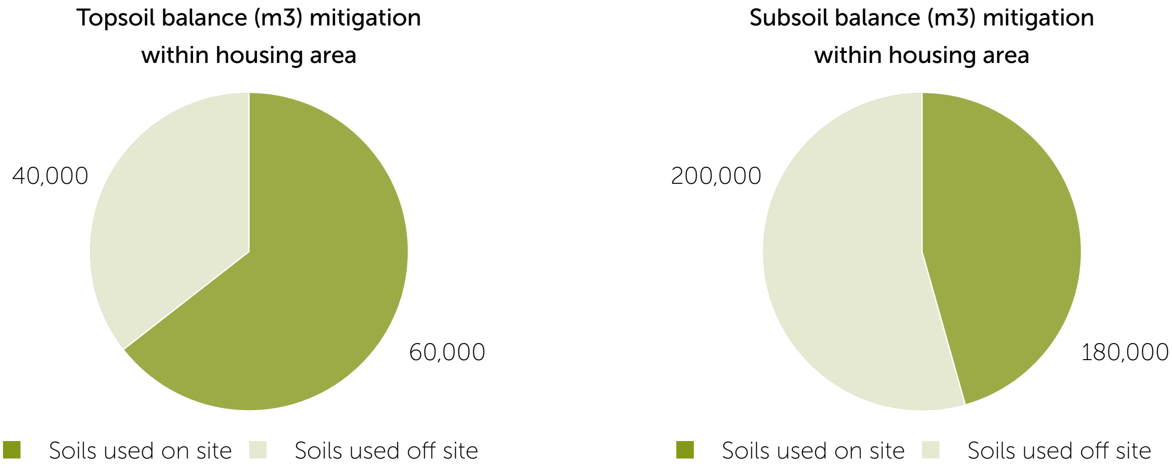


Figure 1: The Topsoil and Subsoil Balance with Topsoil Mitigation within the Housing Area

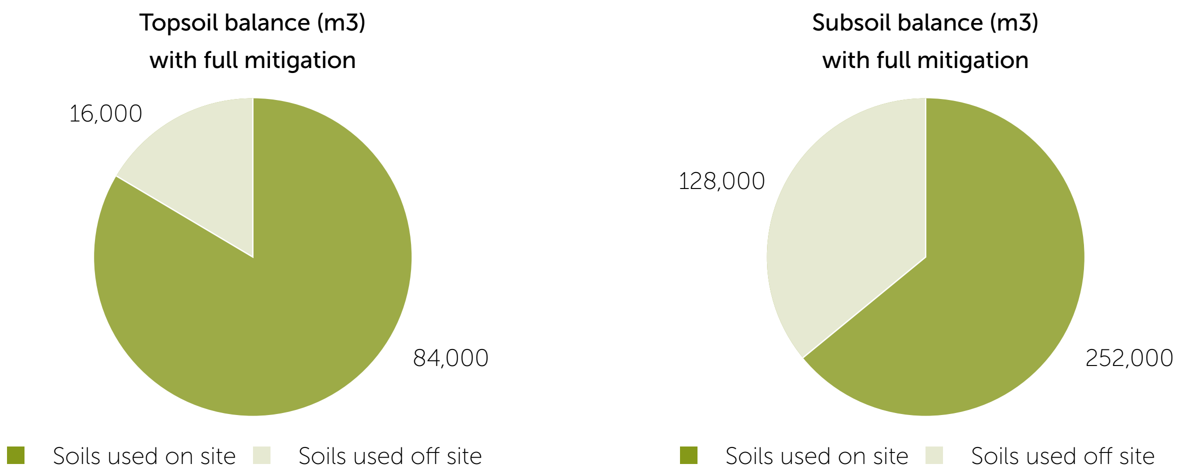


Figure 2: The Topsoil and Subsoil Balance Following Full Mitigation (i.e., Residential, Woodland and Habitat Creation)

Whilst there are limits to what can be achieved in terms of soil conservation, given the lack of opportunities within the planning system to find a sustainable off-site use for displaced soils, this approach would begin to quantify the scale of the loss of this finite resource.

In addition to this audit of land use changes and volumes of displaced soils, this part of the ES would have a narrative describing the way in which soil functions would be maintained, enhanced or lost. For instance (and with reference to Tables 2 to 6 in Section 9.2 of the main guidelines), the proposed development would have the following effects.

Biomass Production

With reference to Table 2, the ALC Grade 3a has a **high** level of **sensitivity**. Table 3, supplemented by the ICE EIA Handbook (paragraph 7.11.4) indicates that the loss of more than 20ha of agricultural land would result in a **major magnitude** of impact. Therefore, in the absence of mitigation, the potential effect of disturbance to the biomass soil function would be of **large** or **very large significance (adverse)**. Following mitigation, it is possible that the 4ha of proposed grassland might remain accessible for future agricultural use; however, the potential effect of disturbance to the biomass soil function would remain just as significant (adverse).

With reference to Annex H, and in respect of cumulative effects at the local level, the proposed land take of less than 1% of the total undeveloped land within the administrative boundary used as a baseline could be deemed non-significant, but a database of 5-year averages could provide a more informative understanding of the significance of changes in the rate of land losses, and an insight into the effectiveness of local policies for land and soil conservation.

The proportion of Subgrade 3a land lost could also be related to the proportion of BMV land within the administrative boundary compared with national estimate of 42% of agricultural land, to determine, perhaps from a sustainability appraisal perspective, whether this is a suitable location for the proposed development.

Displaced Soil Resources

With reference to Table 6 in Section 9 of the main guidelines (derived from Table 7.2 of the ICE EIA Handbook), the loamy topsoil and clay loam subsoil would have a **medium** level of resilience and **sensitivity** to structural damage during soil handling. With reference to Table 3, the displacement of soil (with downgrading and other potential loss of soil functions) over more than 20ha would be an impact of **major magnitude**. Therefore, in the absence of mitigation, the potential effect of disturbance to the soil resources during soil handling would be of **moderate or large significance (adverse)**.

With appropriate mitigation measures for the handling, storage and reinstatement of all displaced soils, such as those set out in the Construction Code of Practice (Defra), the soils would retain their structure, function, quality and resilience; and the **magnitude** of impact would be reduced to **minor**. The residual impact to the **medium sensitivity** soils would be of **slight significance (adverse).** Therefore, the residual effect of disturbance to all soil resources would be **not significant**. However, a beneficial off-site use would have to be found for the displaced topsoil and subsoil (16% and 34% respectively) to achieve this.

Assuming that over 50% of the agricultural soil is retained on-site, either within gardens, SUDS, landscaping or on the brownfield land, the benefits to be derived from these soils relate to other soil functions.

Ecological Habitat and as a Platform for Landscape

Ecology

The ecological soil function of the agricultural and brownfield land is of **low sensitivity** (Table 2).

The suitable reuse of the soil resource to establish ground cover on 4ha of brownfield land, with appropriate planting to match the soil characteristics, together with the management of the woodland would deliver biodiversity gains (both above and below ground). The impact of the development on biodiversity will be addressed in the Ecology Chapter of the EIA. The management of the other green infrastructure could also deliver biodiversity gains. This would retain and enhance the ability of the reused soil to support this function, giving a **moderate magnitude** of change, and the resulting impact of the development on the ecological soil function would therefore be of **slight significance (beneficial)**. A consideration of this soil function should form part of a Biodiversity Net Gain (BNG) Assessment carried out on the land use and habitat changes.

In respect of the direct and indirect effects of air pollution (via the atmosphere and soil respectively), the development will be designed to conform with local air quality standards, and it will make no more than a commensurate increase in background levels of air pollution arising from an anticipated expansion of the wider urban area within the development plan for the area.

As a Platform for Landscape

The development site does not currently support any soft landscaping and is therefore of **low sensitivity.** The characteristics of the identified soil resources should inform the type of appropriate landscaping that could be introduced, including green infrastructure and open space.

The availability of over 50% of the soil resource retained for beneficial use on-site could deliver a platform for landscaping over more than 5ha. This would be a **moderate magnitude** of change**.** Therefore, the residual effect of development on landscape would be of **slight significance (beneficial).**

Component of Carbon Cycle

The mineral soils present on the site are a carbon store of **medium sensitivity**. Continued agricultural cultivation can lead to the repeated aeration of the topsoil, leading to oxidation and gradual carbon losses over time.

If less than 50% of the displaced soil of **medium sensitivity** is taken off-site and potentially lost, then this would be an impact of **moderate magnitude** and **moderate significance (adverse)**.

The carbon balance for the 8ha of permanent woodland, new grass cover, and the residential open areas, as compared with the agricultural biomass production would have to be quantified in the carbon account for the development, to complete this part of the evaluation methodology.

Component of Hydrological Cycle

Development should be designed to avoid an adverse effect on catchment water flows and flood risk in particular. Any increase in runoff rates from built surfaces compared to baseline soils needs to be offset through sustainable drainage (SUDS) design (infiltration and storage ponds).

The medium-textured agricultural soils are of **medium sensitivity**. The assessment of the soil properties will include infiltration rate, storage capacity, hydraulic conductivity, depth to groundwater, soil wetness class, depth to slowly permeable layer, presence or absence of mottling and susceptibility to flood risk. These properties (as well, as soil compaction) will inform the likelihood of waterlogging and flood risk.

Compaction caused by soil handling activities and construction traffic can cause significantly reduced soil infiltration rates.[182] With appropriate mitigation measures in place for the handling, storage and reinstatement of soils, such as those set out in the Construction Code of Practice (Defra) and the appropriate design of SUDS, considering the available soil resource, there would be no change in the runoff from residual areas of soft development within the site. The soils as a pathway for local water flows and flood risk management are of **low sensitivity** for hydrology. The magnitude of impact in these areas would be **minor or negligible**. The residual impact to the **low** to **medium sensitivity** soils would be of **neutral** or **slight significance.** Because the impact is likely to be temporary, however, the residual effect of development on soil hydrology over the whole site would not be significant.

Additional benefits as a result of the development include the cessation of fertiliser and other chemical applications for agricultural production and removal of the carbon in vegetation during harvesting. Subject to good soil handling practices, infiltration rates and soil water storage capacity should be maintained or improved, and water quality could be improved in local watercourses and groundwater in respect of the land used for community woodland and grassland. Overall. this would enhance the contribution of the brownfield land to the hydrological cycle.

Source of Materials

Unless the proposed development was preceded by extraction of any materials present, they would be sterilised under the hard development. Should any materials present be extracted before the proposed development, the worked-out and restored site presents a blank canvas for the residential development and reinstatement of soils, together with the introduction of soil functions and a wide range of sustainable end uses. There are no materials present.

Archaeology, Cultural Heritage, Geodiversity and Community Benefits

Archaeology, Cultural Heritage, Geodiversity

There are no known features of archaeological, cultural or geodiversity value within or adjacent to the development site, therefore there are no potential archaeological, cultural or geodiversity impacts as a result of this development. Features discovered within the hard development area would be recorded and preserved in-situ.

Community Benefits

The soil can function as a platform for access to the countryside for recreational and educational community use. Where soil is used for the establishment of ground cover in the form of 4ha of community woodland with enhanced public access, there would be recreational gains. In addition to the community woodland, where soil is used for soft landscaping within the residential

182 BSSS (2022) Working with Soil Guidance Note on Benefitting from Soil Management in Development and Construction https://soils.org.uk/wp-content/uploads/2022/01/WWS3-Benefitting-from-Soil-Management-in-Development-and-Construction-Jan-2022.pdf

development for green infrastructure, there could be other recreational gains.

There are no public rights of way across the agricultural land, and the current provision for public access to open spaces and the countryside is poor, therefore, the **sensitivity** of this soil function is **low**. Within the new soft land uses, there is potential for improvement in this soil function over more than 5ha of land. This gives a **moderate** level of impact **magnitude** of **slight significance (beneficial)** for this community benefit to meet the recreational requirements of incoming residents of the new houses.

Summary of Effects on Soil Functions

EIA relies on disciplines that are not exact sciences and there will always be an element of subjectivity and professional judgement involved in this process. However, the proposed all functions approach provides a structured and comprehensive means of assessing the full range of development impacts on land and soils.

The worked example has been selected to demonstrate to practitioners and developers the sustainable development benefits of incorporating brownfield land into a development site, but it is recognised that this may be a realistic option, only in the more industrialised parts of the UK.

Based on the permanent loss of 40ha of agricultural land; the secured reuse on-site of at least 50% of the available soil resource, and the creation of 8ha of woodland and grassland on a previously brownfield site, the significant residual impacts on this soil function are:

- The impact of the development to the biomass soil function (i.e., permanent agricultural land take) would be **large** or **very large** and **significant (adverse)**.
- In the absence of effective soil handling mitigation, the potential effect on soil resources would be of **moderate or large significance (adverse)**. With appropriate mitigation for all displaced soil resources (off-site as well as on-site), the residual impact would be of **slight significance (adverse)**.
- The impact of the development on the ecological soil function would be of **slight significance (beneficial)**.
- The impact of the development to the soils as a platform for landscape would be of **slight significance (beneficial)**.
- The impact of the development on soil carbon would be of **moderate significance (adverse)**.
- The impact of the development on community benefits would be of **slight significance (beneficial)**.

The residual balance of impacts is set out in Table 3.

Table 3: Balance of Impacts

	Soil Functions & Other Community Services	Significance Of Impacts Before Mitigation	Significance Of Impacts After Mitigation
Adverse Impacts	Biomass Production: Agricultural land Quality	Large to Very Large*	
	Biomass Production: Soil Resources	Moderate to Large	Slight
	Soil Carbon	Moderate	Moderate
Beneficial Impacts	Ecology		Slight
	Platform for Landscape		Slight
	Community Benefits		Slight

*Depending on the subgrade of the agricultural land before development

Matrix Table 1: Proposed Soil Functions Methodology Worked Example

EIA of land use changes arising from proposed residential development/presence/maintenance/introduction of soil functions for the provision of terrestrial ecosystem services

Land Use Changes (ha) Within and Adjacent to a Site's Red Line	Available Soil Resources *1	Displaced Soil Resources (Retained) *2 for Beneficial Use or [lost]	Soil Functions as Components of Terrestrial Ecosystem Services					
			Biomass Production (Refer To ALC Grade Of Land) *3	Ecological Habitat & Platform for Landscape *4	Interactions with Atmosphere: Component of Carbon Cycle *4	Interactions with Atmosphere: Component of Hydrological Cycle *4	Source of Materials (e.g. minerals) *5	Recording and Preservation of Archaeology & Cultural Features, Geodiversity (e.g. RIGS) & Community Benefits *6
Current								
Agricultural Land (40ha)	100,000m3 topsoil 380,000m3 subsoil	Y	Y 15ha Subgrade 3a 25ha Subgrade 3b	Y	Y	N	N	N
Brownfield Land (8ha)	None	N	N	N	N	Y	N	N
Proposed								
Residential Development & Open Space (40ha)		[60,000m3 topsoil] [180,000m3 subsoil]	N	Y	N	N	N	N
Community Woodland (4ha)		(12,000m3 topsoil) (36,000m3 subsoil)	N	Y	Y	Y	N	Y
Grassland(4ha)		(12,000) m3 topsoil (36,000m3 subsoil)	N	Y	Y	Y	N	N

*1 e.g., Natural undisturbed soils; disturbed natural soils; topsoil or subsoil only; soil-forming materials; contaminated/uncontaminated etc. or no soils present.

*2 Retained on land controlled by the developer.

*3 Following development, land must remain accessible from agricultural land/farms and retain original ALC grade/subgrade.

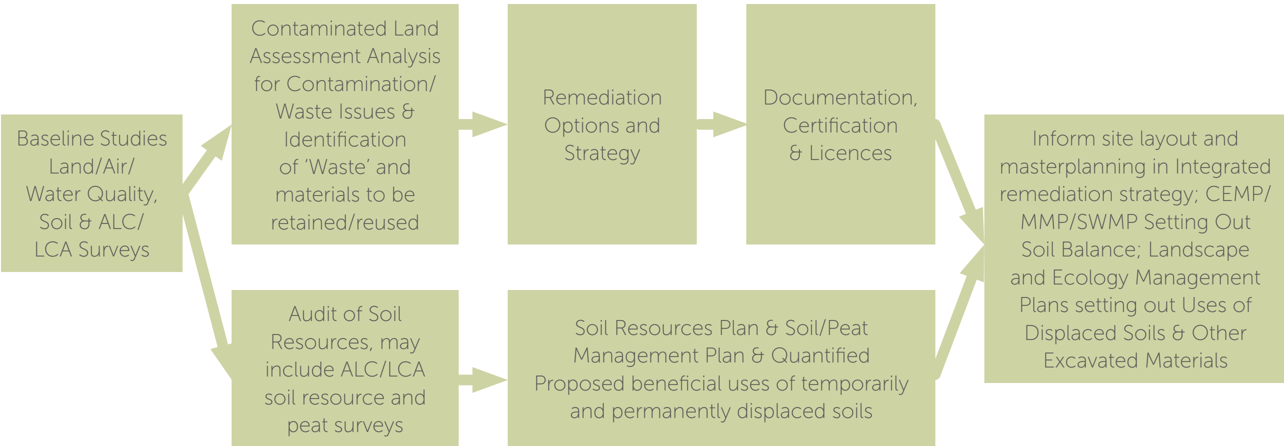
*4 Following development, land must remain accessible for management.

*5 Development must prevent the unnecessary sterilisation of minerals.

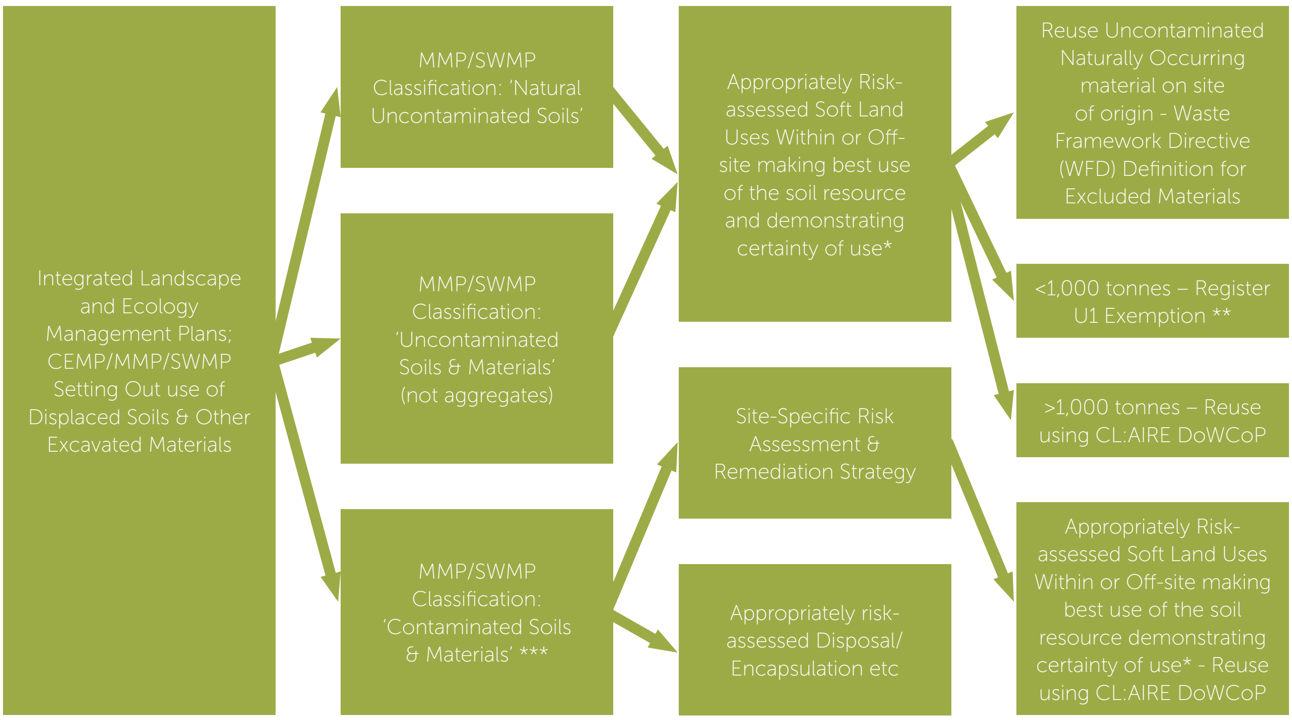
*6 Following development, land must remain accessible for the recording and preservation of archaeology and cultural heritage features.

Annexe J Process for the Sustainable use of Soil Resources and other Excavated Materials

Stage I – Pre-Consent Planning By The EIA Team



Stage II – Post-Consent Implementation By Developers & Contractors



* The waste hierarchy supports the reuse of soil on-site in preference to off-site and seeks to avoid the classification of soil as waste if it is to be used off-site.

**The U1 waste exemption allows the use of certain construction wastes including uncontaminated soils and stones in construction projects. The limit for soils is 1,000 tonnes. Waste should be classified using WM3 guidance.

***In scenarios where soils have naturally elevated concentrations of substances (i.e., geologically derived metals) that are proven to be widespread and typical of local background conditions, they may still be re-used, provided that the representative concentrations (both total and leachable) of such naturally occurring substances at the source site are comparable or below that of the receiving development site soils. This must be demonstrated by adequate site investigations at both sites and appropriate risk assessments.

Annexe K Soil Handling Guidance for Site Agents and Contractors

This annex is derived from an interpretation of the good practice guidance on soil handling in the Defra (2009) '*Construction Code of Practice for the Sustainable Use of Soils on Construction Sites*'; the IQ (2021) *'Good Practice Guide for Handling Soils in Mineral Workings'*, and Defra's (2004) '*Guidance for Successful Reclamation of Mineral and Waste Sites*'.

The advice in this annex sets out the good practice guidance for soil handling in non-technical terms suitable for an on-site induction procedure that can be readily understood by contractors, their subcontractors, and other suppliers of services. The advice is adjusted specifically in the first example for the translocation of Ancient Woodland topsoils, and in the second example for land temporarily disturbed by development. The actual approach should be adjusted for the soil types present, the nature of the site and the proposed development, and the detailed objectives of the soil handling operation. It should also be supported by on-site supervision by a suitably qualified soil practitioner.

Example 1: Ancient Woodland Topsoil Translocation

Why are we doing this?

- Ancient Woodland topsoil is an important part of a wildlife habitat
- Some Ancient Woodland topsoils would otherwise be lost because of [*describe the development*]
- We are going to save the topsoil by moving it to a safe location called a 'receptor site'

What are we doing?

- Now that the trees have been cut down, we are going to strip the topsoils between the stumps and move them to a receptor site
- Subsoil is to be left in place
- The dark brown material at the ground surface is topsoil and it lies above lighter-coloured subsoil
- If in doubt about what is topsoil, ask the soil supervisor
- Using your excavator, strip the topsoil down to the lighter-coloured subsoil
- The soil supervisor will be on hand to tell you when you have got all the topsoil, until you get the hang of it
- You will load the topsoil onto the dumper trucks and they will take it to the receptor site along haulage routes
- At the receptor site, the ordinary topsoils will be stripped and stored for use elsewhere
- At the receptor site, the exposed subsoils will be ripped for good drainage, in strips the width of your excavator arm
- The dumper trucks will loose-tip the incoming topsoil on the prepared strips and, using your excavator, you will spread it to the thickness shown on the marked stakes in the ground
- Trees will be planted, and woodland will grow at the receptor site

Important Rules

Dos
Follow your instructions and if in doubt ask the soil supervisor
Keep to designated haul routes and tracks
Clearly separate and label different stockpiles
Keep off soil stockpiles
Strip as much topsoil as you can
Use only the machinery and methods specified in the contract
Help the soil supervisor keep records of soil movements
Stop work and ask the soil supervisor how to proceed if there is any doubt about what you are doing. Pay attention to notable changes in the thickness or quality of the topsoil you are stripping, or if you observe or smell any evidence of potential contamination or waste materials. It is important not to mix different materials or spread contamination
Stop work if you encounter unexpected contamination within the soil and ask the soil supervisor how to proceed

Don'ts
Don't cut corners or try to do it your way
Don't drive over topsoils anywhere
Don't allow stockpile toes to overlap
Don't drive over prepared subsoil strips in receptor areas
Don't mix the topsoils with subsoils
Don't handle soils in wet conditions
Don't over-rev engines and cause wheel slippage
Don't over-compact soil stockpiles

Remember:

- This is not just another 'muck-shifting' operation
- We are protecting topsoils that are valuable for wildlife
- The woodland won't grow properly at the receptor site if we lose topsoil and damage the subsoil structure

YOUR SOIL SUPERVISOR [NAME AND MOBILE PHONE NUMBER] WILL BE ON-SITE AND AVAILABLE AT ALL TIMES

Example 2: Soil Handling for Land Temporarily Disturbed by Development

Why are we doing this?

- We are stripping and storing soils so that they can be put back following the [describe the development]
- Otherwise soils would be lost or damaged during construction
- We are going to protect the soils by moving them to storage areas

What are we doing?

- Now that the ground has been cleared, we are going to strip the soils and move them to a storage area
- The dark brown material at the ground surface is topsoil and it lies above lighter-coloured subsoil
- Using your excavator, strip the topsoil down to the lighter-coloured subsoil
- You will remove the topsoil in strips the width of your excavator arm
- The soil supervisor will be on hand to tell you when you have got all the topsoil, until you get the hang of it
- Variations in topsoil that require separate stripping and storage will be clearly marked on the ground and explained to you
- You will load the topsoil onto the dumper trucks and they will take it to the topsoil storage area along haulage routes
- The exposed subsoils will be stripped in strips the width of your excavator arm
- Variations in subsoil that require separate stripping and storage will be clearly marked on the ground and explained to you
- You will load the subsoil onto the dumper trucks and they will take it to the separate subsoil storage area along haulage routes
- Following construction in areas where soils are to be respread, the exposed ground surface will be ripped for good drainage in strips the width of your excavator arm
- At the stockpiles, excavators will load dumper trucks with subsoil and this will be loose-tipped on the prepared strips
- Using your excavator, you will spread the subsoil to the thickness shown on the marked stakes in the ground
- Excavators will load dumper trucks with topsoil and this will be loose-tipped on strips the width of your excavator arm
- Working from the exposed ground surface (where both the topsoil and subsoil have been removed), you will spread the topsoil to the thickness shown on the marked stakes in the ground
- With loose tipping there should be no subsoil compaction, but any compaction caused by replacing topsoil and subsoil will be removed by subsoiling

·Important Rules

Dos
Follow your instructions and if in doubt ask the soil supervisor
Keep to designated haul routes and tracks
Clearly separate and label different stockpiles
Keep off soil stockpiles
Strip as much topsoil as you can
Use only the machinery and methods specified in the contract
Help the soil supervisor keep records of soil movements
Stop work and ask the soil supervisor how to proceed if there is any doubt about what you are doing. Pay attention to notable changes in the thickness or quality of the topsoil you are stripping, or if you observe or smell any evidence of potential contamination or waste materials. It is important not to mix different materials or spread contamination
Stop work if you encounter unexpected contamination within the soil and ask the soil supervisor how to proceed

Don'ts
Don't cut corners or try to do it your way
Don't drive over topsoils anywhere
Don't mix topsoils and subsoils
Don't drive over prepared subsoil strips in soil replacement areas
When stripping topsoils don't mix them with subsoils
Don't over-compact soil stockpiles
Don't handle soils in wet conditions
Don't over-rev engines and cause wheel slippage

Remember:

- This is not just another 'muck-shifting' operation
- We are protecting valuable soils
- Crops and plants will not grow properly if we lose topsoil and damage the subsoil structure

YOUR SOIL SUPERVISOR [NAME AND MOBILE PHONE NUMBER] WILL BE ON-SITE AND AVAILABLE AT ALL TIMES

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